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SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

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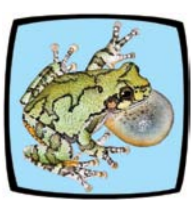


The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most diverse society-sponsored program of services and publications for herpetologists. Membership is open to anyone with an interest in herpetology—professionals and serious amateurs alike—who wish to join with us to advance the goals of the Society.

All members of the SSAR are entitled to vote by mail ballot for Society officers, which allows overseas members to participate in determining the Society's activities; also, many international members attend the annual meetings and serve on editorial boards and committees.

All members and institutions receive the Society's primary technical publication, the *Journal of Herpetology,* and its news-journal, *Herpetological Review*; both are published four times per year. Members also receive pre-publication discounts on other Society publications, which are advertised in *Herpetological Review*.

To join SSAR or to renew your membership, please visit the secure online ZenScientist website via this link:

http://www.ssarherps.org/pages/membership.php

Future Annual Meetings
2012 — Vancouver, British Columbia, 8–14 August (with World Congress of Herpetology)
2013 — Albuquerque, New Mexico, 10–15 July (JMIH with ASIH, HL, and AES)

ABOUT OUR COVER: *Protobothrops trungkhanhensis*

Most of the widely distributed pitvipers of Indochina and southern China have karst inclusions within their ranges, although these areas are mostly covered by forest in granite-basalt massifs. A number of narrowly distributed species of *Trimeresurus* senso lato appear to be highly adapted to karst habitats: *Viridovipera truongsonensis*, *Cryptelytrops honsonensis*, *C. venustus*, *C. kanburiensis*, *Triceratolepidophis sieversorum*, *Protobothrops cornutus*, and *Zhaoermia mangshanensis*. Unique characteristics of karst, such as an extreme surface irregularity, deep caves, ravines, and shelf-like laminations, along with low ambient light conditions, appear to have influenced morphology and behavior of the karst-associated pitviper species. Although basking is rare in the largely nocturnal green forest pitvipers, most grey-brown karst pitvipers periodically bask in sunny spots. Karst pitvipers have dark spots and “tiger” bands that provide excellent camouflage among stony outcrops, lichens, and leaf litter. These snakes have a rough integument that may facilitate mobility in rocks, although on leaf litter they are sluggish and clumsy (Orlov et al. 2010. Karst pitvipers: natural history and morphological correlations. Abstracts book, Biology of the Vipers, 3rd Conference, pp. 13–14, Pisa, Italy).

On the basis of this information, a team of Russian and Vietnamese herpetologists—Nikolai L. Orlov, Sergei A. Ryabov, Nguyen Thien Tao)—initiated field work in 2008, targeting hitherto unexplored karst regions of northeastern Vietnam and bordering southeastern China. Their efforts yielded a new karst-associated pitviper, *Protobothrops trungkhanhensis* (Orlov et al. 2009. Russian Journal of Herpetology 16[1]:69–82), as well as a new population of *P. cornutus*, a species otherwise known only from a handful of localities in western and central Vietnam. The new species is a dwarf form of *Protobothrops* (maximum size is 733 mm TL), and its muted colors are typical of the karst-inhabiting species of Asian pitvipers. With other recent discoveries (Orlov et al. 2009, *op. cit.*; Yang et al. 2011. Zootaxa 2936:59–68), the number of karst-associated pitvipers species now stands at seven.

Northeastern Vietnam exhibits high levels of endemism across various taxonomic groups, including a unique population of gibbons, undescribed species of frogs (*Theloderma*), a new cat-eyed snake (*Boiga*), and a new gecko (*Goniurosaurus huuliensis*), among others.

The cover subject, the adult male holotype of *Protobothrops trungkhanhensis* (Trungkhanh Pitviper) was discovered in September 2008 in Trung Khanh Nature Reserve, Cao Bang province, northeastern Vietnam, at an elevation of 600 m. The cover image was recorded at night by **Nikolai Orlov,** using a Nikon D700 DSLR and a Nikkor 105mm AF-2 micro lens, with lighting provided by two Nikon SB900 speedlights. Orlov is a senior research scientist in the Department of Herpetology, Zoological Institute, Russian Academy of Sciences (St. Petersburg, Russia; http://www.zin.ru/labs/herplab/index.html). Orlov has been thoroughly engaged in field explorations throughout Asia, resulting in a number of new discoveries and numerous publications. He has also had a long-standing interest in developing methods of captive breeding of rare and endangered amphibians and reptiles.

PHOTO BY NIKOLAI ORLOV

SSAR BUSINESS

SSAR Silent Auction Donations

SSAR announces the 16th Annual Silent Auction to be held at the 2012 World Congress of Herpetology in Vancouver, BC, 8–14 August. Again this year we are glad to accept any herp-related donations, including but not limited to, frameable art (photographs, paintings, and line illustrations), books, music, glassware, jewelry, clothing and gift certificates for Vancouver area services/events during the meeting week. The SSAR Student Travel Committee organizes the Annual Silent Auction to raise money to fund the student travel awards to the annual JMIH. Increasing travel costs each year make it more difficult for students to attend meetings and become involved in societies. However, your continued support through donations to the silent auction helps offset these costs enabling students to attend, network and present their research. If you are interested in donating an item or two (tax deductible for U.S. residents), please contact Vincent Farallo (e-mail: vfarallo@gmail.com) for more information.

SSAR Student Travel Awards — Call for Applications

Ten awards of US $400 each are available to students to help defray the cost of traveling to the 2012 World Congress of Herpetology. An applicant for a travel award must be a student and a current member of SSAR, must not have previously received a travel award from SSAR, and must be the first author of a paper or poster to be presented at the 2012 WCH. The application package must include: 1) a letter signed by his/her major advisor or department chair that states that he/she is not completely funded for travel from another source and, if the research is co-authored, that the work was primarily the product of the applicant; 2) a copy of the abstract that was submitted for either poster or oral presentation. The qualified applicants will be pooled and the winners will be drawn at random. Winning applicants must volunteer 5 hours during the 2012 WCH to work at the bidding table. Students from the immediate vicinity of the WCH, as well as current members of the SSAR Travel Awards Committee,

NEW BOOK FROM S.S.A.R.

A Contribution to the Herpetology of Northern Pakistan

by Rafaqat Masroor

(Pakistan Museum of Natural History, Islamabad)

"Masroor's book exceeds the scope of a field guide and turns it into a sound handbook on the herpetology of northern Pakistan." — Wolfgang Böhme (from the book's foreword)

This book on the herpetology of northern Pakistan is built around an intensive, 7-year-long survey of the Margalla Hills National Park—a 175-square-kilometer reserve that surrounds the country's capital city, Islamabad—together with further surveys of adjacent regions. This overall area, lying near the base of the Himalayan Mountains, contains the headwaters of Pakistan's major river system, the Indus. The habitats in this region range from arid desert-like biomes to monsoonal subtropical forests. Biogeographically, the region is the meeting place between the Palearctic and Oriental zones, as reflected in the diversity of its herpetofauna.

The book covers 16 families of amphibians and reptiles: three of amphibians: Bufonidae (1 genus: 2 species), Microhylidae (2:2), and Dicroglossidae (5:5); and 13 families of reptiles, including two of turtles: Geoemydidae (1:1) and Trionychidae (2:2); six families of lizards: Agamidae (3:3), Eublepharidae (1:1), Gekkonidae (2:3), Lacertidae (2:2), Scincidae (3:3), and Varanidae (1:1); and five of snakes: Leptotyphlopidae (1:1), Typhlopidae (2:2), Colubridae (8:9), Elapidae (2:3), and Viperidae (2:2).

Each species account contains: the animal's classification, its English name, diagnostic features, description (including tadpoles), habits and habitat, distribution, and remarks. There is a color-illustrated key to families and species, a chapter on distribution of species by habitat types, another chapter on threats to the herpetofauna with conservation recommendations, a glossary of technical terms, an extensive bibliography, and a comprehensive index. In addition, there is a complete, up-to-date *checklist of Pakistan's 210 species of amphibians and reptiles* (including marine species) with English names. Color photographs and country-wide distribution maps are spread throughout the book; the maps have individual localities plotted. Much new unpublished information is included in this book.

The author: Rafaqat Masroor is in charge of the Herpetological Collections at the Pakistan Museum of Natural History, Pakistan's national museum located in Islamabad. He publishes regularly in international journals on the systematics and ecology of Pakistan amphibians and reptiles and has named several new species of lizards.

Fig. 77**:** Distribution of *Varanus bengalensis* in Pakistan.

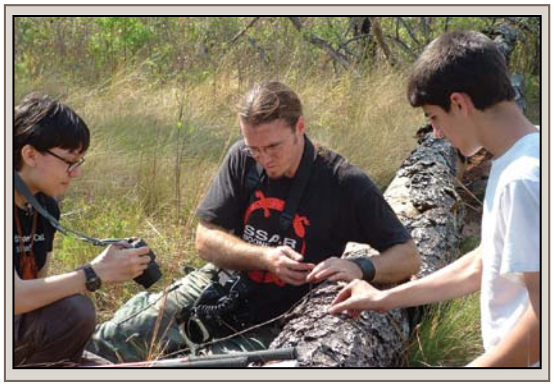
Specifications: 217 pages, 5½ × 8½ inches (14 × 22 cm), 3 color base maps, 107 color photographs of animals and habitats, 42 color distribution maps, illustrated keys to species, clothbound with dust jacket. ISBN 978-0-916984-83-0. ***To be issued April 2012.***

Prices: **SSAR members US$35 before July 2012; Institutions, non-members US$45.** ***Shipping:*** **USA address, add US$5; non-USA, at cost.**

Send orders to: Breck Bartholomew, SSAR Publications Secretary, P. O. Box 58517, Salt Lake City, Utah 84158–0517, USA (*telephone*: area code 801, 562–2660; *e-mail*: ssar@herplit.com). Make checks payable to "SSAR." Overseas customers may make payment in USA funds using a draft drawn on American banks or by International Money Order. All persons may charge to MasterCard, American Express, Discover Card, or VISA (please provide account number and expiration date). SSAR membership details and a complete list of all Society publications can be obtained on request to the Publications Secretary (address above). For details, check the Society's website at www.ssarherps.org.

are excluded from applying for a travel award. Award checks will be disbursed at the SSAR Business Meeting to be held during the WCH. Application materials are preferred in electronic form (either PDF or Microsoft Word) and should be sent to Vincent Farallo by 1 May 2012 (vfarallo@gmail.com); however, hard copies can be mailed to Vincent Farallo, Ohio University, Department of Biology, 107 Irvine Hall, Athens, Ohio 45701, USA. Hard copies sent via postal mail must be postmarked prior to 1 May 2012 to be considered. For more information, contact: Vincent Farallo (vfarallo@gmail.com) or Mike Jorgensen (mjorgensen08@gmail.com).

New Student Mentorship Program



Attention Student Members! Would you like to have help making the most of attending the World Congress? SSAR will be introducing a mentorship program for undergraduate and graduate students for whom the World Congress of Herpetology (Vancouver, 8–14 August 2012) will be their first national or international herpetology meeting. Mentorship positions will be limited to seven applicants, chosen at random, with the expectation that this program will be expanded in future years. Mentors will be advanced graduate students who have attended international herpetology meetings in previous years and who can orient you to the meeting, help make introductions, and enhance your overall meeting experience.

If this is your first meeting, we invite you to apply for a graduate student mentor. Applications will be accepted during the meeting registration period. For more information, please contact Kristine Kaiser (Chair, SSAR Mentorship Committee) at kristinekaiser@gmail.com.

