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FrogLog

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www.amphibians.org

Promoting Conservation, Research and Education for the World's Amphibians

New Amphibians.org Website

Successful Coexistence of Humans and Amphibians

Caecilians of Goa

Recent Publications

And Much More!

Harlequin tree frog (*Rhacophorus pardalis*).
Photo: Andrea Ferrari.

Future Conservationist Award

Updates from Russia, Asia and Oceania

FrogLog

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NEWS FROM THE AMPHIBIAN COMMUNITY

REGIONAL FOCUS — Asia, Russia and Oceania

Editorial

Finding solutions to counter amphibian declines and extinctions is one of the greatest conservation challenges of the century. But with a membership of over 500 of the world's leading amphibian experts, the Amphibian Specialist Group (ASG) is uniquely positioned to identify the current challenges to amphibian conservation, and to recommend potential solutions.

In mid 2013 the ASG, in partnership with the Amphibian Survival Alliance (ASA), initiated a number of thematic working groups designed to review efforts since the publication of the ACAP in 2006 and identify a clear strategy for how we need to move forward as a community to address amphibian conservation challenges worldwide.

Each thematic working group maintains a web page aimed at sharing information and encouraging conversation action, which evolves as knowledge increases and progress is made. Using this as a basis for discussion these groups collaborate to identify immediate actions that could be achieved during the subsequent two years. The ASA, as an alliance of concerned institutions, is taking the lead on establishing partnerships to implement these priorities.

As you know, for too long now we have heard stories of declines, extinction and lack of hope with regards to conserving biodiversity and especially amphibians. The ASA also plans to change this rhetoric by focusing on new opportunities and delivering conservation successes.

We believe that this movement needs to be about more than people donating to a cause that they believe in; it needs to be about you sharing your stories, becoming engaged and focusing on making a difference to the survival of the 7000+ amphibian species that share our planet. We want you to be advocates for the cause and inspired to take action in many different ways.

This regional edition of *FrogLog* highlights some of the exciting ways that people are taking action for amphibians that we hope will inspire you to act as well. Inside these pages you will discover how volunteers are helping scientists learn more about endangered frogs in Korea and even how a toad conservation project has led to the successful coexistence of humans and amphibians in a region. Everyone can play a role in helping us save amphibians around the world. To find more about what you can do as an individual or organization be sure to also visit the new amphibians.org website.

This is a new and exciting time for amphibian conservation and research, and we hope you will join us.

Don Church
Executive Director, ASA

FrogLog

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Changes to the ASG Secretariat

As many of you will be aware, the ASG has been working closely with the Amphibian Survival Alliance to identify ways of working closely together and maximizing the strengths of both groups. Over the course of 2013 both the ASG and ASA have undergone a number of dramatic structural and operational changes in order to make sure the partnership is a success.

For the ASG this has meant a move away from project implementation to allow us to focus on developing and providing scientific advice to groups such as the ASA. As you will read in the below section, the ASG has now established a number of Working Groups that are already providing clear targets for Alliance partners to act upon. With this focusing of the ASG remit it was decided that a number of new program officers would be needed to help drive the new approach forward. Sally Wren joined the team in May and we are now pleased to announce that Helen Meredith and Jos Kielgast are volunteering their time and expertise to help run the ASG. Helen and Jos are bringing with them fantastic experience and enthusiasm and will be playing a major part in ensure the ASG continues to make progress over the coming years.

Jos has been interested in amphibians since he was a tadpole. He hold s and Msc. in biology and is currently working on his PhD at the University of Copenhagen in Denmark. He has a broad interest in ecology, evolution and conservation and worked with a variety of topics all sharing a context amphibian biology. His research has focused on the epidemiology of amphibian chytridiomycosis in Africa and Europe, biodiversity and systematics of amphibians in central Africa and more lately using environmental DNA to study amphibians and other aquatic animals.

Helen coordinated the EDGE Amphibians conservation initiative at the Zoological Society of London for 5 years, developing conservation programmes for evolutionarily distinct and threatened species and raising awareness of the plight of amphibians globally. She is now working on a PhD entitled "Improving the impact of amphibian conservation programmes", based at the Institute of Zoology, Durrell Institute of Conservation and Ecology and University College London.

With the new arrivals comes a few goodbyes. Candace Hansen, Robin Moore and James Lewis will all be stepping down from their ASG roles over the next few months to focus on developing the ASA but will of course continue to work very closely with the Specialist Group.

New Action Plans Online

The amphibians.org Action Plan library continues to grow thanks to help from supporters around the world. Since the last edition of *FrogLog* we have added several new Actions Plans to the library from Europe and Africa. All of these plans plus many others can be found at http://www.amphibians.org/publications/national-action-plans/.

If you know of any plans that are not included in the library we would love to hear about them. Please contact James Lewis (jplewis@amphibians.org) or Candace Hansen (cmhansen@amphibians.org).

Working Groups Update

In mid-2013 the ASG formed several thematic Working Groups (WGs) with the aim of increasing conservation efforts and developing a clear strategy for the future. Each WG is focusing on a different aspect of amphibian conservation, research and education, utilising the expertise of ASG members to define necessary conservation measures and ensure priority actions are driven by the latest research.

Thirteen WGs have been established, under the following themes:

- Habitat Protection
- Climate Change
- Infectious Diseases
- Trade & Policy
- Ecotoxicology
- Captive Breeding
- Reintroductions
- Red List
- Taxonomy & Systematics
- Genome Banking
- Species Conservation Strategies
- Surveys & Monitoring
- Communications & Education

WGs are comprised of one or two facilitators and several members, drawn from the ASG membership, all with relevant expertise in that field. Through discussion, each WG is developing a set of prioritised long-, medium-, and short-term goals, the completion of which will significantly contribute to solving the most pressing challenges for each theme. These priorities for conservation action build upon and update the relevant section of the Amphibian Conservation Action Plan (ACAP), and have been requested by the Amphibian Survival Alliance, which is looking for a clear strategy to drive their immediate work in developing projects and partnerships.

The aim is to have all priority action lists completed by the end of 2013; as priority lists are completed they will be uploaded to the amphibians.org website, where we hope they will initiate and guide action in amphibian conservation beyond the ASA. Some WGs have already reached this stage, and the Amphibian Survival Alliance has begun work on how best to address the issues raised, and to seek partners with whom they can work to achieve the prioritised actions.

In the long-term we hope that WGs will continue the discussion in each thematic area, and that the online information can be kept up to date with advances in research and progress with conservation actions, as a living document.

Membership Updates

The membership of the ASG continues to grow with a number of new and renewing members added to the list since the last publication of *FrogLog*. We are pleased to welcome onboard the following people:

Angelica Crottini
Barkha Subba
Joachim Nopper
Jeff Dawson
Lucas Ferrante
Leslie Ruyle
Penny Langhammer
Carlijn Laurijssens
Aravind Madhyastha N. A.
Tariq Stark

If you are interested in joining the ASG or know someone who is not yet a member but can contribute to our efforts please feel free to contact an ASG Program Officer via email at info@amphibians.org.

FrogLog Schedule

January – Special Topical Edition
April – The Americas
July – Africa, West Asia, Madagascar, Mediterranean and Europe
October – Asia, Russia and Oceania

Amphibian Survival Alliance Updates

As part of a strategic approach to helping facilitate collaboration between the ASG Members and ASA Partners, www.amphibians.org will now be the new home to both the ASG and ASA. Over the past few months there has been increasing overlap in the content present on both the ASA and ASG website so it was deemed more efficient to have the ASA provide the required resources to run amphibians.org thereby focusing the website on raising the profile of amphibians and increasing engagement with conservation initiatives.

The website will continue to evolve into a comprehensive one-stop-shop for amphibian conservation, research and education as new features are continuously rolled out in partnership with organizations and initiatives around the world. Through this platform both the ASG and ASA will be able to communicate and launch a series of initiatives geared towards both the general public and science community alike that will have a long-term positive impact on amphibians around the world.

We are also eager to promote the fantastic work that you are doing to help save amphibians and the environments where they live by expanding upon the ASG's approach of promoting all those who are involved in amphibian conservation, research and education through this new website. If you would like a project featured on amphibians.org please contact us to discuss options.

Each Alliance partner commits to working on a specific action from the WGs. As actions are identified ASA staff will reach out to find suitable partners to implement the actions.

We are focusing our efforts on reaching out to those organizations who are perhaps not aware of how they can help amphibians or are not necessarily directly involved with amphibian conservation at the moment. Lots of groups are already working on amphibians but we need more and from a diverse range of fields and that is what the ASA is seeking to do.

We invite you to join the efforts of the ASA by becoming a registered partner. The ASA offers its partners the opportunity to build close relationships, exchange ideas and collaborate with a global Alliance of organizations sharing a joint concern for amphibians. As an ASA partner you will not only demonstrate your dedication to stopping this severe extinction crisis, but also provide the much needed support to drive this initiative forward and on to success. Your support will demonstrate that inaction and indifference to this crisis are unacceptable and that we must work together to restore populations of all threatened native amphibian species within natural ecosystems worldwide.

Please contact us for further details about joining the Alliance.

ASA Partners

The Amphibian Survival Alliance is a **dynamic partnership** of more than forty active institutions worldwide, and growing. Join us.

amphibians.org

asa

amphibian survival alliance

Darrel Frost Wins the 2013 Sabin Award for Amphibian Conservation

The Amphibian Survival Alliance and Andrew Sabin Family Foundation are thrilled to announce Darrel R Frost as the winner of the 2013 Sabin Award for Amphibian Conservation. The annual award, now in its seventh year, recognizes outstanding contributions by individuals to the field of amphibian conservation and research. Darrel was selected from an exceptional list of candidates, with a nomination that was supported by 35 amphibian experts across the world.

Darrel feels strongly that meticulously prepared catalogues help knit the world's scientific community together by providing workers in the developing world with access to current literature and up-to-date summaries of our knowledge of the biodiversity of living amphibians. When it comes to catalogues for amphibian species, few come close to the Amphibian Species of the World (ASW), through which Darrel has contributed what many consider to be the most significant single work in the history of amphibian biology.

For three decades ASW has been the primary reference for amphibian taxonomy. By providing a centralized source of taxonomic and geographic information that is otherwise scattered across a vast literature, ASW facilitates and enables research in systematics and provides easy access to this information for workers in fields like conservation biology and ecology. ASW is also the authority database used by numerous governmental and non-governmental organizations and other online databases to obtain information on amphibian taxonomy.

The Amphibian Survival Alliance, the world's largest partnership for amphibian conservation, has featured Darrel as their first "Amphibian Champion" to honor his contribution to the field (http://www.amphibians.org/amphibian-champions/)

leapfrog CONSERVATION FUND

Announcing the Leapfrog Conservation Fund

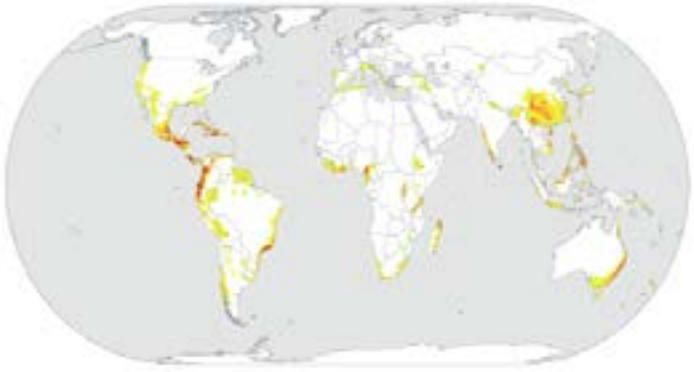
We are thrilled to announce the launch of the Leapfrog Conservation Fund for the protection of critical amphibian habitat worldwide. The Leapfrog Conservation Fund was founded by the Rainforest Trust and Global Wildlife Conservation to support immediate action to avert the threats that are driving our planet's wildlife towards extinction. The Amphibian Survival Alliance is currently working to develop and screen projects for support, and we welcome inquiries.

Why do we support habitat protection?

Over 800 threatened amphibians are afforded no protection; half of these have extremely restricted geographic ranges and many only occur at a single locality. This presents a rare opportunity for conservation. By protecting these localities, which are concentrated in the tropics (see map below) we can literally save species from impending extinction with relatively modest and focused investment. This is why the Leapfrog Conservation Fund exists.

Our Approach

Critical amphibian habitats in the Tropics often lie in private hands. A lack of restrictions on deforestation in private lands can place these tracts of habitat at imminent risk of destruction or degradation. Land purchase, where possible, can be a valuable approach to habitat protection because it places ownership and management responsibility directly in the hands of the in-country partner organization. We have found this to be effective in ensuring the long-term protection and management of key sites for amphibians, which typically have small home ranges in the tropics and therefore can be protected with the strategic acquisition of small tracts of land.



Richness map of Threatened amphibian species, with dark red colors corresponding to higher number of species. From Chanson et al. 2008

Founding partners of the Leapfrog Conservation Fund share the philosophy that the most beneficial approach is for the ownership and management responsibility of private reserves to be in the hands of a local, in-country conservation organization. The goal of the Leapfrog Conservation Fund is to provide the support necessary to allow these local organizations to purchase (when possible) and manage critical lands for biodiversity conservation.

Local partners are carefully selected to ensure they are legally constituted non-profits, with good governance, an experienced staff familiar with the local situation, and have the highest legal and ethical insight. Each project is vetted to ensure that due diligence is done on the transfer of land title and to ensure that local communities are not displaced or negatively impacted by the creation of a new reserve. Projects are monitored through regular reporting from local partners to ensure their long-term viability.

Apply For Funding: Criteria

The Leapfrog Conservation Fund supports the strategic protection of critical amphibian habitat through local partners. Land purchase is the primary action supported by the fund; however, other actions that result in protection of critical habitat for amphibians will be considered if these actions are deemed more effective.

Priority is given to the protection of habitat supporting Endangered and Critically Endangered amphibian species. New species will be eligible if they are clear candidates for threatened status on the Red List. If matching funds are secured this will significantly increase the likelihood of support.

Proposals must clearly demonstrate how the proposed actions will be implemented by a local partner and how the protected area will be managed over the long-term. High quality maps in Google Earth, and Lat/Long coordinates for the proposed project site are a requirement.

How to Apply

If you have a project to submit for consideration or are interested in developing a proposal for the Leapfrog Conservation Fund please contact Robin Moore at rdmoore@amphibians.org

"Courting the Wild: Love Affairs with Reptiles and Amphibians"

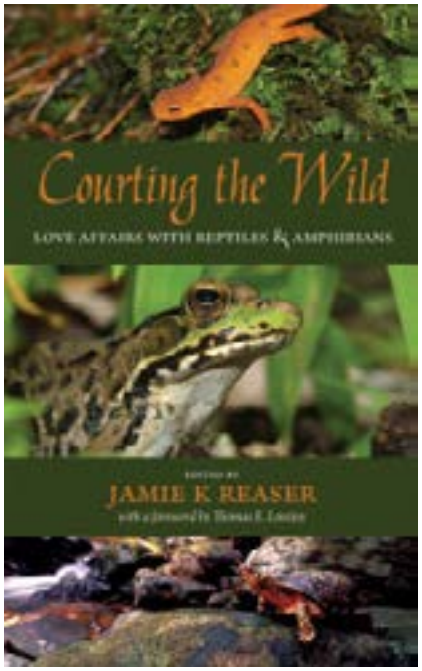
By Jamie Reaser

Somewhere within you there's a story—a story about that very moment when you first fell in love with an amphibian, or a reptile. More than likely, you were a child. But, maybe you were an adult suddenly overwhelmed with a child-like sense of awe and excitement.

Do you remember it? What was the species? What were the circumstances? Can you still feel it ...that feeling that you felt then?

Who are you now as a result of that moment? What has been the nature of your commitment to that "magical other?"

These are some of the questions answered by the authors in the anthology, "Courting the Wild: Love Affairs with Reptiles and Amphibians." Hiraeth Press released the second edition of the book earlier this year and is donating US$2/sale to the IUCN SCC Amphibian Specialist Group.



Within pages of "Courting the Wild" you will find what are, often, surprise encounters with love. Whether as free-roaming boys or girls or responsibility-laden adults, the authors all have a tale to tell about an amphibian or reptile that unexpectedly "called" or "bit" them into a remarkable courtship. For each of the authors, the encounter was as life altering as any human love affair. For some, it has been far longer lasting—perhaps, one speculates, eternal.

In each instance, "falling in love" with a reptile or amphibian inspired the author to shift both mind and heart consciousness. Not only did they grow to care about their specific paramour, but also the full suite of reptiles and amphibians, as well as the habitats that support them. Relationships between human and herp were deepened through intimate explorations into natural history and ecology. Com-

mitments were made through pledges of environmental stewardship.Many of the authors chose to make a career of their curiosity and concerns, and are well known herpetologists who have made substantial contributions to the scientific study and conservation of reptiles and amphibians. Other authors are aspiring herpetologists, young people upon which the future of many reptile and amphibian species will depend. A few contributors are simply herp-inspired.As much as the stories are about reptiles and amphibians, they are also about the people who wrote them and humanity as a whole. For most, if not all, of the story tellers the herps they encountered became mirrors, teachers and guides through their own metamorphosis. Their interactions with reptiles and amphibians have made them better people. Yet, sadly, many of the authors also came to recognize that not everyone shares in their fondness of or concern for herps. Time and time again relationships ended because of head-chopping garden tools, bulldozers and housing developments. Who will *we* be in a world less frequented by turtles, toads and their kin?

We invite you to support the Amphibian Specialist Group by purchasing a copy of "Courting the Wild: Love Affairs with Reptiles and Amphibians" from your favorite retailer. Open the pages prepared for ponds and swamps, deserts and prairies, woodlands and suburban backyards. You'll encounter the slimy and scaly, the venomous, and the hilarious.

If you've already read the book, please consider providing a review on Amazon.com. Let people know that time spent with herps is worth their while, even if it is time spent among the pages of a book.

Amazing Amphibian: Archey's Frog

Leiopelma archeyi, commonly known as Archey's Frog, is listed on the IUCN Red List of Threatened SpeciesTM as 'Critically Endangered'. Archey's Frog is a small green-brown frog found only in New Zealand, where it lives on the North Island in the Coromandel Peninsula and the Whareorino Forest. This frog prefers moist forest at altitudes of 400 - 1000 m. It is the smallest of the four remaining endemic Leiopelma species and is one of the world's most primitive species of frog. Archey's Frog is a nocturnal species that lives under stones and logs during the day and is a terrestrial breeder. The larvae of Archey's Frog hatch from eggs with small arms and legs already developed, thereby skipping the free-swimming tadpole stage. Between 1996 and 2001 there was an 88% decrease in the Archey's Frog population at monitored locations. Chytrid fungus was confirmed from wild frogs in 2001 and is implicated in the observed decline but several other factors may have been involved.

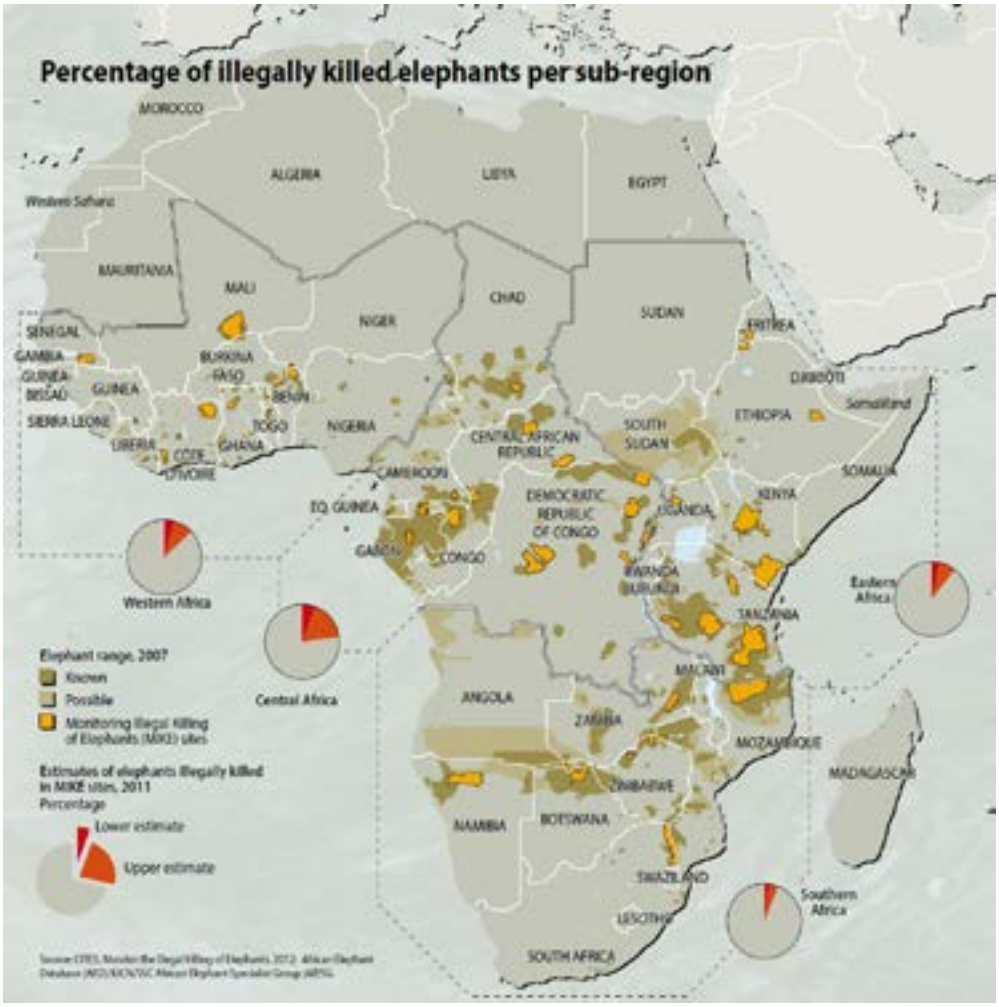
The New Zealand Department of Conservation Native Frog Recovery Group is responsible for applying conservation methods, including mammalian predator-control, appropriate research and captive breeding. The Auckland Zoo is currently the only institution to hold the species in captivity and successfully hatched and metamorphosed the species for the first time in 2012/13. There is a significant research effort both in the wild and the lab, including population monitoring, basic ecology and biology, benefits of rodent control in frog habitat, pathology and reproductive biology.

Archey's Frog is listed as the number one Evolutionarily Distinct & Globally Endangered (EDGE) amphibian. EDGE species have very few close relatives and often have unique appearance, behavior or lifestyles. They represent a unique and irreplaceable part of the Earth's natural heritage.

Request for Information: Vertebrate Fauna in West and Central Africa

By Julia Marton-Lefèvre

The International Union for Conservation of Nature (IUCN), has recently commissioned a situation analysis desk study that aims to: i) draw on existing published and unpublished data to summarize currently available information on the large terrestrial and freshwater vertebrate fauna of West and Central Africa; ii) document the main impacts and drivers of wildlife loss in the region; and iii) review existing conservation measures and effectiveness. The study will provide an evidence base for future conservation efforts in West and Central Africa, mindful of commitments that Parties have made towards meeting, in particular, the 2020 Aichi Biodiversity Targets of the Convention on Biological Diversity, especially Targets 5 and 12 (*1*).The study serves as a partial response to a resolution adopted by IUCN's members at the 2012 World Conservation Congress (*2*). It will involve extensive consultation with stake-holders in-region, including IUCN state and government agency members. As the first step in the consultation process, to provide a factually sound basis to this study we are inviting all interested parties to submit any relevant information or data for consideration for inclusion, especially on:



1) Published or unpublished census figures or long-term trends of globally threatened or Near Threatened vertebrates in the region, from protected areas or otherwise.2) Any national/sub-national laws or legislation in place that regulate biodiversity, land-use planning, and/or environmental impact assessments, and any gaps in national/sub-national policy/law.

3) Existing or planned external policies/guidelines/investments that currently/could positively or negatively affect wildlife populations (e.g., development or private banks).

4) Evidence of socio-economic consequences of wildlife declines at a national or sub-national level.

IUCN would be grateful to receive any such information, supported, where appropriate, by details on methodology and citations of published studies and sources. Inputs should be received no later than end-November 2013 in order to allow sufficient time for data to be incorporated into the study. IUCN assures that any such information provided and used or cited will be credited and acknowledged accordingly. Please submit any information to the study co-leaders at the following email: bwca@iucn.org. IUCN will extend to all stakeholders a formal invitation to comment on the draft report at a later date and welcomes open dialogue with any parties on interpretation and presentation of data.

The resulting study will be made freely available in electronic format in both English and French. To be published in early 2014, we anticipate that the desk study report will be an authoritative review of the status of terrestrial and freshwater vertebrate fauna in West and Central Africa.

References

1. http://www.cbd.int/sp/targets/
2. Resolution 22, available at: http://www.iucnworldconservationcongress.org/member_s_assembly/resolutions/

Oregon Spotted Frog. Photo: Washington Dept Of Fish and Wildlife.

Endangered Species Act Protection Proposed for Oregon Spotted Frogs, Other Amphibians Under Settlement

By Collette Adkins Giese

In accordance with a landmark settlement agreement with the Center for Biological Diversity (CBD), the U.S. Fish and Wildlife Service (USWFS) recently proposed Endangered Species Act protection for Oregon spotted frogs. The agency also proposed to designate more than 68,000 acres and 24 stream miles as protected "critical habitat" for the amphibians. Once abundant from British Columbia to California, spotted frogs have disappeared from 90 percent of their former range, mostly because their wetland habitats are being destroyed.

These protections are the result of a 2011 agreement between the CBD and the USFWS to speed up endangered species protection decisions for 757 imperiled animals and plants around the country. So far, more than 100 species have been fully protected and dozens more have been proposed for protection under the settlement agreement. Several other amphibians have also received protections this year under the agreement. In August, the USFWS protected two central Texas blind salamanders under the Endangered Species Act. The Austin blind salamanders are now protected as an "endangered species" with 120 acres of protected habitat, and the Jollyville Plateau salamanders are protected as a "threatened species" with 4,331 acres of protected habitat. These fully aquatic salamanders require clean, well-oxygenated water and are threatened by activities that pollute or reduce water flow to their aquatic habitats. In addition, this year the USFWS proposed protections for the Sierra Nevada yellow-legged frog and Yosemite toad, along with about two million acres of proposed critical habitat across the Sierra Nevada Mountains. The USFWS also proposed protection for a population of mountain yellow-legged frogs that lives in the southern Sierra Nevada. Yellow-legged frogs throughout the Sierra Nevada have suffered dramatic declines in range and numbers due to habitat destruction and degradation, disease, predation by nonnative trout, pesticides and climate change. Yosemite toads have also disappeared from many areas and suffered population losses primarily from livestock grazing, climate change and pesticides.

Scientists estimate that approximately 20 percent of amphibians in the U.S. are at risk of extinction. Surprisingly, though, just 27 of the approximately 1,400 species protected under the U.S. Endangered Species Act are amphibians. Because the Endangered Species Act is America's strongest environmental law and surest way to save species threatened with extinction, the CBD works to gain these needed protections through scientific petitions, advocacy and lawsuits. More information on the CBD's campaign to address the amphibian extinction crisis is available here: BiologicalDiversity.org/herps

Amphibian and Reptile Staff Attorney, Center for Biological Diversity
http://www.biologicaldiversity.org

Yosemite toad. Photo: Lucas Wilkinson, US Forest Service.

Texas blind Salamander. Photo: USFWS.

Western leopard Toad. Photo: Jeanne Tarrant.

