

scientists to gather data on a larger scale geographically and over a longer period of time, which in turn helps researchers distinguish trends and understand differences among geographic areas. Citizen scientists have largely been able to learn to use equipment and collect results with a reasonable degree of accuracy as long as they are properly trained and are provided with the correct tools, such as guide books and other printed materials. By pairing trained staff and scientists with volunteers, scientists can compare data to determine its reliability, and therefore keep variable data to a minimum.

The science of citizen research is still a work in progress, but it is evident that it has enabled scientists to broaden their scope of study, while getting people involved in the scientific process and enhancing the appreciation of the natural world.

#### Earlier Breeding of Japanese Amphibians

Reports of declines in amphibian populations from all over the world have been attributed to global climate change. Warming trends affect a wide range of ecological processes, including epidemic diseases in amphibians. Climate change also has led to documented long-term shifts toward earlier breeding in at least some amphibian populations in Europe and North America.

KUSANO AND INOUE (2008. *Journal of Herpetology* 42:608–614) monitored four



Several species of Japanese amphibians, such as the Montane Brown Frog (*Rana ornativentris*), are breeding earlier in the year, a change almost certainly driven by warming climatic conditions.

breeding populations of three species of Japanese amphibians (*Hynobius tokyoensis*, *Rana ornativentris*, and *Rhacophorus arboreus*) to identify shifts in breeding patterns of amphibians in eastern Asia. The study was conducted at two sites in the suburbs of Tokyo for 12–31-year periods. The authors analyzed long-term data sets for first spawning and correlations between time of breeding and climatic factors. All of the amphibian populations analyzed showed significant trends toward earlier breeding. A relationship between the monthly mean air temperature in February and the dates of first spawning of *H. tokyoensis* showed that as the mean monthly temperature increased, the timing of breeding tended to become earlier.

The advance in dates of first spawning almost certainly is driven by a warming climate. Dates of first spawning were strongly correlated with temperature. However, earlier spawning may not necessarily imply a shift in entire breeding periods, especially if populations are growing. Consequently, some caution in interpreting the results is appropriate. Nevertheless, this study clearly demonstrated that significant long-term trends of warming in the region have affected timing of breeding in some species or populations.

#### Clearcut Logging Affects Gray Treefrog Tadpole Performance

Clearcutting is a major cause of many declining amphibian populations due to habitat alteration and loss. However, a previous study determined that Gray Treefrogs (*Hyla versicolor*) prefer breeding in ponds in clearcuts near forested habitat rather than in closed canopy ponds. HOCKING AND SEMLITSCH (2008. *Journal of Herpetology* 42:689–698) examined how biotic and abiotic factors influenced tadpole performance to test the implications of this apparent preference. The study was conducted in the Daniel Boone Conservation Area in Warren County, Missouri. Cattle tanks were set up in clear cuts and control forests at three replicate sites. Each site represented habitats associated with logged forests: Clearcut, clearcut-edge, forest-edge, and forest treatments. Tadpoles were measured during the larval period, size at metamorphosis, and by survival. The authors also evaluated the influence of temperature and food sources, such as periphyton productivity and invertebrate predator abundances.



Gray Treefrog (*Hyla versicolor*) tadpoles in clearcuts metamorphosed an average of 6.9 days sooner than tadpoles in forested areas.

Tadpoles in the clearcut treatments metamorphosed an average of 6.9 days sooner than tadpoles in forested treatments. The ability to metamorphose quickly from ephemeral ponds in clearcuts may enhance survival, which was 8.5% higher for tadpoles in clearcut than in forest ponds. However, tadpoles in clearcuts tended to be smaller in size at metamorphosis than those in forest treatments. Smaller size can reduce fitness through lower energy stores, delayed reproductive maturity, reduced fecundity of females, and lower survival, and may make them more susceptible to desiccation. Invertebrate predators did not have an influence. Further research should be done to examine the effects of clearcutting on competitive and predatory interactions among amphibians.