SSAR Thanks 2011 Seibert Award Judges

Although we published names of the winners of Seibert Awards from the 2011 annual meeting in Minneapolis, we failed to acknowledge the excellent work of the judges. Last year's judging panel consisted of Shawn Kuchta (Ohio University), Todd Jackman (Villanova University), Gerardo Carfagno (Gettysburg College), Robert Weaver (Central Washington University), Eric Juterbock (The Ohio State University), Carol Spencer (University of California, Berkeley), Patrick Owen (University of Cincinnati), Nancy Karraker (The University of Hong Kong), Kris Kaiser (University of California, Los Angeles), and David Lesbarrères (Laurentian University). Rafe Brown (University of Kansas) coordinated the judging efforts. Thanks to all!

NEWSNOTES

Kansas Herpetological Society Annual Meeting

The Kansas Herpetological Society held its 38th Annual Meeting at the Great Plains Nature Center in Wichita, Kansas, USA, on 5–6 November 2011. Over 125 participants attended scientific paper sessions presented by scientists and students from across the nation. Keynote speaker Richard Kazmaier from West Texas A&M University gave an excellent presentation on Western Indigo Snakes and Western Diamondback Rattlesnakes.

Jennifer M. Singleton, a student at Emporia State University, received the 2011 Howard K. Gloyd/Edward H. Taylor Scholarship, honoring the memory of two great biologists with strong ties to Kansas. The 2011 Alan H. Kamb Grant for Research on Kansas Snakes was made to Dexter Mardis (Friends University, Wichita, Kansas). Greg Sievert (Emporia State University, Emporia, Kansas) was chosen as the recipient of "The Suzanne L. & Joseph T. Collins Award for Excellence in Kansas Herpetology." Denise M. Thompson (Missouri State University, Springfield) was presented with the George Toland Award for the best student paper given at the meeting. Mary Kate Baldwin (Topeka Collegiate School) and Eric Kessler (Blue Valley School District Center for Advanced Professional Studies) each received the Bronze Salamander Award for their years of service to KHS. The "Henry S. Fitch-Dwight R. Platt Award for Excellence in Field Herpetology" was made to Eddie Stegall (Sedgwick County Zoo, Wichita).

The J. Larry Landers Student Research Grant

The J. Larry Landers Student Research Grant is a Gopher Tortoise Council competitive grant program for undergraduate and graduate college students. Proposals can address research concerning Gopher Tortoise (*Gopherus polyphemus*) biology or any other relevant aspect of upland habitat conservation and management. The amount of the award is variable, but projects up to US $2,000 have been awarded.

The proposal should be limited to four pages in length and should include a description of the project, a concise budget and a brief resume of the student. Submissions via e-mail as text files are preferred.

This is an excellent opportunity for undergraduate and graduate students to access funding for their projects. The deadline for grant proposals is 15 September 2012. Please send submissions to: Dr. Bob Herrington, Chairperson, Research Advisory Committee, Department of Biology, Georgia Southwestern State University, Americus, Georgia 31709, USA; e-mail: bherring@canes.gsw.edu.

Field Course in Tropical Herpetology

The Institute for Tropical Ecology and Conservation is offering a summer course at Bocas del Toro Biological Station, Boca del Drago, Isla Colon, Panama. The biological station is located on a beach facing the Caribbean Sea. The course will run from 15 June to 10 July 2012. Class is limited to 15 students, and the deadline for registration is 15 May 2012. For details, please contact: Dr. Peter Lahanas, Institute for Tropical Ecology and Conservation, 2911 NW 40th PL, Gainesville, Florida 32605, USA (Tel. 352-367-9128; itec@itec-edu.org, http://www.itec-edu.org/index.html).

Fresno Chaffee Zoo Wildlife Conservation Fund

The Fresno Chaffee Zoo Wildlife Conservation Fund was established in 2006 to promote understanding and enjoyment of rare, threatened, and endangered animals and their habitats and to support zoological research that will directly benefit captive animal management. Awards may be made in any amount; however awards are typically in the range of US $1,000-$2,000. Awards are generally announced in August of each year. The principal investigator must be associated with a recognized institution (accredited zoo, academic institution, conservation or non-profit organization). Applications for exhibit development/graphics for zoos or facilities in North America will not be considered. Higher priority will be given to *in situ* conservation projects.

The application deadline is 1 June 2012. A copy of the application form may be downloaded here: http://www.fresnochaffeezoo.org/the-news/111-conservation.html. For additional information, please contact: Adrienne Castro (e-mail: acastro@fresnochaffeezoo.org).

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (HerpReview@gmail.com) well in advance of the event.

13 April 2012— Amphibian Taxon Advisory Group Annual Meeting, Miami, Florida, USA. Information: Diane Barber (e-mail: dbarber@fortworthzoo.org).

2–4 June 2012—Fifth Asian Herpetological Conference, Chengdu, China (including Annual Meeting of the Chinese Herpetological Society). Information: http://test.ox120.com/ahr/index.html

8–12 July 2012—10th International Congress of Vertebrate Morphology, Barcelona, Spain. Information: http://icvn2013.com/ or http://www.facebook.com/ICVM10.

8–13 July 2012—17th World Congress of the International Society on Toxinology & Venom Week 2012, 4th International Scientific Symposium on All Things Venomous, Honolulu, Hawaii, USA. Information: http://www.istworldcongress17-venomweek2012.org/index.html.

24–26 July 2012—2012 Northeast Partners in Amphibian and Reptile Conservation (NE PARC) Annual Meeting, Crawford Notch, New Hampshire, USA. Information: www.northeastparc.org.

25–28 July 2012—35th International Herpetological Symposium, Hanover, Maryland, USA. Information: http://www.kingsnake.com/ihs/.

8–14 August 2012—World Congress of Herpetology 7, Vancouver, British Columbia, Canada (together with SSAR, HL, ASIH). Information: http://www.worldcongressofherpetology.org/

16–19 August 2012—10th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles, Tucson, Arizona, USA. Co-hosted by the Turtle Survival Alliance and IUCN Tortoise and Freshwater Turtle Specialist Group. Information: http://www.turtlesurvival.org.

2–7 September 2012—4th International Zoological Congress (IZC), Mount Carmel Campus, University of Haifa, Haifa, Israel. To receive the first and subsequent meeting announcements, contact the organizers at: izc2012@sci.haifa.ac.il.

CURRENT RESEARCH

The purpose of Current Research is to present brief summaries and citations for selected papers from journals other than those published by the American Society of Ichthyologists and Herpetologists, The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles. Limited space prohibits comprehensive coverage of the literature, but an effort will be made to cover a variety of taxa and topics. To ensure that the coverage is as broad and current as possible, authors are invited to send reprints to the Current Research section editors, Joshua Hale or Ben Lowe; e-mail addresses may be found on the inside front cover.

A listing of current contents of various herpetological journals and other publications is available online. Go to: http://www.herplit.com and click on "Current Herpetological Contents."

Behavior Enhances Anti-Predator Strategies in Poison Frogs

Though northern populations are generally red with blue legs, the Strawberry Poison Frog (*Oophaga pumilio*) exhibits radically different color patterns across Panamá. Previous authors have hypothesized that these different color forms can be divided into aposematic and cryptic morphs and have demonstrated that aposematic morphs are more toxic and visually conspicuous than cryptic morphs. The authors of this paper set out to determine if aposematic and cryptic morphs also differ behaviorally in ways that complement their color strategy. They conducted observational field studies with two island populations (an orange-red aposematic population, and a green-with-black-spots cryptic population) in Panamá's Bocas del Toro Archipelago. A dozen focal males at each site were observed for movement patterns, location, and time spent performing various activities for 25 mornings. Flight distance (proximity of observer eliciting flight), ambient light, and frog and habitat reflectance were also calculated. From these data, home range, density, preferred position, and detectability under models of both frog and bird vision were determined. Aposematic frogs were found to be more active than cryptic frogs. Specifically, aposematic frogs had longer flight distances, spent more time foraging, moved more, and had larger home ranges than cryptic morphs. Under models of both bird and frog vision, aposematic morphs were more conspicuous than cryptic morphs. Furthermore, aposematic morphs chose tree trunk bases as calling sites, where their dorsal surfaces were significantly more conspicuous than on leaf litter to both frogs and birds. In contrast, cryptic frogs preferentially chose to call from bamboo trunks, where they were significantly less conspicuous than on other potential calling locations. Despite these differences, males in the two populations did not differ in amount of time spent calling or in their distance to the nearest male. This study reveals that crypsis and aposematism can be enhanced by coupling color pattern and behavior, and that closely related populations can independently adopt divergent anti-predator strategies requiring different color-behavior combinations.

Pröhl, H., and T. Ostrowski. 2011. Behavioural elements reflect phenotypic colour divergence in a poison frog. Evolutionary Ecology 25:993–1015.

Correspondence to: **Heike Pröhl**, Institute of Zoology, University of Veterinary Medicine of Hannover, Bünteweg 17, 30559 Hannover, Germany; e-mail: heike.proehl@tiho-hannover.de

Patterns of Snake Diversification Revealed

Many researchers have questioned why some clades are diverse while others are species poor. The simplest model of diversification assumes a simple birth minus death rate of species accumulation (a "rate-limited" process). Recognition that ancient, species-poor lineages (tuataras [Rhynchocephalia: *Sphenodon*] being a prime example) are in conflict with this model has led researchers to postulate a "diversity-limited" model, wherein at some point extinction rate and speciation rate converge and the lineage reaches a diversity ceiling (possibly because energy or space are limiting maximum diversity). However, when data from the fossil record are considered, many lineages that are currently species-poor are revealed to have once been significantly more diverse (again, rhynchocephalians are a good example). The authors of this paper propose an additional model, wherein after an initial period of rate-limited diversification (a lineage "half life"), lineages either decline toward extinction or, through the evolution of a key innovation or dispersal to a new region, produce daughter lineages which in turn exhibit rate-limited diversification (an "extinction-limited" model). Furthermore, they evaluate the fit of these different models to a new time-calibrated phylogeny of snakes with representatives from all families and subfamilies. Their phylogeny, generated using sequence data from 27 independent molecular markers, was concordant with other recent molecular phylogenies in regard to both relationships and divergence dates. A software program designed to locate shifts in diversification rate across a time-calibrated phylogeny using extant species diversity (medusa) identified four significant rate shifts: increases in the blindsnake family Typhlopidae and in a clade containing most of Colubroidea, and decreases in the colubroid subfamilies Azemiopinae and Lamprophiidae. Simulations were conducted to evaluate the fit of several different models of diversification to the data. Generally, models where the parameter values were allowed to vary across taxa fit better than those where the parameter values were held constant. Furthermore, the diversity-limited models out-performed the rate-limited models. Only the extinction-limited model with a constant parameter value was evaluated; however, it was a better fit than the equivalent rate-limited model, and clade age-diversity correlation estimates from simulations under the extinction-limited model were a better fit to the observed data in this regard than those from simulations under the other models. Although the final verdict of these models awaits the evaluation of the extinction-limited model with variable parameter values as well as estimates of extinction rates incorporating fossil data, these analyses highlight the significance net diversification rate changes have had in generating extant snake diversity.

Pyron, R. A., and F. T. Burbrink. 2012. Extinction, ecological opportunity, and the origins of global snake diversity. Evolution 66:163–178.