Toad-in-the-hole: Western Leopard Toad Roadkill Mitigation Project

By Jeanne Tarrant

The Endangered Wildlife Trust Threatened Amphibian Programme is excited to be collaborating, together with the EWT Wildlife and Transport Programme, with the Noordhoek Toad NUTS on a project in the Western Cape, in a pilot study to implement mitigatory barriers to curb road kill of the Endangered Western Leopard Toad, Amietophrynus pantherinus. The species is endemic to the Cape Peninsula coastal area. Each year, usually during August, the toads migrate from their terrestrial habitat (often local gardens) to suitable nearby ponds to breed. Most of the breeding sites are located within low-lying areas in suburbs that are surrounded by roads, with the result that many hundreds of toads are killed each year and their numbers are radically declining. In response, a number of volunteer groups have been working tirelessly during the breeding season for the past six seasons to curb these road deaths. The various groups are active Muizenberg, Kirstenhof, Tokai, Constantia, Bergvliet, Grassy Park, Obesevatory, Hout Bay, Kommetjie, Glencairn, Fish Hoek and Noordhoek.

The Noordhoek group, Toad NUTS (Noordhoek Unpaid Toad Savers) is this year investigating the effectiveness of barrier fencing along one of the busiest stretches of road on Noordhoek Road. This road is hazardous not only to the toads, but to the volunteers themselves, with one even being hit by a drunk driver earlier this season. The need for additional protection of both toads and toad-savers is becoming paramount. To this end, drift fences and pitfall traps were put in place on 5 August (below) and where monitored for the duration of the breeding season and removed on the 2nd of October. This project will be trialing a method that has been widely used effectively in other parts of the world, but is a first for South Africa. Any toads collected in the pitfall traps (buckets) were safely relocated by volunteers across the road to the breeding site. Barrier fencing was put up on both sides of the road to prevent road death on the return journey. This project ties into work being done by the EWT Wildlife and Transport Programme (WTP) in Limpopo, using funnel fencing to mitigate road kill of amphibians, reptiles and small mammals within the Greater Mapungubwe Transfrontier Conservation Area. The timing of the two projects coincides perfectly, and therefore lend themselves to joint learning in terms of methodology and data collection.

The ultimate goal of the project is to provide motivation for erecting permanent mitigation barriers in the Western Cape, and other biodiversity road-kill hotspots. Even after the first few nights of having the barriers in place an immediate effect was noticed. No dead toads were detected along the stretches of road protected by fences, and all toads caught were moved to the breeding site at Lake Michelle. Conservation in action for sure!

Visit www.leopardtoad.co.za or call the WLT hotline on 082-516-3602 for more information on the Western Leopard Toad and how to volunteer.

Contact: jeannet@ewt.org.za

Barrier fencing erected along Noordhoek Road, Western Cape, South Africa. Photo: Alison Faraday.

Western leopard Toad in pit-fall trap prior to rescue and relocation to breeding site. Photo: Alison Faraday.

Pesticide Accumulation in California Sierra Nevada Frogs

By [1]Kelly L. Smalling, [2]Gary M. Fellers, [3]Patrick M. Kleeman & [4]Kathryn M. Kuivila

Our study on frogs in remote Sierra Nevada mountain habitats in California, USA—including Yosemite National Park and Giant Sequoia National Monument—detected concentrations of pesticides in frog tissue that potentially came from California's Central Valley sources (*1*).The results show that current-use pesticides, particularly fungicides, are accumulating in the bodies of Pacific chorus frogs (*Pseudacris regilla*) in the Sierra Nevada. This is the first time we have detected many of these compounds, including fungicides, in the Sierra Nevada. The data generated by this study support past research on the potential of pesticides to be transported by wind or rain from the Central Valley to the Sierras—regions at least 80 km (50 mi) apart in distance.

We sampled seven sites across Lassen Volcanic National Park, Lake Tahoe, Yosemite National Park, Stanislaus National Forest and Giant Sequoia National Monument. Our US Geological Survey (USGS) team collected and analyzed water and sediment samples and frogs for more than 90 different types of pesticides. The Pacific chorus frog was chosen because it is commonly found in water bodies across the Sierra Nevada, allowing researchers to compare results across locations.

Pacific Chorus Frog (*Pseudacris regilla*). Photo: Gary M. Fellers.

Compound	Pesticide Type	Lassen Volcanic NP – Reading Peak	Lake Tahoe Page Meadow	Stanislaus NF – Spicer Sno-Park	Stanislaus NF – Ebbetts Pass	Yosemite NP – Summit Meadow*	Yosemite NP – Tioga Pass*	Giant Sequoia NM – Rabbit Meadow
Tebucanoazole	Fungicide	Detected	Detected	Detected	Detected	Not Detected	Detected	Detected
Simazine	Herbicide	Not Detected	Detected	Not Detected	Detected	Not Detected	Not Detected	Detected
Pyraclostrobin	Fungicide	Detected	Detected	Detected	Detected	Not Detected	Detected	Detected
DDE	Insecticide degradate	Detected	Detected	Detected	Detected	Detected	Not Detected	Detected

Table 1: Select pesticide types detected in study. Data collected during 2009 and 2010 sampling. Asterisk denotes sampling only took place in 2010. NP=National Park; NF=National Forest; NM=National Monument.

Two fungicides, commonly used in agriculture, pyraclostrobin and tebuconazole, and one herbicide, simazine, were the most frequently detected compounds, and this is the first time these compounds have ever been reported in wild frog tissue. Dichlorodiphenyldichloroethylene (DDE), a byproduct of the pesticide dichlorodiphenyltrichloroethane (DDT), was another compound frequently found in frogs collected—though this is not surprising since DDE is one of the most widely detected compounds globally, even decades after DDT was banned in the US.

One notable finding was that among sites where pesticides were detected in frog tissue, none of those compounds were detected in the water samples and only a few were detected in the sediment samples. This suggests that frogs might be a more reliable indicator of environmental accumulation for these types of pesticides, than either water or soil.

Pesticides continue to be a suspected factor in the decline of amphibian species across the US and the world, but much remains to be learned about how pesticides impact amphibians, and whether pesticide exposure could influence other amphibian decline factors like the deadly chytrid fungus.

Documenting the presence of environmental contaminants in amphibians found in US protected federal lands is an important first step in finding out whether the frogs are experiencing health consequences from such exposure. Unfortunately, these animals are often exposed to a cocktail of multiple contaminants, making it difficult to parse out the effects of individual contaminants.

Acknowledgements

The study was supported by the USGS Amphibian Research and Monitoring Initiative (ARMI), chartered in 2000 by a congressional mandate to investigate amphibian declines in the United States (http://armi.usgs.gov). Additional support came from the USGS Toxic Substances Hydrology Program (http://toxics.usgs.gov).

References

1. K. L. Smalling, G. M. Fellers, P. M. Kleeman, K. M. Kuivila, *Environ. Toxicol. Chem.* **32**, 9 (2013). http://dx.doi.org/ 10.1002/etc.2308

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Find the Frog!

By Reid Harris, Molly Bletz & Devin Edmonds

Frogs in Madagascar are threatened by the expected arrival of the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*), which has already decimated frog populations around the world and caused extinctions of numerous species. For example, about half of the frog species in upland areas of Panama have gone extinct or are greatly reduced in population size due to *Bd*. We do not want the same catastrophic extinctions and declines to happen to the frogs of Madagascar. Therefore, it is imperative to consider a prevention and mitigation strategy promptly. Initiatives to keep *Bd* out of Madagascar and monitor its potential arrival are in place, and some species are already protected in the survival assurance center at Association Mitsinjo in Andasibe, Madagascar. However, a plan to mitigate and limit *Bd*'s spread around Madagascar once it arrives is needed, as well as a method to allow frogs from the survival assurance center to be protected when they are released if *Bd* is present in the environment.

Amphibian skin harbors many bacterial species. Some of these bacteria are beneficial and can inhibit the lethal chytrid fungus. The addition of locally-occurring protective bacteria to amphibians has effectively prevented disease in lab experiments and recent field trials in the USA. We are currently sampling Malagasy frogs for their skin microbes in order to identify effective anti-*Bd* probiotics. This will allow us to implement probiotic conservation strategies to curb the devastation of *Bd* if and when it arrives in Madagascar and help preserve the remarkable amphibian biodiversity on the island.

Please visit our Facebook page, https://www.facebook.com/pages/Frog-Probiotics/147308962096815, and our website, www.frogprobiotics.org, for more details and updates about our project and to meet the scientists involved. Please visit http://www.mitsinjo.org/frogs for more on frog conservation at Association Mitsinjo.

Can you find the Madagascar frog (***Mantidactylus pauliani***) in this picture? Photo: Devin Edmonds.

Kihansi spray toad *(Nectophrynoides asperginis)*. Photo: Tim Herman.

Conservation in Action: The Road to Recovery

By Verity Pitts

From saving the world's most threatened species of sea turtle to bringing unusual amphibians back from the brink of extinction, no conservation challenge is a lost cause if knowledge, dedication and strong partnerships are put into play. This is the message being championed by ARKive to celebrate its tenth anniversary this year.

Through its unparalleled collection of wildlife imagery, ARKive – an initiative of wildlife charity Wildscreen – has become a platform to inform, and a place to encourage conversation for conservation. To mark a decade spent highlighting the importance of biodiversity and educating and inspiring people to care about the natural world, ARKive is flying the flag for conservation by featuring ten species which are set to improve in status over the next ten years should positive action continue.

ARKive's chosen species, which were selected in consultation with experts from IUCN's Species Survival Commission (SSC), represent a variety of taxonomic groups and reflect the fascinating array of organisms with which we share our planet. From Juliana's golden-mole (*Neamblysomus julianae*), one of Africa's oldest and most enigmatic mammals, to the Asian white-backed vulture (*Gyps bengalensis*), a bird which has suffered a 99.9% population decline in just over a decade, this selection of species aims to raise awareness of the myriad threats faced by wildlife, and demonstrates how targeted conservation action can truly make a difference.

"*ARKive is working with the world's leading wildlife filmmakers, photographers, conservationists and scientists to promote a greater appreciation of our natural world and the need for its conservation*," said Wildscreen CEO, Richard Edwards. "*In this our tenth year, we wanted*

Lord Howe Island stick insect *(Dryococelus australis).* Photo: Paul Brock.

to celebrate not only the great diversity of life on Earth, but also the vital conservation work that is being carried out around the world, and highlight that by working together to raise awareness, share knowledge and take positive action conservation can and does work."

One particularly impressive conservation story is that of the Lord Howe Island stick insect (*Dryococelus australis*), a large, flightless invertebrate endemic to Australia. Once common on Lord Howe Island, this unusual insect was almost driven to extinction following the accidental introduction of rats to the island, only surviving in an area of 180 square metres on a large rock to the southeast of its original habitat. Without detailed scientific knowledge of the reasons behind its decline, this fascinating species might by now have been added to the ever-increasing list of extinct species. However, thanks to scientific exploration and understanding, and with the invaluable application of appropriate conservation measures, it is believed that the Lord Howe Island stick insect could be reintroduced to its native habitat in the next few years.

Another species on the road to recovery as a result of targeted conservation action is the Kihansi spray toad (*Nectophrynoides asperginis*), a rare dwarf amphibian found only in a two-hectare area of habitat in eastern Tanzania's Kihansi River Gorge. In addition to catastrophic population declines due to a devastating amphibian fungal disease, the Kihansi spray toad has suffered the effects of habitat loss. The construction of a dam on the Kihansi River in 2000 caused the diminutive toad's wetland habitat - which relied on being moistened by waterfall spray - to dry out, leading to the amphibian's dramatic decline and its listing as Extinct in the Wild.

By working in partnership, zoos and conservation organisations were able to set up successful captive breeding programmes for the Kihansi spray toad, boosting an initial captive population of 499 individuals to an incredible 6,000. Conservationists also took the unusual step of setting up an artificial sprinkler system, which by 2010 had restored the Kihansi spray toad's habitat. By December 2012 an international team of experts – including scientists from the IUCN SSC Amphibian and Re-introduction Specialist Groups – had reintroduced 2,000 toads to Kihansi. This marks an incredible achievement – an amphibian classified as Extinct in the Wild has now returned to its native habitat.

"*The state of the natural world is increasingly worrying, with many species teetering on the brink of extinction,*" said Dr Simon Stuart, Chair of IUCN's SSC. "*However, conservation does work and we should be greatly encouraged by success stories such as the re-introduction of the Kihansi spray toad. Many other admirable conservation achievements also show that the situation can be reversed thanks to the dedication and determination of experts and scientists worldwide. With continued effort and support, there is much we can achieve.*"

The Kemp's ridley turtle (*Lepidochelys kempii*) is considered to be the most severely endangered marine turtle in the world, having declined dramatically in the 1950s and 1960s due primarily to the overexploitation of eggs and adult turtles. However, the population is now showing signs of recovery after a series of conservation efforts were put in place to protect the species, including a ban on international trade in the turtles and the introduction of turtle excluder devices (TEDs) fitted to shrimp nets to help prevent bycatch.

"*Parties to the Convention on Biological Diversity have made a commitment, through the Aichi Targets, not only to prevent the extinction of threatened species but also to improve their conservation status – ARKive's tenth anniversary campaign is a perfect opportunity to raise awareness of the importance of conservation and show that it really does work,*" said Dr Jane Smart, Director of IUCN's Biodiversity Conservation Group. "*Along with our extensive network of scientific experts, we look forward to working even more closely with ARKive, an IUCN Red List Partner, to strive towards achieving the important goals the world has set.*"

Kemp's ridley turtle *(Lepidochelys kempii).* Photo: Michael Patrick.

While the work of conservationists and scientific experts is a vital component in the fight against species extinctions, ARKive is also keen to highlight the role that members of the general public can play in the future survival of Earth's incredible biodiversity. By learning more about the natural world around them and understanding its importance, it is hoped that people will be inspired to take action in their daily lives to safeguard our invaluable species and ecosystems. From recycling and limiting plastic usage to making wiser seafood choices and supporting some of the many hundreds of organisations and scientists who devote their lives to conservation, we can all strive towards building a healthier planet.

Find out more about the ten species on the road to recovery on ARKive's Conservation in Action page - www.arkive.org/conservation-in-action.

Meet Amphibians.org Blogger Tariq Stark

By Tariq Stark

How does one become so fascinated with stuff that others find repulsive? Frogs, newt, lizards and tortoises and all the other herps we hold so dear are a nightmare for others. I have never viewed this group, or two groups to be exact, in this way. For me they have always been animals that are more than worthy of our respect, care and yes, even love. Especially amphibians, I have always found to be hardy and vulnerable at the same time. So to come back to the initial question: why do I love these critters?

It all started when I was around four years old. My mother told me that back then I always was looking for frogs and newts and even wanted lizards in captivity instead of a bunny or something like that. But, for a young boy, the skills to care for a lizard at that age was not yet within my grasp. Instead I kept tropical fish and yes, even an aquatic herp: *Hymenochirus boettgeri*. This species even displayed courtship, called, mated and laid eggs, but the tadpoles never came. I blame the fish, my bad of course.

Even when I was older, around seven-eight years old, the fascination with herps never left my side. I grew up in the west of the Netherlands, a very agricultural area. My mother bought my first European field guide ("Lanka.V., Vit. Z. 1985. Amphibians and Reptiles. Artia, Pragua, Dutch translation 1987). What a wonderful book! Suddenly a lot of information was available to me! I learned at this early age which species were native to my country and what their habits were. At this time I caught a lot of common newts (*Lissotriton vulgaris*), common toads (*Bufo bufo*), common frogs (*Rana temporaria*) and edible frogs (*Pelophylax* klepton *esculentus*). During this time we got a small pond in our yard and soon the common newts discovered it. I was very happy staring in the pond watching their lives day after day. At the same time I also learned from new books I got that amphibians where on the decline. In my own, foolish, childish way I wanted to help them. I noticed that some of my favorite newt sites where being destroyed to create roads and bicycle paths in my hometown. How can a child help? I already had newts in our garden and the occasional toad also paid a visit but never bred in the pond. This had to change! Together with a friend (we were about nine) we created what we called a "toad sanctuary" in the garden. It basically consisted of dug in buckets and containers filled with water and some plants. Needless to say, the toads never came. But it was a start. At the same time I started to write "books." These books consisted of folded papers with a drawing and a description of a frog or newt. I showed them to my friends and family, trying to educate them (again a bit foolish) about my favorite animals.

Years went by and when I was about 10 or 11 it was time for my first lizard species: *Eublepharis macularius*. I got two beautiful, wild caught females. They were already adults and one of the females (my oldest lizard) is still alive and breeding! I estimate her to be around 22-23 years old. It is still my favorite gecko species and I am proud to say they are still in my care (still new wild types enter my little colony). After this I kept and bred loads of other lizard species and I still do. My interests revolve mostly around geckos but I also keep some other lizards like Cordylids, Lacertids and Agamids. I never stopped keeping lizards and later on also tortoises in captivity. It has helped me a lot to understand their behavior and apply this knowledge later on to my field studies. At a young age I became involved in lots of herpetological societies and projects and this continues to this day (both *in situ* and *ex situ*) [These specific organizations can be referenced in my bio].

Photo: Marc Monsanto.

Nowadays I try to find a balance between my field studies and keeping herps in captivity. Both disciplines have taught me a lot and continue to educated and surprise me. I have done field studies on Dutch herps but my interests and education also have taken me far across the border to places like Central America and South Africa. During our seven months in Nicaragua my girlfriend Carlijn Laurijssens and I sampled several amphibian communities on Ometepe Island for Chytridiomycosis and Rana virus (article in press). Also, we have found range extensions of several snake and frog species in that same country and made an diversity analysis for both the reptile and amphibian communities on Ometepe Island (article in press). In South Africa we have conducted a behavioral study on *Homopus signatus*, the world' smallest tortoise, for the Homopus Research Foundation (article in prep).

Back in Holland we continued our conservation work in the town we currently live in, Leeuwarden. I have come full circle with the project we have been running here for the last two years: helping a population of common newts, the same species that made me fall in love with herps in the first place, cross the road safely during their annual spring migration (and several other species). This has been published in the latest Issue of *FrogLog* of the IUCN SSC Amphibian Specialist Group (Laurijssens & Stark, 2013). Mostly students from our University are involved. We have run a course to get them acquainted to fieldwork with amphibians. For our third season we would love to get parents and children form that neighborhood to become involved. Who knows, maybe there is a young herpetologist among them?

So, in retrospect, why do I love these animals? The truth is that I honestly do not know. I just do and I don't question why anymore. They are awesome and I am happy and honored to spend my time and life in their service!

Tariq Stark is a herpetologist from the Netherlands who has done fieldwork with reptiles and amphibians in the Netherlands, Belgium, Central America and South Africa. His interests are infectious diseases in amphibians, herpetological biodiversity, taxonomy, surveys, habitat assessment, risk assessment and monitoring. Tariq can be contacted at: tariqstark@hotmail.com (or) www.tariqstark.com

The Endemic *Conraua derooi* in Immediate Conservation Need in Togo

By [1,2]Gabriel Hoinsoudé Segniagbeto, [2]Dede Okangny & [3]Luca Luiselli

Fig. 1 *Conraua derooi*, Photo: G. Segniagbeto

The Togo slippery frog (*Conraua derooi*, Figure 1) was described from the Missahohe forest (*1*), near Kpalimé (Togo, West Africa). In 1980, studies conducted on amphibian trematodas in Togo (*2*) indicated the occurrence of this species in Danyi Attigba, from the same forested area of Togo, about 100 km away from the original type locality. The occurrence of this species was also recently confirmed from the Volta Region of Ghana and the area around the Togolese border in particular in Missahohe and Atewa forest (*3-5*).

The Togolese population of the slippery frog of Missahohe forest is relatively well known by most of the batrachologists visiting Togo. This population is supposed to be preserved because of the status of Missahohe forest which is legally considered as a protected area [Figure 2 (*6*)]. As Missahohe is a montane forest, there are many other forest-dwelling species of amphibians and reptiles, including *Hyperolius torrentis*, *Hyperolius baumanni*, *Phrynobatrachus calcaratus*, *Bitis rhinoceros*, *Bitis nasicornis*, *Cophoscincopus simulans* and others. In addition to the herpetofauna, some forest primates like *Cercopithecus petaurista petaurista* occur in the forest.

Threats to the Missahohe forest

Despite its status as a protected area, Missahohe forest is nowadays strongly degraded by not only local community settlement in this forest (Figure 4), but also by the increased surface of farms surrounding the forest. The Camalo stream, which for a longtime has been considered a refuge of habitats for many forest species, is currently heavily altered. In addition, women in the settlement install palm oil production in the Camalo stream without any control by the local administration who are in charge of the protection of this forest. According to our investigations, in four villages situated around the park (Yo, Kuma Tchame, Kuma Konda and Kuma Adame), there is rampant deforestation for charcoal production with big bags of charcoal being transported by vehicles on the road as evidence. Thus, most of the original forest ecosystems of this protected area are under a process of rapid disappearance.

New threats on *Conraua derooi* population of the Missahohe forest

Currently, there is still an additional threat for the *Conraua derooi* population in the Missahohe forest. This new phenomenon has first been observed March 2013 when we visited the site of this species. This site is characterized by a forest waterfall and it creates a particular natural ecosystem which is very attractive from the tourist point-of-view. Indeed, it has become a popular place to visit for people visiting the town of Kpalimé. These tourists come from many countries, most of them being Togolese and Europeans. We immediately contacted our local guide who always helps us on our field survey in the area. A short meeting had been organized at Yo and Kuma Kunda villages in order to give explanation concerning the status of *Conraua derooi* and it unique importance as an endemic and threatened species.

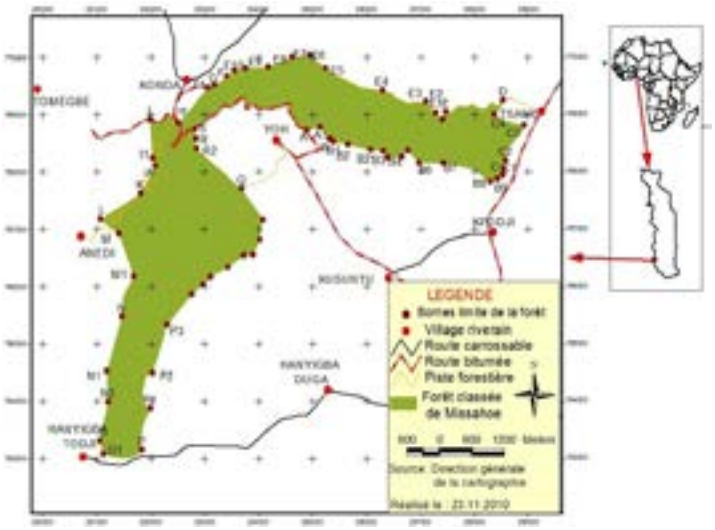

Fig. 2 Location of Missahohe forest.

We have also informed some locally based NGOs working on environmental issues to contribute to the preservation of both the forest and this species. In May 2013, during another visit to the Kpalimé area, the presence of a high number of visitors to the Camalo waterfall was observed, with the NGOs personnel being busy in explaining to the visitors the main environmental issues of the study site and the species.

However, we were surprised when, on 18th August 2013, we visited once more the *Conraua* site, and there was noted a high number of tourists. The visitors came from diverse origins: Togo, Benin, several countries in Europe, North America and Asia (China). Overall, we determined clear evidence through our observations that the touristic attention to the site has increased during the past six months. This situation becomes more worrisome for the population of *Conraua* at the Missahohe forest. The vegetation of the site has been cleared and seats have been installed bordering the stream for the visitor. In addition, visitors can easily take a shower in the

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waterfall. For the moment, the NGO's personnel patrolling these visits do ensure that visitors will not use soap or any detergents in the stream because the local Yo village community use the water of the stream for drinking and other familiar uses. During our visit, tadpoles and juveniles of the species have been observed in the stream during the day time; adults are also present in the stream during the night.

Fig. 3 Settlement installation in Missahohe forest, Photo: G. Segniagbeto..

But, for how long will this habitat survive under these current increased pressures from visitors? Will tourists eventually bring diseases like, e.g., *Batrachochytrium dendrobatidis*, into this habitat? Considering the potential seriousness of this phenomenon, we bring attention to this potential threat. Today there is no threat on the population of this species of the Missahohe forest with chytrid fungus. According to recent information (*7*) chytrid fungus is absent in Togo and the rest of the Upper Guinea forests. We presume that tourist could potentially introduce chytrid fungus into the habitat of *Conraua* in Togo. Therefore, we would like to share our concerns to the public and the international amphibian specialists' community as well.

It should be further stated, in addition to the potential problems posed by tourists, the population of this species is exploited by local communities for consumption. But the most important issue is that, there is some commercial exploitation by the young people of Kpalime area who capture individuals and sell them in Lome to the Chinese restaurants. The frog consumption in West Africa has recently increased in various regions (*8*). The price per specimen is 500 F CFA, i.e., about $1 US. The trade exploitation for the Chinese restaurants constitutes another serious problem for the population of this species. The impact of this commercial exploitation needs urgently to be undertaken for the evaluation of the mid- and long-term viability of the local population of this species.

Conclusion

Conraua derooi is classified as a Critically Endangered according to the IUCN Red List of Threatened Species™. With the consideration of all the threats on the population of this species in Missahohe forest, we fear that this population will quickly disappear under current pressures from the local community and the increased tourist trade. Urgent conservation measures need to be undertaken for not only the restoration of the habitats, but also for the protection of this unique population of species. The Togolese Society of nature Conservation "AGBO-ZEGUE" NGO (based in Lomé) has been trying to organize the local communities in four villages surrounding the site of the species (Yo, Kuma Tchame, Kuma Konda and Kuma Adame) on education and awareness program. Collaboration has been initiated with the Office in Charge of Fauna and Wildlife in order to controlling the natural resource poaching in this protected area. In this case, any partner on amphibian conservation will be very useful for the conservation of this particular species of amphibians of the West Africa.

Acknowledgement

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References

1. J. L. M. Hulselmans *Rev. Zool. Bot. afr.*, **84**, 153 (1971).
2. R. Bourgat et *al*., *Rev. suisse Zool*., **103,** 383 (1996).
3. A. D. Leaché et *al*., *Amphib. Rept. Conserv*., **4**, 22 (2006).
4. A. Hillers *et al., Zoosyst. Evol*., **85**, 127 (2009).
5. N.G. Kouamé *et al*. ed. A rapid biological assessment of the Atewa Range Forest Reserve, Eastern Ghana. RAP Bulletin of Biological Assessment **47**, Conservation International, Washington D.C. (2007).
6. MERF-Togo, Rapport technique, 144 p. (2010).
7. J. Penner *et al*., *PLoS ONE*, **8**, e56236. doi:10.1371/journal.pone.0056236 (2013).
8. M. Mohneke *et al., TRAFFIC Bull*., **22**, 117 (2010).

Fig. 4 Strong degradation of Missahohe forest, Photo: G. Segniagbeto.

Teams from Reed College, Kangwon National University, and University of Oregon Collaborate on Multi-Year Study on Thermal Biology of Oriental Fire-Bellied Toad, *Bombina orientalis*

By Robert H. Kaplan

The evolution of form and function in response to genetic and environmental effects has long been an area of intense ecological research. Populations of Oriental fire-bellied toads, *Bombina orientalis*, (Fig. 1) from several localities in the Republic of Korea have been the focus of such studies for years and have contributed to an increased understanding of fundamental issues in amphibian and vertebrate development in relation to environment-genetic interactions.