#### Madagascar's Biodiversity Vastly Underestimated

Amphibians are in decline worldwide. However, patterns of diversity, especially in the tropics, are not well understood, mainly because of incomplete information on taxonomy and distribution. VIEITES ET AL. (2009. *Proceedings of the National Academy of Sciences*, published online before print 4 May 2009, doi: 10.1073/pnas.0810821106) assessed morphologi-



Guibe's Treefrog (*Guibemantis guibeii*) is only one of the species that increased the known amphibian diversity on Madagascar from 244 to a minimum of 373 and as many as 465 species.

cal, bioacoustic, and genetic variation of Madagascar's amphibians, one of the first near-complete taxon samplings from a biodiversity hotspot. Based on DNA sequences of 2,850 specimens sampled from over 170 localities, their analyses revealed an extreme proportion of amphibian diversity, projecting an almost two-fold increase in species numbers from the currently described

244 species to a minimum of 373 and as many as 465. This diversity is widespread geographically and across most major phylogenetic lineages, except a few previously well-studied genera, and is not restricted to morphologically cryptic clades. Results suggest that the spatial pattern of amphibian richness and endemism in Madagascar must be revisited, and current habitat destruction

may be affecting more species than previously thought, in amphibians as well as in other animal groups. This case study suggests that worldwide tropical amphibian diversity is probably underestimated at an unprecedented level and stresses the need for integrated taxonomic surveys as a basis for prioritizing conservation efforts within biodiversity hotspots.

## NATURAL HISTORY RESEARCH REPORTS

#### Geographic Overlap Drives Reproductive Character Displacement in Frogs

Theoretical models suggest that populations overlapping geographically with different combinations of other species can evolve traits that increase the likelihood of proper mate recognition. When such phenomena occur, they are recognized as examples of reproductive character displacement. LEMMON (2009. *Evolution* 63:1155–1170) tested this hypothesis by assessing differences in mating calls (patterns of acoustic signals) in two- and three-species assemblages of Chorus Frogs (*Pseudacris*), focusing in particular on *P. feriarum* and *P. nigrita*, and determined that only the rarer species displayed substantial displacement in this trait (*P. feriarum* in three cases and *P. nigrita* in one instance). Moreover, the three displaced *P. feriarum* populations diverged in different signal traits across the contact zone, evolving in directions that increased the energetic cost of calling over that incurred by populations free from competition. Divergences invariably maximized differences from other species present. Females in the same geographic area also diverged in their preference for mat-



Upland Chorus Frogs (*Pseudacris feriarum*) modified their calls when found in the same areas with the Southern Chorus Frog (*P. nigrita*).

ing calls, thus reducing an inclination to hybridize. Together, signal and preference data suggested that interactions between species can promote diversification within species, potentially contributing to reproductive isolation among conspecific populations.

#### Lizard Rolls Over to Avoid Sex

In some lizards, females develop bright coloration to signal reproductive status and exhibit behavioral repertoires to incite male courtship and/or reduce male harassment and forced copulation. Sex steroids, including progesterone and testosterone, might influence female reproductive coloration and behavior. JESSOP ET AL. (2009. *Journal of Comparative Physiology. A, Neuroethology, Sensory, Neural, and Behavioral Physiology*. Epub.) measured associations among plasma profiles of testosterone and progesterone with variation in color expression and reproductive behavior, including unique courtship rejection behaviors, in female Lake Eyre Dragon Lizards (*Ctenophorus maculosus*). At onset of breeding, progesterone and testosterone increased with vitellogenesis, coincident with color intensification and sexual receptivity, indicated by acceptance of copulations. As steroid levels peaked around the inferred ovulation time, maximal color development occurred and sexual receptivity declined. When females were gravid and exhibited maximal mate rejection behaviors, progesterone levels remained consistently high, while testosterone exhibited a discrete second peak. At oviposition, significant declines in plasma steroid levels, fading of coloration and a dramatic decrease in male rejection behaviors co-occurred. These results indicate a generally concordant association among steroid levels, col-



Male Lake Eyre Dragon Lizards (*Ctenophorus maculosus*) are really persistent, attempting to force females to copulate, harassing them all through the breeding season. Unreceptive females scare off advancing males by taking on a threatening posture. If that doesn't work, they throw themselves on their backs and reveal their bright orange underside. Males can't force themselves onto a female when she's on her back.

oration, behavior, and reproductive events. However, the prolonged elevation in progesterone and a second peak of testosterone was unrelated to reproductive state or further color change, possibly suggesting selection on females to retain high steroid levels for inducing rejection behaviors.

#### Small Snakes Use Active Ant Nests as Hibernacula

Ant mounds offer potential hibernacula both for small snake species and also for juveniles of many species, although this potential may be offset by aggression from ants in active nests and the concomitant



Snakes, such as Western Worm Snakes (*Carphophis vermis*), that are not adapted for burrowing in dense or rocky soils, might benefit from using active ant nests as hibernacula despite the risk of aggression from ants.

risk of death for snakes, especially juveniles. Despite this risk, PISANI (2009, *Transactions of the Kansas Academy of Science* 112:113–118) suggested that such hibernacula may be especially important for snake species not adapted for burrowing in habitats where soils are dense, or rocky, and difficult for snakes to excavate. Thermal characteristics of ant nests appear only to offer snakes access to survivable temperatures below the frost line, rather than temperatures notably warmer than surrounding soils.