Correspondence to: **Alexander Pyron**, Department of Biological Sciences, The George Washington University, 2023 G St. NW, Washington, DC 20052, USA; e-mail: rpyron@colubroid.org

Phylogenetic Position of Turtles Unveiled

Considerable research has focused on determining the phylogenetic position of turtles. Through the years, morphological, mitochondrial DNA, and nuclear DNA datasets have failed to resolve the phylogenetic placement of Testudines relative to Archosauria (birds and crocodilians) and Squamata, leaving us to wonder if this problem is fundamentally intractable. To identify DNA regions that might be sufficiently conserved to allow amplification across amniotes and yet variable enough to be informative, the authors of this paper employed a novel method to identify new DNA markers. This method simultaneously compares multiple genomes and identifies variable regions flanked by highly conserved regions (and is detailed in the paper). Using this method, they identified 21 new potential markers. They then sequenced these markers, the nuclear gene RAG-1, and a section of the mitochondrial genome (a total of 21,137 base pairs) for 28 vertebrates, including representatives from most major teleost and sarcopterygian lineages. Traditional concatenated and recent "species tree" phylogenetic methods were used to reconstruct evolutionary relationships. The latter estimates individual trees for each independent marker and subsequently uses them to estimate the true species tree while accounting for gene-tree discordances. All analyses found turtles to be the sister of Archosauria with strong support. Indeed, a jackknifing exercise demonstrated that only 14,000 base pairs of sequence data were needed to achieve this relationship with strong support. While the concatenated analysis was concordant with other recent molecular studies in finding strong support for Dibamidae being sister to a clade containing the remaining included squamates (skink, gecko, *Anolis*, and snake), the species tree analysis failed to resolve this clade with the exception of the Iguania-Serpentes relationship; the authors posit that this is indication of significant gene tree discordance within Squamata. These new methods for molecular marker discovery represent an important breakthrough in systematics and bioinformatics, and offer a path to resolving other problematic sections of the tree of life.

Shen, X.-X., D. Liang, J.-Z. Wen, and P. Zhang. 2011. Multiple genome alignments facilitate development of NPCL markers: a case study of tetrapod phylogeny focusing on the position of turtles. Molecular Biology and Evolution 28(12):3237–3252.

Correspondence to: **Peng Zhang**, State Key Laboratory of Biocontrol, Key Laboratory of Gene Engineering of the Ministry of Education, School of Life Sciences, Sun Yat-Sen University, Guangzhou, People's Republic of China; e-mail: alarzhang@gmail.com

Insights into Patterns of Galápagos Iguana Digestive Tract Microbial Diversity

Despite being sister taxa, the iguanas of the Galápagos Islands have very different diets, with Marine Iguanas (*Amblyrynchus cristatus*) eating marine algae and land iguanas (*Conolophus* spp.) eating cacti and other terrestrial plant material. As herbivores require microbes to digest the complex carbohydrates of vegetation, it follows that these divergent diets might be correlated with different gut flora. To investigate patterns of microbial diversity in this system, the authors of this study collected fecal samples from 25 Marine Iguanas and 16 land iguanas (from four and three islands, respectively). Additionally, samples were secured from other reptilian herbivores (four Galápagos Giant Tortoises [*Geochelone nigra*] and two Green Iguanas [*Iguana iguana*]), as their comparison with the ingroup could be instructive. Microbial diversity was assayed using next-generation DNA sequencing techniques. Samples were PCR amplified with universal 16S primers with attached sample-specific barcodes. These were then combined and subjected to pyrosequencing, wherein hundreds of thousands of individual strands of amplified DNA are simultaneously sequenced in a single run, and the resulting sequences were subsequently binned by fecal sample using the barcodes. These sequences were checked against a library of known 16S sequences to determine taxonomic identity, as well as compared with other within-set sequences to identify operational taxonomic units (OTUs). Despite not being able to assign a majority of the 16S sequences to a taxon below the level of class, each sample revealed from 112 to over a thousand OTUs. Marine Iguanas exhibited significantly lower microbial taxonomic diversity than the other reptiles. In particular, Marine Iguanas possessed significantly fewer methane-producing bacteria species than land iguanas, likely a consequence of dietary difference. A multivariate analysis of the microbial community membership and structure found that Marine Iguanas, land iguanas, and giant tortoises all exhibited different fecal flora, with the Green Iguana flora overlapping that of the land iguana. This study is an example of how cutting edge techniques can be employed to explore natural systems.

Hong, P.-Y., E. Wheeler, I. K. O. Cann, and R. I. Mackie. 2011. Phylogenetic analysis of the fecal microbial community in herbivorous land and marine iguanas of the Galápagos Islands using 16S rRNA-based pyrosequencing. International Society for Microbial Ecology Journal 5:1461–1470.

Correspondence to: **Roderick Mackie**, Department of Animal Sciences, Institute for Genomic Biology, University of Illinois, 1207 W Gregory Dr, 458 Animal Sciences Laboratory, Urbana, Illinois 61801, USA; e-mail: r-mackie@illinois.edu

New Revelations Regarding North America's Eocene Squamate Fauna

Because they are small and generally occur at low densities relative to other similarly-sized organisms, squamates are underrepresented in the fossil record, which obscures ancestral patterns of distribution. The author of this paper presents results from an investigation of a mid-Wasatchian (middle early Eocene) squamate fauna (excluding snakes) from northern Wyoming, USA. The Bighorn Basin site was deposited about 2.5 million years after the Paleocene-Eocene Thermal Maximum (PETM), a global temperature spike and crash likely caused by greenhouse gasses released from sedimentary material by magma along the Mid-Atlantic Ridge. Therefore, Bighorn Basin lizards could show whether North America's squamate fauna received intercontinental dispersal subsequent to the PETM as that seen for its mammalian fauna. Thirteen lizard taxa were uncovered at this site; most of these taxa, or close relatives, also occurred at another Wyoming site (Castle Gardens) deposited at the time of the PETM. One new iguanian species discovered at Bighorn Basin, *Anolbanolis geminus*, was represented by more material than exists for the *Anolbanolis* type species and close examination revealed that the genus is likely allied with the family Dactyloidae. Four Castle Gardens taxa lacked Bighorn Basin representatives, including *Lepidophyma*-allied Xantusiidae and Amphisbaenia (both of which are now restricted to below 30˚N, suggesting range contraction following the PETM). The most interesting discovery at the site was a lizard assigned to the genus *Scincoideus*. This genus was previously only known from the mid-Paleocene of Belgium and is thought to be a member of or allied with Scinciformata. As this was the most abundant lizard at Bighorn Basin, its absence from Castle Gardens strongly suggests an intervening range expansion into the region, possibly beginning in Europe. Therefore, despite the general pattern of intracontinental dispersal with limited dispersal out of the continent, this study adds to the growing list of squamate lineages found to have dispersed into North America during the Cenozoic.

Smith, K. T. 2011. The long-term history of dispersal among lizards in the early Eocene: new evidence from a microvertebrate assemblage in the Bighorn Basin of Wyoming, USA. Palaeontology 54:1243–1270.

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Snake-Primate Interactions Driven by Mutual Competition and Predation

Although anecdotal accounts abound, little concrete evidence exists supporting the idea that pre-modern indigenous cultures faced significant threats from giant constricting snakes. The authors of this paper present data from anthropological work conducted in 1976 with Philippine Agta Negritos, a hunter-gatherer society that coexists with Reticulated Pythons (*Python reticulatus*), the world's longest snake. This work revealed that 16 of 120 people living at the time had survived a total of 18 python attacks. Additionally, six recent python-implicated human deaths were corroborated by multiple individuals, including the deaths of two sibling children supported by the Catholic priest who presided over their burial. People survived recent python attacks with the aid of firearms or iron knives, implements unavailable in previous millennia; thus prehistoric rates of python mortality were presumably higher. The authors further document the taxonomic breadth of primate-eating and snake-killing/eating among snakes and primates, respectively. Additionally, they note the dietary overlap of co-occurring snakes and primates (e.g., the Agta Negritos and *P. reticulatus* both regularly consume mammals as large as 60 kg). These observations illustrate the degree to which both primates and snakes are simultaneously each other's predators and competitors. Finally, the authors remark that several extant snake lineages containing representatives of appropriate size for preying upon primates were well established prior to the rise and diversification of primates, indicating that primates have been killing, suffering predation from, and competing with snakes since their inception. Demonstrating how natural, cultural, and phylogenetic history can be combined to elucidate longstanding, clade-level predator-prey-competitor interactions, this study addresses the similarly interdisciplinary evolution of primate responses to snakes.

Headland, T. N., and H. W. Greene. 2011. Hunter-gatherers and other primates as prey, predators, and competitors of snakes. Proceedings of the National Academy of Sciences of the United States of America (*in press*) doi:10.1073/pnas.1115116108.

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Inducible Anti-Predator Phenotypes Not Expressed When Tadpoles are Exposed to Novel Predators

Invasive predators are a major threat to native wildlife, as indigenous species frequently lack appropriate defensive adaptations. However, it may sometimes be the case that native species possess useful defensive mechanisms, but initially lack the instinct to employ them when faced with a novel predator. The authors of this paper examined how captive Iberian Green Frog (*Pelophylax* [*Rana*] *perezi*) tadpoles from Doñana National Park, southwestern Spain, responded to the sustained presence of the Red Swamp Crayfish (*Procambarus clarkii*), an invasive species introduced to Europe from the USA and demonstrated to prey on larval *P. perezi*. Tadpoles were collected from two lakes in the park, one with invasive crayfish present and the other without. Subjects were kept alone, with caged predators that had been fed tadpoles, or with unfed caged predators. Predators were either dragonfly nymphs (*Anax imperator*; a native predator) or crayfish. Tadpoles were observed for activity patterns and subsequent to the experiment, evaluated for pigmentation and several morphological measurements. Finally, in a separate experiment, pairs of tadpoles, one raised with tadpole-fed dragonfly nymphs and one raised without predators, were placed in a container with free-ranging nymphs or crayfish to determine if any induced phenotype changes in the predator-exposed tadpoles confer increased fitness when faced with predators. Tadpoles raised under each dragonfly nymph treatment exhibited significantly deeper tails and decreased activity time relative to controls, and pigment in tadpole-fed nymph treatment was significantly greater than observed in controls, while neither crayfish treatment differed from controls in any of these regards. This indicates larval *P. perezi* are capable of developing an anti-predator phenotype when in the presence of native, but not introduced, predators. An analysis of variance revealed that while tail height and activity were slightly but significantly different for the two source populations, the two populations did not vary in their responses to the different treatments. Finally, while tadpoles with induced anti-predator phenotypes experienced 60% and 80% survivorship when exposed to crayfish and dragonfly nymphs, respectively, naive tadpoles experienced less than 10% survivorship in both treatments. These findings show that even species with pre-adapted defenses to novel predators may not necessarily have the innate behavior to make use of them.

Gomez-Mestre, I., and C. Díaz-Paniagua. 2011. Invasive predatory crayfish do not trigger inducible defences in tadpoles. Proceedings of the Royal Society B 278:3364–3370.

Correspondence to: **Ivan Gomez-Mestre**, Research Unit of Biodiversity (CSIC, UO, PA), c/Catedrático Rodrigo Uría s/n, Oviedo 33071, Spain; e-mail: igmestre@ebd.csic.es

Bd Genetic Diversity and Patterns of Virulence Revealed

Recent research has uncovered much about the anuran pathogen *Batrachochytrium dendrobatidis* (*Bd*), including patterns of frog susceptibility and potential biocontrol agents. However, evidence pointing to its genetic and geographic origin has remained elusive. The authors of this study used next-generation DNA sequencing techniques to reconstruct the mitochondrial and nuclear genomes of twenty *Bd* samples procured from sites where anurans have suffered *Bd*-implicated declines (North and Central America, Europe, and Australia) as well as a suspected source region (southern Africa). From across the nuclear genomes, 22,000 suitable single-base sites were genotyped for each sample for use in subsequent molecular analyses. These genotype datasets were subjected to phylogenetic analyses and the nuclear dataset was investigated for evidence of recombination. These analyses revealed three deeply divergent genetic lineages within *Bd*. In addition to a previously known widespread lineage (sixteen sites), the authors uncovered one new lineage occurring in both South Africa and on the Mediterranean island of Mallorca (three sites) and another lineage restricted to Switzerland (one site). Members of the widespread lineage were found to be

>99.9% identical and exhibited fourteen likely positions of recombination in the nuclear genome. Phylogenetic analyses of the individual recombination units found them to have different genealogical histories; together with the evidence for recombination and low genetic diversity, the authors interpret these results to be evidence for a rare meiotic event leading to increased virulence and followed by range expansion. To test this hypothesis, the authors exposed larval toads (*Bufo bufo*) to *Bd* of either the widespread lineage or one of the newly-discovered, localized lineages. Indeed, the toads in the widespread lineage treatment suffered significantly more mortality than those in the other treatment. The discovery of genetically divergent and apparently more benign *Bd* lineages might explain why some anuran communities appear to coexist with *Bd* while showing no ill effects. These findings also reveal the potential dangers to society and biodiversity posed by rare meiotic events occurring in otherwise clonal organisms.