Over the past 30 years there has been tremendous urbanization and economic growth both globally and locally. In Korea this has caused increasing changes in temperature environments and land use for amphibians. In the case of *Bombina orientalis* these changes have resulted in alteration of two commonly used environments. In the mountains there has been a reduction in availability of stream habitat and associated pond breeding sites. In the lowlands, many rice paddies that were co-opted as breeding sites have dried up as agricultural practices have changed.

Fig. 1: Bombina orientalis from the Republic of Korea. Photo: Robert Kaplan.

Bombina's ability to live in diverse habitats means that embryos easily endure temperatures that range from 8 ºC to 41 ºC on a daily basis (Fig. 2). Very little is known about how unprotected embryos respond to such temperature fluctuation differences. These responses may range from gene regulatory, biochemistry, cell-cell interaction and consequent whole organism properties such as shape, size, physiology, performance ability, predator avoidance and swimming ability. In addition, properties of the immune system may be impacted in unknown ways. In this study we focused on the daily temperature extremes for *Bombina*, using mathematical models based on development at a variety of constant temperatures in the laboratory to predict outcomes for fluctuating temperatures. Surprisingly, we found that the with

the standard models based on development in constant temperature environments do not predict important changes in development, growth, shape and size of larvae that are susceptible to various predators (Fig. 3 and 4). The complexity of this issue requires more work in exploring the implications of daily temperature fluctuations on larval developmental rate and morphology, and how it might impact the long-term success of *Bombina.* With more collaborative research we will better understand both how to protect *Bombina* and how to preserve amphibian biodiversity in Korea, in general.

Acknowledgements

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References

1. R. H. Kaplan, P. C. Phillips, *Evolution*, **60**, 142 (2006)

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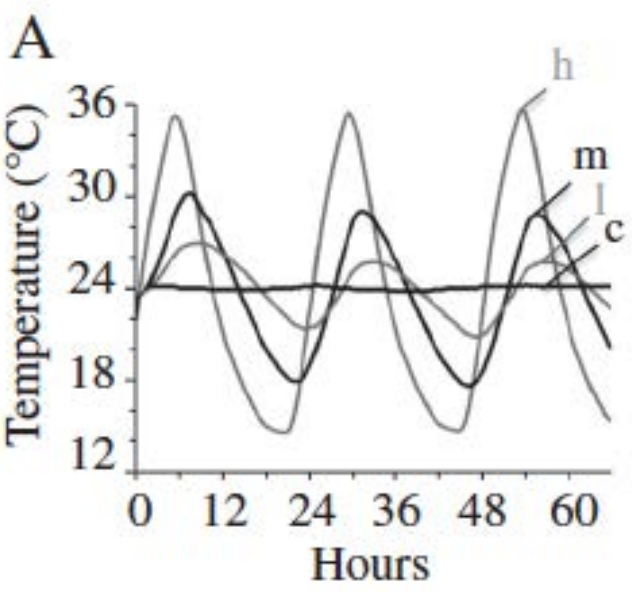

Fig. 2: Example of thermal profiles used to test for similarities in development of Bombina embryos.

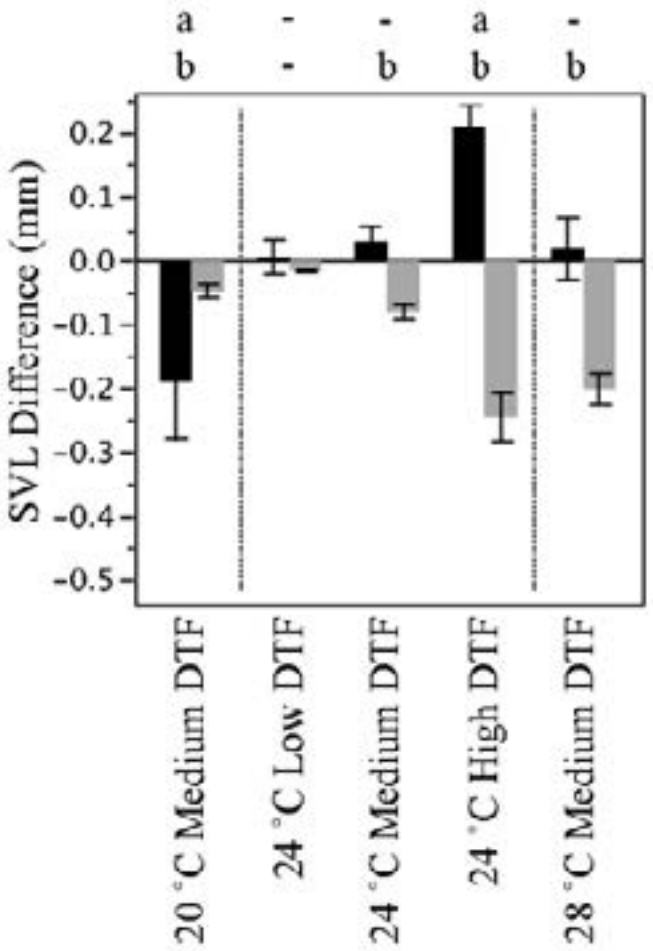

Fig. 3: Theoretically predicted from Bompertz-Gaussian models of development in constant temperatures (gray bars) to those observed in empirical tests in actual fluctuating environments (black bars) for the snout to vent length of hatching stage *Bombina orientalis*. The temperature refers to the average (or constant) temperature. Low, medium and high refer to daily thermal variation as exemplified in Fig. 2.

Fig. 4: A typical *Bombina orientalis* hatching stage larvae. Blue lines are in mm. Differences in relative length of the tail compared to the snout-to-vent length have been shown to have profound implications on locomotor performance and predator avoidance. (Kaplan and Phillips, 2006).

Asia as a Center of Amphibian Resistance against Killer Fungus

By [1]Arnaud Bataille, [2]Mi-Sook Min & [1]Bruce Waldman

Amphibian population declines in many parts of the world have been attributed to the spread of the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*). Indeed, amphibian populations naïve to *Bd* may face significant risk of infection upon first *Bd* incursion. Recent surveys suggest, however, that *Bd* already may be more widely distributed around the globe than previously thought (*1*,*2*). In Asia, *Bd* appears to be ubiquitous, yet has not been implicated as a cause of morbidity or mortality in amphibian populations (*3*-*5*).

Virulence among *Bd* strains varies, but field surveys to date have not mapped specific *Bd* strains to localities. Recently it has been hypothesized that a particularly virulent *Bd* lineage, termed *Bd*-GPL, was created from the intermingling of different *Bd* strains as they were mixed by the animal trade (*1*). However, the evolutionary history of *Bd*-GPL and other possibly hypervirulent *Bd* strains remains unclear (*6*).

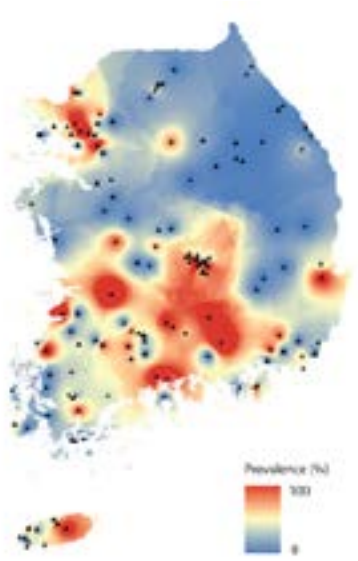

Fig. 1. Spatial variation in prevalence of *Batrachochytrium dendrobatidis* in South Korea. Prevalence values are color-coded following a gradient from blue (0-10%) to light blue (10-22%), yellow (22-35%), orange (35-50%) and red (50-100%). Collection localities are indicated by triangles. From ref (8).

Our poor understanding of the origin of this pathogen may reflect the manner in which study populations have been selected. Most studies on effects of *Bd* have focused on rapidly declining populations, or on *Bd* carried by invasive species (*7*). Virulent *Bd* strains associated with epizootics consequently may have been oversampled in comparison to *Bd* strains associated with amphibians in populations not experiencing declines. A fair representation of the distribution and diversity of worldwide *Bd* strains is needed to unravel the complex evolutionary history of *Bd* so that we can better evaluate its effects on amphibian populations.

We recently completed the first intensive survey of *Bd* genetic differentiation, distribution and prevalence in Asian amphibians, focusing on South Korea (*8*, Fig. 1). Our findings suggest that *Bd* is present in amphibians at high prevalence, but at low infection intensities, in many cases less than those thought necessary to spread the disease. Further, we discovered a high diversity of *Bd* strains that are specific to Asia, infecting many species of frogs and salamanders. Indeed, based on variation in multiple genetic markers, *Bd* strains in Korea are more genetically diverse than those found elsewhere in the world.

The results suggest that *Bd* has evolved with its amphibian hosts in Asia, possibly over hundreds or thousands of years. The historical presence of local chytrid strains in Asia may have given amphibians in the region the opportunity to evolve strong immune defenses against *Bd* which would explain the resilience of Asian amphibians against the disease-causing fungus.

Although we found *Bd* strains genetically similar to *Bd*-GPL in many localities, these strains were rare in comparison to the *Bd* strains that appear native to South Korea. We found *Bd*-GPL mostly on introduced American bullfrogs. Given the extensive trade in amphibians in Asia, the rarity of *Bd*-GPL in South Korea is surprising. Invasive bullfrogs and other commercially traded amphibians are known to spread *Bd* around the globe. Possibly *Bd*-GPL only recently has been introduced into Korea, and thus has not yet had an opportunity to cause disease in native species. Yet if this were true we would expect to find evidence of morbidity, mortality or population declines in areas in which *Bd*-GPL is found, and we did not.

Instead, we suspect that native fungus may out-compete *Bd*-GPL, thus actively helping to protect their hosts. This home-grown resistance to the killer fungus may not be limited to South Korea and Asia. Local chytrid strains have been identified on amphibians in Brazil (*2*), China (*5*), Japan (*3*), South Korea (*8*), Spain, South Africa and Switzerland (*1*), and probably exist elsewhere too. This finding raises the intriguing possibility that native *Bd* strains, possibly harmless to native species, can themselves be used as an effective probiotic treatment to populations threatened by hypervirulent *Bd* strains such as *Bd*-GPL.

The origin of frog-killing strains of *Bd* remains elusive. Presence of chytrid fungus on frogs and salamanders recently has been detected in museum specimens collected in the early 20th century from Africa (*9*), Asia (*3*) and South America (*10*). The isolation and study of local strains of chytrid fungus in Asia and other poorly explored regions will prove critical to resolving this question.

Acknowledgments

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References

1. R. A. Farrer *et al.*, *P. Natl. Acad. Sci. USA* **108**, 18732 (2011).
2. L. M. Schloegel *et al.*, *Mol. Ecol.* **21**, 5162 (2012).
3. K. Goka *et al.*, *Mol. Ecol.* **18**, 4757 (2009).
4. A. Swei *et al.*, PLoS ONE **6**, e23179 (2011).
5. C. Bai *et al.*, *Divers. Distrib.* **18**, 307 (2012).
6. E. B. Rosenblum *et al.*, *P. Natl. Acad. Sci. USA* **110**, 9385 (2013).
7. M. C. Fisher, T. W. J. Garner, S. F. Walker, *Annu. Rev. Microbiol.* **63**, 291 (2009).
8. A. Bataille *et al.*, *Mol. Ecol.* **22**, 4196 (2013).
9. C. Soto-Azat, B. T. Clarke, J. J. Poynton, A. A. Cunningham, *Divers. Distrib.* **16**, 126 (2010).
10. D. Rodriguez *et al.*, paper presented at the World Congress of Herpetology 7, Vancouver, p. 606 (2012).

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Volunteers Help Scientists Learn More about the Endangered Suwon Treefrogs in Korea

By Yikweon Jang

"One, two, three, four ...seventy seven, seventy eight, seventy nine, eighty!!!

Let's stop here and listen to the frogs calling!"

Since 2012, grade-school children and their parents have participated in an annual survey of treefrogs in western central Korea, called "Suwon Treefrog Explorer." These volunteers are at the forefront of a campaign to conserve the treefrog, *Hyla suweonensis*, in Korea. They are equipped with the latest in conservation technology: smartphones with audio and visual recording and Global Positioning System capabilities. Each time they step outside into the darkness of rice paddies, they hope to hear the calls of Suwon treefrogs.

Volunteers of the Suwon Treefrog Explorer program surveying the calls of *Hyla suweonensis.* Photo: Yikweon Jang.

In Korea, there are two treefrog species: *H. suweonensis* and *H. japonica*. While *H. japonica* is distributed widely in East Asia from Japan to Manchuria and from Korea to Mongolia, *H. suweonensis* is restricted to the western coastal plains in central Korea (*1*). These two treefrog species both typically breed from late April to July in places holding water, such as rice paddies and wetlands. However, calls are often heard until late September. These two species are morphologically similar to each other. Thus, it was not until 1980 that *H. suweonensis* was described as a separate species based on differences in call characteristics and minute morphological characters (2). Since the discovery and description of *H. suweonensis*, most studies have been devoted to differences in genetics, advertisement calls and morphology. Based on analyses of mitochondrial and nuclear genes, *H. suweonensis* and *H. japonica* are clearly differentiated (*3-5*). The calls of *H. suweonensis* are generally lower in note repetition rate and higher in dominant frequency than those of *H. japonica* (*6*). Furthermore, the note of *H. japonica* consists of only single pulses, whereas that of *H. suweonensis* consists of several single pulses, followed by connected pulses. Recently, a morphometrical study revealed that the distributions of five characters related to head width and the angle between eyes and nostrils do not overlap in the two treefrog species (7). In general, *H. suweonensis* is smaller and more slender than *H. japonica*.

The Suwon Treefrog Explorer

Despite advances in genetic and behavioral studies, there has been almost no attempt to understand the ecology of *H. suweonensis*. There were anecdotal reports that *H. suweonensis* was disappearing rapidly across its entire range. My students and I have worked on acoustic communication of both treefrog species since 2007. One impetus to establish the Suwon Treefrog Explorer program was that we noticed population decline in one of our study sites in Pyeongtaek, which is located southwest of Seoul. This area used to be where *H. suweonensis* was frequently heard. Recently, the American military bases in this city had been enlarged to relocate the headquarters of the United States Forces Korea. Since then, advertisement calls of *H. suweonensis* have declined noticeably.

Conservation of an endangered species starts with an effective monitoring program. Because treefrogs produce loud species-specific advertisement calls, call surveys have been extensively used to monitor populations. For example, the North American Amphibian Monitoring Program (NAAMP), established in 1994, monitors the distribution and abundance of amphibian populations in the United States and Canada (*8*). This protocol is based on volunteer-based auditory surveys during the breeding season. If many volunteers are secured, a wide range of localities and habitats can be covered. The first survey of the Suwon Treefrog Explorer program was conducted from May 15 through July 16, 2012. One locality was typically surveyed by three to six volunteers in a given night. All volunteers were asked to begin the call survey in their assigned localities around sunset. To increase the probability of detecting *H. suweonensis*, a locality was typically composed of five listening posts with 80 adult steps apart from each other. The five listening posts were arranged on a straight line following the banks of rice paddies. Upon arrival at each listening post, volunteers had to wait silently for one minute to minimize human interference with the frog calling activity. To validate the information, volunteers were

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asked to record advertisement calls for two minutes during monitoring at each listening post. Recordings were made using a smartphone with a built-in recording application, supplemented with GPS information.

Although volunteers agree to conduct call surveys faithfully, they are not frog experts. Volunteers often claimed to have detected *H. suweonensis* in their locality, but the report often turned out to be false. Thus, we invested significantly in training them to conduct reliable call surveys. We invited volunteers for a classroom orientation session in which we explained the biology of the two treefrog species, the call survey method and the purpose of the study. We also distributed a written "survey manual" with all the information mentioned above for ready reference in the field. One thing we quickly realized was that volunteers were helpless once they were out in the locality for a call survey. Thus, we added a field training component, in which we conducted the first call survey together with volunteers at their assigned localities. Volunteers usually had no problem conducting the call survey after the field survey with us.

Rice paddies in the city of Paju where the majority of the Suwon treefrog populations are located in the Republic of Korea. Photo: Amaël Borzée.

All told, the Suwon Treefrog Explorer program carried out acoustic monitoring in 70 localities across the entire known range of *H. suweonensis* in 2012. Each locality was at least two kilometers away from an adjacent locality or separated by geographic barriers that cannot be crossed by treefrogs. As a measure of relative density of anuran populations, we used the calling index (CI), which ranges from zero to three, corresponding in an increasing order to call intensity. *H. suweonensis* was found in only 14 out of 70 localities, whereas *H. japonica* occurred in all 70 localities. The calling activity of *H. japonica* was high, with 56.1% of all surveys registering a CI of three throughout the study period. By contrast, the calling activity of *H. suweonensis* was weak, with only 13.4% of all surveys registering a CI of one or higher. Geographic Information System (GIS) analyses revealed that localities where the Suwon treefrog was found contained a significantly higher percentage of rice paddy area and a lower percentage of the forested area than the other localities. Binary logistic regression confirmed that the percentage of rice paddy had a significant positive effect on the occurrence of *H. suweonensis*. Although not significant, the result of GIS analysis also showed that the percentage of urban area was close to zero in localities where *H. suweonensis* occurred. The results of this study are in preparation to be submitted to a peer-reviewed journal.

The spatiotemporal distributions of the two treefrog species throughout the breeding season of 2012 confirmed that *H. suweonensis* is indeed rare. Furthermore, populations of *H. suweonensis* seem to be isolated from each other, based on the fixation index of 0.41, which is a measure of population differentiation due to genetic structure (*6*). The range of *H. suweonensis* is small in Korea. Thus, *H. suweonensis* seems to suffer from the fatal combination of isolated populations, small population size and narrow distribution, habitat conditions that may lead to extinction in Korea (*6*).

In all aspects, populations of the Suwon treefrogs are declining rapidly. The geographic range of *H. suweonensis* lies within the western central Korea where metropolitan Seoul and its many sprawling suburbs are located. We suspect that habitat fragmentation due to urban development may be one of the major causes of population collapse (*9*). The largest populations of *H. suweonensis* are found in the city of Paju, which borders with the Demilitarized Line (DMZ) in central Korea. Due to a large military presence in this city, urban development has lagged compared to other cities in Gyeongi Province. Thus, the city of Paju still contains vast areas of rice paddies that may be ideal habitats for *H. Suweonensis*. Unfortunately, many development projects are either underway or planned in this city. I fear that once these development plans are underway, the city of Paju will become like the city of Suwon, from which the Suwon treefrog got its common name. Now the Suwon treefrogs are almost no longer found in the city of Suwon, due to rapid urban development.

The people of Korea have a responsibility to help this species survive, because it is endemic and native to our country. I believe that if we take swift and decisive measures, including the immediate establishment of protected areas, the Suwon treefrog may be saved from extinction. There are many pieces of critical information necessary for the conservation of *H. suweonensis*, including habitat and ecological requirements, genetic background and the exact extent of its range. However, the most important piece of information may come from interested children and their parents: That is, the population dynamics of *H. suweonensis*, which studies the change of population size over time.

Acknowledgment

I am indebted to all volunteers of the Suwon Treefrog Explorer program and to Dongascience, which organized this program. I would like to acknowledge Gyeongah Roh and Amaël Borzée for all the work on this project. This work was supported financially by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MEST) (2012R1A2A2A01046977) and the Ewha Global Top 5 Project.

References

1. IUCN, www.iucnredlist.org (2013).
2. M. Kuramoto, Copeia 1980, 100 (1980).
3. X Hua *et al.*, *Herpetologica* **65**, 246 (2009).
4. C. J. Riehl, J. T. Lell, L. R. Maxson, *Biochem. Syst. Ecol.* **23**, 245 (1995).
5. S. Y. Yang, B. S. Park, Korea. *Korean J. Zool.* **31**, 11 (1988).
6. S. Park, G. Jeong, Y. Jang, *Behav. Ecol. Sociobiol.* **67**, 1345 (2013).
7. A. Borzée *et al.*, *Anim. Cells Syst.*, in press (2013).
8. USGS, https://www.pwrc.usgs.gov/naamp/index.cfm? (2013).
9. R. Frankham, J. D. Ballou, D. A. Briscoe, *Introduction to Conservation Genetics* (Cambridge University Press, Cambridge, UK (2010).

A Review on Frog Find 1.0

By [1]Ramya Badrinath & [2]Preeti Gururaja

India boasts a rich diversity of amphibians, which is concentrated in the Western Ghats and in Northeast India. About 360 species have so far been reported from the Indian subcontinent, about two-thirds of which are endemic to the Western Ghats and Northeast region. Most of the species in these regions are facing serious threats of extinction and there are many species awaiting discovery and documentation. With a large number of amphibian enthusiasts coming in, there was a need for easy access to some basic information about frogs and toads. The gap between the scientific data and people is slowly narrowing and the technology today have advanced to greater heights making the data availability to millions of people like never before. The recent past has witnessed a drastic shift in gaining the access to data from research papers, text books and documents on the Internet and handy mobile phone applications that are easy to use, besides gaining knowledge. One such mobile application built on the android operating system is Frog Find 1.0, which is the first android application in India that is developed for easy identification of frogs and toads of the Western Ghats in the field.The application is developed by Harish Shanthi Kumar, Ashwin Murugesh, Vinay Kumar and Gururaja K V based on the popular amphibian field guide "Pocket Pictorial Guide to Frogs and Toads of Western Ghats" written by Gururaja K V. It features high resolution photographs of 55 species of 157 species of frogs and toads in and around Western Ghats in India. The App displays information like common and scientific names of the frogs with their habitats and distribution data. It also provides information on the ecological status of the amphibians (whether common or endemic based on IUCN Red List of Threatened Species™) as well as relative size and grouping details. An important and very useful feature of the App is the icon hotspot which provides information on the distinguishing characters of the frog that facilitates easy identification of the species. The user(s) can also avail a species distribution map which is professionally rendered with the species distribution shown in red spots and the surrounding known regions and cities in and nearing the Western Ghats stretch. The application has a horizontal view which aids in comfortable viewing and usage.

The interface of the application is crisp, with a high resolution photograph of the species which takes to the center screen, with all the icons of relevance surrounding the sides and corners of the display. Features like slideshow mode, landscape book style naviga-

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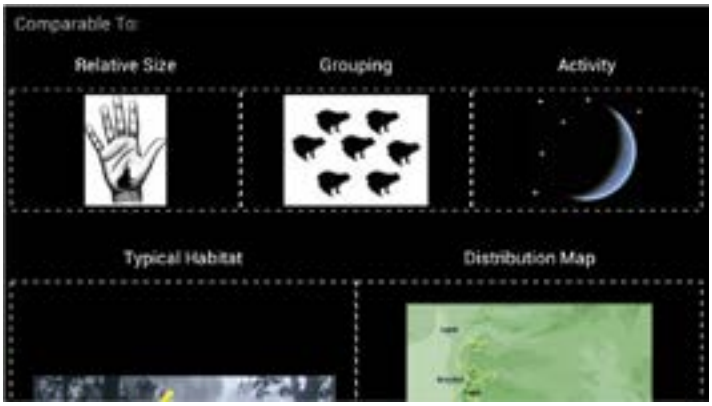
tion and wallpaper icons make this application very user friendly. Overall, the performance of the application is good.

The developers have made an excellent effort in designing the application with respect to content and user friendliness. For a novice who wishes to explore further in this area of Indian anuran diversity, the content delivered aims to equip the reader required basic information about frogs and toads. The application is of no cost and is available for free download in the Google Play store <https://play.google.com/store/apps/details?id=com.gubbilabs.frogsandtoads>. It is easily downloaded and installed into most android operated smart phones and tablets. The application presently supports the Android system and very soon will be made available in an iOS version as well. From June 2013 to date, over 397 installs have been made with both national and international users.Frog Find is one of the unique mobile applications which can help the citizens in raising the awareness of Western Ghats frogs and will be a good stepping stone for helping Indian amphibian conservation measures.



App Authors: Gururaja KV, Harish Shanthi Kumar, Ashwin Murugesh and Vinay Kumar

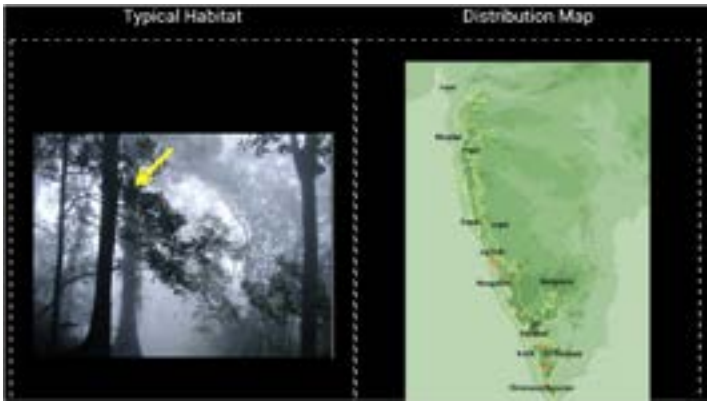
Publisher: Gubbi Labs LLP

Android Application

Price: Free

Application (App) runs on: Android operated smart phones and tablets

Application available in: Google Play



Research Highlights: Launching Amphibian Conservation Physiology in India through Australia-India Collaborative Research

Jerdon's Bullfrog, *Hoplobatrachus crassus*. Photo: Dr Edward Narayan.

By Edward Narayan

Conservation physiology provides a powerful diagnostic tool to conservation biologists for assessing the physiological sensitivity of threatened species to environmental challenges (*1*). This emerging field of biological sciences is the focus of Dr. Narayan's research career since commencing his Ph.D. in 2006 in the Fiji Islands. He has discovered many interesting aspects of reproductive biology, stress physiology and captive breeding of threatened amphibians, including dynamic direct embryonic development in the endangered Fijian ground frog (*Platymantis vitiana*) (*2*). Together with numerous Honours and Ph.D. students and collaboration with senior ecologist (Prof Jean-Marc Hero) from Griffith University, Australia, Dr. Narayan's postdoctoral research has also provided pioneering knowledge in reproductive ecology and stress physiology of numerous native frog species in Queensland, Australia. Recently, this team has discovered sub-lethal impacts of globally debilitating disease (chytridiomycosis) on native amphibian populations in Queensland (*3*).

Presently, Dr. Narayan is exploring India, which has taken him back to his ancestral roots from Australia. This opportunity has been possible through the successful Australian Academy of Science (Australia-India) Fellowship program. This prestigious fellowship was awarded this year by the Australian Academy of Science to 16 highly talented early career Australian researchers. Under this program, Dr. Narayan has initiated collaboration with dynamic Indian researcher (Dr. Narahari Gramapurohit from the University of Pune), whose research interests and focus in amphibian physiology are outstanding. Together, this research team (also comprising of numerous students and volunteers) has taken up the challenge to discover the ecological physiology of some of India most unique and understudied amphibians. The aim of this collaborative research is to discover the ecological physiology of native amphibians against environmental threats, such as the pathogenic disease chytridiomycosis. Dr. Narayan has introduced the methods of non-invasive reproductive and stress hormone analysis to students and staff at the Department of Zoology, University of Pune. Like Australia, India also harbors a rich diversity of amphibians, mainly situated in the Western Ghats and North-east India. Native amphibians in India (> 50%) are currently facing immense environmental threats that increase extinction risk. The impacts of two globally devastating environmental stressors; pathogenic diseases and climate variability upon biology of native amphibians of India are virtually unknown. Fieldwork for this research is based in the rugged terrains of the Western Ghats. This research team has also taken opportunities to study physiological stress in common

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species, such as the Asian common toad (*Duttaphrynus melanostictus*), which are abundant near the University of Pune campus. The outcomes of this collaborative research will highlight fitness consequences and survival of native amphibians under predictable and unpredictable climatic scenarios.