### Thermal Ecology and Reproduction

The Eastern Massasauga (*Sistrurus catenatus*) is a viviparous rattlesnake that is a species of “special concern” in Michigan and listed as state-threatened or endangered throughout the rest of its range. Viviparous species typically have unique thermal needs associated with the internal development of young, and these needs can influence vegetation selection patterns. FOSTER ET AL. (2009, *Herpetological Conservation and Biology* 4:48–54) investigated the thermal ecology and vegetation selection of female *S. c. catenatus*. They radio-tracked eight gravid and six non-gravid females implanted with temperature-sensitive transmitters in southwestern Michigan during May–August 2004 and 2005. Gravid *S. c. catenatus* generally maintained higher average body temperatures ( $T_b$ ; 29.1–34.1°C) throughout the season than non-gravid females (22.2–30.8°C), and also maintained plateau temperatures longer in the diel cycle. Gravid females maintained significantly higher mean temperatures above ambient compared with non-gravids early (i.e., May; gravid = 11.7°C; non-gravid = 6.1°C) and late (i.e., July and August;

gravid = 7.1°C; non-gravid = 4.9°C) in the season. These results suggest that gravid females were thermoregulating to facilitate embryogenesis. Gravid *S. c. catenatus* selected early/mid-successional deciduous upland vegetation, and these areas had significantly higher mean soil temperatures (19.9°C) than early/midsuccessional wetlands (17.4°C). Therefore, the authors recommended that upland areas adjacent to wetlands supporting *S. c. catenatus* be maintained in early successional vegetation types with limited woody encroachment. This vegetation type provides gravid females with favorable thermal conditions to meet their reproductive requirements.



Gravid Eastern Massasaugas (*Sistrurus catenatus catenatus*) maintain higher body temperatures than non-gravid females.

## NEWSBRIEFS

### Dead Mountain Chickens Litter the Streams of Montserrat

Montserrat’s “Mountain Chicken” (not a chicken, but a frog) has become the latest victim of the killer fungal disease that is devastating amphibians worldwide. Only two small pockets of the animals on the tiny Caribbean island remain disease-free. The Mountain Chicken (*Leptodactylus fallax*) is one of the world’s largest frogs, and appears on the coat of arms of neighboring Dominica.

Conservationists suspect the chytrid fungus entered Montserrat on small frogs stowing away in consignments of produce from Dominica. “We’ve always been afraid that frogs coming in banana consignments from Dominica would bring chytrid, and that it would then spread into the center of the island,” said John Fa, director of conservation science at Durrell Wildlife Conservation Trust. “The northern popu-



Montserrat’s “Mountain Chicken” (*Leptodactylus fallax*) has become the latest victim of the killer fungal disease that is devastating amphibians worldwide.

lations are closer to the port, and the disease appears to have spread southward along the river systems. Essentially, all populations to the north and north-west of the Centre Hills have been decimated, and there are just two remaining populations of seemingly healthy animals in the southeastern

corner.” An expedition in 2005 found no sign of fungal infection.

The frogs are called “Mountain Chickens” because their meat tastes like chicken. On both Montserrat and Dominica — the only places where they now occur naturally — hunting was already impacting populations before the arrival of chytrid. Most of the Montserrat populations also were affected by the volcanic eruptions that began in 1995, although the creation of an “exclusion zone” around the volcano’s slopes has provided some help to wildlife by freeing it from human pressures.

Events on Montserrat now appear to be mimicking what happened on Dominica in 2002. Within 15 months of the fungus arriving, about 80% of that island’s Mountain Chickens had been wiped out.

First identified just over a decade ago, the fungus (*Batrachochytrium dendrobatidis*) has spread through hundreds of amphibian

species on different continents. It sweeps some to extinction in a matter of months, while others are apparently immune. “We still don’t know how chytrid kills frogs, and there’s some very basic stuff about the biology of the fungus that we need to understand,” observed Andrew Cunningham from the Zoological Society of London. “We’ve known about it for 10 years, but so little money has been spent on it. If this was killing mammals or birds in the same way it’s killing amphibians, millions and millions would have been spent on it.”