Farrer, R. A., and colleagues. 2011. Multiple emergences of genetically diverse amphibian infecting chytrids include a globalized hypervirulent recombinant lineage. Proceedings of the National Academy of Sciences 108:18732–18736.

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Ancient Mummy DNA Helps Uncover Contemporary Cryptic Crocodile

As methods for obtaining DNA data have advanced, ancient samples have become increasingly available for molecular evolution analyses. The authors of this paper incorporated DNA data from 34 pre-1973 historical samples (including eight Egyptian crocodile mummies) and 48 contemporary samples into a range-wide molecular analysis of the Nile Crocodile (*Crocodylus niloticus*). They attempted to collect sequence data for two mitochondrial genes (12s and D-loop) for all samples as well as three additional mitochondrial and four nuclear genes for the contemporary samples ($N \geq 46$) and outgroups (including six other *Crocodylus*). A phylogenetic analysis of the contemporary samples revealed a deep phylogenetic split within the species, forming two clades roughly corresponding to eastern Africa and equatorial western Africa; the eastern Africa clade was recovered as more closely related to the four New World *Crododylus* examined than to the western Africa clade. Close inspection of karyotype data revealed the two lineages possess different chromosome numbers, further supporting the distinctiveness of the two clades. The name *Crocodylus suchus* was determined to be the available name with priority for the western Africa clade (with the eastern clade retaining the name *C. niloticus*). When localities for the two species are separated into historical and contemporary maps, it is revealed that extralimital western localities of the *C. suchus* in the Nile River drainage basin (mostly Sudan and Egypt) have been extirpated during the last 30 years, leaving only the core distribution in areas of western Africa draining to the Atlantic Ocean (with possible remaining outliers in Chad and Uganda). This discovery answers an age-old mystery, as writings of Egyptian priests mention two crocodile forms, the smaller of which was preferentially used in ceremonies; as it turned out, all of the mummies were found to belong to *C. suchus*. As there is deep phylogenetic structure within each species (particularly *C. niloticus*), these findings underscore the importance of incorporating genetic structure into conservation plans, as solely protecting a single, Africa-wide *C. niloticus* would risk losing important, locally adapted lineages. Future studies of this system should employ broader karyotype sampling and investigate morphology and behavior in light of these new phylogenetic discoveries.

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Investigation into Enigmatic Montane Vipers Leads to the Erection of a New Genus

New World pitvipers are a diverse clade containing many poorly known species. Known from only a handful of specimens each, the species *Cerrophidion barbouri* and *Agkistrodon browni* co-occur in the central highlands of the Mexican state of Gurrero. *A. browni* has remained allocated to *Agkistrodon* despite longstanding suspicion that it is actually conspecific with *C. barbouri* (which, in turn, has undergone several generic reassignments). To investigate the species limits within this system, the authors of this paper amassed all but three known specimens of these snakes and performed detailed morphological examinations. Furthermore, they collected mitochondrial DNA sequence data for three *A. browni* and one *C. barbouri*, and along with previously published orthologous sequences from 50 other New World viperids, conducted phylogenetic analyses aimed at shedding light on the phylogenetic placement of these snakes. Morphological examination of the specimens revealed two distinct morphologies, each assignable to one of the two holotypes. In particular, the two hemipenial morphologies are radically different, and *A. browni* exhibits two unusual characteristics: large, unkeeled head scales and a prehensile tail. The phylogenetic analyses found the four focal samples to form a clade with the two species of the genus *Ophryacus*, montane Mexican snakes formerly placed in the genus *Porthidium*. *C. barbouri* and *Ophryacus melanurus* form a clade, which in turn is sister to *A. browni*. Because of morphological synapomorphies and the large genetic distance between this clade and the remaining *Ophryacus* (*O. undulatus*), the authors decided to erect a new genus *Mixcoatlus* to contain these three closely related species. The authors close with a systematic revision of these four species, as well as the remaining *Cerrophidion*, and a discussion of the natural history of *Mixcoatlus*.

Jadin, R. C., E. N. Smith, and J. A. Campbell. 2011. Unravelling a tangle of Mexican serpents: a systematic revision of highland pitvipers. Zoological Journal of the Linnean Society 163:943–958.

Correspondence to: **Robert Jadin**, Department of Ecology and Evolutionary Biology, University of Colorado at Boulder, N122 Ramaley Campus Box 334, Boulder, Colorado 80309, USA; e-mail: rcjadin@gmail.com

Florida's Introduced Amphibian and Reptile Species Problem Documented and Analyzed

In addition to a rich native herpetofauna, Florida (USA) boasts the world's most extensive roll of non-native amphibian and reptile species. Before the impacts on native species can be evaluated or insights into the process of invasion can be revealed, a systematic account of Florida's historical and current introduced herpetofauna is required. The authors of this paper compiled information on Florida non-native reptile and amphibian species from literature, museum collections, and almost two decades of field surveys. Importantly, they restricted inclusion to species for which a voucher specimen from Florida exists, as the literature is littered with uncorroborated claims of non-native species in the state. In addition to verifying presence in Florida, the invasion status of species was determined (escaped, established, localized or widespread, rare or abundant). In this effort, the authors either documented for the first time or found evidence of advanced invasion status for 83 reptile and amphibian species. In total, they documented vouchers for 137 species of non-native species. As 56 of these species are confirmed as established, the percentage of Florida's introduced species that have become established (~40%) more closely resembles an island ecosystem (such as Hawaii: ~50%) than a continental system (where the rule of thumb is 10%). Of the established species, 43 (77%) are lizards, which is interesting in light of Florida's relatively depauperate native non-ophidian squamate fauna (17 species). Further analysis of the data revealed that the pet trade was overwhelmingly responsible for the introduced species problem; indeed, ~23% of non-native species introductions can be traced back to a single animal importer. The authors discuss future problems invasive species could induce and compare Florida's situation with that of Guam and their Brown Tree Snake (*Boiga irregularis*) problem.

Krysko, K. L., and colleagues. 2011. Verified non-indigenous amphibians and reptiles in Florida from 1863 through 2010: outlining the invasion process and identifying invasion pathways and stages. Zootaxa 3028:1–64.

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Patterns of International Python Trade Elucidated and Explained

Hundreds of thousands of wild *Python* from Southeast Asia and sub-Saharan Africa enter the international market annually, destined for Europe, America, and East Asia. To investigate patterns and trends in the python trade, the authors of this paper accumulated and analyzed pertinent data from the CITES wildlife trade database (http://www.cites.org). These data show the large majority of pythons originate from Southeast Asia (mostly Reticulated Pythons, *P. reticulatus*) and these are mostly destined for the leather trade; African pythons (mostly Ball Pythons, *P. regius*) are disproportionately destined for the pet trade. Additionally, the African python trade experienced a steep decline about a decade ago, likely linked to changes in monetary exchange rate between destination (USA) and source. During this period, Asian python exports have increased, likely beyond sustainable levels. The authors suggest that the python pet and leather trades are affected differently by changes in global exchange rates; these observations coupled with differences in demographic consequences (juveniles are sought for the pet trade while the largest females are sought for the skin trade) should be considered when designing conservation efforts.

Luiselli, L., X. Bonnet, M. Rocco, and G. Amori. 2011. Conservation implications of rapid shifts in the trade of wild African and Asian pythons. Biotropica (*in press*) doi: 10.1111/j.1744-7429.2011.00842.x.

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OBITUARIES

Herpetological Review, 2012, 43(1), 10–11.

Findlay Ewing Russell: 1919–2011

"Do you want some water for your dog?" I stopped as I heard the voice call down from the road. It was a hot August afternoon in southeastern Arizona, and we were walking up the South Fork Cave Creek Canyon Road from Portal toward the Forest Service building. Looking up, I saw Dr. Findlay Russell standing at the driveway of his home, the Bar-M Ranch. As my black Labrador downed several gallons of water, Russell invited us back to join him that evening for "drinks on the veranda." Over daiquiris, with the spectacular Chiricahua Mountains as the backdrop for an impressive sunset, Russell talked of snakes, venoms, academia, and the desert. For this budding toxinologist, it was a rare opportunity to discuss science and life away from the hustle and constant interruptions that have characterized much of life since, and I have never forgotten Russell's mentoring and friendship at such a critical point in my early graduate career nearly three decades ago.

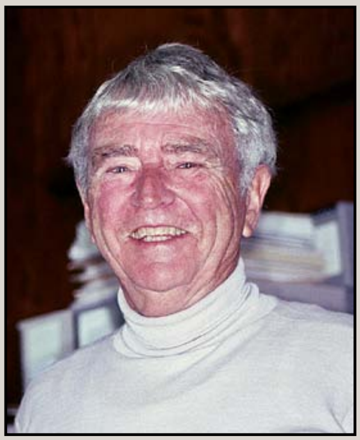
PHOTO BY A. E. LEVITON
Findlay Ewing Russell, 2001.

Findlay Ewing Russell was born in San Francisco on 1 September 1919, to William and Mary Jane Russell, but he spent most of his early years growing up in Los Angeles. As detailed in the Oral History Project at California Institute of Technology (Caltech) Archives (Cohen 1994), he attended grammar school at Santa Barbara Avenue Grammar School and then completed his public education at Foshay Junior High School and Manual Arts High School. Like many of us "herper types," he had an interest in venomous and poisonous animals in high school, an interest that would lie dormant but not dissipate. Awarded a scholarship after graduating, he initially attended the University of Southern California (USC) but finished his bachelor's degree at Walla Walla College in Walla Walla, Washington. He worked for a short time as a chemical engineer in Ohio and then joined the Army during the Second World War, serving as an army medic in the Okinawa Campaign. He received a Purple Heart and two Bronze Stars during his time in the military and left in 1946 after an injury. At this time, he decided to enter medical school where he completed his initial medical training at USC before transferring to Loma Linda University to finish his MD in 1952.

Russell was a Caltech research fellow from1951–1953, during which time he initiated research on stingray venom, work that was later supported by the Office of Naval Research. This early work marked the beginning of his professional research with venoms and venomous animals, research which would take him around the world and involve him in refining treatment of one of the most enigmatic and difficult to manage medical emergencies: snakebite. In addition to his research duties (and numerous practical jokes on fellow students and faculty), he sought to improve the social life of students and peers by teaching ballroom dancing; Russell and Dr. Albert Tyler also organized dances and invited female students from nearby Pasadena City College to join them. In 1951, Russell worked as an intern at the Los Angeles County General Hospital, and in 1953 he accepted a position at the Huntington Institute of Medical Research at the Henry Huntington Hospital in Pasadena. He remained at Huntington until 1955, when he received a professorship at USC. He was at USC for over thirty years, serving as professor of neurology, biology and physiology and as director of the Laboratory of Neurological Research and Venom Poisoning Center at Los Angeles County-USC Medical Center.

At the Center, he was intimately involved in the treatment of venomous bites. The tremendous population growth in southern California at that time meant that encounters with biting and stinging creatures were inevitable and increasing. A relatively common problem, particularly in the nearby southern Mojave Desert communities, was the treatment of black widow spider (*Latrodectus hesperus*) bites on rather delicate parts of the male anatomy, received while using outdoor toilet facilities. In those days before well-established regional Poison Centers, Dr. Russell served as an important consultant and source of information on emergency treatment for envenomations, and he became a leading world authority on the treatment of snakebite. Fortunately for me, and my bewildered attending physician, Russell was only 45 minutes away from the hospital where I received treatment for an all-too-close encounter with a neonate Southern Pacific Rattlesnake (*Crotalus oreganus helleri*) when I was a teenager. Although I did not know him personally then, I benefited from his near proximity and the treatments developed to aid my recovery.