According to Dr. Narayan, such rare opportunities provide a major stepping stone for joint research between Australian researchers and scientists in developing countries such as India. This is important for the promotion and advancement of science and discovery, which also helps our efforts to increasing biological knowledge for threatened species. The future looks highly promising for the advancement of amphibian conservation physiology in India.

References

1. Narayan, *Conservation Physiology* 1: 1-16 (2013).
2. Narayan *et al., Journal of Zoology*, 284: 68-75(2011).
3. Kinderman *et al., Comparative Biochemistry and Physiology, Part A* 162: 171–176 (2012).

Diverse mountain ranges of the Western Ghats. Photo: Dr Edward Narayan.

Dr. Narayan (middle) demonstrating hormone analysis to Dr. Narahari Gramapurohit. and student.

Dr. Edward Narayan sampling frogs (*Rana* sp.) in the Western Ghats.

Bombay night frog (*Nyctibatrachus humayuni*) adult male frog guarding eggs. Photo: Dr. Edward Narayan.

Korea Regional Update

Endangered Suwon tree frog (*Hyla suwonensis)* newly designated in 2012. Photo: Eun-Young Kim.

By [1]Daesik Park & [2]Robert H. Kaplan

Several important events have occurred in Korea since the last regional update.

First, the Korean Ministry of Environments re-evaluated the list of Endangered Korean amphibian species and as a result, added the Suwon tree frog (*Hyla suwonensis*) as an Endangered category I species for their limited distribution range and small population size. Therefore, Korea has now listed three Endangered amphibian species, including two Endangered category II species, the Narrow-mouthed toad (*Kaloula borealis*) and the Gold-striped pond frog (*Rana plancyi chosenica*). The National Institute of Biological Resources and National Research Foundation of Korea have recently funded several research projects to determine the distribution of the species in the Korean peninsula and to investigate the basic ecologies, such as the reproductive biology and interaction with conspecific *Hyla japonica* (See research insights).Second, the National Institute of Ecology (NIE, http://ecoplex.go.kr/) in Korea invested more than 448 million dollars and is set to open October 2013. The NIE recently got a nickname, Ecoplex. The Ecoplex will mainly function to manage various future ecological research projects related to basic ecology, long-term ecological monitoring, climate change, conservation and re-introduction of Endangered species and invasive species management. Also, the Ecoplex will have five different ecosystem facilities, including tropical, desert, mediterranean, temperate and polar for public education and special ecosystem research.Third, the 6th annual meeting and conference of the Society of Korean Herpetologists (http://www.krsh.co.kr/rb/) was successfully held at Jeju National University 6-7 July 2013. Twenty research papers were presented, covering recent chytrid research results (see research insights), climate change effects on herpetofauna in national parks, phylogenetic reinvestigation of *Hynobius* species in Korea and spatiotemporal distributions of Suwon tree frog.

Finally, several important papers were published in peer-reviewed journals by Korean ASG members:

1) J. M. Arrighi, E. S. Lencer, A. Jukar, D. Park, P. C. Phillips, R. H. Kaplan. 2013. Daily temperature fluctuations unpredictably influence developmental rate and morphology at a critical early larval stage in a frog. *BMC Ecology* 13: 1-11;

2) A. Bataille, J. J. Fong, M. Cha, G. O. Wogan, H. J. Baek, H. Lee, M. S. Min, B. Waldman. 2013. Genetic evidence for a high diversity and wide distribution of endemic strains of the pathogenic chytrid fungus *Batrachochytrium dendrobatidis* in wild Asian amphibians. *Molecular Ecology* 22: 4196-4209;

3) S. Park, G. Jeong, Y. Jang. 2013. No reproductive character displacement in male advertisement signals of *Hyla japonica* in relation to the sympatric *H. suweonensis*. *Behavioral Ecology and Sociobiology*

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67: 1345-1355;

4) D. Park, M. S. Min, K. C. Lasater, J. Y. Song, J. H. Suh, S. H. Son, R. H. Kaplan. 2013. The conservation of amphibians in Korea. Chapter 4 *in* Part 1. Asia *in* "Status of Conservation and Decline of Amphibians: Eastern Hemisphere," editors H. Heatwole and I. Das. Vol. 11 in the series "Amphibian Biology," edited by H. Heatwole. Natural History Publications (Borneo), Sdn. Bhd, Kota Kinabalu, Sabah.

Attendees of the 6th Annual Conference of the Korean Society of Herpetologists.

Photographs of National Institute of Ecology (photos by Young-Chae Park). Photo: Young-Chae Park.

Successful Coexistence of Humans and Amphibians: A Long Term Toad Conservation Project in Cheongju-si, South Korea

By Wan Hee Park

A pair of migrating toads (*Bufo gargarizans)* moving towards Wonheung cofferdam for breeding, and toadlets moving towards Guryong mountain after metamorphosis. Photo: Wan Hee Park.

The toad conservation project was started in 2003, when numerous toadlets (*Bufo gargarizans)* were found moving towards Guryong mountain from the Wonheung cofferdam (a large watertight enclosure used for agriculture) where a large-scale city development project was planned. Between 2003 and 2004, members of ToadFriends, a non-governmental organization (http://cafe.daum.net/toadfriends/), visited numerous government offices involved in the project and met with multiple representatives to discuss the importance of conservation of the cofferdam, including how critical this ecological area is for the local populations of toads (*1*). Finally, in 2005, the Korea Land and Housing Corporation (LH) decided to conserve the cofferdam and nearby areas and support development of the land into an ecological park. Since that time, ToadFriends has put much effort toward conserving the cofferdam and nearby areas for the last 10 years. As a result of ToadFriends' work, this project is seen as one of the best examples in Korea for how conservation and development can work together in the face of rapidly and widely occurring developments in rural areas (*2,3*).

Wonheung cofferdam was originally surrounded by rice paddies and dried crop lands in 2003, but now it is encircled by tall apartments and commercial buildings, including a district public prosecutor's office and a local court. Many original features of the Guryong mountain that surrounds the cofferdam have changed due to increased local development and the large increase in visits to the area by residents living in nearby apartments (*4*). Despite these pressures, in 2013 approximately 50 pairs of toads migrated between the tall buildings to their breeding sites located in the cofferdam. Toadlets were found moving back to the Guryong mountain after metamorphosis. During these migration periods, many apartment residents have been seen with their children gathering and facilitating the migrations of the toads and toadlets.

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Building an Ecological Community of Co-existence

Today, the ToadFriends continues to build an ecological community of co-existence between wildlife and local residents. They achieve this by working to protect the toads in the area and by managing an ecological park with numerous ecological education programs for the younger generations. Recently, the Council of San Nam Toad Ecology Town Apartment was established by independent resident organizations from eight different apartment complexes. The Council's work is funded by donations from the local apartment residents. Each year the Council organizes several ecological activities, such as ornamental and native plantings in the area during April, the ToadLife festival in May and the ToadLife Lecture series throughout the year. Each activity has many different components. For example, the ToadLife festival consists of a parade in frog and animal costumes, animal plays, a drawing competition for children, resident song contests, screening movies, opening a local marketplace and much more. Recently the Council also started publishing and distributing 6,000 copies of a biweekly newsletter with reports on recent ecological issues in the area and daily life stories of apartment residents. All of these activities help bring the residents out of their apartments and encourage them to meet others living in their area and help create a shared vision for their community and the local wildlife.

Before and after: Wonheung cofferdam in 2003 (before) and in 2013 after completion of a city developmental project (after development). Photo: Wan Hee Park.

Initial toad conservation activity at the Wonheung cofferdam that was started in 2003 is now being extended to support concerted actions by apartment residents to conserve the local wildlife and ecology and to create more ways to bring a small town neighborhood feel to the residents in the densely populated apartment complexes. ToadFriends is encouraged that these numerous actions will result in the healthy development of an ecological friendly Eco-city Cheongju and Eco-Korea and that the efforts will lead to the critically important co-existence between the wildlife and the local residents of our community.

Acknowledgments

I would like to dedicate this article to members of ToadFriends Corporation, local residents in the area and much thanks to Drs. D. S. Park and R. Kaplan, co-chairs of Korean ASG, for translating the article.

References

1. H. Y. Hwang, W. S. Jeon, D. H. Kim, *J. Korean Plann. Assoc.* **44**, 147 (2009).
2. W. S. Jeon, D. H. Kim, H. Y. Hwang, *J. Korean Urban Geogr. Soc.* **12**, 41 (2009).
3. J. J. Kwon, D. H. Kim, H. Y. Hwang, *J Korean Inst. Landscape Archit.* **39**, 65 (2011).
4. B. K. Jin, thesis, Korea National University of Education (2008).

Various community activities: eco-park (up left) and how to organize resident independent organizations (toad drawing on the apartment, below right).

Translocation of the Endangered Boreal Digging Frog (*Kaloula borealis*) in Lake Shihwa, Gyeonggi Province, Korea

By Ha-cheol Sung

Release of Boreal digging frog tadpoles. Photo: Yu-Young Lee.

Anthropogenic habitat destruction, modification and fragmentation have been the primary causal factors in global amphibian population declines (*1*). The Boreal digging frog (*Kaloula borealis*), also known as the narrow-mouthed frog, is threatened by local population extinction in Korea as a result of human activity. The majority of the frog's breeding sites are fragmented, so recent development and construction of human facilities (i.e., new buildings and roads, and cutting of hillsides) has caused great concern for the decreasing local populations of *Kaloula borealis*. To legally protect this species, the Ministry of Environment of Korea has listed it as an Endangered category II species since 2005. Since 2012, we have undertaken a translocation project to protect *Kaloula borealis* populations from recent development and construction of new buildings and roads on the eastern side (354 ha) of Lake Shihwa (an artificial seawater lake), Gyeonggi Province, Korea. In 2012, we surveyed the area in detail and observed approximately 60 adults and several spawning sites. At that time, we preserved approximately 1.5 ha of the habitat, including several spawning sites, for conservation and management of the species. The preserved habitats were selected after considering crucial breeding and hibernation sites, and we prepared the area to ensure suitable habitats were available for winter. We created more ponds, ditches and rainwater pools; provided shelters and resting places using wood pyres and rocks; removed a field of reeds that promoted dry breeding sites; and replanted the area with herbaceous plants, shrubs and several tall trees. To minimize translocation failure from the movement of frogs from the release site to their original habitats (homing), we set up an outer fence surrounding the preserved habitats, that was made of blue wire gauze with a 0.3 cm mesh (80 cm high) and buried about 10 cm below the surface of the ground to prevent frogs from passing under the fence. Metal stakes supported the fence at 1.5 m

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intervals, and the upper 15-20 cm of the fence was bent to prevent the frogs from passing over the fence.To move frogs to the prepared release sites, we visited the breeding sites nine times from 12 June to 8 August, 2013. We captured and translocated a total of 69 adults (64 males, five females), approximately 4,000 tadpoles, one juvenile and approximately 2,000 eggs (by hand or with dip nets) to the preserved habitats. For each frog captured, we recorded the capture date, time, location, sex and measured the frog's snout-vent length (SVL) and body mass, and tagged it with a visible implant elastomer (VIE) tag, with seven colors for individual identification. Out of 64 males released, three males were recaptured in their home range almost 400 m away during the third and seventh capturing trials.

Translocation is a relatively common and important tool for conservation and management of threatened populations. Recently in Korea, approximately eight to 15 translocation projects per year have been undertaken. Germano and Bishop (2), after reviewing 91 translocation projects of amphibian and reptile species, suggested three causes of translocation failure: homing, migration of introduced individuals out of release sites and poor habitat. From the beginning of this project, we worked to minimize these three factors with the support of "Songsan Green City Management Team" of Korea Water Resources Corporation. To date, our project finished the first step with the aim to reduce the risk of local extinctions and to maintain healthy, breeding frog populations by preserving critical original habitats despite the destruction and modification of the surrounding landscape. We plan to monitor the released *Kaloula borealis* and the habitats to examine short and long-term population trends, and to check for unpredicted disturbances that may impact the stability of the population.

Acknowledgments

This project was carried out with the support of "Songsan Green City Management Team," Korea Water Resources Corporation, South Korea.

References

1. R. A. Alford, S. J. Richards, *Ann. Rev. Ecol. Syst.* 30, 133 (1999).
2. J. M. Germano, P. J. Bishop, *Conserv. Biol.* 23, 7 (2008).

Preserved habitats for translocation of Boreal digging frogs. Photo: Yu-Young Lee.

Measurement of weight of a Boreal digging frog. Photo: Yu-Young Lee.

Individual marking with visible implant elastomer (VIE) tags for monitoring. Photo: Yu-Young Lee.

Amphibian Conservation Programs at Taronga Zoo

The Southern corroboree frog (*Pseudophryne corroboree*) may be reduced to less than 50 individuals in the wild. Photo: M. McFadden.

By [1]Michael McFadden & [2]Peter Harlow

Taronga Zoo has been actively involved in conservation programs for a number of south-eastern Australia's most threatened amphibians in recent years. There are six threatened frog species that have been the focus of captive breeding, reintroduction, conservation research or educational campaigns. These are all housed at the zoo in climate-controlled facilities ranging from quarantined rooms to converted shipping container facilities. Below is a short overview of each of these conservation programs.

One of our key focus species is the Southern corroboree frog (*Pseudophryne corroboree*). *Pseudophryne corroboree* has suffered dramatic declines throughout their high altitude, subalpine habitat since the 1980's. Recent surveys indicate that there are less than 50 wild adults remaining and no breeding recorded in the wild for 2013. Taronga Zoo currently holds the largest *ex-situ* breeding population of this species with over 400 frogs housed in two facilities. Additional *ex-situ* populations also exist at Melbourne Zoo, Healesville Sanctuary and the Amphibian Research Centre. Over the last three years, captive breeding has been highly successful and over 1,400 eggs have been reintroduced from the zoo as part of an experimental translocation study led by Dr. David Hunter from the New South Wales Office of Environmental and Heritage (NSW OEH) (*1,2*). These include releasing eggs into chytrid-free, artificial pools in natural bogs and also into a large disease-free enclosure constructed in the Snowy Mountains.

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Corroboree frog conservation facility at Taronga Zoo. Photo: M. McFadden.

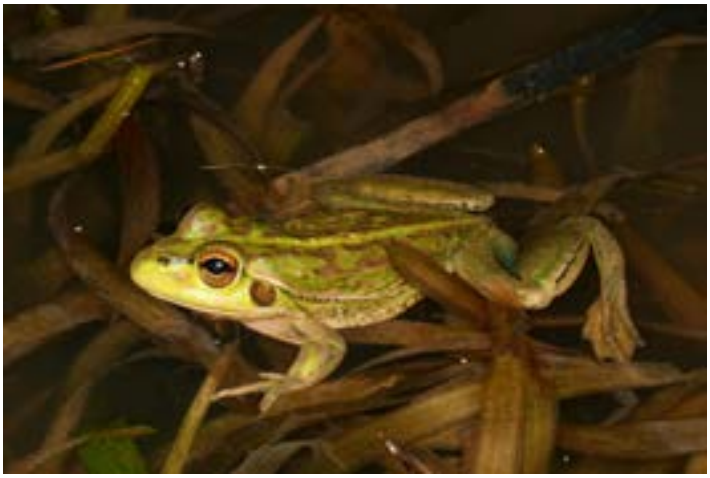
Similarly to *P. corroboree*, the Northern corroboree frog (*P. pengilleyi*) is also Critically Endangered due primarily to amphibian chytrid fungus. Taronga Zoo has been breeding this species using animals collected as eggs ten years ago from a genetically-significant population in the Northern Brindabella mountains. With this wild population now restricted to a couple of small bogs, the zoo has been working with the NSW OEH to re-establish wild populations, releasing between 150-300 eggs and tadpoles per year for the last four years. As *P. pengilleyi* does not mature until four to five years of

Green and golden bell frog (*Litoria aurea*), formerly common in south-eastern Australia is now highly threatened. Photo: M. McFadden.

age, the success of this is not yet known. In early 2014, we will also trial the release of juvenile frogs.

Taronga Zoo has been involved in conservation actions for the Green and Golden bell frog (*Litoria aurea*) for many years, including the release of 20,000 tadpoles and young frogs between 1996 and 2004 (*3*). *Litoria. aurea* was formally one of south-eastern Australia's most abundant frog species but it rapidly declined in recent decades and is now restricted to isolated, and mostly coastal, populations. Currently, the zoo has been working with one population, located south of Sydney, in collaboration with consultant Arthur White and the Village Building Company. Recent sharp declines in this population have required the need for urgent habitat restoration work and supplementation of animals from the insurance population at the zoo. In 2012 and 2013, with successful breeding from numerous pairs at the zoo, 7,500 tadpoles were released at the site. These will be monitored over the next two years to determine their survival.

A similar high profile species of bell frog that the zoo is now working with is the Yellow-spotted bell frog (*Litoria castanea*). This species was rediscovered on the Southern Tablelands of NSW in 2009 after it was thought to have gone extinct 30 years earlier. It i currently only known from less than a hundred individuals on a small stretch of creek on private property. Taronga Zoo has been working in collaboration with NSW OEH and now has a small *ex-situ* population of ten frogs, collected as tadpoles in recent years. Attempts will be made this summer to breed these specimens so that experimental reintroductions can be attempted at additional sites in the Southern Tablelands.



Yellow-spotted bell frog (*Litoria castanea*), rediscovered after disappearing for thirty years. Photo: M. McFadden.

Since 2009, Taronga Zoo has been working in collaboration with James Cook University (JCU) and the NSW OEH on a project investigating acquired and innate immunity of threatened frog species to chytrid fungus. The Booroolong frog (*L. booroolongensis*) is a Critically Endangered riverine species that the zoo has been maintaining and breeding for a number of years for reintroduction trials, conservation research and a community education campaign (*4*). Studies at the zoo undertaken by JCU researchers Dr. Scott Cashins and Laura Grogan on acquired immunity to chytrid fungus have demonstrated that prior exposure to this pathogen did not provide it with a greater chance of survival (*5*). This research has

continued to investigate whether the Endangered Alpine tree frog (*L. verreauxii alpina*) has developed innate immunity to the disease. Initially, a lab trial was undertaken on this species at the zoo. More recently, over 1,100 juvenile *L. v. alpina* were released that were collected from the wild as eggs from chytrid-free and chytrid-exposed populations and reared at the zoo. These frogs will be monitored by JCU Ph.D. candidate Laura Brannelly.

References

1. M. McFadden *et al., Amphib. Reptile Conserv. In press*.
2. D. Hunter *et al*., in: Global Reintroduction Perspectives: 2010; Additional case studies from around the globe, P. S. Soorae, Ed. (IUCN SSC Re-introduction Specialist Group, Abu Dhabi, UAE, 2010), pp. 72-76.
3. M. McFadden *et al*., *Aust. Zool.* **34**, 291 (2008).
4. M. McFadden, D. Hunter, P. Harlow, R. Pietsch, B. Scheele, in: Global Reintroduction Perspectives: 2010; Additional case studies from around the globe, P.S. Soorae, Ed. (IUCN/ SSC Re-introduction Specialist Group, Abu Dhabi, UAE, 2010), pp. 77-80.
5. S.D. Cashins *et al*., *PLoS ONE* **8**, e56747 (2013).

Booroolong frog (*Litoria booroolongensis*), a Critically Endangered riverine frog in south-eastern Australia. Photo: M. McFadden.

Alpine tree frog (*Litoria verreauxii alpina*) is the focus of studies innate immunity to chytridiomycosis. Photo: M. McFadden.

Green Cascade Frog (*Odorrana chloronata*). Photo: Jonathan Kolby.

Amphibian Chytrid Fungus and Ranavirus in Asia: Is Hong Kong Sitting in Hot Water?

By[1*,2,3]Jonathan E. Kolby & [4]Sara D. Ramirez

The spread of emerging infectious amphibian diseases is a significant factor in the global decline of amphibian populations. Two agents are of particular concern: amphibian chytrid fungus (*Batrachochytrium dendrobatidis*, *Bd*) and ranaviruses, both of which are highly transmissible, demonstrate low host species specificity, capable of producing high mortality, and are closely associated with aquatic systems. These pathogens have now been detected in dozens of countries and hundreds of species, and the global trade in live amphibians is believed to provide an efficient avenue of dispersal (*1*,*2*). Although the presence of both *Bd* and *Ranavirus* in Asia has been confirmed (*3*-*6*), neither have yet been described from Hong Kong nor have enigmatic amphibian declines been observed in the region (*7*).

The apparent absence of amphibian diseases in Hong Kong is remarkable, as global wildlife trade hubs are particularly prone to "pathogen pollution", especially in the absence of wildlife disease control. If introduced, the region's 24 species of native amphibians, and in particular three endangered species, may currently be in jeopardy. Accordingly, the high risk of pathogen introduction from trade activities and potential spillover into wild populations generated our concern and an investigation to evaluate the presence of amphibian pathogens in Hong Kong's trade sector was performed.

In 2012, wildlife disease screening was performed on shipments of amphibians imported into the USA from Hong Kong. This collaborative effort between James Cook University and EcoHealth Alliance discovered that some animals arriving from Hong Kong were, in fact, infected with *Bd* and *Ranavirus*. This surprising information confirmed the physical presence of these pathogens in Hong Kong within the amphibian trade and demonstrated a genuine threat to the region's amphibian biodiversity.

Alarmed by these findings, a rapid response project was recently conducted in Hong Kong to determine the extent of *Bd* and *Ranavirus* distribution throughout the region. This rapid response effort was a collaborative effort between EcoHealth Alliance, James Cook University, the Amphibian Disease Lab at the San Diego Zoo Institute for Conservation Research, the Hong Kong Agriculture, Fisheries, and Conservation Department, and Ocean Park Hong Kong. Hundreds of amphibians were sampled, including both traded and free-ranging animals. In addition, water was sampled from am-

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Lesser Spiny Frog (*Quasipaa exilispinosa*). Photo: Jonathan Kolby.

phibian habitats throughout the region to increase the probability of detecting *Bd* considering prevalence in wild populations may have been low enough to evade detection by conventional skin swab methods. In addition, environmental metrics including air and water temperatures were recorded throughout the field surveys to determine whether conditions in Hong Kong are hostile to the survival of *Bd* and *Ranavirus*; a potential explanation for the lack of *Bd* detection in previous surveys.

While performing this investigation, activities promoting pathogen exposure and establishment were commonly observed. Wastewater from pet markets potentially contaminated with *Bd* and *Ranavirus* was disposed of directly into the environment via storm drains, providing a potential avenue of dispersal into native amphibian habitats. Even more alarming were indications of merit release, a religious practice involving the purchase of imported exotic amphibians and release into Hong Kong's country parks, where contact with native amphibians would encourage transmission of *Bd* and *Ranavirus*. On several occasions, dead or dying amphibians were encountered in natural water bodies and the location and species suggested intentional release.

Samples are being processed by Katy Richards-Hrdlicka and Dana Reed at Yale University, the Amphibian Disease Lab at the San Diego Zoo Institute for Conservation Research, and Ocean Park Hong Kong. Sample analysis is currently underway and results will soon be made available. Results from this project will provide the most comprehensive illustration of amphibian disease presence in Hong Kong to date and help facilitate risk management to protect native species.

Acknowledgments

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References

1. D. H. Olson *et al.*, PLoS ONE **8**: e56802. doi:10.1371/journal.pone.0056802.
2. L. M. Schloegel, A. Picco, A. M. Kilpatrick, A. Hyatt, P. Daszak, *Biol. Conserv.* **142**, 1420 (2009).
3. M. Gilbert *et al.*, *Ecohealth* (2013). DOI: 10.1007/s10393-013-0817-7
4. Y. Une, A. Sakuma, H. Matsueda, K. Nakai, M. Murakami, *Emerg. Infect. Dis.* **15**, 1146 (2009).
5. J. Vörös, C. Satasook, P. Bates, S. Wangkulangkul, *Herpetol. Notes* **5**, 519 (2012).
6. K. Xu *et al.*, *EcoHealth* **7**, 18 (2010).
7. J. J. L. Rowley *et al.*, *Dis. Aquatic Organ*. **78**, 87 (2007).

Despite the common public image of Hong Kong as a bustling metropolis, a significant portion of the land remains protected in a network of country parks, preserving a wealth of biodiversity. Photo: Jonathan Kolby.

Hong Kong Cascade Frog (*Amolops hongkongensis*). Photo: Jonathan Kolby.

Asian Painted Frog (*Kaloula pulchra*). Photo: Jonathan Kolby.

Short-legged Horned Toad (*Xenophrys brachykolos*). Photo: Jonathan Kolby.

Sampling river water for the presence of amphibian chytrid fungus in Hong Kong, where a dead bullfrog (*Hoplobatrachus rugulosus*) was discovered. Photo: Jonathan Kolby.

Lesser Spiny Frog (*Quasipaa exilispinosa*). Photo: Jonathan Kolby.

East-Asian Bullfrog (*Hoplobatrachus rugulosus*). Photo: Jonathan Kolby.

Jonathan Kolby sampling a Giant Spiny Frog (*Quasipaa spinosa*) to detect chytrid and ranavirus infection. This is both the largest and most range-restricted amphibian species in Hong Kong and is of special conservation concern. Photo: Sara Ramirez.

Understanding Possible Etiologies of Amphibian Crisis in Sri Lanka

By Uthpala Jayawardena & Rupika Rajakaruna

Sri Lanka, harboring 113 known species of amphibians (*1,2*), reports loss of 19 species from her fauna, contributing to the global amphibian crisis (*1*). Apart from these declines, naturally occurring malformations have also been reported by researchers in many instances where, scoliosis, ectromelia, amelia, eye opaqueness, brachygnathia, etc. have been observed in the wild due to causes unknown to date (*3,4*). Habitat destruction and fragmentation are the major causes for declining amphibian populations while ultraviolet (UV) radiation, xenobiotics and trematode infection, are also listed as having a role in declines. Very few studies have been carried out in Sri Lanka to assess these etiologies on local amphibian fauna. This article highlights major findings from a number of pioneering laboratory studies conducted to test the effects of; UV-B radiation, pesticides and trematode infection on two common anuran species, Common hourglass tree frog, *Polypedates cruciger* and the Asian common toad, *Duttaphrynus melanostictus* in the Department of Zoology, University of Peradeniya in Sri Lanka.

Pesticide as a Prime Suspect

Acute and chronic exposures to four commonly used agricultural pesticides including two insecticides, chlorpyrifos (Lorbosan EC 40® or Pattas®), dimethoate (Dimethoate EC 40®) and two herbicides, glyphosate (Roundup®), propanil (3,4 DPA®), induced malformations and reduced survival in tadpoles of both anuran species to a varying degrees (*5,6*). Acute exposure to higher concentration series (≤ 25 ppm) for 48 hr period were conducted to determine the LC_{50} values while chronic exposure to ecologically relevant concentrations (≤ 1 ppm) until metamorphosis were conducted with Gosner stage 25-26 tadpoles of the two species. For both species 48 hr LC_{50} values obtained for the amphibians were within the PAN specified values for amphibians (*5-7*). At chronic exposure, glyphosate reported the highest decline in survival and highest percentage malformations for both species (*5,6*). However, *D. melanostictus* showed remarkably low survival (36%) compared to *P. cruciger* (75%). Growth parameters were measured as size at metamorphosis and TE_{50}. Metamorphosis of exposed tadpoles was significantly delayed where 57 days for *P.cruciger* extended to 147 days and 34 days of *D. melanostictus* extended to 73 days. However, the size, measured as snout to vent length (SVL) and body weight of metamorphs confirmed that this delaying benefited *D. melanostictus* by increasing the body size while *P. cruciger* reported smaller body sizes compared to their control animals. Malformations reported were mainly kyphosis (Fig. 1), scoliosis, skin edema and lumps (Fig. 2), present in very high percentages as high as 75% in *P. cruciger.* The study confirmed that ecologically relevant concentrations of pesticides can pose severe threats to our amphibian fauna. Some other studies conducted elsewhere with the same test species reported severe mortality, growth retardations, and reduced activity up on exposure to gramaxone, chlorpyrifos, carbofuran and diazinon (*8*). In agreement with our results, they reported growth retardations in exposed animals together with similar array of malformations such as tail curvature, swollen body, etc.