In captivity, chemicals can be used to rid amphibians of the fungus, but no cure for wild populations is known, nor can infected bodies of water be cleansed. As a result, many conservation groups are focusing their energies on establishing captive populations. Durrell and other conservation organizations already have Mountain Chickens in captivity, and will be taking more from the apparently healthy Montserrat populations. In contrast to some other operations, however, it plans to treat and return some frogs to the wild within a couple of years, placing them in areas that appear to be free of chytrid.

Richard Black  
Environment Correspondent, BBC News website

### Fighting for Forest Frogs

Nineteen species of frogs native to Sri Lanka have gone extinct due to continuing habitat loss essentially caused by smallholder farming activities and logging. Drought and the use of agrochemicals in cardamom cultivation are additional threats. No other country in the world has more documented amphibian extinctions. Therefore, protecting the remaining forests in Sri Lanka is an urgent priority to prevent further losses of species.

The IUCN SSC Amphibian Specialist Group identified a 1,000-hectare cloud forest called Morningside as a top priority because a total of 11 globally threatened amphibians, three endemic lizards, and three species of endemic freshwater crabs are native to this threatened forest. The Morningside Cloud Forest, where Conservation International has now been working for the past five years, is located in southeastern Sri Lanka just east of the Sinharaja World Heritage Site.

The IUCN SSC Amphibian Specialist Group and local partners, including Conservation International, the Wildlife



Poppy's Shrub Frog (*Philautus poppiae*) is native to Sri Lanka and lives in closed canopy cloud forest. It is classified as Endangered on The IUCN Red List of Threatened Species due to the ongoing decline in the quality and extent of its forest habitat.

Heritage Trust of Sri Lanka, IUCN Sri Lanka, and the Forest Department of Sri Lanka convinced the government of Sri Lanka to designate all 1,000 hectares of the Morningside Cloud Forest as a Forest Reserve for Biodiversity Conservation, which ensures its protection in perpetuity.

Concerned about the local economy for people in the region around Morningside, IUCN and Conservation International staff are developing and implementing a management plan that targets the sustainable harvest of cardamom within portions of the Morningside Cloud Forest. Cardamom plants, which do not tolerate direct sunlight, are currently grown in the understory of the forest, where cloud forest trees provide necessary shade. However, the cardamom is being grown in a way that is not only incompatible with maintaining a tree canopy, but is also potentially harming threatened frog species in other ways.

The IUCN SSC Amphibian Specialist Group and local partners are now developing and implementing a management plan to enable reserve staff to effectively protect threatened species within Morningside. Because both cardamom plants and threatened species benefit from a healthy cloud forest habitat, the management plan will focus on how to cultivate cardamom efficiently, providing revenue to the local community without negatively impacting cloud

forest trees and the threatened species that inhabit the forest.

In addition, the IUCN SSC Amphibian Specialist Group is working with IUCN Sri Lanka to incorporate the Morningside Cloud Forest Reserve within the Sinharaja World Heritage Site, which will help ensure the long-term allocation of funds to protect and manage the species unique to Morningside.

IUCN News story  
23 April 2009

### Florida Leads the Way for Freshwater Turtles

The Florida Fish and Wildlife Conservation Commission voted unanimously to ban the commercial harvest of freshwater turtles throughout the state on Wednesday, April 15. This move comes after several of the world’s leading turtle scientists called on Florida’s Governor Charlie Crist to end the commercial hunting of turtles, which supplies eastern Asian food markets. The experts, brought together by the Tortoise and Freshwater Turtle Specialist Group of the IUCN’s Species Survival Commission, alerted the Governor that the state’s turtles were at high risk of being wiped out by the expanding global trade in turtles that had recently begun to target Florida’s fairly robust turtle populations. That trade has been driven by the almost insatiable



The Florida Fish and Wildlife Conservation Commission voted unanimously to ban the commercial harvest of freshwater turtles throughout the state. Species such as this Florida Softshell Turtle (*Apalone ferox*) are beneficiaries of the new regulations.

demand for turtle meat and medicinal products in Chinese markets and led to the previously destructive Asian turtle trade, which has driven many populations of wild turtles in Asia into near extinction.

Governor Crist demonstrated true conservation leadership by publicly supporting a ban in the turtle trade, and instructed his Wildlife Commission to study the matter carefully and take appropriate action. "This is a great victory for turtle conservation," says Anders Rhodin, Chair of the IUCN's Tortoise and Freshwater Turtle Specialist Group. "The regulations will be the strictest in the U.S. and mean the U.S. is finally facing up to the growing threat of this global consumptive turtle trade. The IUCN Tortoise and Freshwater Turtle Specialist Group was central in helping to achieve this victory."