While at USC, in spite of his considerable workload and in addition to his medical degree, Russell somehow found the time to earn a PhD in English. He also began work on his house in Portal, Arizona, spending as much free time as possible at his ranch there, away from the demands of emergency medicine, research, teaching, and other duties which occupied his life in Los Angeles. By the early 1980s, in fact, the call of the desert proved to be too much to resist. Russell joined the faculty of the University of Arizona College of Pharmacy in Tucson in 1981, where he remained until his retirement in 2006.

Russell was the first president and a founding member of the International Society of Toxinology (IST) in 1962. He and colleagues coined the term toxinology to distinguish this branch of study from the broader field of toxicology, and the society they established is dedicated to the study of venomous animals and their venoms, as well as toxic and poisonous plants, microbes, and fungi. Russell helped establish the Society's journal *Toxicon*,

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PHOTO BY KENT BEAMAN

Panel discussion at the Biology of Rattlesnakes Symposium, Loma Linda University, 2005. From left to right: Henry S. Fitch, Findlay E. Russell, and Robert C. Stebbins.

PHOTO BY S. P. MACKESSY

View from the porch of Bar-M Ranch, looking up the South Fork of Cave Creek Canyon, Chiricahua Mountains, Arizona, 2011.

which published its first issue in October 1962. He was editor of *Toxicon* from its inception through 1969, when Dr. Philip Rosenberg assumed that role. He was a frequent contributor to the new journal, with more than 80 publications over a 35-year span; his first paper in *Toxicon* was published in the inaugural issue in 1962 (Russell et al. 1962), and his last was published in 1997 (Russell 1997). His many contributions to the Society were commemorated at the 17th meeting of the European Section of the IST held in September 2011 in Valencia, Spain. When the IST hosts its 17th World Congress on Animal, Plant and Microbial Toxins in Honolulu, Hawaii in 2012, Russell would undoubtedly be pleased with the venue and to see how the Society has grown and matured over its 50-year history.

From his first publication listed in PubMed in 1953 to his last in 2006, he published over 160 papers on a variety of topics concerning venomous animals and their venoms, and envenomations. He also contributed many chapters on venoms and treatment of envenomation in medical, pharmacological, and toxicological textbooks. Russell published numerous books, and edited many more, but the book most familiar to herpetologists, physicians, and toxinologists is *Snake Venom Poisoning*, published in 1980 (and reprinted in 1983 with corrections). Though nearly 30 years old, this classic text still contains much useful information on the basic biochemistry of venoms, sequelae of envenomation, and treatment of snakebite (if one overlooks the rather bizarre treatment of "Hobbies" at the end of the book). In this landmark publication, he made a strong case for avoiding fasciotomy as a routine treatment for severe edema/swelling often accompanying rattlesnake and other viper bites, and he was a tireless champion for the use of massive quantities of antivenom to counter the necrotizing and potentially fatal outcome of snakebite and other envenomations. Though there have been many changes to emergency health care and tremendous improvements in supportive treatment, the basic approach advocated by Russell remains the standard for treatment of snakebite.

Over the course of his life, Russell was the recipient of numerous awards and recognition, including the receipt in 1974 of the Skylab Achievement award for his work with NASA. He received an Honorary Doctor of Laws degree from the University of California, Santa Barbara, in 1989. In 1992, the University of Arizona College of Pharmacy established the Findlay E. Russell Distinguished Citizen Award in his honor and named him as the first recipient. He was made an Honorary Member of the Society of Toxicology in 2000 and was awarded the Loma Linda University Alumnus of the Year in 2011. He was a Fulbright Scholar, a visiting professor at many universities throughout the world, and a consultant for the World Health Organization, Doctors Without Borders, and the National Science Foundation.

Russell passed away in Phoenix, Arizona, on 21 August 2011, just shy of his 92nd birthday. Less than a month before, I had again stood on the porch of his ranch in Portal, this time to pick up reprints and photographs from Dr. Russell's work given to me by his son, Mark Russell. Standing there that late summer afternoon, I had the opportunity to reflect once more on the career of a man who was a tremendous influence in his field of medical toxinology. Like many, Findlay was a complex person, at times brilliant beyond imagination, at other times arrogant beyond belief. He could rapidly alternate between astonishing and vexing to his colleagues. However, his contributions to the field of toxinology were beyond question. I found him to be a considerate and intellectually stimulating individual, and I am grateful to have had the opportunity to know him. He is survived by his children—Christa Russell Cessaro, Sharon Russell Boyle, Robin Russell, Connie Russell Lane, and Mark Russell—as well as ten grandchildren, and one great-grandson.

Acknowledgments.—I thank Mark Russell, David A. Warrell, Anthony T. Tu, Barney Tomberlin, William Hayes, Kent Beaman, and Alan Leviton for sharing thoughts about and photographs of Findlay Russell, and Kaye Holman for editorial improvements of the manuscript.

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Wilmer Webster Tanner: 17 December 1909 — 28 October 2011

Childhood and Youth.—Wilmer Tanner was born the fourth of five children to John Myron and Lois Ann Stevens Tanner in Fairview, Sanpete County, Utah. His family lived in an adobe house in town, but each summer moved north to the family's ranch in Indianola Valley. The family would work here during the summers and return each fall to the "village." Wilmer's tasks included tending milk cows, pigs, chickens, and by age 6 or 7, moving cows to pasture each day and returning them to corral each evening. He and his siblings were also responsible for feeding lambs, feeding chickens/gathering eggs, keeping the wood box filled, separating milk from cream in a spinning "bole" (that brought cream to the top), and caring for the work horses.

Wilmer has noted in his autobiography (Tanner 1993) and in my interviews with him in the late 1990s for his ASIH-sponsored biographic "Historical Perspectives" (Sites and Stewart 2001), several "stand out" events in his youth. In his pre-teen years, two elderly Ute Indian women living near Fairview taught him how to gather and roast pine nuts (from the native piñon pine), and he continued this activity for some time after all Native Americans left the Indianola Valley. At about the same time he was learning to fish from his older brother Ray, and at age 12 his dad gave him a 22 Remington pump rifle and taught him to shoot ground squirrels in the grain fields. Wilmer soon learned to hunt sage grouse, cottontail rabbits, and snowshoe hares, and field-dressed all for the family kitchen. He remained passionate about hunting and fishing throughout his life, and was certain that both fostered his deep interest in nature at an early age.

Wilmer W. Tanner, photograph taken in early 1990s.

Wilmer attended school for a few months during the war years (1917–1918), in a one-room building in which grades 1–6 were taught by a single teacher who apportioned some time of each day to each of the six grades. Because of Wilmer's chores on the ranch, these early school years were not very rewarding; little time was available for study and he struggled up until the 6th grade. His post-6th grade education was more stable and enjoyable; his grades improved, and as he moved through high school in church and school social functions, athletics (basketball, football, track & field, and swimming), and student government activities. Wilmer contracted scarlet fever and missed his high school graduation ceremony in April 1929.

In this same year Wilmer was called to serve a mission in Holland, an expectation for young men in the Church of Jesus Christ of Latter Day Saints (LDS, or "Mormon"). He postponed college and traveled to Europe via trains to Chicago and New York City, then by ship to Southampton, UK, and he arrived in Rotterdam on 13 December 1929. Here he served for 29 months and returned home in March 1932. During this time he recorded tremendous personal growth; he attained fluency in Dutch via "total immersion," and an in-depth understanding of Dutch and European culture and history. He credits this experience as one of singular importance in learning how to listen to and respect other points of view, and to work with different groups of stakeholders to achieve long-term goals.

Formal Academic Studies.—Wilmer returned to "years of desperation" in Utah, and although he began his college studies at BYU in the winter of 1932, he had to drop out and return to ranching for a while to help his family pay off debt. He returned in the fall of 1933, and despite the constant struggle for financial support ("too many B grades"), he enjoyed university life. By the winter of 1934, he was certain that his future was somewhere in science, and graduated with a BA in the spring of 1936 with a major and minor in Zoology and Geology, respectively.

While at BYU Wilmer met and married Helen Brown on 4 January 1935, and records his 60-yr marriage to Helen and their three children, Lynn, David, and Mary Ann, as his most enduring achievement. Wilmer attributed his academic and professional success to Helen's constant encouragement and in some cases her active participation; he was devastated by her death in 1995. He nevertheless maintained his academic and professional activities, and eventually married again (at age 90); his second wife was Otella Tyndal Devey, and she died in 1999.

Wilmer entered the BYU graduate program in Zoology to begin work on a MS degree in the fall of 1936. By 1938 he had completed this degree with a thesis on the snakes of Utah (Tanner 1939a,b; 1940, 1941; Tanner and Tanner 1939), but again he and Helen had to work to pay off debt. Wilmer wanted to pursue further graduate work, but the US entry into World War II and restrictions on tires, gasoline, etc., made travel impossible, so he took a teaching job at Provo High School while Helen worked in a Provo laundry for \$7/week to help make ends meet. Wilmer spent parts of some summers at the Friday Harbor Marine Lab and the University of Michigan, and by late 1945, he could plan again for PhD studies.

In the fall of 1946 Wilmer started his graduate program at the University of Kansas, after being given a one-year leave from his teaching contract. For financial reasons, Helen and the three children remained in Provo for the first year of Wilmer's graduate program, but moved to Lawrence in June 1947. Wilmer's thesis advisor was Edward Harrison Taylor, and Taylor suggested to Wilmer a possible PhD project—a comparative study of throat anatomy and musculature of Mexican and Central American plethodontid salamanders. Wilmer completed his research by June 1949, and in August he defended his research and filed his dissertation (published three years later; Tanner 1952). He simultaneously received a contract to teach Zoology at BYU and moved his family back to Provo.

Development of an Interest in Herpetology.—In the last year of his BA program at BYU, Wilmer enrolled in a Herpetology class

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taught by his brother, Vasco M. Tanner. Vasco was the oldest of Wilmer's siblings, and at 17 yrs his senior, he was Wilmer's role model. Vasco had earned a PhD from Stanford under the famous ichthyologist David Starr Jordan, and joined the BYU faculty in the early 1920s, where he founded the zoological natural history collections and ultimately the Department of Zoology and Entomology (Welsh 2012). Vasco took his Herpetology class to a snake den on the west side of Utah Lake (near the present town of Lehi) in May 1936, where Wilmer collected the third specimen of *Hypsiglena torquata* (now *H. chlorophaea*) recorded in Utah, and at this point he was encouraged by Vasco to consider additional study in herpetology. Wilmer had focused his undergraduate studies on training for a possible career as a forester or a park naturalist, in part because this was an easy extension of the outdoor skills he had acquired in his youth. However, during the Great Depression, people were laid off in these professions, and early in Wilmer's MS program, Vasco advised him that he (Vasco) was working in the areas of Entomology and Ichthyology, and that another recently hired zoologist (Lynn Hayward) was working in Mammalogy and Ornithology, but that Herpetology was open throughout Utah and the Great Basin region, and much work was needed. So, heeding the advice of his older brother, Wilmer settled on doing the snakes of Utah for his MS thesis, and his career path was set.

Throughout his autobiography and during his oral interviews with me, Wilmer referred to early encounters with Joseph R. Slevin at the California Academic of Sciences, Laurence Klauber's willingness to loan his full collection of *Hypsiglena*, and E.H. Taylor's support of Wilmer's taxonomic and revisionary studies of this genus in parallel to his throat anatomy work on salamanders. Others who had very positive influences on Wilmer's herpetological career included Helen Gaige, Norman Hartweg, Carl Hubbs, and Albert H. Wright.