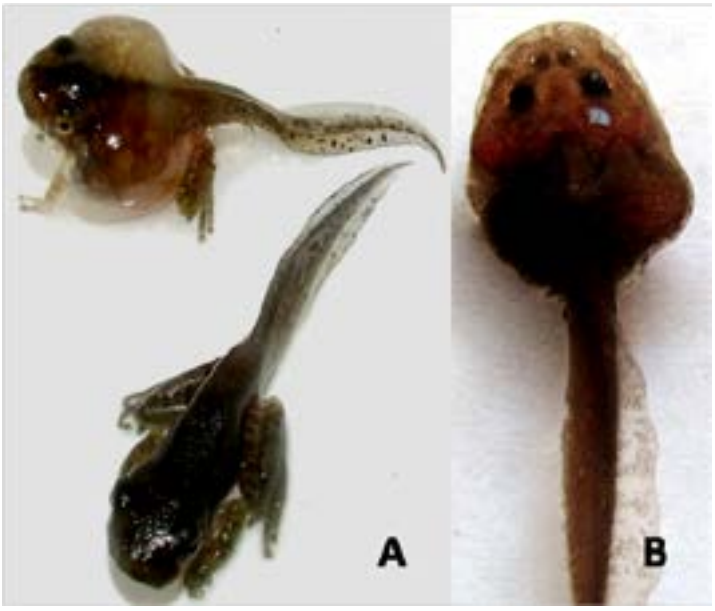

Fig. 2 Skin edema in P. cruciger tadpole above compared to the normal individual below (A), skin lump at the right side of the body of D. melanostictus tadpole (B). Photos: Uthpala Jayawardena.

Being an agricultural country, Sri Lanka imports an average of 2000 tons of insecticides and 5000 tons of herbicides every year (*9*), which exceeds the pesticide usage of any country in the Asian region. Irrigation based agriculture worsen this situation as the agricultural run offs get aggregated and concentrated in adjacent water bodies where natural breeding sites for most of the amphibian species. As the most commonly used pesticides for paddy farming in Sri Lanka, chlorpyrifos and propanil are known to contaminate nearby water bodies as high as 1-7 ppm (*10*). Hence, possible threats over amphibian fauna may be even more devastating.

Ultra Violet-B Radiation as a Possible Agent

Exposure to UV-B radiation at four dose regimes; control (0 kJm^{-2}), low (1.5 x 10^{-2} kJm^{-2}), medium (3.8 x 10^{-2} kJm^{-2}) & high (7.6 x 10^{-2} kJm^{-2}), to match 0%, 10%, 25%, 50% of the erythemal dose of UV-B (258. 048 kJm^{-2}) in the Asian region, affected hatching success and the survival of the two species severely in a dose dependent manner (*11*). Smaller body sizes of the metamorphs and delaying metamorphosis were common to both species. Those who survived to metamorphose suffered severe malformations, comprised mainly of skin edema and swollen body. This study granted the first and the only study conducted to determine the direct effect of UV-B on any amphibian species in Sri Lanka. However, indirect effect of solar radiation has been studied by some other researchers who reported reduced toxicity of carbofuran on *D. melanostictus* due to radiation triggered decomposition of the pesticide (*12*).

Fig. 1 Progress of the hunched back (kyphosis) in *P. cruciger* during the course of metamorphosis (A-D). Photos: Uthpala Jayawardena.

Fig. 3 Pleurolophocercous cercariae (A) used to induced trematode infection in the tadpoles. Cercariae penetrated the tadpole body mainly through the tail (B) region. Photos: Uthpala Jayawardena.

Being a tropical island, positioned 880 km north of the equator, Sri Lanka receives relatively high solar radiation through out the year nearly without seasonal variations. According to World Health Organization (*13*) Sri Lanka scores UV Index 8-12 throughout the year. Hence, UV radiation can also be considered as a possible causative agent for amphibian decline and development of malformationsin natural context.

Trematode Infection as a Causative Agent

Effect of exposure to pleurolophocercous cercariae (Fig. 3) of a common digenetic trematode has been tested as the third culprit of amphibian malformations. The exposure was carried out in four doses of cercariae (control-0, low-16, medium-32 & high-48). Molecular identification of the cercariae confirmed the species as an *Acanthostomum* sp. (14), infecting wild freshwater snakes. Up on exposure to cercariae both species reported decline in survival-where only 50% of the exposed *D. melanostictus* survived to metamorphose. Most of the metamorphs suffered one or more types of malformations, axial and limb malformations being the most common type (14& 15).We reported high variability in test parameters (survival, malformations, and growth) among the two species due to species specific variations such as tolerance and resistance to diseases, life-history characteristics such as size of the metamorphs and length of the development period, etc. As the only study conducted to assess the effect of trematode infection on an amphibian species in Sri Lanka, this study highlights the importance of studying the effect of cercariae of other trematode species abundant (*16*) in our freshwater bodies.

Synergism of Multiple Factors

Synergistic effect of pesticides and trematode infection had been studied by exposing a high dose of cercariae (48) into tadpoles kept in 0.5 ppm pesticide medium (*17*). The exposed tadpoles were raised in the relevant test media until metamorphosis. Cercariae of *Acanthostomum* sp. had no detrimental effect or loss of activity in pesticide media (unpublished data), but they readily penetrated the tadpoles reporting high levels of mortality, growth retardations and percentage malformations in the exposed hosts. In the presence of pesticides, the effects of exposure to trematode infection were enhanced.

Our studies provide the first empirical evidence that the three major etiologies, pesticides, UV radiation and trematode infection induce malformation and reduce survival in two anuran species and hence may contribute to amphibian decline in Sri Lanka. The comparison of all three agents revealed UV-B, contributed to the highest damage reporting severe declines (Fig. 4) in survival. Moreover, UV-B and trematode infection account for the highest percentage and severity of malformations reported. These studies suggest that ecologically relevant concentrations of common agrochemicals, naturally occurring parasites and slight exposure of UV-B radiation may pose threats to local amphibian fauna. Although we cannot extrapolate these laboratory observations to a

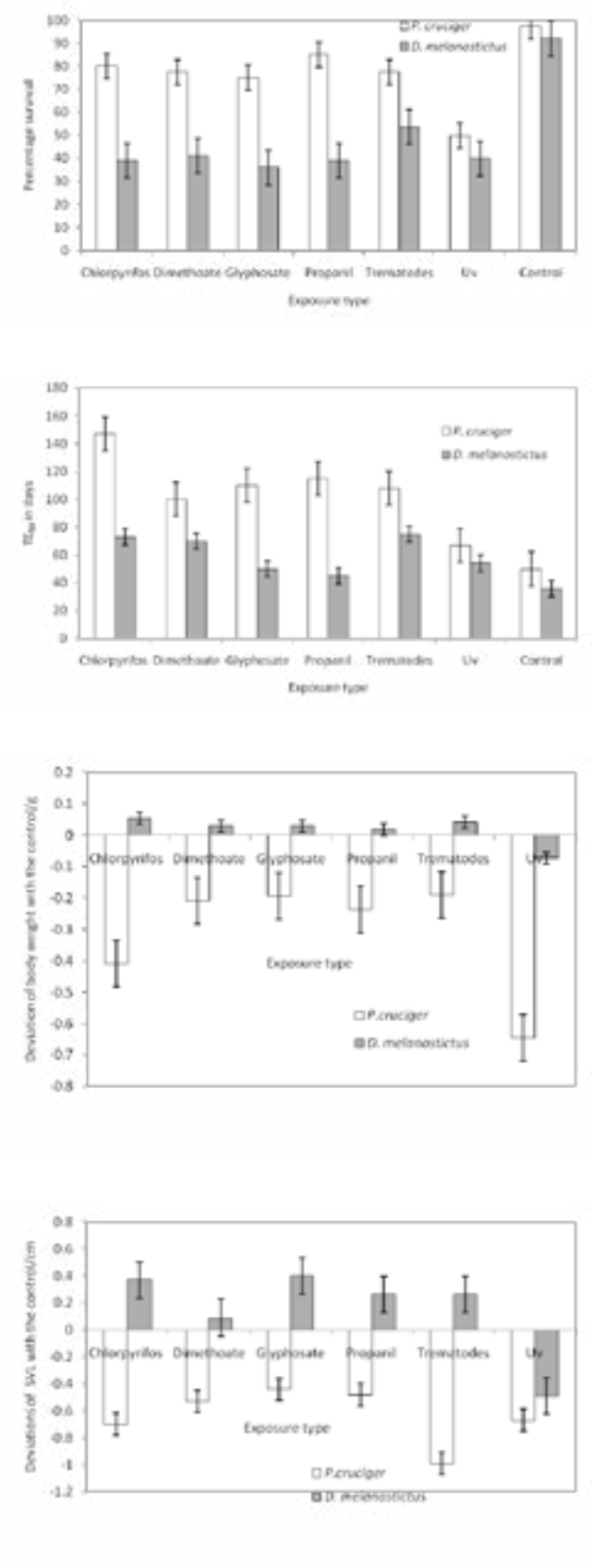

Fig. 4 Percentage survival (a), TE50 in days (b), deviation of the body weight (c) and SVL (d) compared to the control

natural context uncritically, the complexity of natural conditions and the presence of predators undoubtedly worsen the situation. Understanding the possible etiologies and their complex interactions in the wild or laboratory mesocosms are essential for designing mitigation measures to conserve local amphibian fauna.

References

1. K. Manamendra-Arachchi, R. Pethiyagoda. *Raff. Bull. Zool. Sup.* 12, 163 (2005).
2. L. J. M. Wickramasinghe, D. A. I. Munindradasa, P. Fernando. *Zootaxa* 3498, 63 (2012).
3. R. S. Rajakaruna, V. A. M. P. Samarawickrama, K. B. Ranawana. *J. Nat. Sci. Found. Sri Lanka.* 35(1), 3 (2007).
4. A. de Silva. T*he Incidence and Pattern of Malformations, Abnormalities, Injuries, and Parasitic Infection of Amphibians in Sri Lanka* (Preliminary findings, Final Report, Amphibian Specialists Group, Seed Grant. 40 p + 7 plates 2009).
5. U. A. Jayawardena, R. S. Rajakaruna, A. N. Navaratne, P. H. Amerasinghe Int. *J. Agricul. Biol.* 12, 641 (2010).
6. U. A. Jayawardena, R. S. Rajakaruna, A. N. Navaratne, P. H. Amerasinghe J. *Nat. Sci. Found.* 39 (2), 165 (2011).
7. S. B. Kegley, B. Hill, S. Orme. PAN Pesticide Database, Pesticide Action Network North America.www.pesticideinfo.org. (Accessed on 15 March 2007).
8. M. R. Wijesinghe. *FrogLog* 20 (5), 30 (2012).
9. Annual Circular of Pesticide Statistics for 2010. (Personal communication of the Pesticides registrar, Office of the Pesticides Register, Peradeniya, Sri Lanka).
10. M. R. Wijesinghe. Ecotoxicology: Why is it a discipline of growing importance? *Proceedings of the 32nd Annual Sessions of the Institute of Biology, Sri Lanka*, 6-12 (2012b).
11. U. A. Jayawardena, P. H. Amerasinghe, R. S. Rajakaruna *Ceylon Journal of Science* (In press).
12. M. R. Wijesinghe, B. A. D. M. C. Jayathilake, W. D. Ratnasooriya *J. Trop. Forest. Environ.* 1 (1), 48 (2011).
13. Ultraviolet radiation and the INTERSUN Programme. Radiation and Environmental Health Unit, Protection of the Human Environment, World Health Organization, Geneva (2003).
14. U. A. Jayawardena, V. V. Tkach, R. S. Rajakarun, A. N. Navaratne, P. H. Amerasinghe. *Parasitol. Int.* 62, 246 (2013).
15. R. S. Rajakaruna et al., *J. Zool.* 275(1), 89 (2007).
16. U. A. Jayawardena, R. S. Rajakaruna, P. H. Amerasinghe. *Ceylon J. Sci.* 39 (2), 95 (2011).
17. U. A. Jayawardena, R. S. Rajakaruna, A. N. Navaratne, P. H. Amerasinghe. Biocides enhance the severity of parasite induced abnormalities in the hourglass tree frog *(Anura: Ranidae). Proceedings and the abstracts of the Peradeniya University Research Sessions,* pp-131 (2006).

Caecilians of Goa

Ichthyophis davidi. Photo: Vikram Hoshing.

By [1*]Nirmal Kulkarni, [2]K. P. Dinesh, [3]P. Prashanth & [4]G. Bhatta

Caecilians are worm like secretive, fossorial subterranean legless amphibians found in organic debris and/or near the vicinity of water. In India there are three families of caecilians which includs the recently discovered new family Chikilidae from Norteast India, having its genetic relatives in Africa (*1*). In total, there are 39 species (*1-3*) of caecilians in India in three families and five genera. Of the 39 species from India 25 species are found in the Western Ghats and only six species are known from the tiny state of India, Goa.

Goa state is covered by 38% forest and among these forested areas are six wildlife sanctuaries and one national park under protected areas of India. The Goa landscape is known to have distribution for six species caecilians of which type locality for *Gegeneophis goaensis* and *Gegeneophis pareshi* are from Goa itself and type locality for *Gegeneophis mhadeiensis* and *Ichthyophis davidi* are in the villages of Karnataka, adjacent to the political boundaries of Goa. Caecilian research in this state was initiated by our team members with the discovery of *Gegeneophis nadkarnii* (now junior synonym of *G. danieli*) in the 2004. Later annual expeditions were made to different landscapes within Goa to add *G. goaensis* in the 2007 and later in the year, 2011 Giri *et al.*, (*4*) discovered *G. pareshi* from the surroundings of Cotigao Wildlife Sanctuary.

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The Chorla Ghats forests. Photo: Nirmal U Kulkarni/Mhadei Research Centre.

According to the IUCN Red List of Threatened Species™ among the six species of caecilians known from Goa, data is deficient for three species, status is not assessed for two species and one species is considered to be "Least Concerned" (Table 1). To understand the distribution status for these caecilians and to augment the information for assessment for "Data Deficient" and "Not Assessed" categories of IUCN our team is undertaking regular field expeditions into the different landscapes of Goa.During these searches in Goa we have noticed that monocolored *Ichthyophis*, *Ichthyophis bombayensis* is common in all the lower landscapes of Goa and *I. davidi* is restricted to higher elevations and is uncommon. Among the *Gegeneophis*, *Gegeneophis danieli* is common all along the higher

***Gegeneophis goaensis*.**

elevations of Chorla Ghats; *G. mhadeiensis* is found in small pockets at higher elevations bordering Goa and Karnataka; *G. goaensis* is restricted to lower areas of Goa and we have yet to encounter *G. pareshi* in the field.

Prashanth searching for caecilians in organic leaf litter Photo: Nirmal U Kulkarni/Mhadei Research Centre.

During our searches for these secretive fossorial Caecilians we could observe a pattern of availability of caecilians in the areca and banana plantations where organic practices are being followed and next to the homestead areas where household kitchen garbage, straw heaps and cow dung manure were being dumped and were not available in inorganic cultivated lands and dry forested landscapes.

Since most of our searches were post monsoon (August-September), we could only observe the egg clutches of *I. bombayensis* in the field and we are yet to document the egg clutch details for the remaining five species in Goa.

For researchers it is challenging to encounter caecilians in the field due to their habitat specificity, fossorial and subterranean life history. To overcome some of these issues in studying the natural history of this class of amphibians it is essential to developan ex-situ program with proper Forest Permits.

Our team in field. Photo: Nirmal U Kulkarni/Mhadei Research Centre.

Acknowledgements

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References

1. R. G. Kamei *et al., Proc. R. Soc. B.* **279**, 2396 (2012). *doi:10.1098/rspb.2012.0150*
2. K. P. Dinesh, C. Radhakrishnan, K. V. Gururaja, K. Deuti, G. K. Bhatta, ***http://zsi.gov.in/checklist/Amphibia_final*.pdf,** (2013).
3. I, Agarwal, M. Wilkinson, P. P. Mohapatra, S. K. Dutta, *Zootaxa* **3696,** 534 (2013).
4. V. Giri, D.J. Gower, K. Gaikwad, M. Wilkinson, *Zootaxa* **2815,** 49 (2011).
5. D. Gower, M. Wilkinson, IUCN Red List of Threatened Species. Version 2013.1. (www.iucnredlist.org), (2004).
6. G. Bhatta, D. Gower, M. Wilkinson, IUCN Red List of Threatened Species. Version 2013.1. (www.iucnredlist.org), (2008).
7. G. Bhatta, D. Gower, M. Wilkinson, IUCN Red List of Threatened Species. Version 2013.1. (www.iucnredlist.org), (2008).
8. IUCN SSC Amphibian Specialist Group, IUCN Red List of Threatened Species. Version 2013.1. (www.iucnredlist.org), (2011).

Table 1: IUCN Red List of Threatened Species status for caecilians of Goa.

Sl. No.	Family	Species	IUCN Status (2013) (5,6,7,8)
1	Indotyphlidae	*Gegeneophis danieli* Giri, Wilkinson and Gower, 2003	Data deficient
2		*Gegeneophis goaensis* Bhatta, Dinesh, Prashanth and Kulkarni, 2007*	Data deficient
3		*Gegeneophis mhadeiensis* Bhatta, Dinesh, Prashanth and Kulkarni, 2007	Data deficient
4		*Gegeneophis pareshi* Giri, Gower, Gaikwad and Wilkinson, 2011*	Not Assessed
5	Ichthyophiidae	*Ichthyophis bombayensis* Taylor, 1960	Least concern
6		*Ichthyophis davidi* Bhatta, Dinesh, Prashanth, Kulkarni and Radhakrishan, 2011	Not Assessed

*species endemic to Goa state

Above: *G. goaensis*. Photo: Nirmal U Kulkarni/Mhadei Research Centre.

Right: Plantations serve as ideal habitats. Photo: Nirmal U Kulkarni/Mhadei Research Centre.

A Marvel of Nature: The Gastric Brooding Frog

By Manuel Beterams

To understand the importance of conservation we have to keep in mind what we stand to lose if we take no action at all. As Jeremy Hance[1] has put it in his book "Life is good": " it is important to recognize likely vanished species […] to remind ourselves of our own impact and our conservation failures. However, in most cases species do not disappear by one final and audible blow of the hammer, but slip inadvertently into oblivion. And because these species disappear so quietly and because they sometimes haven't even been discovered yet before they go extinct, we hardly take notice to the lessons they have to tell us. Just like humanity has always raised tokens of remembrance for the dead, we too should find a way of honoring the legacy of these extinct species. That's why I would like to talk to you about the gastric-brooding frog.

For me personally there is a feel of melancholy to species that go extinct; there are many scientific and rational arguments that make it worrisome for nature and humanity that species disappear, but there is an emotional depth to it as well. We adapt so well to fluctuating circumstances that we do not ponder too long on the tragic loss of a unique evolutionary accomplishment that a species is: millions and millions of years of survival and adaptation and then just disappeared for good in an instance. If this would be just a case of panta rhei, of the way the river of extinction flows, from a beginning to an end, I would feel differently about it. However, this is our doing, also mine, and we take so little time to understand, truly let it sink in, what this means.

It's this same feeling of melancholy I had when I first heard about the gastric brooding frog and its extinction. The genus of gastric brooding frogs, making up its own evolutionary distinct family, (presumably) disappeared from the wild a couple of years after I was brought into this world and that's definitely my loss. If it's up to Michael Archer and colleagues though, it might be resurrected during my lifetime, within the aptly-named Lazarus Project [2].

My first acquaintance with these special frogs was through reading Tim Flannery's 'The Weather Makers'[3] in which he mentions the very special breeding habits. Well, what was so special about this genus of frogs, comprising of two species? Its name says it all: this was a genus of frogs in which the females of these species incubated their offspring in their stomach, after she had swallowed the fertilized eggs. Giving birth in these species therefore meant that the fully developed froglets emerged from their mother's mouth into the world. And it is this feature that obviously set them apart from all other frogs, even from all other animals.

The story that is told by these frogs is interesting in its own right, because it shows how evolution has given rise to the most wondrous and unimaginable creatures, and provides us with a sense of wonder of what evolution is capable of 'doing'. But it also teaches us a lesson about the often unrecognized value of biodiversity and sadly enough another one about extinction of amphibian species in modern times and its supposed causes. Before I continue on this matter, I first want to point you to a video[4] (reference) from a living Southern gastric breeding frog. It's not a remarkable piece of footage, because it's just a frog in a tank, but of course it's the context that makes it more than moderately interesting; it's footage of a species that no longer hops or swims the earth. This realisation gives me a weird sensation in my stomach. It's just a pity to put it mildly.

Two species made up the genus, the Southern gastric brooding frog, *Rheobatrachus silus*, and its counterpart the Northern gastric brooding frog, *Rheobatrachus vitellinus*. The former was discovered in Queensland, Australia in 1972[6] while the latter was discovered as recently as 1984. Their distribution was confined to freshwater streams over 300 m in altitude, in rainforest and wet sclerophyll forest communities of the Conondale and Blackall Ranges in south-east Queensland. According to the IUCN Red List both of them are listed as extinct, while they are still included in management plans from the Australian government. However, they haven't been seen despite intensive survey effort in the past 25 years.

Because they had been discovered recently and some scientific work had been done on these species, they are not as elusive to us as other extinct species. For instance, we know that the Southern gastric brooding frog was an aquatic species and was never located more than four metres away from water. It preferred rock pools and backwaters with leaf litter and rocks in which to shelter . They were assumed to hibernate during the colder months in spaces between rocks or in crevices in rocks underwater. The Northern gastric brooding frog lived in a similar habitat and had a preference for the shallow section of fast-flowing creeks and streams in rainforest.

The disappearance of the Northern gastric brooding frog is remarkable, because it happened somewhat a year after it was discovered and after a population assessment had shown that it was quite common in its habitat. Both species had a small range where they occurred and were therefore probably vulnerable to human-induced modification of their habitat. Research on their extinction mainly has been done many years after their disappearance, simply because nobody saw this as a priority. For the Southern gastric brooding frog it is known that timber harvesting was going on in their habitat but this hasn't been confirmed as the main agent of decline. Because the numbers of several upland rainforest frog species, all living in similar habitats, had declined in Queensland since the 1970s within a very short period, two researchers (Glen Ingram and Greg Czechura) linked this to an unknown catastrophic event. They had noticed the late rains in for instance 1979, the year the Southern gastric brooding frog disappeared from the wild[5]. They ascribed the late rains to a change in climate, because similar aberrations in the weather had been observed in the same year in Central and South America accompanied by frog declines as well. And they believed the change in climate might have been related to the frog declines.

Elaborating on this, in 1993, Dr. Ingram reported[7] that data had shown an increase in temperature and UV-radiation in Queensland and rains tended to occur less frequently but with more vigour. When it did fall, it mainly occurred in the cooler months when frogs didn't breed, so drought may have affected breeding success in this way. He also mentioned investigating an unknown disease, which we now know as chytridiomycosis. A research by Laurance in 2008[8] focused on the interplay between rising temperatures and the chytrid fungus; by use of statistics he showed it to be likely that range and activity of the chytrid pathogen had increased by global warming. These results indicate that climate change has had a notable impact on these species, together with the notorious chytrid

fungus. So, although it is not sure, after the discovery of the fungus and the role it played in amphibian extinctions, it is now believed that the chytrid fungus probably is an important agent of decline for the Queensland frogs, together with climate change (therefore Flannery mentioned the gastric brooding frog in his book), but also pollution, introduced fish and the damming of rivers.

Going back to the one feature that sets these frogs apart from the rest: their most unusual reproductive behavior. This has actually made them an iconic example of the great wealth that biodiversity presents to us humans, illustrated by the fact that they starred in an article in Time magazine on 'nature's gifts'[9]. Their gift was that while normally anything that ends up in the stomach will be digested by stomach acids, the tadpoles of these species could sit there comfortably and develop into froglets. The discoverer of the Southern gastric brooding frog, Tyler, together with his colleagues, conducted research on this and found the tadpoles to secrete a substance, prostaglandin E2, that inhibited the secretion of gastric acids. Such a chemical that inhibits the secretion of these acids looked like a promising discovery in finding a treatment to stomach ulcers.

Unfortunately the extinction of these species so shortly after their discovery robbed scientists (and the human species in general) of the opportunity to study this chemical and the pathways through which this inhibition works. Their extinction has therefore lead to a hiatus in our medical knowledge that will take a big effort to fill. To all people that believe in the superiority of human technology it teaches a lesson that we still are very dependent on these gifts of nature for our well-being. This should be no surprise, because these gifts are the outcomes of millions or even billions of years of natural selection; even our large and inventive brains cannot cancel out this advantage. And seeing how many species are alive today and have been alive in the past we should expect that nature has come up with much more ingenious ways of battling diseases, reproducing and adapting to its environment than we can ever dream of. And it becomes clear then, that we cannot mimic these inventions so easily. Not as easily as we can destroy them.

References:

1. Hance, J.L., (2011) *Life is good: conservation in an age of mass extinction*. Mongabay.com
2. http://news.mongabay.com/2013/0318-gastric-brooding-frog.html
3. Flannery, T., 2005. *The weather makers: how man is changing the climate and what it means for life on earth*. Grove Press New York
4. http://www.arkive.org/southern-gastric-brooding-frog/rheobatrachus-silus/video-15.html
5. Czechura, G.V. and Ingram, G.J., 1990. *Taudactylus diurnus and the case of the disappearing frogs*. Memoirs of the Queensland Museum 29: 361-365.
6. Corben, C.J., Ingram, G.J. and Tyler, M.J., 1974. *Gastric brooding: Unique form of parental care in an Australian frog*. Science 186: 946-947.
7. http://www.greenleft.org.au/node/5089
8. Laurance, W.F., 2008. *Global warming and amphibian extinctions in eastern Australia*. Austral Ecology. 33: 1–9
9. Plotkin, M.J., 2000. *Nature's Gifts: The Hidden Medicine Chest*. Time Magazine
10. MJ Tyler, DJ Shearman, R Franco, P O'Brien, RF Seamark, & R Kelly, 1983. *Inhibition of gastric acid secretion in the gastric brooding frog, Rheobatrachus silus*. Science, 220 (4597)

Harlequin Tree Frog *Rhacophorus pardalis*, Kinabatangan river basin, Sabah, Borneo.