Turtle biologists such as Matt Aresco first raised warnings about what was happening. "All the scientists who study Florida's turtles are unanimous: We believe that the mass commercial hunting of wild turtles must end," Aresco said in response to the wildlife commission decision.

"If we allowed it, the Chinese — more than one billion Chinese — could and probably would eat every single turtle in existence in Florida in one year," said biologist Dale Jackson. In China, one species of softshell turtle is down to the last two individuals, said Peter Meylan of Eckerd College in St. Petersburg. Scientists said Florida shouldn't wait for turtles there to disappear before taking action.

The Florida commercial turtle harvest ban will be enacted later this year. The draft rule would ban the commercial take or sale of wild freshwater turtles, and would also prohibit taking turtles from the wild that are listed on Florida's endangered species list. In addition, the collection of eggs would be prohibited. Individuals would be allowed to take one freshwater turtle per day per person from the wild for noncommercial use. The transport of more than one turtle per day would be prohibited.

In a letter to the Florida Fish and Wildlife Conservation Commission, the turtle experts said: "The proposed new regulations will provide the best protection for freshwater turtles in any state in the U.S. and establish Florida as a leader on this issue in North America. "Other states are watching Florida," it continued. "As we noted in our earlier letter, Florida is one of the two centers of highest turtle diversity in the world, and it is important that we demonstrate our stewardship of this important natural heritage."

IUCN News story  
23 April 2009

### Project Heloderma Receives Disney Grant

Project Heloderma and its main partners, the IRCF and ZooAtlanta, received a grant from the Disney Worldwide Conservation Fund in the amount of \$24,100. This grant will support the highly effective educational program administered by the project's initiator, Zootropic, for 2009–2010 (see also the Conservation Update on p. 110).



### CITES Listing for the *Ctenosaura palearis* Clade

The *Ctenosaura palearis* clade is comprised of four species (*Ctenosaura palearis*, *C. bakeri*, *C. oedirhina* and *C. melanosterna*), all with narrow ranges and endemic to eastern Guatemala and the Caribbean versant and Bay Islands of Honduras. In 2004, all four species were listed as Critically Endangered (CR) on the IUCN Red List. These species

face a variety of threats, including habitat destruction and over-harvesting for human consumption and the pet trade.

Early this year the CAFTA-DR program of the U.S. Department of the Interior granted support for a proposal by Daniel Ariano, Zootropic, and Stesha Pasachnik, University of Tennessee, to evaluate the potential for listing species in the genus *Ctenosaura* under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).



Participants listen to a presentation by Daniel Ariano (Zootropic) at the meeting and workshop held in La Ceiba, Honduras to gain support for a proposal to list the entire *C. palearis* clade under the CITES Convention.

Specifically, the goals of the proposal were to determine which CITES Appendix is most applicable for these species and to evaluate the viability of a CITES proposal for only selected species (i.e., *C. palearis* and *C. melanosterna*), for the entire *C. palearis* clade, or the entire genus.

On 8 May 2009, Daniel Ariano, Stesha Pasachnik, and the Bay Islands Foundation hosted a meeting and workshop in La Ceiba, Honduras to gain support for a proposal to list the entire *C. palearis* clade. Scientific and administrative authorities from throughout the country were in attendance. Following the presentation of trade data, participants unanimously supported a decision to list these four species under CITES Appendix II. The proposal now has the full support of both the Guatemalan and Honduran governments, as well as a variety of NGOs. At the end of June, the official CITES proposal will be presented at another meeting with the highest-level government administrators in order to affirm their cooperation.



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## Editor's Remarks

In concert with our emphasis on conservation and natural history, we feature in this issue articles dealing with some of the world's most endangered frogs, husbandry and breeding of a threatened tortoise, two projects with which the IRCF is actively involved, and two dealing with efforts to better understand the biodiversity of life. We also feature two commentaries on topics that should be of interest to all of our readers, changes affecting natural history museums, which have motivated so many scientists over the years, and the ongoing mass extinction, the extent and impact of which we can only imagine at this time.

We are very pleased with the enthusiastic response to the addition of color to our pages, and hope that you enjoy the variety of species and topics addressed. Please feel free to contact any of us with suggestions about articles you'd like to see in future issues.

The Editors of *Reptiles & Amphibians*



**Erratum:** The image in *Reptiles & Amphibians*, vol. 16, no. 1, p. 62, labeled "*Cuora amboinensis*" is a photograph of a Bell's Turtle (*Elseya belli*), which is endemic to eastern Australia. A Southeast Asian Box Turtle (*Cuora amboinensis*) is illustrated here. This species is disappearing from parts of Indonesia where it once was common.

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