Professional Life and Contributions.—Wilmer's early academic career was characterized by heavy teaching loads (three classes per semester), and a zoology faculty that included his brother Vasco, D. Elden Beck, and C. Lynn Hayward. Wilmer's group in the Department of Zoology & Entomology was soon joined by entomologists Stephen L. Wood and Dorald M. Allred; as a group they taught a range of courses that spanned the entire breadth of zoology. During this time Stanley L. Welsh and other botanists were joining the Department of Botany & Range Science, and together the botanists and zoologists (all field-oriented) built representative collections of animals and plants as part of their research programs. At higher administrative levels there was no real support for or recognition of these activities for decades, but in the late 1960s and 1970s, BYU began a slow transition from a teacher-preparation institution to a bona fide teaching and research institution.

In herpetology, Wilmer and other BYU faculty conducted what research they could on their own time and out of their own pockets, while carrying heavy teaching loads. Wilmer's regular classes included general biology, general zoology, vertebrate anatomy, herpetology, and genetics, among others. Financial constraints limited his meeting attendance to regional events in his early academic career, and even these had to be covered from personal funds.

Things changed on 31 January 1960, when Chapman Grant turned over editorship and all materials pertaining to *Herpetologica* to Wilmer, at a time when both the journal and its sponsoring society, The Herpetologists' League (HL), "were desperately on the brink of self-destruction through exhaustion and frustration" (Smith 1986; p. 21). Wilmer served as editor of *Herpetologica* for eight years (1960–67), secured financial support from BYU for moving all HL records and back issues of the journal from southern California to Provo, provided storage space and secretarial help to re-organize this material, and BYU printed the journal at cost for the first six years after the transfer (1960–65). Despite having sought such a transfer, Grant could never really "let go" of the journal, and still regarded *Herpetologica* as his alone, and the HL as an adjunct irrelevant to the ownership and publication of the journal. Smith described Grant as hovering "like a wounded black spirit" over Wilmer (1986; p. 21) as the two fought over survival of the HL as the official sponsor of the journal. By August 1960 things had settled sufficiently for Wilmer to call a meeting of the HL officers at BYU to chart a future course for both the society and the journal.

Grant considered this an abrogation of an "agreement" he had with BYU (which never existed) to publish the journal institutionally (as a BYU publication) while continuing all of his policies, and he continued to make things difficult for both BYU and the HL. However, by the end of Wilmer's 8-yr stint as editor, the "Tanner Era" (Smith 1986) was credited with several major accomplishments, including: cessation of the newsletter, addition of covers and increase in number of pages for each issue, authorization of an editorial board to assist the Editor-in-Chief, enactment of a new constitution and bylaws for the society, initiation of a student paper award, and initiation of the "Herpetological Monographs" series. This last decision did not materialize until revived in 1977, and the first monograph was published in 1982.

The HL and *Herpetologica* had shifted from a "one man show" to professional society, and after Wilmer stepped down as editor, he served as HL Vice-President for two years, President for two years, and as a member of the Executive Council for six more years. This total of 18 yrs of service (1960–77) to the HL was longer than any other officer (Grant served from 1946–59) except for Peter Chrapliwy (Index Editor from 1956–1979). In the late 1970s, Wilmer was assisted by one of his PhD students, Nathan Smith (the life science librarian by BYU), in the sale of back issues of *Herpetologica* and other HL publications, when both served unofficially as publications secretaries of the HL. By the late 1960s and early 1970s the HL was facing competition "from an exuberant, innovative new national herpetological society (SSAR), which indeed the League attempted to discourage from advancement from regional to national status . . . , because it was thought that the country could not support two national herpetological societies" (Smith 1986; p. 31). The HL's prediction was close to accurate as the SSAR grew rapidly to the detriment of the HL, which saw a slump in membership and came close to bankruptcy. Only Wilmer's organization of ". . a massive publicity campaign (using a text and design supplied by Kraig Adler) to sell back issues of *Herpetologica*, bringing in some $12,000, averted bankruptcy. For the second time Tanner rescued the League" (Smith 1986; p. 31).

Dediction of a Natural History Museum at BYU.—By the early 1970s it became apparent that the biological collections then housed with the departments of Zoology and Entomology (arthropods, reptiles and amphibians, birds, and mammals), and Botany (the herbarium of dried, pressed, and mounted plants) required a centralized location apart from those departments. Given a history at BYU of departmental collections being degraded and sometimes destroyed by non-research related activities, the rationale for a change in administration of the collections was justified on the basis of their long-term security. About 1970, Professor of Botany Kent McKnight was given the task of exploring options for a collections facility separate from the departments.

McKnight soon moved away, and Wilmer was chosen as his successor, and quickly recruited Stephen Wood (curator of insects and related groups) and Stanley Welsh (curator of the herbarium) as the committee members. They worked together to outline goals and procedures for organization of a separate entity to initially oversee, and ultimately house the collections.

By 1972 this committee had guidelines established when a letter arrived at the BYU Development Office where Helen Tanner was working as a secretary. The letter was from Seattle businessman Monte L. Bean, who had amassed a collection of trophy animal mounts as a result of several decades of big game hunting around the world. Bean was offering to donate his trophy collection to BYU, but the administration had no interest and his letter was discarded. Helen saw the letter and with permission, retrieved it and showed it to Wilmer. Wilmer saw at once a possible opportunity to secure support for a separate facility to permanently house the animal and plant collections. With permission, Wilmer contacted the Bean family, and soon he and Helen were personally meeting with the Bean family, and shortly thereafter Bean's trophies arrived and were displayed temporarily in a portion of the Grant Library. The east end of the library reading room housed the herbarium, while the life sciences building housed the insect-arthropod, herpetology, bird, and mammal collections (under extremely cramped conditions). Wilmer and Monte, and members of the committee, worked together to define what would be required; a new building on the BYU campus large enough to house all of the research collections in a single place. Monte both listened and agreed, and he, Wilmer's committee, and personnel from the BYU Physical Plant office, worked together to draw up plans for this facility. The blueprint was presented to and approved by the Bean family, and construction began in the mid-1970s. The Bean family donated $3.5 million for construction of, and to establish an endowment fund for, the museum. The Monte L. Bean Life Science Museum was occupied in the autumn of 1977, and officially opened in the spring of 1978.

Wilmer served as the Bean Museum's first director (1977–79), and today it houses research collections of arthropods (mainly insects and crustaceans), mollusks, Antarctic "meio-fauna," birds, mammals, amphibians & reptiles, fishes, vascular plants, mosses & lichens, and fungi. These collections are curated by 10 faculty from two academic departments holding formal curatorial assignments. The largest collections (arthropods, vascular plants, vertebrates) are now overseen by PhD-level collections managers, and the museum manages several dedicated endowments for support of curation and collections-based research. For his pivotal role in securing support for the Bean Life Science Museum, Wilmer was given the W. Frank Blair Award by the Southwestern Association of Naturalists in 2004, for "outstanding contributions to the study of natural history."

In 1985, then-BYU president Jeffery Holland requested all academic departments to develop goals for building research excellence in a small number of "focal areas," which were to be chosen and justified on the basis of BYU's strengths and limitations. I was a member of the committee set up to draft such a plan for the Department of Zoology, and the presence of the Bean Museum made it easy for us to argue for a "directed hiring policy" centered on a museum-based evolutionary biology research focus. Wilmer was delighted when the Zoology Department adopted this plan (in 1986–87), and he was also proud of the fact that Zoology and Botany both retained a full complement of field-oriented natural history courses (the "-ology" courses), and that museum endowments continued to grow.

PHOTO BY RANDY BAKER

The five living current and former directors of the Bean Life Science Museum gathered in 2008 for this photo. From left to right: Dr. Larry St. Clair (present director), and past directors Drs. Stanley Welsh, Wilmer Tanner, Richard Baumann, and Duane Smith (these are not arranged in any chronological order).

Wilmer Tanner examining Bean Museum's bird egg collection, ca. 1978. Courtesy of M. L. Bean Museum, Brigham Young University.

Wilmer's Research Contributions in Herpetology.—Wilmer's research career includes 130 publications spanning 60 yrs (1939–1999) (http://mlbean.byu.edu/ResearchCollections/Collections/ReptilesandAmphibians.aspx), and focused mainly on systematics, anatomy/morphology, and ecology of a wide variety of taxa. Major foci included studies of the throat musculature of ambystomatid and plethodontid salamanders, the myology and osteology of iguanid lizards, taxonomic studies of the genera *Crotaphytus* and *Hypsiglena*, and the herpetofauna of western Chihuahua. As a result of a multi-year contract between BYU and the U.S. Atomic Energy Commission for ecological studies of the Nevada Test Site, Wilmer and his students completed a number of autecological studies of several desert lizards. His systematic studies included descriptions of about 50 new genera, species, and subspecies. These include two new genera—the plethodontid salamander *Lineatriton* (Tanner 1950) and the colubrid snake *Eridiphas* (Leviton and Tanner 1960; but see Mulcahy 2008)—and the rattlesnake *Crotalus lannomi* (Tanner 1966).

Wilmer's legacies.—Wilmer notes in his autobiography (Tanner 1993) that, outside of family, he was most proud of four professional accomplishments. In chronological order these are: 1) earning a PhD under E. H. Taylor at KU; 2) securing a teaching position at BYU, implementing a research program at a time when it was not supported or appreciated, and building a sizeable collection of amphibians and reptiles (Edwards 1975); 3) describing the novel genera *Lineatriton* and *Eridiphas*; and 4) securing support from the Bean family to build and endow a natural history museum on the BYU campus.

Long after official retirement Wilmer continued to work in the museum several days/week, even into his late 90s. The museum annually sponsors two guest lectureships and a Christmas party, and even at age 100, in a wheel chair and on oxygen, Wilmer faithfully attended all such events. For invited seminars he made certain that his family seated him near the front row in the Tanner Auditorium (which was officially dedicated to him), so that he could hear the speakers, and he always had questions, regardless of the topic.

I can think of no better tribute to Wilmer than this quote from E. O. Wilson's foreword in a recent book dedicated to field biology and field notes (Canfield 2011): "If there is a heaven, and I am allowed entrance, I will ask for no more than an endless living world to walk through and explore. I will carry with me an inexhaustible supply of notebooks, from which I can send back reports to the more sedentary spirits (mostly molecular and cell biologists). Along the way I would expect to meet kindred spirits . . . ." Wilmer, you'll be in great company!

Acknowledgments.—I thank Drs. Larry St. Clair and Stan Welsh, Director and Curator Emeritus of Botany, respectively, in the Bean Life Science Museum, and the Tanner family for their assistance in compiling this tribute.

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INSTITUTIONAL PROFILE

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Herpetology at the Zoologisches Forschungsmuseum Alexander Koenig (ZFMK), Bonn, Germany

German natural history museums and particularly their herpetological research sections and collections have been briefly reviewed and described for a US museological readership by Crumly (1984) who started his overview with the Zoologisches Forschungsinstitut und Museum Alexander Koenig (ZFMK), today renamed as Zoologisches Forschungsmuseum (= Zoological Research Museum) Alexander Koenig (Fig. 1). More than a quarter of a century afterwards it seems appropriate to give a short update. Among the German natural history museums with a significant herpetological collection, ZFMK—having been founded in 1900—is by far the youngest and, on average, one century younger than those in Berlin (ZMB), Dresden (MTKD), Hamburg (ZMH), Frankfurt am Main (SMF), Munich (ZSM), and Stuttgart (SMNS). Moreover, a dedicated curatorship for ZFMK's herpetological section has been in place only since 1951. Another distinction from the aforenamed institutions is that the scope of ZFMK comprises only zoology, i.e., there are no geological, botanical, and paleontological collections. In the herpetological collection, however, there are a few exceptions concerning single specimens of mid-Tertiary amber-preserved lizards and some subfossil skeletal material, both including type specimens.