Frogs of Asia and Madagascar

By Andrea Ferrari

Well-traveled (both above and underwater) for the past 30 years and widely-published in half a dozen different languages, Andrea and Antonella Ferrari are the husband-and-wife team behind several best-selling guidebooks—including the groundbreaking *A Diver's Guide to Reef Life* and *A Diver's Guide to Underwater Malaysia Macrolife*. Staunch conservationists, they are firm believers in the free sharing of knowledge and the free dissemination of information worldwide as powerful educational tools for a better environmental culture, and as such are the editors and publishers of the free online quarterly magazine *ANIMA MUNDI—Adventures in Wildlife Photography*, which advocates the use of stunning imagery and scientifically correct but easily accessible texts to bring forward a strong message of species and habitat conservation. Contributors to the magazine who share their vision include scientific authorities such as Piotr Naskrecki and Dante Fenolio. All issues of *ANIMA MUNDI—Adventures in Wildlife Photography* can be permanently accessed and/or downloaded at no cost from their home page http://www.animamundimag.com

Subscribing is also completely free. You can follow them on Facebook at http://www.facebook.com/pages/Anima-Mundi-Adventures-in-Wildlife-Photography/153627834692022

Andrea and Antonella have devoted themselves to underwater photography for 25 years, but of late have opted for a broader scope and are now ceaselessly exploring and documenting the vanishing beauty of the planet's wilderness. Despite being interested in and fascinated by all living things—from the largest to the smallest—they are quite obviously extremely partial to herps (especially venomous snakes!) and never miss the opportunity to portray the members of the amphibian tribe they meet in their rainforest forays. Published in these pages is just a small representative selection of the frogs they have encountered in the Western Ghats of India, the Cameron Highlands of West Malaysia, Tioman island in the South China Sea, the Kinabatangan river basin of Borneo and all over the island of Madagascar.

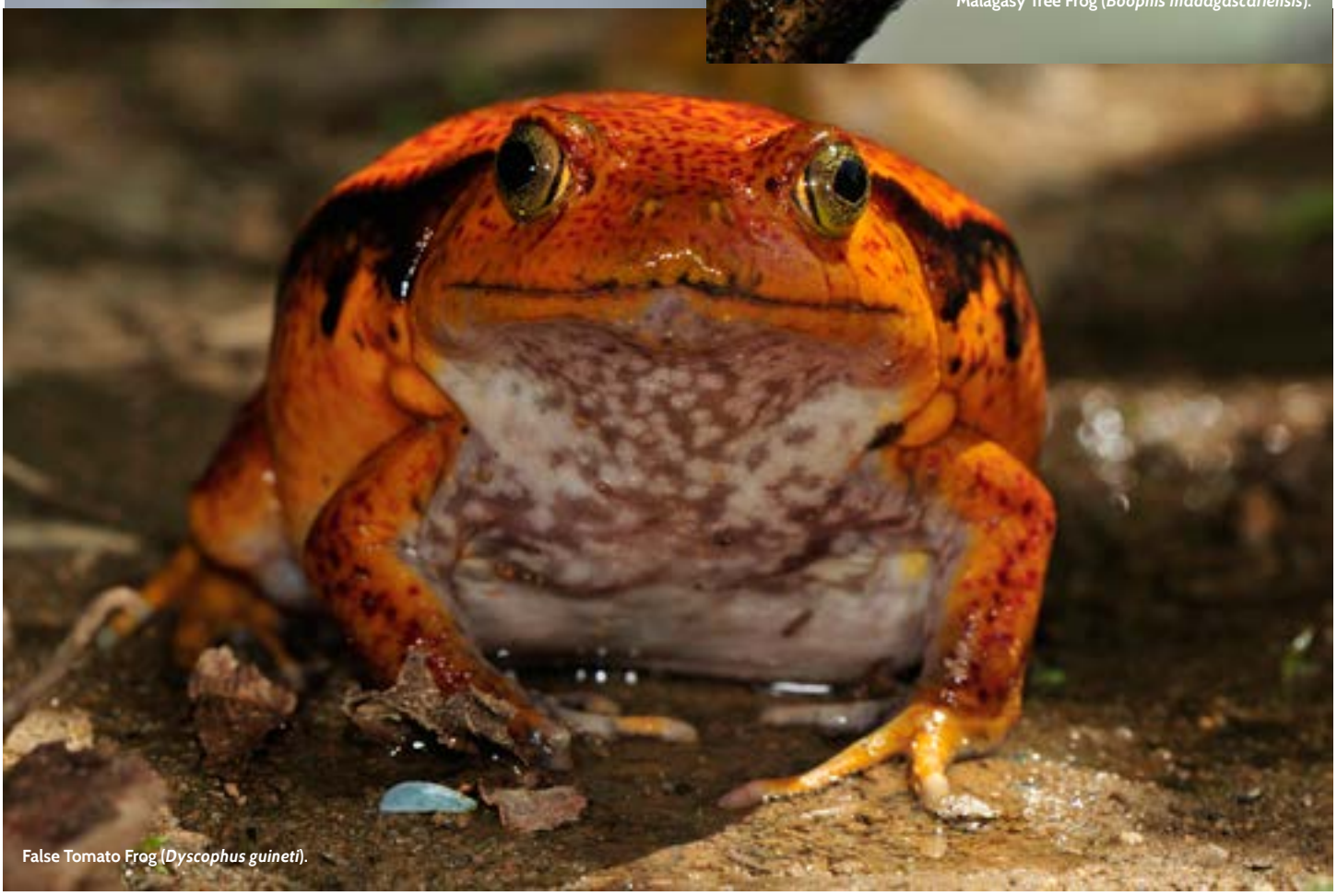
Photo: Antonella Ferrari.

All photos by Andrea and Antonella Ferrari.

Bornean horned frog (*Megophrys nasuta*).

Malagasy Red Tree Frog (*Boophis pyrrhus*).

Malagasy Tree Frog (*Boophis madagascariensis*).



False Tomato Frog (*Dyscophus guineti*).

Bornean horned frog (*Megophrys nasuta*).

Rough Tree frog (*Theloderma horridum*).

Malagasy Frilled Tree Frog (*Spinomantis phantasticus*).

Bornean horned frog (*Megophrys nasuta*).

Harlequin tree frog (*Rhacophorus pardalis*).

Malagasy Red Eyed Tree Frog (*Boophis boehmei*).

Harlequin tree frog (*Rhacophorus pardalis*).

Jade Tree Frogs (*Rhacophorus dulitensis*).

Malagasy Tree Frog (*Boophis madagascariensis*).

Lesser Sticky frog (*Kalophrynus subterrestris*).

Himalayan Flying frog (*Rhacophorus bipunctatus*).

Malaysian Horned frog or Long-nosed frog (*Megophrys nasuta*).

Ground frog (*Mantella ebenaui*).

Pied Mossy Frog (*Theloderma asperum*).

Tree frog (*Heterixalus variabilis*).

Ground frog (*Mantella madagascariensis*).

Yellow-spotted Tree Frog (*Heterixalus alboguttatus*).

Yellow-striped Tree frog (*Heterixalus betsileo*).

Yellow-spotted Tree Frog (*Heterixalus alboguttatus*).

Yellow-spotted Tree Frog (*Heterixalus alboguttatus*).

Malaysian Horned frog or Long-nosed frog (*Megophrys nasuta*).

Tree Frog (*Boophis* cf *madagascariensis*).

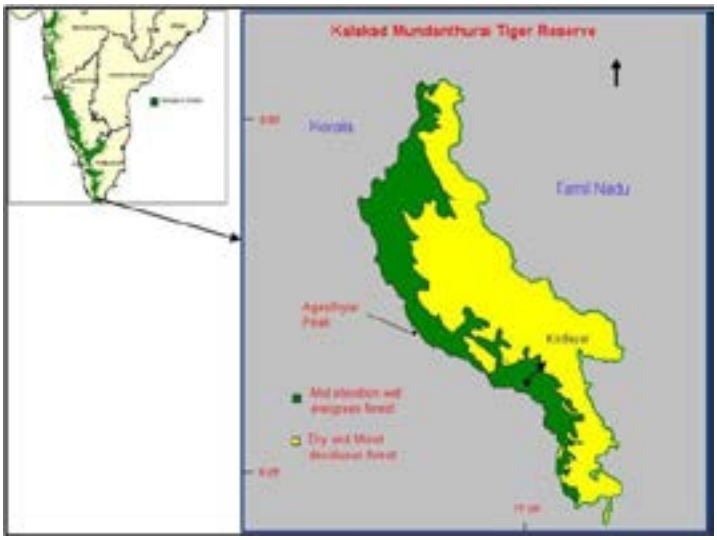
Himalayan Flying frog (*Rhacophorus bipunctatus*).

Back from being extinct. *Raorchestes chalazodes* was rediscovered by a group of us working in the remote forests of Western Ghats in 2010. Photo by Seshadri KS.

Promoting Amphibian Conservation in the Western Ghats of India - The Role of the Future Conservationist Award

By [1]Seshadri. K. S

The Western Ghats biodiversity hotspot of India is termed as one of the 'hottest' hotspots. It is one of the few places on earth where a vast amount of biodiversity exists in spite of the burgeoning human populations. Apart from being home to well known charismatic animals like Tigers and Elephants, the Western Ghats is known to harbor a rich diversity of over 180 species of Amphibians[1]. Not only does this diversity have an existential value, the findings of novelties like the Pig nosed frog *Nasikabatrachus sahyadrensis* the closest relative of which, lives in Seychelles islands, have provided insights into geological history of earth and evolution of amphibians themselves[2]. Over half the amphibian species found in the Western Ghats are found nowhere else (ca. 160 species)[1]. For several families of amphibians, Western Ghats is known to be a point of radiation-where several species evolved in a relatively short span of time. And in the last decade, over 50 species new to science have been described and several species, thought to be extinct have been rediscovered[3]. These discoveries are at a time of amphibian crisis with amphibians declining world over[4]. The declines being fuelled by largely myopic



The location of Kalakad Mundanthurai Tiger Reserve where the studies were carried out. Credit ATREE.

With inputs from Allwin Jesudasan. [1]Graduate student, Department of Biological Sciences, National University of Singapore, Singapore. Email: seshadri.ali@gmail.com

anthropogenic pressures of development like submerging forests to dams; agricultural expansion and abuse of pesticides to name a few. Many of these disturbances have led to emergence of infectious diseases like *Chytrid* fungus- responsible for near extinction of several species[5].

India being a developing country has been no different. Paradoxically enough, Western Ghats is riddled with growing human populations within and around it. While large dams have already been built, smaller ones are being pushed for. Roads and other linear intrusions are fragmenting the forest. Habitat degradation is skyrocketing. Urbanization is taking a toll on the flora and fauna in and around human settlements. And yet, there was, if one looked up on the wide web, little information of how such anthropogenic activities are affecting amphibians. Many of the protected areas did not even have a list of all amphibians found there. The knowledge we had on amphibians was very limited to even answer a simple question as to how long a frog lives or what it eats. Yes, we have simple answers from studies elsewhere but they are mere generalizations.

With such issues in the backdrop, as a masters' student in Ecology, several thoughts arose in my head. Could it be possible that we are losing species even before we know they existed? Is our lack of understanding of the unique complexity of amphibians fuelling their extinction? Could Indians-who have shown phenomenal tolerance to wildlife, do something positive about conserving this rich heritage?

At the crucial moment, I came across the call for applications by the Conservation Leadership Programme (CLP). I had heard about the CLP from my colleagues and they encouraged me to go for it and pitch in an application. The deadline was fast approaching. I managed to form a team with three other colleagues located in four different places back then. We proposed to investigate the effects of habitat degradation on amphibians in the remote forests of the Kalakad Mundanthurai Tiger Reserve in the southern Western Ghats.

After that, I continued with my education until one late night several months later. A mail from CLP was in my inbox and my joy knew no bounds. Our proposal had been selected and we were among the few who bagged the 'Future Conservationist' award. This opened the window to a bright future. Not only in building my career but making a change on ground- working with people who matter the most.

Our team had varied skills and interests. Allwin, an engineer turned economist; Mrugank, a zoologist and; Mathivanan, an administrator working closely with locals on conservation issues. Together, we were guided by Dr. Ganesh, a senior ecologist with vast experience of working on several ecological systems and Dr. Gururaja, an amphibian ecologist and urban planner who had already discovered several amphibians. Our goal was to bring in cutting edge science into amphibian ecology and use various means for science communication to the people living around forests and those that directly or indirectly depend on it.

As part of the award, CLP invited one of us to attend a 20 day training program held in the base of Rocky Mountains of the Canadian West. On a personal note, getting the CLP award meant a lot to me. It was the first proposal I had written, the first award I had ever got, the first time I was flying; the first time I was attending an international conference and the first time I was leaving India and that to an exotic country like Canada. The workshop brought together over 20 participants from various countries. The workshops were meaningful and there was a lot to take away for everyone.

Future Conservationists at the CLP training workshop, Alberta, Canada. Photo: Seshadri KS.

The CLP alumni community was warm and forthcoming. It forged a strong sense of oneness and the whole group is like an extended family for most of us.

Back in India, as early as the project started, it ran into trouble. The local agencies were slow in processing applications for research permits. Running pillar to post cost us a lot of time and energy. Finally, at a presentation made to the senior officials, we convinced them about the importance of this work and after about six months of getting the award, we were on our way in field work. The field work brought its own challenges. The weather seemed to be up against us and the rains were later than usual. But we had begun to survey the forests for amphibians. The last comprehensive survey was over a decade old and no one had studied the forests for amphibians in the meantime. Initially, we struggled with identifying the frogs and expected to find several new species. For the first time, we used Single Rope Ascending techniques to climb the tall trees in the wet evergreen forest in search of frogs. The region received an annual rainfall of over 3000 mm and posed challenging conditions. One of the cutting edge tools we used was Song Meter®. It was a sound recording device which, at pre programmed intervals would record sounds in a forest. We used that to detect amphibian species and understand what was happening over time.

The cold misty canopy where the Song Meter can be seen near a platform. Photo: Seshadri KS.

It was the first attempt to setting up a long term amphibian monitoring program. Perhaps, because there were no such programs, we could not detect any decline in amphibian populations in India.

The data we gathered from this study provided several insights into how frogs and toads vocalize during a 24 hour cycle and how they vary over season. From the sound recordings we found evidence of several un-described species and soon began to work on them. The initial findings were presented at the International Congress for Conservation Biology organized by the Society for Conservation Biology in Auckland, New Zealand in December of 2011.

CLP also funded the travel expenses for myself and Allwin as part of the CLP Alumni Travel Grants. This conference helped me interact with several like minded people and forge academic collaborations. An interaction with a senior ecologist working on roads and their impacts led to co-organize a symposia and workshop at the regional conference of Society for Conservation Biology in India in 2012.

Back to India after the conference and touring the wonderful country, members of the team began working on publishing the science part of the project. Very soon, we described a new species of frog. It was first seen in the canopies on a cold rainy night and after several days of searching, we could be sure it was new and described it. The paper describing the frog, *Raorchestes kakachi* was published in Zootaxa. The forest reserve where we worked also had a revised checklist of frogs.

The automated sound recorders however were at work all the time, in a couple of months, we could analyze the data and a short chapter was authored in Treetops at Risk- an edited volume on the threatened forest canopies.

Children who took part in street play's on frogs and owls. Photo: Seshadri KS.

***Raorchestes kakachi,* the new species described by the team. a-male, b-female. Photo: Seshadri KS.**

While these publications were of value in the academia, people living in the fringe of forests had little to do with it. Here is where science communication plays a vital role. The findings had to be translated to common man and this we did using two important media. We brought out a bilingual pocket guide to the frogs of Kalakad Mundanthurai Tiger Reserve. It was an attempt to increase the awareness about amphibians among the people living inside, around and visiting the Tiger reserve. The photographs were meant to be clear and help them identify the most common frogs they would encounter in the region. The posters were also distributed free of cost to school children around the reserve. Art was another means we used to reach out to people. Using street drama, we trained children to perform a drama to educate people on why frogs are important. This even attracted over 200 people from two villages on one night. Many of the children were enthusiastic about it and many of the adults found the drama to be enlightening.

The project we were awarded is now complete. It was a great learning experience for all of us involved. We faced several challenges and overcame many of those. Interacting and communicating with people changed our perspectives. Many of our colleagues have gained from the skills we learnt at the training workshops and I think we have come a long way from when we started as young passionate researchers wanting to make a difference to the society and hopefully conserve the rich heritage we are losing.

More importantly, the CLP call for applications for the year 2014 is now open till 11th November 2013. If you are young, passionate and think you can make a difference- don't miss this fantastic opportunity to be part of the CLP family.

The former team members have moved ahead in their own careers but remain connected in the ultimate goal of conservation. Allwin, Mathivanan are based at the Ashoka Trust for Research in Ecology and the Environment. I continue to collaborate with them on a project documenting the importance of frogs in wet paddy agriculture. This unique project uses ecology and economics to find why frogs should be conserved. They also are working together in a

project funded by the National Geographic Society on understanding why people protect birds and their heronries. Mrugank moved to the Centre for Ecological Sciences at the Indian Institute of Science where he worked on Amphibians. I am now a graduate student at the National University of Singapore and will be studying the behavior of a few amphibians in India.

References:

1. A Checklist of Amphibia of India with IUCN Red list Status. 2013. K.P. Dinesh, C. Radhakrishnan, K.V. Gururaja, K. Deuti and G. Bhatta. http://zsi.gov.in/checklist/Amphibia_final.pdf As accessed on 4-10-13.
2. Biju, S.D. and F. Bossuyt. 2003. New frog family from India reveals an ancient biogeographical link with the Seychelles. Nature 425: 711 - 714.
3. Aravind, N. A. and K. V. Gururaja. 2011. Theme Paper on the Amphibians of Western Ghats. *Report submitted to Western Ghats ecology panel, MoEF.*
4. Stuart, S. N., J. S. Chanson, N. A. Cox, B. E. Young, A. S. L. Rodrigues, D. L. Fischman, and R. W. Waller. 2004. Status and Trends of Amphibian Declines and Extinctions Worldwide. Science 306: 1783–1786.
5. Gardner, T. A., J. Barlow, and C. A. Peres. 2007. Paradox, presumption and pitfalls in conservation biology: The importance of habitat change for amphibians and reptiles. Biological Conservation. 138: 166–179.

Call for Applications:
2014 Conservation Team Awards

Deadline: 11th November 2013

The Conservation Leadership Programme (CLP) aims to advance biodiversity conservation globally by building the leadership capabilities of early-career conservation professionals working in places with limited capacity to address high-priority conservation issues. This partnership initiative, including BirdLife International, Conservation International, Fauna & Flora International, and Wildlife Conservation Society, has been building conservation leaders across the world for over 25 years. The Programme currently works toward its aims by offering awards, training and mentoring support. The CLP offers three levels of Conservation Awards:

- Future Conservationist Awards: Approximately 20 awards of up to $15,000 each
- Conservation Follow-up Awards: Approximately 6 awards of up to $25,000 each (available only to previous CLP Future Conservationist Award winners)
- Conservation Leadership Awards: 1 award of $50,000 (available only to previous CLP Follow-up Award winners)

CLP projects must occur in and be led by nationals of countries excluded from the World Bank list of high-income economies across Africa, Asia, Eastern and South-eastern Europe, the Middle East, the Pacific, Latin America and the Caribbean, where there tends to be fewer resources and capacity for conservation. Exceptions include some high-income economies located in some temperate and tropical areas of high biological diversity but thought to have low national capacity for conservation, including the Pacific Islands, Caribbean Islands and the Middle East. See list of countries below.

The application deadline for full proposals is **11th November 2013 for ALL applications.** Those applying for **Conservation Follow-up** and **Conservation Leadership Awards** must submit a Logical Framework to the CLP by Tuesday, **1st October 2013.** CLP will provide feedback on all logical frameworks by 16th October and, based on this review, will either invite applicants to submit a full proposal or not. Awards will be announced in April 2014. Please visit the CLP website (www.ConservationLeadershipProgramme.org) for detailed eligibility criteria, guidelines and an application form.

Successful applicants will: 1.) Develop the knowledge, skills and abilities of team members; 2.) Implement a focused, high-priority conservation project combining research and action; and 3.) Contribute to the long-term success of local conservation efforts. All eligible teams submitting an application will receive feedback on their proposal. The CLP is piloting an Alumni Ambassador programme this year whereby applicants can request feedback on their proposals from CLP alumni in their region prior to submission. More information on this programme is found on the CLP website. Applicants may also contact a member of the CLP team well before and up to two weeks before the application deadline for advice on project eligibility, methods and project activities. The CLP may be able to put teams in touch with local partner offices or other experts for additional advice.

A representative from each award-winning team will be invited to attend an international training event in June/July 2014 organized by the CLP to share ideas and develop skills, knowledge and contacts. Additionally, winning teams are able to network with experts from within each of the partner organisations and past winners. CLP team members are available to help with project implementation, including guidance required during the planning and team training stages.

Have additional questions or seeking advice? Email clp@birdlife.org for more information. Please forward this announcement to other potentially interested individuals, organizations or academic institutions.

Conservation and Ecology

Ecosystem services provided by amphibians and reptiles in Neotropical ecosystems

By Anyelet Valencia-Aguilar , Angela M. Cortés-Gómez & César Augusto Ruiz-Agudelo

Human welfare depends directly or indirectly on the services provided by ecosystems. Amphibians and reptiles represent a high proportion of global species diversity and include species that are widely distributed throughout the world and play a variety of roles that benefit humans. The aim of this study was to identify and describe the ecosystem services provided by amphibians and reptiles in Neotropical ecosystems to evaluate the contribution of these highly diverse groups to human welfare. We conducted a literature review of articles and books from databases and university libraries and collected data from 106 studies. Amphibians and reptiles contributed directly and indirectly to the four types of ecosystem services: provisioning, regulating, cultural and supporting. Most available studies reported the use of direct services from reptiles and indirect services from amphibians. Although eight ecosystem services were identified, most studies focused on reptiles as seed dispersers and protein sources. Biological pest control and bioturbation were the most widely studied services obtained from amphibians. Further research are necessary to understand the ecological functions involving amphibians and reptiles and their importance in the provision of key ecosystem services for human well-being.

Figure 1. A. Survey of inhabitants of Putumayo (Colombia) to evaluate the use of herpetofauna in the region. Photo: Anyelet Valencia.

A.Valencia-Aguilar, A. M. Cortes - Gomez, Cesar Augusto Ruiz-A. Int. J. Biodiv. Sci., Eco. Serv. Man. PAGE,VOL (2013). doi: 10.1080/21513732.2013.821168.

The population decline and extinction of Darwin's frogs

By Claudio Soto-Azat, Andrés Valenzuela-Sánchez, Ben Collen, J. Marcus Rowcliffe, A. Veloso & Andrew. A. Cunningham.

Darwin's frogs (*Rhinoderma darwinii* and *R. rufum*) are two species of mouth-brooding frogs from Chile and Argentina. Here, we present evidence on the extent of declines, current distribution and conservation status of *Rhinoderma* spp.; including information on abundance, habitat and threats to extant Darwin's frog populations. All known archived *Rhinoderma* specimens were examined in museums in North America, Europe and South America. Extensive surveys were carried out throughout the historical ranges of *R. rufum* and *R. darwinii* from 2008 to 2012. Literature review and location data of 2,244 archived specimens were used to develop historical distribution maps for *Rhinoderma* spp. Based on records of sightings, optimal linear estimation was used to estimate whether *R. rufum* can be considered extinct. No extant *R. rufum* was found and our modelling inferred that this species became extinct in 1982 (95% CI, 1980–2000). *Rhinoderma darwinii* was found in 36 sites. All populations were within native forest and abundance was highest in Chiloe ´ Island, when compared with Coast, Andes and South populations. Estimated population size and density (five populations) averaged 33.2 frogs/population (range, 10.2–56.3) and 14.9 frogs/100 m2 (range, 5.3–74.1), respectively. Our results provide further evidence that *R. rufum* is extinct and indicate that *R. darwinii* has declined to a much greater degree than previously recognised. Although this species can still be found across a large part of its historical range, remaining populations are small and severely fragmented. Conservation efforts for *R. darwinii* should be stepped up and the species re-classified as Endangered.

Pregnant male southern Darwin's frog (*Rhinoderma darwinii*). Photo: C. Soto-Azat.

C. Soto-Azat, A. Valenzuela-Sánchez, B. Collen, J. M. Rowcliffe, A. Veloso, A. A. Cunningham, PLoS ONE 8(6): e66957 (2013).

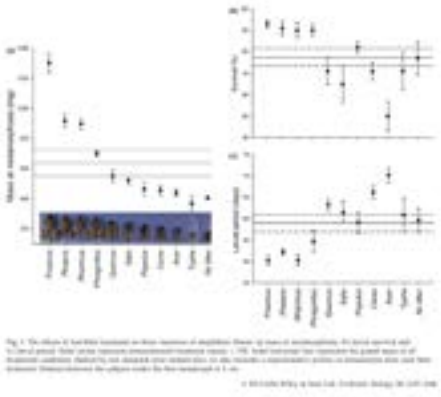
Anthropogenic changes to leaf litter input affect the fitness of a larval amphibian

By Jeffrey P. Stephens, Keith A. Berven & Scott D. Tiegs

Human activities, invasive species and climate change have altered the composition of native forest plant communities in North America. These changes have, in turn, altered the composition of leaf litter in woodland ponds with consequences for the organisms they harbor, such as amphibian larvae.

We used mesocosms to assess how 10 species of allochthonous litter, which differ in their regional abundance and chemical composition, affect ephemeral ponds. We were particularly interested in effects on larval amphibian fitness, including metamorphic mass, larval period and survival.

Litter had strong effects on the fitness of



larval Wood frogs (*Lithobates sylvaticus*), water chemistry, and phytoplankton and periphyton biomass in the mesocosms. Litter from Green ash (*Fraxinus pennsylvanica*), a tree species in decline, enabled frog larvae to grow larger, develop faster and survive better than larvae from other litter treatments. Interestingly, three invasive wetland plant species produced heavy metamorphs, with shorter larval periods and higher survival relative to native wetland plants. Litter from Red maple (*Acer rubrum*, now among the most abundant native trees in the eastern United States), Cattail (*Typha latifolia*) and Sedge (*Carex stricta*) produced metamorphs that were small and survived poorly.

Mass at metamorphosis was best explained by litter quality (carbon, nitrogen and phosphorus content) and primary producer biomass, while survival and larval period were best explained by a combination of litter quality, primary producer biomass and water chemistry (polyphenolics and pH). Additionally, litter quality and primary

producer biomass explained differences in the elemental composition of metamorphs. Lastly, our data suggest that litter nitrogen may be a limiting resource that affects the export of metamorphic frog biomass from ephemeral ponds.

Overall, our results indicate that anthropogenic changes in plant communities lead to changes in the quality of allochthonous litter input and strongly affect amphibian fitness.

J. P. Stephens, K. A. Berven, S. D. Tiegs, *Freshwater Biol.*, 58, 1631–1646. (2013).

Do global models predicting environmental suitability for the amphibian fungus, *Batrachochytrium dendrobatidis*, have local value to conservation managers?

By Karen Riley, Oliver F. Berry & J. Dale Roberts

The amphibian chytrid fungus *Batrachochytrium dendrobatidis* is a major cause of frog declines globally. Recent Maxent models have modelled environmental suitability for *B. dendrobatidis* within Australia and, in a separate analysis, globally. Both models predict high suitability for *B. dendrobatidis* in south-western Australia. In SW Australia chytrid has been reported on frog species that are: direct developers never entering water, species that never enter water post metamorphosis and in species breeding in very ephemeral water bodies contrary to patterns seen in eastern Australia and globally.

We determined *B. dendrobatidis* occurrence, and, intensity of infection, in 15 populations of *Crinia georgiana*, a frog which breeds in ephemeral ponds, to assess i) current validity of claims about environmental suitability for chytrid as models were based on relatively old chytrid records ii) risk of decline against recent suggestions of 100% prevalence and chytrid loads of > 10,000 zoospore equivalents per frog as predictors of imminent decline and ii) to assess apparent change in prevalence over 20 years. *B. dendrobatidis* occurred on 40–100% of frogs at all sites and in water samples at 11 sites but infection levels were generally well below 10,000 zoospore equivalents per frog. Based on immediate and 5-year climate averages, higher rainfall, more rain days and temperatures >3°C but <30°C were positively correlated with infection levels–consistent with the known physiology and growth patterns of *B. dendrobatidis*. Overall infection levels have changed little from 1992 to 2008 with no associated evidence of decline in *C. georgiana*.

Southwestern Australia does maintain *B. dendrobatidis* infections as the models predicted but infection has not lead to frog decline or extinction. Innate or acquired immunity, chytrid strain type and limited opportunities for chytrid growth may all explain absence of disease impacts. Occurrence of *B. dendrobatidis* is not a current critical management issue for conservation managers in south-western Australia despite a known presence since 1985. Models predicting high environmental suitability for chytrid in Mediterranean type climate zones should be interpreted cautiously in the absence of documentation of current, rather than historic, chytrid loads and a clear evaluation of any impact of chytrid on frog survival.

Riley, K, Berry OF & Roberts, JD J. *Appl. Ecol.* 50, 713–720. (2013).

Morbidity and mortality of the Critically Endangered Lake Oku clawed frog *Xenopus longipes*

By Thomas M. Doherty-Bone, Roland K. Ndifon, Oscar N. Nyingchia, F. Eric Landrie, Fred T. Yonghabi, Amanda L. J. Duffus, Stephen Price, Matthew Perkins, Jon Bielby, N. Benjamin Kome, Matthew LeBreton, L. Nono Gonwouo & Andrew A. Cunningham

Between 2006 and 2010, recurring morbidity and mortality of the endemic Lake Oku clawed frog *Xenopus longipes* was observed at its only known locality, Lake Oku, Cameroon. During repeated visits in 2006, 2008, 2009 and 2010, we found large numbers of dead frogs around the lake shore, as well as a higher than expected prevalence of diseased frogs. No significant relationships between disease occurrence and environmental parameters were found, with the exception of a significant but unexplained association between phosphate concentration and disease incidence. Tissue samples from *X. longipes* collected during three field seasons were negative for the amphibian chytrid fungus *Batrachochytrium dendrobatidis (Bd)* using a *Bd*-specific real-time PCR test, although other species of sympatric amphibians were positive for this pathogen. Only one of 48 tissue samples from diseased frogs was positive for ranavirus infection using a ranavirus-specific PCR, suggesting that this pathogen is not necessarily the cause of this disease. No evidence of pathogens was found in tissues examined histologically from 10 *X. longipes* which had been collected and fixed when freshly dead. The cause(s) of the morbidities and mortalities remain(s) unknown, as does their consequence to the population of this Critically Endangered species. Identifying the causative factor(s) of the *X. longipes* mortality and its impact on the population is crucial for planning conservation actions.

Dead frogs at Lake Oku, observed each year since 2006. Photo: T.M. Doherty-Bone.

Doherty-Bone *et al.*, *Endang. Species Res.*, 21, 115 (2013).

The value of remnant trees in pastures for a neotropical poison frog

By Darvé Robinson, Adrienne Warmsley, A. Justin Nowakowski, Kelsey E. Reider & Maureen A. Donnelly

Conversion of natural habitats to anthropogenic land uses is a primary cause of amphibian declines in species-rich tropical regions. However, agricultural lands are frequently used by a subset of forest-associated species, and the habitat value of a given land use is likely modified by the presence and characteristics of remnant trees. Here we used mark-recapture methods to examine abundances and movement probability of the poison frog, *Oophaga pumilio*, at individual trees in forest-fragment edges and adjacent pastures in north-eastern Costa Rica. One hundred and forty-seven trees were surveyed at three replicate sites that each included a forest fragment and adjacent pasture. Trees were sampled at distances of ≤30 m into forest and ≤150 m into pastures for *Oophaga pumilio*, and local environmental characteristics were measured at each tree. We also measured indices of physical condition (size and endurance) of frogs captured in forest edges and in nearby pastures. Analyses of 167 marked individuals showed no difference in per-tree abundances or sex ratios between pasture and forest edges. We found significant interactions between habitat type and leaf-litter cover, tree dbh and number of logs, indicating greater influence of local variables on abundances in pastures. Movement among trees was infrequent and not predicted by sex, size,

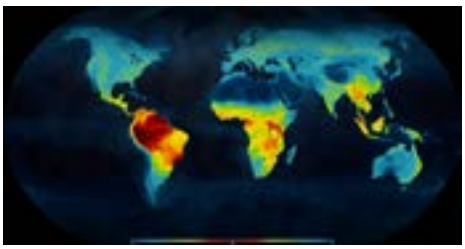
habitat type or environmental variables. While results of endurance tests did not differ for individuals from the two habitats, frogs captured in pastures were, on average, larger than frogs captured in forest edges. These data indicate that remnant trees are important habitat features for *O. pumilio* in pastures and corroborate research in other systems that suggests that large relictual trees should be retained to maximize the potential for altered landscapes to provide habitat for native species.

D. Robinson, A. Warmsley, A. J. Nowakowski, K. E. Reider, M. A. Donnelly, *J.Trop. Ecol.*, 29, 345 (2013).

Global patterns of terrestrial vertebrate diversity and conservation

By Clinton N. Jenkins, Stuart L. Pimm & Lucas N. Joppa

Identifying priority areas for biodiversity is essential for directing conservation resources. Fundamentally, we must know where individual species live, which ones are vulnerable, where human actions threaten them and their levels of protection. As conservation knowledge and threats change, we must reevaluate priorities. We mapped priority areas for vertebrates using newly updated data on >21,000 species of mammals, amphibians and birds. For each taxon, we identified centers of richness for all species, small-ranged species and threatened species listed with the International Union for the Conservation of Nature. Importantly, all analyses were at a spatial grain of 10 × 10 km, 100 times finer than previous assessments. This fine scale is a significant methodological improvement, because it brings mapping to scales comparable with regional decisions on where to place protected areas. We also mapped recent species discoveries, because they suggest where as-yet-unknown species might be living. To assess the protection of the priority areas, we calculated the percentage of priority areas within protected areas using the latest data from the World Database of Protected Areas, providing a snapshot of how well the planet's protected area system encompasses vertebrate biodiversity. Although the priority areas do have more protection than the global average, the level of protection still is insufficient given the importance of these areas for preventing vertebrate extinctions. We also found substantial differences between our identified vertebrate priorities and the leading map of global conservation priorities, the biodiversity hotspots. Our findings suggest a need to reassess the global allocation of conservation resources to reflect today's improved knowledge of biodiversity and conservation.



Combined species richness of amphibians, birds, and mammals, overlain on topography. Reds are high diversity while blues have lower diversity. Data from Clinton Jenkins, BirdLife, and IUCN. Illustration design by Félix Pharand-Deschênes (Globaïa).

C.N. Jenkins, S.L. Pimm, L.N. Joppa, *PNAS* 110, 28: E2602-E2610 (2013).

Threatened amphibians and their conservation status within the protected area network in northeastern Brazil

By Felipe S. Campos, Daniel Brito & Mirco Solé

Amphibians are the most threatened vertebrate group in the world. One of the conservation strategies most used to preserve threatened species is the establishment of protected areas. We used gap analysis to evaluate whether or not the protected area network of northeastern Brazil safeguards populations of threatened amphibians that occur in this region. Data on species geographical ranges were obtained from the International Union for the Conservation of Nature (IUCN) and were overlapped on the northeastern Brazilian protected area network using ArcGIS 9.3. The threatened amphibians found in northeastern Brazil were represented by remnant populations of *Adelophryne baturitensis*, *Adelophryne maranguapensis*, *Allobates olfersioides* and *Agalychnis granulosa*. There are 174 protected areas in the protected area network in northeastern Brazil. The network is made up of 65 strict protection areas (IUCN categories I–II) and 109 sustainable use areas (IUCN categories III–VI). The network corresponds to more than 15 million ha, which equates to about 10% of the region's total area. However, the size of the protected areas along the geographical range of these species doesn't necessarily guarantee their persistence in the future. The main threat to these species is loss of habitat due to deforestation and agricultural expansion. Therefore, the viability of new reserves with a diversity of representative ecosystems in northeastern Brazil may be the best solution to avoid extinction processes in this region.

F. S. Campos, D. Brito, M. Solé, *J. Herpetol.* 47, 277 (2013).

Woodland salamanders as metrics of forest ecosystem recovery: A case study from California's Redwoods

By Hartwell H. Welsh, Jr. & Garth R. Hodgson

Restoration ecology is a relatively new yet maturing scientific discipline with forest restoration recognized for its potential to ameliorate global climate change and sustain native biodiversity. However, there is a need to develop monitoring tools that can track the status of recovering forest ecosystems. For example, biometrics whose numbers link directly to seral advancement and the related ecological service of increasing carbon capture at the litter/soil interface would be of particular value. PSW Research Wildlife Biologist Dr. Hartwell Welsh and collaborator Garth Hodgson have recently published research in the journal Ecosphere that investigated the use of woodland salamanders to document seral recovery in previously harvested redwood forest in northwest California. This research found that the numbers and body condition of two salamander species tracked closely with seral development and related environmental gradients in this unique forest type that contains the world's largest standing terrestrial carbon stocks. They compared salamander numbers and physiological condition on adjacent never harvested old-growth parkland to reference advancement along the successional trajectory. In so doing they demonstrated relationships between salamander counts and body condition with several aspects of seral advancement including stand age, tree size, ambient moisture, canopy closure, and litter depth. Two of the three common salamander species studied provided quantifiable measures of seral recovery of redwood forest at this northern California site.

Welsh, H.H., and G.R. Hodgson. *Ecosphere* 4(5):59. http://dx.doi.org/10.1890/ES12-00400.1 (2013).

Distribution, ecology and conservation of *Ommatotriton vittatus* and *Salamandra infraimmaculata* in Syria

By Sergé Bogaerts, Max Sparreboom, Frank Pasmans, Aroub Almasri, Wouter Beukema, Adwan Shehab & Zuhair S. Amr

The distribution, ecology and conservation status of the Syrian urodeles *Salamandra infraimmaculata* and *Ommatotriton vittatus* are poorly known. We present the results of a field study, conducted in February 2009. *Salamandra infraimmaculata* was found at six localities, ranging from 228 to 960 m a.s.l., and co-occurred with *O. vittatus* at three localities.

Ommatotriton vittatus male in optimal breeding condition. Photo: S. Bogaerts.

All localities were near small, clear streams or springs. Temperatures ranged from 9.4 to 16.4°C, pH 7.5–8.5, GH 3–18 and KH 3–18. The distribution model of *S. infraimmaculata* reveals that the distribution of this species is nearly entirely shaped by precipitation in the coldest quarter "92.9% contribution to the model". The rarity of suitable surface waters is probably the main reason for the supposed scarcity of this species in northwestern Syria. Tapping a water source for drinking water resulted in one case in extensive mortality of larvae. *Ommatotriton vittatus* was found at nine different localities, ranging from 172 to 960 m a.s.l. Habitat characteristics, water quality and morphological data were recorded. The average total length of adult *O. vittatus* was 116 mm (range 93–138 mm, n = 22) for males and 93 mm (range 86–108 mm, n = 34) for females. Mean weight was 6.7 g for males and 3.9 for females. The mean body condition index of females was comparable to that of males. Water temperatures ranged from 8.7 to 14.6°C, pH 7.5–8.5, GH 3–18 and KH 3–18. The distribution model of *O. vittatus* reveals that the distribution of this species is mainly shaped by precipitation, both during the winter and summer periods. The collection of large numbers of adult *O. vittatus* for fish bait was observed.

S. Bogaerts *et al.*, *Salamandra* **49**, 87 (2013).

Diseases and Toxicology

Effects of the glyphosate-based herbicide Roundup WeatherMax® on metamorphosis of wood frogs (*Lithobates sylvaticus*) in natural wetlands

Chantal Lanctôt, Courtney Robertson, Laia Navarro-Martín, Christopher Edge, Steven D. Melvin, Jeff Houlahan & Vance L. Trudeau

Amphibian tadpoles develop in aquatic environments where they are susceptible to the effects of pesticides and other environmental contaminants. Glyphosate-based herbicides are currently the most commonly used herbicide in the world and have been shown to affect survival and development of

Photograph of the experimental setup. Wetlands were split in half using an impermeable curtain. One side of each wetland was oversprayed with Roundup WeatherMax® (0.21 or 2.89 mg a.e./L) and the other side was oversprayed with water (control). In this example, the left side of wetland was treated with 2.89 mg a.e./L Roundup WeatherMax® and the right side was treated with water (control). Photo: C. Lanctôt.

tadpoles under laboratory and mesocosm conditions. In the present study, whole wetland manipulations were used to determine if exposure to an agriculturally relevant application of Roundup WeatherMax®, a herbicide formulation containing the potassium salt of glyphosate and an undisclosed surfactant, influences the development of wood frog tadpoles (*Lithobates sylvaticus*) under natural conditions. Wetlands were divided in half with an impermeable curtain so that each wetland contained a treatment and control side. Tadpoles were exposed to two pulses of this herbicide at an environmentally realistic concentration (ERC, 0.21 mg acid equivalent (a.e.)/L) and the predicted maximum environmental concentration (PMEC, 2.89 mg a.e./L), after which abundance, growth, development and mRNA levels of genes involved in tadpole metamorphosis were measured. Results present little evidence that exposure to this herbicide affects abundance, growth and development of wood frog tadpoles. As part of the Long-term Experimental Wetlands Area (LEWA) project, this research demonstrates that typical agricultural use of Roundup WeatherMax® poses minimal risk to larval amphibian development. However, our gene expression data (mRNA levels) suggests that glyphosate-based herbicides have the potential to alter hormonal pathways during tadpole development.

C. Lanctôt *et al.*, *Aquat. Toxicol.* 140-141, Pages 48-57 (2013). http://dx.doi.org/10.1016/j.aquatox.2013.05.012

Accumulation of pesticides in Pacific chorus frogs (*Pseudacris regilla*) from California's Sierra Nevada Mountains, USA

By Kelly L. Smalling, Gary M. Fellers, Patrick M. Kleeman & Kathryn M. Kuivila

Exposure to single pesticides, multiple pesticides or pesticides combined with other stressors has been proposed to explain some of the declines in amphibian populations across the United States. However, there is limited information on whether frogs in the wild are accumulating current-use pesticides in their tissues. The authors of this study, scientists with the Amphibian Research and Monitoring Initiative (ARMI) of the U.S. Geological Survey (USGS), examined the potential exposure and accumulation of several newly registered fungicides in free-living Pacific chorus frogs (Pseudacris regilla) from northern California. The frogs were collected from seven high-elevation sites on protected lands ranging from Lassen Volcanic National Park in the north to Giant Sequoia National Monument in the south. All of the sites are at least 50 miles away and downwind of California's Central Valley, the state's agriculture center, and receive inputs of pesticides by precipitation and/or dry deposition. Whole frog tissue, water, and sediment were analyzed for more than 90 current-use pesticides and pesticide degradates using gas chromatography–mass spectrometry. Two agricultural fungicides, pyraclostrobin and tebuconazole, and the herbicide simazine, were the most frequently detected compounds in frogs. The primary degradate of the legacy insecticide p,p-DDT, banned in the US in 1972 , was the most frequently detected pesticide in frog tissues (i.e., p,p-DDE). Tebuconazole was also detected frequently in greater than 40 percent of frogs from all sites and this is the first documentation of fungicides in wild frog tissue. Median pesticide concentration ranged from13 μg/kg to 235 μg/kg wet weight. In the current study, water was not a good indicator of exposure because none of the pesticides detected in

Pacific Chorus Frog (*Pseudacris regilla*). Photo: Gary M. Fellers.

the frog tissue were observed in the water samples (with the exception of one very low DDE detection). Most of the pesticides detected in frog tissue were not detected in the sediment samples. Specifically, tebuconazole was only detected in both sediment and tissue half of the time, and the concentration observed in the sediment from a specific site was not directly related to the concentrations and number of tissue samples in which it was detected. Analyses of water and sediment samples are used to describe the exposure to organisms such as frogs to pesticides. However, our results indicate that the types of pesticides observed in the environment were not indicative of the body burdens in chorus frogs making the animal itself a better indicator of environmental exposure to contaminants such as pesticides.

K. L. Smalling, G. M. Fellers, P. M. Kleeman, K. M. Kuivila, *Environ. Toxicol. Chem.* 32, 9 (2013). http://dx.doi.org/10.1002/etc.2308

Lethal and sublethal effects of three insecticides on two developmental stages of *Xenopus laevis* and comparison with other amphibians

By Shuangying Yu, Mike R. Wages, Qingsong Cai, Jonathan D. Maul & George P. Cobb

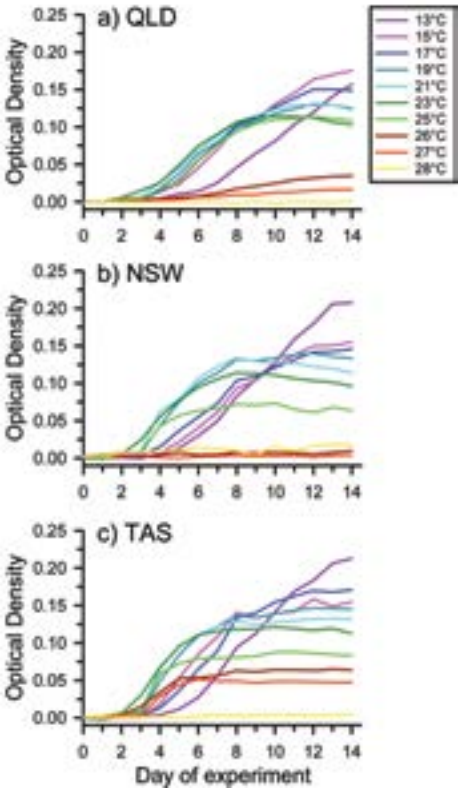
It has been documented that amphibians are declining world-wide and environmental contamination may be a contributing factor. Agricultural chemicals are widely applied and have been shown to elicit various adverse effects on amphibians. However, standardized toxicity testing species and procedures have not been established for assessing the risk of these chemicals to North American amphibians. African clawed frog *Xenopus laevis* embryos are commonly used to evaluate developmental toxicity of chemicals (FETAX assay) although FETAX is also frequently used as a surrogate to determine lethal and sublethal effects of chemicals to endemic amphibians. The application of FETAX in ecological risk assessments has been criticized partly because some studies suggest a lower sensitivity of *X. laevis* to toxicants than North American amphibians. However, we noticed that certain practices in FETAX could confound toxicity estimates. For example, embryos were considered dead if no heartbeat was observed in FETAX assay whereas no response to prodding is often used in studies with endemic species. Removing egg jelly in FETAX before the exposure may increase toxicity because the jelly may act as a protective barrier. In addition, amphibian larvae are often more sensitive to toxicants than embryos, thus using *X. laevis* embryos in risk assessments may underestimate the adverse effects of chemicals. We conducted the current study to determine the toxicity of agricultural chemicals to *X. laevis* embryos and larvae and to evaluate whether *X. laevis* is an appropriate indicator of toxicity for endemic amphibians. We conducted standard 96-h toxicity tests for three insecticides (malathion, endosulfan, and α-cypermethrin) and determined the median lethal concentration (LC50; i.e., concentration that kills 50% of the population) for each chemical. We then compared the LC50s of *X. laevis* with the LC50s reported in the literature for other amphibians. Our results on mortality and malformations suggest that *X. laevis* larvae are more sensitive to two of the three insecticides than embryos and that toxicity estimates from this developmental stage is more likely to provide protection to amphibians. Compared with other amphibians, *X. laevis* larvae have similar sensitivity to α-cypermethrin and malathion, but lower sensitivity to endosulfan. Our study indicates that *X. laevis* larvae can be used to evaluate the risk of some agricultural chemicals to endemic species.

Yu, S., Wages, M., Cai, Q., Maul, J.D., Cobb, G.P. (2013). *Environ. Toxicol. Chem.* 32: 2056-2064.

Variation in thermal performance of a widespread pathogen, the amphibian chytrid fungus *Batrachochytrium dendrobatidis*

By Lisa A. Stevenson, Ross A. Alford, Elizabeth A. Roznik, Sara C. Bell, Lee Berger & David A. Pike

Determining pathogen growth rates and reproduction, and how these attributes are influenced by environmental temperatures, is important for understanding disease ecology and developing mitigation strategies. The fungal disease chytridiomycosis has had devastating effects on amphibian populations and it is well known that its effects can be influenced strongly by environmental temperature. However, the thermal tolerances of the causative pathogen, *Batrachochytrium dendrobatidis* (*Bd*), have received relatively little study. We examined the thermal responses of three *Bd* isolates collected across a latitudinal gradient spanning eastern Australia. Temperature (13-28°C) affected all aspects of *Bd* growth and reproduction that we measured, in ways that often differed among *Bd* isolates. We found strong differences among isolates in the upper thermal limit for growth (26, 27 or 28°C, depending on the isolate) and strong relationships between zoospore production and temperature and zoospore activity and temperature. Two isolates decreased zoospore production as temperature increased, whereas the third isolate was less fecund overall, but did not show a strong response to temperature until reaching the upper limit of its thermal tolerance. Our results suggest that *Bd* isolates within Australia may exhibit local thermal adaptation, an understanding of which is crucial for predicting the times and places where amphibians may be vulnerable to infection. In general, understanding how environmental temperatures can alter the interactions between ectorhermic hosts and their pathogens will enhance our ability to assess pathogen dynamics in the field, model pathogen spread, and conduct realistic experiments on host susceptibility and disease transmission.



Patterns of growth of *Bd* (measured as optical density) over time (days) at constant temperatures ranging from 13-28°C, shown for isolates from (a) Queensland (QLD), (b) New South Wales (NSW), and (c) Tasmania (TAS), Australia. Shown are mean optical densities of *Bd* grown at an initial concentration of 0.575 x 10^6 zoospores per ml. Figure reproduced from Stevenson *et al.* 2013 under a Creative Commons License.

L. Stevenson, *et al.*, *PLoS ONE* 8, e73830 (2013). doi:10.1371/journal.pone.0073830

A *Ranavirus*-related mortality event and the first report of *Ranavirus* in New Jersey

By Kirsten Monsen-Collar, Lisa Hazard, Paola Dolcemascolo

Although Ranavirus has been reported in many states throughout the Northeast, it has until now not been documented in New Jersey. We conducted a side-by-side comparison of PCR and RT-PCR to screen 114 animals sampled on three dates from a site in southern New Jersey that experienced a mass mortality event involving *Lithobates clamitans* and *Anaxyrus fowleri* tadpoles. Additionally, we tested a non-lethal sampling method to detect Ranavirus DNA from water occupied by asymptomatic *A. fowleri* tadpoles. Twenty-four of 114 animals tested positive for Ranavirus with PCR and 32/114 tested positive with RT-PCR, suggesting RT-PCR may be a more effective detection method. The water from all (14) of the asymptomatic *A. fowleri* tadpoles tested negative for ranavirus using traditional PCR, but eight tested positive with RT-PCR. Three species were infected at this site: *L. clamitans* (tadpole), *A. fowleri* (tadpole), and *L. sphenocephala* (adult). Our research demonstrates the need to sample during multiple time periods when a ranavirus outbreak is suspected of occurring. Our initial screening of *A. fowleri* tadpoles during the first sampling session, combined with their healthy physical form, gave the appearance they were not infected with *Ranavirus*. We only detected the presence of *Ranavirus* in multiple tadpoles of this species with traditional PCR after 10 days of exposure to known infected *L. clamitans* individuals in the same pond. Although we detected *Ranavirus* DNA using a non-lethal technique in asymptomatic *A. fowleri* tadpoles, further comparative tests between our non-lethal sampling (tadpole water) and tissue sampling will be necessary before we can determine if this non-lethal method is sensitive enough to consistently detect the presence of ranavirus. To our knowledge, this is the first report of Ranavirus in New Jersey.

K. Monsen-Collar, L. Hazard, P. Dolcemascolo, *Herpetol. Rev.* 44, 263 (2013).

Amphibian Chytrid Fungus Confirmed in Endemic Frogs and Caecilians on the Island of São Tomé, Africa

By Marina E. Hydeman, Rayna C. Bell, Robert C. Drewes & Kelly R. Zamudio

A major contributor to global amphibian declines, the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*), is now confirmed in amphibian populations on

The São Tomé & Príncipe Reedfrog, *Hyperolius molleri*, is one of the island's five endemic amphibians. Photo: Rayna C. Bell.

six continents. Though western and central Africa are proposed source regions for the global expansion of *Bd*, the presence of the pathogen and its possible role in amphibian declines in these areas is not well documented. Our study provides baseline data on the geographic and taxonomic extent of *Bd* on the volcanic island of São Tomé to elucidate the extent of its distribution in Africa, the possible spread of the pathogen to oceanic islands, and the degree of threat to the island's endemic species. We surveyed the four endemic anurans and one endemic caecilian that occur on the island across several elevations and habitats using standard methods for field sampling, DNA extraction, and quantitative *Bd* detection in the laboratory. We found a high prevalence of *Bd* across sample sites (20 out of 62 individuals tested positive) but very low infection intensities (maximum genomic equivalent of 18.3 zoospores), suggesting a historic presence of the pathogen on the Gulf of Guinea islands. We also report one of the first records of *Bd* infection in a wild caecilian species, indicating that caecilians should be included in surveys for *Bd* infection in amphibians.

M. E. Hydeman, R. C. Bell, R. C. Drewes, K.R. Zamudio, *Herp. Review*, 44, 254 (2013).

Batrachochytrium dendrobatidis in amphibians of Cameroon, including first records for caecilians

By Thomas M. Doherty-Bone, Nono L. Gonwouo, Mareike Hirschfeld, Torsten Ohst, Che Weldon, Matthew Perkins, Marcel T. Kouete, Robert K. Browne, Simon P. Loader, David J. Gower, Mark W. Wilkinson, Mark-Oliver Rödel, Johannes Penner, Michael F. Barej, Andreas Schmitz, Johannes Plötner & Andrew A. Cunningham

Amphibian chytrid fungus *Batrachochytrium dendrobatidis (Bd)* has been hypothesised to be an indigenous parasite of African amphibians. In Cameroon, however, previous surveys in one region (in the northwest) failed to detect this pathogen, despite the earliest African Bd having been recorded from a frog in eastern Cameroon, plus one recent record in the far southeast. To reconcile these contrasting results, we present survey data from 12 localities across six regions of Cameroon from anurans (n = 1052) and caecilians (n = 85) of ca. 108 species. Bd was detected in 124 amphibian hosts at seven localities, including Mt. Oku, Mt. Cameroon, Mt. Manengouba and lowland localities in the centre and west of the country. None of the hosts were observed dead or dying. Infected amphibian hosts were not detected in other localities in the south and eastern rainforest belt. Infection occurred in both anurans and caecilians, making this the first reported case of infection in the latter order (Gymnophiona) of amphibians. There was no significant difference between prevalence and infection intensity in frogs and caecilians. We highlight the importance of taking into account the inhibition of diagnostic qPCR in studies on Bd, based on all Bd-positive hosts being undetected when screened without bovine serum albumin in the qPCR mix. The status of Bd as an indigenous, cosmopolitan amphibian parasite in Africa, including Cameroon, is supported by this work. Isolating and sequencing strains of Bd from Cameroon should now be a priority. Longitudinal host population monitoring will be required to determine the effects, if any, of the infection on amphibians in Cameroon.