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Within zoology, Museum Koenig has focused on arthropods and vertebrates. From the latter, ornithology has the longest tradition at ZFMK because the founder of the Museum, Alexander Koenig (1858–1940), had his main interest in ornithology since childhood. He was the son of a family of German immigrants to Russia where his father, Leopold Koenig, was the first to introduce sugar beets to Russia and subsequently created an imperium of sugar factories all over the Russian empire, centered in St. Petersburg. On the occasion of a holiday tour to Germany, the Koenig family visited Bonn and was so pleased by the mild climate of the Rhine River valley that Leopold Koenig decided to take residence in Bonn. The house he bought was situated on the Rhine River and was a representative villa that many decades later became famous as the "White House of Bonn" (Fig. 2), viz. the residence of the federal presidents of West Germany after World War II when Bonn had become the capital of the first Federal Republic. Its later and still current name is "Villa Hammerschmidt." Since the reunification of Germany, when capital status, government and parliament moved back to Berlin, Bonn retained a status as "Bundesstadt" (= Federal City) and this building, parental home of Alexander Koenig, is now the second residence of the German Federal President.

Alexander Koenig was six years old when he moved with his parents from St. Petersburg to Bonn. He soon developed a nearly fanatical interest in collecting natural history items, particularly bird nests and eggs, subsequently also the birds themselves. After having finished high school, he studied zoology and achieved a doctoral degree and subsequently also received the title of professor. Following the death of his father, Koenig used part of his inheritance to build a museum to (1) accomodate his large collections in a proper way, and (2) to make them partly accessible to the public. Although construction began in 1912, the building was not finished and did not open for the public until 1934, due to World War I and the consequences for Germany in those years (Fig. 1). As noted above, the first herpetological curatorship was opened by A. Koenig's successor Adolf von Jordans in 1951. Karl F. Buchholz (1911–1967) worked first in the herpetological section, followed by Ulrich Gruber (born 1932) who left ZFMK in 1971 for the museum in Munich (ZSM). Both concentrated on the herpetofauna of southern Europe, mostly of the Aegean Islands of Greece. Curatorship by Wolfgang Böhme was held from 1971–2010, and was replaced by Dennis Rödder following his retirement. Böhme continues to work in the collection and guide students as Emeritus Curator of Herpetology on a voluntary basis.

Since 1951, there was always only one permanent curator post in ZFMK's herpetology section, along with a single support

Fig. 2. "Villa Hammerschmidt," parental house of Alexander Koenig and later the residence of the German Federal Presidents.

Fig. 1. Museum Alexander Koenig, Bonn.

technician. Since 1978, technician position was filled by Wolfgang Bischoff (born 1945), who previously worked at the Magdeburg Museum in East Germany (former GDR). From 1978–present, further help and invaluable support has been provided by Ursula Bott (born 1957) although she was originally attached to the ichthyological section. Two long-term focal points of research involved genital morphology in lizards, together with biodiversity studies on amphibians and reptiles in West and Central Africa. Other projects included the compilation of the current knowledge within a treatise of European reptiles, and checklists including synonymies/chresonymies of chameleonid and varanid lizards. Side projects dealt with aspects of Tertiary and Pleistocene fossils including lizards embedded in amber, and the history of herpetology has also become an important area of interest. Recently, bionics (surface properties of lizards) became a topic of research for ZFMK's herpetology section, in cooperation with the Technical University of Aachen.

Since 1988 (when the senior author received his habilitation degree, i.e. the right to supervise graduate students in his own responsibility), the number of persons working on herpetological topics constantly increased. Apart from the 125 masters students who finished their theses under Wolfgang Böhme's supervision, there are 38 PhD students who successfully received their doctoral degrees. Of these, 30 worked with herpetological subjects, among them quite a number of well-known herpetologists (see below). Currently, the team comprises two postdocs, nine PhD students, and numerous bachelor, masters, and diploma candidates. The topics of their projects are manifold and have included, for example, studies on diversity, systematics, and biogeography of amphibians and/or reptiles of several tropical countries, such as Bolivia (Jörn Köhler, Lutz Dirksen, Steffen Reichle, Dirk Embert), Tanzania (Patrick Krause), Rwanda (Harald Hinkel), Madagascar (Frank Glaw, Miguel Vences), Vietnam (Thomas Ziegler, Nguyen Quang Truong), and Indonesia (Mark Auliya, André Koch); taxonomy, phylogeography, and phylogeny of various squamate groups such as cordyliform lizards (Mathias Lang), scincid lizards (Patrick Mausfeld, Andreas Schmitz), chameleons (Nicolà Lutzmann), uromastycine agamid lizards (Thomas Wilms), agamine agamid lizards (Philipp Wagner), monitor lizards (Hans-Otto Becker, Thomas Ziegler, André Koch, Evy Arida), boid snakes (*Eunectes*: Lutz Dirksen; *Calabaria*: Nicole Ernst), psammophiid snakes (Frank Brandstätter); autecology of amphibians and reptiles, both Palearctic and Afrotropical (Peter Heimes, Kirsten Osenegg-Leconte, Sigrid Lenz, Stephan Kneitz, Birgit Blosat, Daniel Ortmann); snake behavior (colubrids: Thomas Kölpin, psammophiids: Stéphanie de Pury); and more recently, evolution of environmental niches, assessed by means of species distribution modelling as well as assessments of invasive potentials in amphibians, reptiles, and other groups (Dennis Rödder).


Fig. 3. Students working in the molecular lab.

ZFMK is able to provide a variety of important technical research facilities which are organized as central services open for all research sections of the institute. ZFMK was the first and is the only one among the German natural history museums having its own animal house, including a small greenhouse, as a facility to keep live animals for various purposes under proper conditions. As a matter of fact, this facility has been always nearly exclusively used by the herpetology section. Apart from its function as a quarantine station for reptiles kept in the museum's public vivarium, the animal house offers possibilities to work on behavior and reproductive biology of both amphibians and reptiles, and has played an important role in a number of masters and doctoral theses. A sound laboratory with a modern computer equipment serves to analyze animal voices including those of anuran amphibians. ZFMK's Scanning Electron Microscope (SEM), model Hitachi S-2460N, has often been used and is still in intensive use to investigate ultrastructure of reptilian skin, and a modern digital x-ray machine (Faxitron X Ray, Modell LX60) permits acquisition of anatomical (mostly osteological) data without destroying complete specimens.

The most important acquisition, however, is that ZFMK was allowed by the regional government of Nordrhein-Westfalen (the German federal state in which Bonn is situated) to create its own, new center for molecular biology (called "zmb") with several scientists and additional technical staff that offers central services for all taxonomic sections of ZFMK, including herpetology. It comprises several modern molecular laboratories (Fig. 3), a bioinformatics lab, and good computing capabilities.

ZFMK's herpetological collections comprise currently ca. 100,000 specimens, 93,000 of them being catalogued to date. This is remarkable because in 1971 when WB started his curatorship, the collection included only 9,500 specimens of amphibians and reptiles. This rather rapid growth was partly due to the acquisition of some historically important collections that came from other, much older university museums, and which for the first time gave ZFMK's relatively young collection a true historical dimension. The main sources of this valuable material were the university museums of Kiel, Heidelberg, and most important, Göttingen. The Göttingen collection contained invaluable type material of famous herpetologists such as Adolph Arnold Berthold, Wilhelm Keferstein, and Franz Werner (see also Böhme and Bischoff 1984; Böhme 2001, 2011). The most recent acquisition was the collection of the well-known biogeographer Prof. Paul Müller (1940–2010) of the Saarbrücken University who had collected mainly in SE Brazil in the 1960s and early 1970s. He donated his several thousand specimens to ZFMK upon his retirement in 2009.

The geographic focus of the collection in Bonn was originally rather narrow: western Palearctic, the Mediterranean Basin, with a focus on the Aegean islands of Greece. The former director of ZFMK, Prof. Martin Eisentraut (1902–1994), added an important stock of Central African material (Cameroon) to the collection. From 1971 onwards, more Middle East material (Turkey, Levant, Afghanistan) could be acquired but only after the transfer of the Göttingen collection to Bonn was a worldwide geographic scope

Fig. 4. View of the newly constructed “Snake Gallery” where the collection of snakes is accomodates in two floors..

Fig. 5. Alcohol preserved specimens of Grass Snakes, *Natrix natrix* ssp.

achieved. This was continued by the numerous biodiversity projects of our masters and PhD students in various tropical countries (see above). Only North America and Australia are relatively weakly represented, but in the latter case at least some invaluable historical type specimens are kept at ZFMK. Today, the collection comprises more than 530 species group names that are documented by type material. There are over 300 primary type specimens (i.e., name bearers or onomatophores) present in the collection, which chronologically range from 1801 to 2011.

The collection consists mostly of specimens kept in alcohol, but there is also an osteological collection of ca. 1000 skulls and skeletons; this has been used extensively by paleontological colleagues. Special small collections concern lizard hemipenes and lungs, former subjects of respective anatomical studies. For bioacoustic documentation, there are voice records of about 500 frog species, most of them, however, on commercial acoustic matrices. But there are also original recordings of several species. Except for Asia, all continents are represented. Several European species are documented with voice records from various geographic regions within their distributional ranges. The voice archive is kept in the central bioacoustic laboratory, together with mammalian, avian, orthopteran, etc., voice recordings. The same is true for the DNA tissue collection of amphibians and reptiles, which is also stored in the central molecular genetic facility of ZFMK.

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ARTICLES

Herpetological Review, 2012, 43(1), 19–21.

Intrasexual Aggression in Tuatara: Males and Females Respond Differently to Same-Sex Intruders

Intrasexual aggression patterns may reflect sex-specific strategies for maximizing fitness. Studies of aggression have typically focused on males because their behavior is often more dramatic and their morphology often more conspicuous than those of females (Andersson 1994). However, female intrasexual aggression is widespread and can serve several functions, including (1) competition for male parental care (e.g., preventing mates from courting and attracting other females; Slagsvold 1993; Slagsvold and Lifjeld 1994), (2) defending resources in a territory from other females (Berglund et al. 1993; Schofield et al. 2007), and (3) defending nests from females attempting to destroy them or deposit their own eggs (Bensch and Hasselquist 1994; McPhee and Quinn 1998).

Tuatara (*Sphenodon* spp.) are the last living representatives of the reptilian order Rhynchocephalia; they are endemic to New Zealand, sexually dimorphic, and highly territorial (Daugherty and Cree 1990). Tuatara are polygynous and polyandrous, and clutches can be multiply sired (Moore et al. 2008). Aggression has been documented in both sexes, but experimental studies of intrasexual aggression have only been conducted with male tuatara (Gillingham et al. 1995).

Aggressive behaviors among tuatara include erect and alert body posturing, inflation of the gular (throat) region, dorsal and nuchal crest erection, mouth gaping, lateral head shaking, chasing, and physical attack (Gillingham et al. 1995). Physical attacks can last for hours and sometimes end in serious injury. Male and female tuatara display nearly the same suite of aggressive behaviours. However, only males display pronounced dorsal and nuchal crest erection and lateral head shaking. In addition, females exhibit a head nodding behavior that may indicate their sex to other tuatara and thus promote the initiation of male courtship and help females avoid attack by aggressive males during the mating season (Gillingham et al. 1995).

Aggressive encounters between male tuatara follow a stereotyped pattern, beginning with alert posturing, body inflation and crest erection, followed by reciprocal mouth gaping and eventually biting and physical combat (Gillingham et al. 1995). Aggressive encounters among males take place throughout the year but are particularly frequent during mating season when testosterone levels peak (March; Cree et al. 1992). Larger males are more effective at monopolizing and guarding mates and territories by winning aggressive encounters with other males (Moore et al. 2009)

The extent of female-female aggression during mating season is unknown. However, female tuatara aggressively defend their nest sites from excavation by other females during nesting season (November; Refsnider et al. 2009). Females tuatara display nest-site fidelity, returning to the same communal rookeries outside of their home ranges to oviposit every 2–4 years (Refsnider et al. 2009). A study of intrasexual aggression, during mating season and in both sexes, is necessary for understanding the mating system of tuatara, and previous findings for males cannot be assumed to be true for females. Here we investigate (1) whether female-female aggression occurs during the mating season (8–10 months before nesting; Cree et al. 1992) and (2) if the form and pattern of aggression differs between the sexes.