Doherty-Bone *et al.*, *Dis Aquat Org.*, **102**, 187 (2013).

Batrachochytrium salamandrivorans sp. nov. Causes Lethal Chytridiomycosis in Amphibians

By An Martel, Annemarieke Spitzen-van der Sluijs, Mark Blooi, Wim Bert, Richard Ducatelle, Matthew C. Fisher, Antonius Woeltjes, Wilbert Bosman, Koen Chiers, Franky Bossuyt & Frank Pasmans

In *FrogLog* 107 (pages 17 and 18) we described the enigmatic decline of the Fire salamander (*Salamandra salamandra terrestris*) in the Netherlands. In a recent paper we describe a new pathogen being the cause for this steep decline. We isolated and characterized a unique chytrid fungus, *Batrachochytrium salamandrivorans* sp. nov., from the salamander population mentioned above. This chytrid causes erosive skin disease and rapid mortality in experimentally infected fire salamanders and was present in skin lesions of salamanders found dead during the decline event. Together with the closely related *B. dendrobatidis*, this taxon forms a well-supported chytridiomycete clade, adapted to vertebrate hosts and highly pathogenic

to amphibians. However, the lower thermal growth preference of *B. salamandrivorans*, compared with *B. dendrobatidis*, and resistance of Midwife toads (*Alytes obstetricans*) to experimental infection with *B. salamandrivorans* suggest differential niche occupation of the two chytrid fungi. Our finding provides another explanation for the phenomenon of amphibian biodiversity loss that is emblematic of the current global biodiversity crisis.

A. Martel *et al.*, *PNAS* (2013) doi/10.1073/pnas.1307356110

Pesticide tolerance in amphibians: Induced tolerance in susceptible populations, constitutive tolerance in tolerant populations

By Jessica Hua, Nathan I. Morehouse & Rick Relyea

The role of plasticity in shaping adaptations is important to understanding the expression of traits within individuals and the evolution of populations. With increasing human impacts on the environment, one challenge is to consider how plasticity shapes responses to anthropogenic stressors such as contaminants. To our knowledge, only one study (using mosquitoes) has considered the possibility of induced insecticide tolerance. Using populations of Wood frogs (*Lithobates sylvaticus*) located close to and far from agricultural fields, we discovered that exposing some populations of embryos and hatchlings to sublethal concentrations of the insecticide carbaryl induced higher tolerance to a subsequent lethal concentration later in life. Interestingly, the inducible populations were located >800 m from agricultural areas and were the most susceptible to the insecticide. In contrast, the noninducible populations were located close to agricultural areas and were the least susceptible. We also found that sublethal concentrations of carbaryl induced higher tadpole AChE concentrations in several cases. This is the first study to demonstrate inducible tolerance in a vertebrate species and the pattern of inducible and constitutive tolerance among populations suggests the process of genetic assimilation.

J. Hua, N. I. Morehouse, R. Relyea, *Evol. App.*, 6, 1028–1040 (2013) doi: 10.1111/eva.12083

Wood frog hatchling exposed to a sublethal concentration of carbaryl (magnification 0.3x). Photo: J. Hua.

Possible correlation of worldwide amphibian decline and increasing use of glyphosate in agriculture

By Norman Wagner & Stefan Lötters

Researchers from Trier University investigated if the worldwide amphibian decline possibly correlates with the increasing use of glyphosate in the agrarian industry. They found that only sparse data exist on concentrations of glyphosate and associated herbicidal compounds, e.g. surfactants, in the environment. This is although glyphosate has become the most dominant herbicide worldwide, one of the main reasons being the cultivation of genetically modified crops. In their extensive literature evaluation Norman Wagner and Stefan Lötters found that herbicide formulations containing tallowamine surfactants, ranked among the most harmful ones to different amphibians species. They cannot name a risk per se for all amphibian populations through glyphosate herbicides, as reported reactions highly depend on the amphibian species, the life-stage, the formulation of the herbicide and its application. Should glyphosate resistant GM crops be approved for cultivation in the EU, the experts recommend at least to monitor possible impacts on nearby amphibian populations. The review was commissioned by the Federal Agency for Nature Conservation. It evaluates more than 150 studies and collates a range of data. It is available for download as BfN-Skripten 343 "Possible correlation of the worldwide amphibian decline and the increasing use of glyphosate in the agrarian industry" at http://www.bfn.de/fileadmin/MDB/documents/service/skript_343.pdf

N. Wagner, S. Lötters, *BfN-Skripten* 343, 202 (2013).

Photo: Rob Puschendorf.

Do pathogens become more virulent as they spread? Evidence from the amphibian declines in Central America

By Ben L. Phillips & Robert Puschendorf

In Central America, there is compelling evidence for the recent spread of pathogenic *Batrachochytrium dendrobatidis* (*Bd*) and for its strong impact on amphibian populations. Here we re-examine data on *Bd* prevalence and amphibian population decline across 13 sites from southern Mexico through Central America and show that, in the initial phases of the *Bd* invasion, amphibian population decline lagged approximately nine years behind the arrival of the pathogen, but that this lag diminished markedly over time. In total, our analysis suggests an increase in *Bd* virulence as it spread southwards; a pattern consistent with rapid evolution of increased virulence on *Bd*'s invading front. The impact of *Bd* on amphibians might, therefore, be driven by rapid evolution in addition to more proximate environmental drivers.

B. L. Phillips, R. Puschendorf, *Proc. R. Soc. B: Biol. Scie.*, 280(1766), 20131290 (2013). doi:10.1098/rspb.2013.1290

Call for recent publication abstracts

If you would like to include an abstract from a recent publication in this section of *FrogLog* please email: froglog@amphibians.org. We also encourage all authors of recent publications to inform Professor Tim Halliday (formerly DAPTF International Director) (tim.r.halliday@gmail.com) of their publication in order for it to be referenced on the AmpibiaWeb latest papers page. The full list of latest papers from AmphibiaWeb is also included in every edition of *FrogLog* following the recent publications abstract section.

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

Assistant Professor of Biology Position - Radford University

Radford, VA (Posted to PARC 09/24/13)

Post-doctoral Researcher, Lizard Physiology

University of São Paulo (USP), Brazil (Posted to PARC 09/23/13, closes 10/20/13)

Rapid Response Coordinator - USGS Brown Treesnake Project

Invasive Reptile Biologist

Everglades National Park, FL (Posted to PARC 08/29/13, closes 9/12/13)

Rapid Response Coordinator - USGS Brown Treesnake Project

Guam (Posted to PARC 08/22/13)

Postdoctoral Research Associate (Gopher Tortoise Conservation), Georgia Cooperative Fish and Wildlife Research Unit

Athens, GA (Posted to PARC 08/14/13; Closing October 31, 2013)

Fish & Wildlife Biological Scientist II, Florida Fish and Wildlife Conservation Commission

Gainesville, FL (Posted to PARC 08/09/13; Closing August 16, 2013)

Herpetofauna Technician

Current River and Peck Ranch Conservation Area, MO (Posted to PARC 08/09/13; Closing September 9, 2013)

Biological Field Technician I

Camp Shelby, MS (Posted to PARC 08/09/13; Closing August 18, 2013)

Ph.D. studentships in Reptile Ecology

James Cook University, Australia (Posted to PARC 08/09/13; Closing August 31 (International Applicants) / October 31 (Australian Applicants), 2013)

PARC Federal Coordinator Position Fort Collins, CO

(Posted July 18, 2013; Closing July 30, 2013)

Lecturer of Biology, Department of Biological and Environmental Sciences Farmville, VA

(Posted July 18, 2013; Closing August 2013)

Ranid Frogs Project Specialist , Arizona Fish and Game Department

Phoenix, AZ (Posted 06/18/13; Closing June 21; 2013)

Threatened & Endangered Species Field Biologist, Florida Fish and Wildlife Conservation Commission

Holt, FL (Posted 05/05/13; Closing May 10, 2013)

Amphibian Research Technician Needed

Patuxent, MD (Posted 05/05/13; Closing May 30, 2013)

TX A&M, Kingsville: M.Sc. Fellowship for Women in the Wildlife Profession

Sinton, TX (Posted 04/29/13; Closing May 30, 2013)

Herpetology Field Technician - Green Diamond Resource Company

Korbel, CA (Posted 04/18/13; Closing April 30, 2013)

Sales Director Positions (2) - ZooMed Labs

(Posted 03/17/2013; open till filled)

MS Assistantship - Wildlife Biodiversity in NC Christmas Tree Farms - NC State University

Raleigh, NC (Posted 03/17/2013; open till filled)

Priority Amphibian and Reptile Conservation Areas (PARCAs) Field Technician - The Orianne Society

North Carolina, South Carolina, Georgia, USA (Posted 03/21/2013; Closing March 31, 2013)

Timber Rattlesnake Spatial Ecology Technician - The Orianne Society (TOS)

Nantahala Mountains of Georgia and North Carolina (Posted 03/21/2013; Closing March 28, 2013)

Flat-tailed Horned Lizard Occupancy study, Arizona Game and Fish Department

Yuma Desert of Arizona (Posted 03/21/2013; Closing 03/22/2013)

Northeast Regional Blanding's Turtle Field Technician, Massachusetts Cooperative Fish and Wildlife Research Unit

Amherst, MA. (Posted 03/21/2013; Closing 4/3/13)

Wyoming Toad Field Technician Position - Mortenson Lake National Wildlife Refuge

Laramie, WY (Posted 03/14/13; Closing March 25, 2013)

Desert Tortoise Telemetry Research Associate

Las Vegas, NV (Posted 03/01/13; Closing March 14, 2013)

Research Assistant for Bog Turtle and Bat Work (Seasonal) - Delaware Division of Fish and Wildlife

Smyrna, DE (Posted 02/28/13; Closing March 22, 2013)

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Las Vegas, NV (Posted 03/01/13; Closing March 14, 2013)

Research Assistant for Bog Turtle and Bat Work (Seasonal) - Delaware Division of Fish and Wildlife

Smyrna, DE (Posted 02/28/13; Closing March 22, 2013)

Desert Tortoise Research Assitant - Penn State University

Fort Irwin National Training Center near Barstow, CA and Henderson, NV (Posted 02/28/13; Closing Mid - Late March)

Wildlife Inventory Intern Vacancy - HRM

Ann Arbor and Lansing areas, MI (Posted 02/28/13; Closing March 22, 2013)

GIS Intern Vacancy - HRM

Ann Arbor and Lansing areas, MI (Posted 02/28/13; Closing March 22, 2013)

Fisheries / Wildlife Technicians (7) -

USGS Forest and Rangeland Ecosystem Science Center

Corvallis, OR (Posted 02//28/13; Closing 20 March, 2013)

Wood Turtle Monitors

Northeast US (Posted 02/15/2013)

Venomous Snake Construction Monitor

Northeast US (Posted 02/15/2013)

Volunteer Herpetological Field Technician, Southern Illinois University

Nachusa Grasslands, Franklin Grove, IL (Posted 01/29/2013; Closing 04/30/13)

Unpaid Internship/Volunteer Position - Northern Pacific Rattlesnake/California Ground Squirrel Research - Ohio State University

Central and Northern California, USA (Posted 1/24/13; open till filled)

Graduate Research Position - Applied Population Ecology - Penn State University

University Park, PA (Posted 1/23/13; Closing 03/01/2013)

Summer Research Internship at The Wetlands Institute through CNAH

The Wetlands Institute, Cape May Peninsula of southernmost New Jersey (Posted 1/14/13; Closing 03/01/2013)

Field technicians (3 Positions Available), Columbia Spotted Frogs in the Bighorn Mountains of Wyoming

The University of Wyoming, Bighorn Mountains (north central Wyoming) (Posted 1/11/13; Closing 03/08/2013)

Herpetological Researcher/Educator Internship - Research 4 Reptiles LLC

Wilmington, IL (Application Deadline April 1, 2013)

Funding Opportunities

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

October 2013

American Forests -- Global ReLeaf 2014. Since 1990, Global ReLeaf has supported the planting of over 44 million trees in the USA and internationally for long-term environmental, economic, and social benefits. The program invites applications for tree-planting projects in 2014. Most grants range from US$3 thousand to US$30 thousand. The closing date for applications is 25 October 2013. **Link**

Center for Science and Technology of the Non-Aligned and Other Developing Countries -- Research Training Fellowships in India. With funding by the government of India, the RTF-DCS program will select twenty young scientists from developing countries to work at Indian R&D institutions for a period of six months. Fellowships are available in several areas, including agricultural sciences. Applicants should possess at least a master's degree, and should be working in a national R&D or academic institution in his/her home country. The fellowships aim to provide full financial assistance. The closing date for applications is 14 October 2013. **Link**

Climate and Development Knowledge Network (CDKN) -- Business-to-Business Partnerships. CDKN will support business-to-business partnerships that have potential to deliver sustained benefits for climate, poverty reduction, and economic growth. Funding for pilot projects will range from £60 thousand to £125 thousand per project in the following focus countries and regions: Bangladesh, India, Nepal, Pakistan, Indonesia, Ethiopia, Kenya, Rwanda, Uganda, Caribbean, Colombia, El Salvador, and Peru. The deadline for submissions is 07 October 2013. **Link**

CRDF Global -- Energy Research Collaboration, USA-Russia. CRDF Global will support joint teams of university researchers in the USA and Russia for non-commercial research in the areas of (i) nanotechnology, and (ii) alternative energy and energy efficiency. Grants are up to US$57,500 for projects of one year. Applications (English, Russian) should be submitted before 14 October 2013. **Link**

Critical Ecosystem Partnership Fund -- Biodiversity Conservation in Papua New Guinea. As part of its program to support conservation in the East Melanesian Islands Biodiversity Hotspot, the CEPF calls for letters of interest for projects in Papua New Guinea. Applicants should consult the ecosystem profile and conservation priorities, identified in the announcement. The deadline for letters of interest for small (less than US$20 thousand) and large grants is 28 October 2013. **Link**

Critical Ecosystem Partnership Fund -- Biodiversity Conservation in the Solomon Islands and Vanuatu. As part of its program to support conservation in the East Melanesian Islands Biodiversity Hotspot, the CEPF calls for letters of interest for projects in the Solomon Islands and Vanuatu. Applicants should consult the ecosystem profile and conservation priorities, identified in the announcement. The deadline for letters of interest for small (less than US$20 thousand) and large grants is 14 October 2013. **Link**

European Commission (EC) -- Environmental Governance in Sierra Leone. The EC announces funding to support Sierra Leone in environmental awareness and education, and pilot projects concerning climate change. The program is open to nonprofit organizations established in Sierra Leone and to international organizations. Grants are a maximum of €600 thousand for environmental awareness, and €800 thousand for climate change, subject to cost shares. Reference EuropeAid/135003/M/ACT/SL. The deadline for concept notes is 07 October 2013. **Link**

Forest Europe -- Photos and Videos of European Forests. Forest Europe announces a contest to obtain photos and videos that illustrate sustainable forest management in the pan-European region (i.e., including Georgia, Russia, Turkey, Ukraine, etc.). This refers to economic issues, socio-cultural issues, and environmental issues. The contest is open to all individuals over the age of 18. The winners will be awarded tablet computers and photographic products. The deadline for submissions is 31 October 2013. **Link**

Netherlands Organization for Cooperation in Higher Education (NUFFIC) -- Netherlands Fellowship Programs. The Netherlands Fellowship Programs (NFP) offer opportunities for professionals in 50 developing countries to pursue masters degrees, PhD studies, and short courses in the Netherlands. Individuals applying for fellowships must be admitted to the relevant academic programs in order to be eligible for funding. The deadline to apply for financial support is 01 October 2013 *(the deadlines for admission to the academic programs and courses are earlier, with many in September)*. **Link**

Oklahoma City Zoo & Botanical Garden -- Conservation Grants 2013. The OKC Zoo (USA) manages "Conservation Action Now" as a program of small grants for conservation education, scientific research, and species preservation. Grants are up to US$2,500. The application deadline is 18 October 2013. **Link**

Santa Clara University (USA) -- Global Social Benefit Incubator 2014. The GSBI at Santa Clara University is an annual program to strengthen social enterprises that use science and technology to address problems of people living in poverty. Past participants include many in water supply, energy, agriculture, and environment in developing countries. The GSBI Accelerator assists selected participants with business plans and other capacity building in support of investment. The GSBI Accelerator invites applicants from social entrepreneurs around the world. The application deadline is 31 October 2013. **Link**

U.S. Fish and Wildlife Service -- Conservation of Marine Turtles 2014. In its program "Wildlife Without Borders," the USFWS makes grants for the conservation of selected wildlife species, including marine turtles. Grants are for applied research, training, conservation management, community outreach, law enforcement, decreased human-wildlife conflicts, and other activities in conservation. Preference is for proposals that request less than US$50 thousand. Eligibility extends worldwide to qualified and relevant government agencies, other organizations, multi-national secretariats, and individuals. Proposal deadlines for marine turtles are 01 April and 01 October of each year. **Link**

November 2013

African-Eurasian Waterbird Agreement -- Small Grants Fund 2013. AEWA makes grants to support waterbird conservation in eligible African countries of the African-Eurasian Flyways. Grants are up to €20 thousand for projects of up to two years in African AEWA contracting parties, and up to €10 thousand for African non-contracting parties to complete their accession to AEWA. Applications are welcomed from government organizations and NGOs. Proposals need to be endorsed by AEWA's national focal points. The next application deadline is 30 November 2013. **Link**

Cleveland Metroparks Zoo -- Africa Seed Grants and Asia Seed Grants 2014. Both programs make grants for wildlife

conservation and research in their respective regions. The priority is for projects focusing on wildlife and habitat protection, human-wildlife conflict, sustainable environmental practices, capacity building, and conservation biology. There are no application restrictions by nationality. In both programs, the seed grants range from US$1,000 to US$3,500. The deadline for pre-proposals (both programs) is 04 November 2013. **Link**

Conservation Leadership Programme (CLP) -- Conservation Awards 2014. The CLP makes grants to advance the leadership capacity of early-career conservationists in the developing world. Grants combine research with conservation. CLP provides support to small teams of at least three individuals. Future Conservationist Awards are up to US$15 thousand. Follow-Up Awards and Leadership Awards are up to US$25 thousand and US$50 thousand, respectively. CLP explains each category of award; eligibility criteria; and details on how to apply. The application deadline is 11 November 2013. **Link**

Convention on Migratory Species -- Small Grants 2013-2014. The CMS offers small grants to strengthen the implementation of the Convention, with a strong focus on implementation in developing countries. Eligibility for grants extends to governmental institutions, NGOs, communities, conservationists, and researchers engaged in the conservation of migratory species. Projects can receive up to €15 thousand, although CMS encourages applications for lower amounts. The application deadline is 30 November 2013. **Link**

European Commission (EC) -- Support for Forest Governance in Guyana. The EC aims to strengthen the role of civil society and private-sector organizations in Guyana to participate in the program of Forest Law Enforcement, Governance, and Trade (FLEGT). Specific themes are to combat illegal logging, and to promote legal timber trade in Guyana. Eligibility for grants extends to NGOs and private-sector organizations established in Guyana, and to international organizations. Grants range from €100 thousand to €150 thousand, subject to cost shares. Reference EuropeAid/134854/L/ACT/GY. The closing date is 01 November 2013. **Link**

French Global Environment Facility (FFEM) -- Phase 4 of the Small-Scale Initiatives. The FFEM announces a fourth phase of the Small-Scale Initiatives for years 2013-2016. This program funds civil society organizations in Central and West Africa, Madagascar, and Mozambique for biodiversity conservation, the fight against climate change, and improvements of local livelihoods. Grants are to NGOs based in the eligible African countries, and to international NGOs in partnership with local NGOs that do not yet have legal status. FFEM will provide an average of €35 thousand per project, up to 50% of project costs (75% if there is only local participation). The deadline for applications (English, French, Portuguese, Spanish) is 15 November 2013. **Link**

Schlumberger Foundation -- Funding for Women in PhD and Post-Doctoral Studies 2014-2015. 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 submissions is 09 September 2013 through 15 November 2013. **Link**

UK Department for International Development (DFID) -- Building Resilience and Adaptation to Climate Change. DFID announces BRACED ("Building Resilience and Adaptation to Climate Extremes and Disasters") to build the resilience of people to extreme climate events in selected countries of the Sahel, Sub-Saharan Africa, and South Asia. Grants will be made to nonprofit NGOs that lead consortia with project partners (e.g., other NGOs, local governments, research organizations, UN agencies, and the private sector). The current call is for concept notes. The proponents of the best concept notes will be asked to develop full proposals for a three-year period. The deadline for concept notes is 10 November 2013. **Link**

UK Foreign and Commonwealth Office -- Chevening Scholarships 2014-2015. The Chevening Scholarships provide full or partial funding for full-time courses at postgraduate level, normally a one-year master's degree, in any subject at any UK university. Chevening Scholars come from 118 countries (excluding the USA and the EU). The scholarships will support more than 600 individuals in year 2014-2015. Applicants apply through the British diplomatic missions in their countries, with variable deadlines in November 2013. **Link**

December 2013

Both ENDS -- JWH Initiative to Promote Leadership of Young Environmentalists. The Joke Waller-Hunter Initiative offers grants to advance the leadership and learning of junior persons working for -- or affiliated with -- environmental civil society organizations in developing and emerging countries. JWH especially encourages the nomination of young women and local community leaders. Grants range from €2,500 to €10,000 each. The next application deadline is 01 December 2013. **Link**

East-West Center -- Asia Pacific Leadership Program 2014-2015. The APLP invites professionals from Asia-Pacific countries to apply for a 9-month program of leadership training and professional development on emerging issues facing the Asia-Pacific region. Inter-disciplinary interests at the East-West Center include climate change, land use, water and energy demands, etc., -- among other social and environmental themes. Fellowships of US$15 thousand cover the majority of costs. Applicants who request funding should complete their applications by the priority deadline of 01 December 2013. **Link**

Society for the Study of Amphibians and Reptiles (SSAR) -- Herpetology Grants 2014. The SSAR makes grants of US$500 to deserving individuals and organizations for herpetological research, education, and conservation. Projects should focus on endangered or threatened species. Some of the grant categories are restricted to SSAR members and students. The application period is 15 September 2013 through 15 December 2013. **Link**

January 2014

U.S. National Science Foundation (NSF) -- New International Collaborations for U.S. Researchers and Students. The NSF offers grants of US$10 thousand to US$75 thousand to U.S.-based scientists and students to promote future international collaborations. Past grants have included several on development issues related to water management, climate change, biodiversity conservation, and agricultural sciences (among others). The application deadline is 22 January 2014. **Link**

Wildlife Conservation Network -- Partnership Applications 2014. 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. WCN collaborates with its partners for networking, fund raising, and organizational support. The deadline for

letters of inquiry is 15 January 2014. **Link**

World Wide Fund For Nature (WWF) -- Prince Bernhard Scholarships for Nature Conservation 2014. WWF supports professional training and formal studies of individuals working in disciplines directly relevant to nature conservation. Eligibility extends to mid-career nationals from Africa; Asia and Pacific; Latin America and Caribbean; Eastern Europe; and the Middle East -- including WWF staff, or candidates working as partners with WWF. The maximum grant is CHF 10 thousand for studies or training lasting one year or less. The application deadline is 11 January 2014. **Link**

Instructions to Authors

Background

FrogLog has been one of the leading amphibian conservation community newsletters since the early 1990's. Over the years it has been affiliated with different groups but has always strived to help inform the community. In 2005 *FrogLog* became the official newsletter of the IUCN SSC Amphibian Specialist Group and is produced on a quarterly basis.

As the ASG's newsletter members are encouraged to contribute to *FrogLog*'s content and direction. To aid in this process each edition of *FrogLog* focuses on one of the six broad geographical zones identified by the ASG. The publication schedule is as follows:

- January—Special Topical Edition
- April—The Americas
- July—Africa, West Asia, Madagascar, Mediterranean and Europe
- October—Asia, Russia and Oceania

FrogLog invites contributions of research, reviews on current management and conservation issues, methods or techniques papers and, editorials. We also actively encourage submissions describing the current activities relating to projects and academic institutions in order to help inform the community as to the general state of current research and conservation activities.

Publication

FrogLog is published online at: www.amphibians.org and is Open Access.

Review

All contributions should ideally be channeled through Regional ASG Chairs, the details for which can be found at http://www.amphibians.org/asg-members/. If for some reason this cannot be done, contributions will be reviewed by at least one individual within the ASG. *FrogLog* is not a peer-reviewed publication and the onus for submitting accurate information remains with the authors.

Production Editor

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Editorial Committee

Claude Gascon (ASG Co-Chair)
Phillip J. Bishop (ASG Co-Chair)
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Robin D. Moore (ASG Program Officer)
Candace M. Hansen (ASG Program Officer)
Craig Hassapakis (Editor, Amphibian & Reptile Conservation)

Additional reviewers will be requested as required.

Submission of Manuscripts

Manuscripts can only be received as electronic files. Text should be submitted in MS Word format and may contain tables, but figures should be sent as a separate attachment where possible. All documents should be sent to froglog@amphibians.org. Each file should be labeled in a style that illustrates clear association, i.e., authors_name_ms and authors_name _figure1.

Guidelines for Authors

All manuscripts must be written in English.

Title

Titles should ideally be no more than 15 words.

Authors

Authors names should be written in full as follows: By James P. Lewis & Robin D. Moore

Main body of text

Use Georgia 11-point font. Genus and species names should be in italics as should the abbreviation for *Batrachochytrium dendrobatidis*, *Bd*. Suggested headings include Acknowledgements, Author Details, and References and Notes.

Author details

Author details may be provided, including affiliations and contact details.

Figures

Figures should be numbered and include brief, concise legends. Where photographs or illustrations are used please state whom the image should be credited to, e.g., Photo: James P. Lewis. Graphics should preferably be submitted in tiff or jpeg format in the highest possible quality. Resolution should be at least 300 dpi at the final size.

Tables

Tables may be included within the text file and should be numbered and include brief, precise legends.

Citation of literature

FrogLog uses a numbering system for references and notes. This allows explanatory or more detailed notes to be included with the references. Journal names are abbreviated using common abbreviations to save space.

Journals/Periodicals

1. E. Recuero, J. Cruzado-Cortés, G. Parra-Olea, K. R. Zamundio, *Ann. Zool. Fenn.* **47**, 223 (2010).

Books

2. J. Gupta, N. van der Grijp, Eds., Mainstreaming Climate Change in Development Cooperation (Cambrdige Univ. Press, Cambridge, UK, 2010).

Technical reports

3. G. B. Shaw, Practical uses of litmus paper in Möbius strips (Tech. Rep. CUCS-29-82, Columbia Univ., New York, 1982).

Paper presented at a meeting

4. M. Konishi, paper presented at the 14th Annual Meeting of the Society for Neuroscience, Anaheim, CA, 10 October 1984.

Published Online Only

5. N. H. Sleep, Geochem. Geophys. Geosyst., 10, Q11010 (2009): DOI:10.1029/2009GC002702.

Web site

6. National Oceanic and Atmospheric Administration, Beaufort Wind Scale, http://www.spc.noaa.gov/faq/tornado/beaufort.html (2012).

SPECIAL NOTE: Use only one space after all punctuation marks (this includes only one space after "periods" at the end of sentences).

Further examples and details can be found on our web site at: www.amphibians.org/froglog/guidelines/

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Green Cascade Frog (*Odorrana chloronata*). Photo: Jonathan Kolby.