Methods.—We assessed intrasexual aggression through a series of trials conducted during mating season in March 2007 on Stephens Island in Cook Strait, New Zealand, where the largest and most dense population of tuatara (*Sphenodon punctatus*) occurs (~2700 tuatara per ha; Moore et al. 2009). Tuatara occupy extensive, dense burrow systems. Although nocturnal foragers, tuatara emerge from their burrows during the day to thermoregulate and defend against intruders.

Resident male and female tuatara were presented with a non-moving model tuatara representing a same-sex territorial intruder (Fig. 1). Models were carefully placed by hand within territories approximately 1–1.5 m from individual tuatara basking near burrow entrances. Responses of tuatara to the models were either recorded on digital video (19 male trials, 11 female trials) or directly observed when a camera was unavailable (10 female trials). The camera or observer was within view of the focal animal but stationary for the duration of the trial; in very few instances did this process appear to alter the focal animal's immediate behavior. Trials were scored by one of two observers who similarly identified the suite of behaviors under study.

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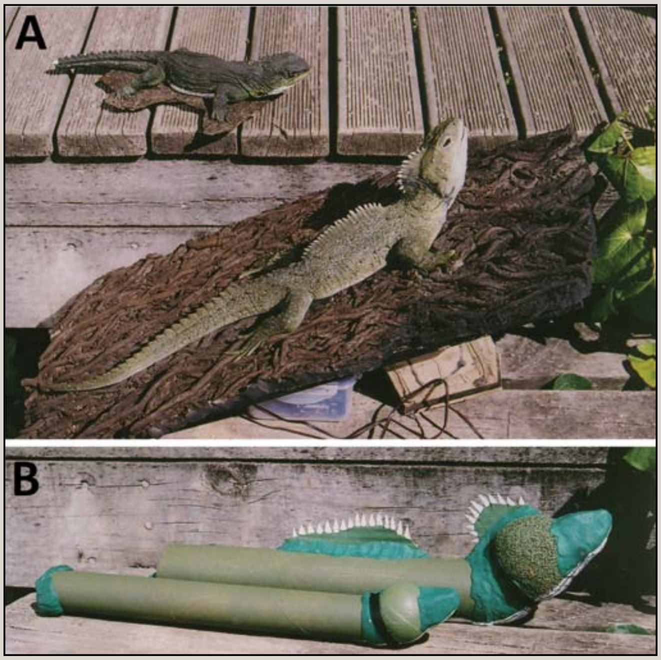

Fig. 1. Realistic (A) and abstract (B) models of male and female (smaller) tuatara. Realistic models were based on molds of deceased tuatara. Abstract models represent only the basic profile and shape of tuatara.

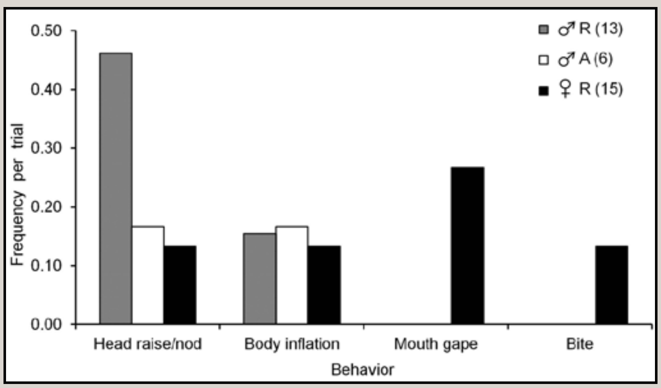

Fig. 2. Frequency of aggressive behavioral responses of tuatara to non-moving, same-sex models. Trials (total number conducted) were male tuatara presented with a realistic model (R), male tuatara presented with an abstract model (A), and female tuatara presented with a realistic model (R); data are the number of times each behaviour was observed divided by the total number of trials. Female tuatara showed no aggressive behavior toward abstract same-sex models.

Both abstract and realistic models for each sex were used in trials to increase the visual cues offered to the tuatara and maximise the possibility of eliciting a response. Realistic models were created from molds of deceased tuatara, while abstract models represented only the basic profile and shape of tuatara (Fig. 1). Models approximated the size and shape of adult tuatara and were similarly sized within sex.

A total of 40 tuatara (19 males and 21 females) were presented with models. Individual tuatara were used in only one trial and were captured when possible after the trial to measure total body length (tip of snout to tip of tail) and snout–vent length (SVL). Trials were conducted between 1100 h and 1800 h; more than 41 h of observation were conducted in total. Encounters between tuatara and models were discreet but varied in duration. Therefore, we did not equalize observation time among trials, but included only trials where the full encounter (tuatara first notices model or emerges from burrow until displaying or attack ceased) was observed (range 30–95 min, mean = 62 min). Data were summarized as counts of response and non-response trials and the frequency in which each behavior was observed (head raise/nod, body inflation, mouth gape, bite) in response trials. Differences in behavior between sexes and model types were assessed with chi square analyses and differences in mean body size between responding and non-responding tuatara were assessed with a two-tailed t-test; significance was assessed at $\alpha = 0.05$.

Results.—Body size was recorded for 14 of 19 male and 18 of 21 female tuatara used in trials. Total body length of the models (male: realistic = 520 mm, abstract = 415 mm; female: realistic = 310 mm, abstract = 370 mm) was within the body size range of captured male (range 373–593 mm, mean = 480.4 mm $\pm$ 33.0 95% CI) and female (range 257–427 mm, mean = 364.2 mm $\pm$ 20.7 95% CI) tuatara, and mean SVL did not differ between tuatara that did and did not respond to the models (males: $t_{12} = 0.036$, $p = 0.97$; females: $t_{16} = -0.490$, $p = 0.63$).

Aggressive responses to the models were recorded in 35% of trials (8 of 19 male tuatara or 42%, 6 of 21 female tuatara or 29%) and male and female tuatara were equally likely to respond aggressively to the models overall ($\chi^2_1 = 0.80$, $p = 0.37$). Female tuatara did not respond to the abstract model while male tuatara responded similarly to both abstract and realistic models (males: $\chi^2_1 = 0.28$, $p = 0.60$; Fig. 2). Where a response was observed, males and females differed in their type of response ($\chi^2_3 = 8.98$, $p = 0.03$; Fig. 2). Males tended to engage in head raises and body inflation; in no trial did a male tuatara mouth-gape at or physically attack a model (Fig. 2). Female tuatara showed similar body inflation to males, but engaged in fewer head nods than males and also mouth-gaped at the models and, in two trials, bit them on the head (Fig. 2).

Discussion.—Our study suggests that both male and female tuatara are aggressive toward same-sex intruders during the mating season, but that physical attack is more likely among female than male tuatara. This may indicate that the fitness cost of fighting (e.g., risk of injury, lost energy or courting time, tail loss) is lower, or the cost of intrusion is higher, among female than male tuatara.

In many birds, females are aggressive toward other females being courted by their mates, which functions to ensure paternal care (Liker and Szekely 1997; Slagsvold 1993; Slagsvold and Lifjeld 1994). Tuatara do not exhibit extensive parental care and do not show pair-bonding. Therefore, female-female aggression in tuatara during the mating season more likely functions as a way to defend individual burrows (i.e., retreat sites) or basking sites, while male-male aggression functions to establish dominance and defend mates. The extremely high density of tuatara in our study population suggests that there could be intense competition for burrows and basking sites.

Intrasexual aggression among female tuatara may have evolved in the context of nest defense. Male tuatara have evolved a stereotyped, reciprocal display that only rarely escalates to physical combat (Gillingham et al. 1995). However, female tuatara do not appear to have evolved a similar passive threat display (e.g., like that observed in female Loggerhead Sea Turtles *Caretta caretta*; Schofield et al. 2007). Outside of nesting, females may rarely come into direct contact because they occupy temporally stable territories (Moore et al. 2009). However, females are in direct and sometimes aggressive contact when nesting at communal rookeries, and frequently excavate each others' nests (Refsnider et al. 2009). Thus, high fitness costs related to nest loss may promote immediate physical combat among nesting females rather than an escalating series of reciprocal displays. This could result in selection for aggression in females generally that is then evident during mating season.

Our observations of head nods in females and a similar, but much slower, behavior in males (here called a head raise) suggests that head raises and nods may be aggressive and not courtship behaviors as previously suggested by Gillingham et al. (1995). This is because both sexes performed this behaviour toward same sex intruders in their territory and head raises were typically the first step in the repertoire of escalating aggressive behavior among males. The behavior was so slow in males that we were often only able to observe it when viewing trial video at high speed, but otherwise closely resembled the head nod that has been previously observed in females.

Appropriate reciprocal movement may be necessary to elicit full attacks from male tuatara. Tuatara are cold adapted and largely sedentary reptiles (Daugherty and Cree 1990), and movement is an important cue used in detection of prey, mates, and competitors (Dawbin 1962; Gillingham et al. 1995; Meyer-Rochow and Teh 1991; Walls 1981). We suspect that movement is key in eliciting aggressive behavior in tuatara, and that reciprocal display may be necessary for aggressive encounters to escalate to physical combat among males. Future studies of intrasexual aggression in tuatara should consider using models that can be manipulated to move in response to aggressive behavioral cues from their same-sex rivals. The present study, however, indicates that movement is not required to elicit highly aggressive responses in female tuatara.

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Geospatial and Behavioral Observations of a Unique Xanthic Colony of Pelagic Sea Snakes, *Pelamis platurus*, Residing in Golfo Dulce, Costa Rica

Golfo Dulce is a curved tropical fiord positioned between 8.3666°N and 8.7500°N on the South Pacific coastline of Costa Rica. The embayment is approximately 50 km in length and 10–15 km wide, supplied with fresh water from four main rivers (Svendsen et al. 2006). The inner basin in the upper region of the inlet, north from 8.5000°N, is of tectonic origin and periodically anoxic (Hebbeln and Cortés 2001). Bathymetric studies show the waters there reach 215 m in depth and are protected by an effective 60 m sill and a submerged valley, ≤ 80 m deep, which extends southward to the mouth of the Gulf. This topography prevents free exchange between the deeper waters of the inner basin and adjacent coastal water masses (Svendsen et al. 2006).

The venomous pelagic sea snake, *Pelamis platurus* (Elapidae: Hydrophiinae), is the most widely distributed snake in the world. This monotypic genus (Pickwell and Culotta 1980) has been reported along the Pacific shores of Latin America since the early 1500s (Taylor 1953) and is the only sea snake on the west coast of Costa Rica (Solórzano 2004). Generally reliant on ocean currents for long distance movement, pelagic sea snakes are often associated with drift lines, and groups of a few to several thousand may aggregate in narrow bands of smooth water on the ocean surface, possibly for the purpose of passive transportation, feeding, and/or reproduction (Kropach 1971a; 1975). However, despite being a true pelagic species that ranges far out to sea, *P. platurus* is most commonly found 1–20 km off shore (Savage 2002). It opportunistically feeds on a wide array of small and young fish species at the water surface (Hecht et al. 1974) and can thrive in lower saline conditions (Dunson 1971).

Pelamis platurus displays diverse color variations (Kropach 1971b). In the Eastern Pacific, the majority of Yellow-bellied Seasnakes are tricolored with black dorsal coloring and brownish ventral coloring separated by yellow lateral stripes. The second most common are bicolored snakes, black and yellow with no brown (Bolaños et at. 1974; Tu 1976). Both variations display black spots or bands on the flat paddle-shaped tail. Such coloration is suggested to be aposematic (Kropach 1975); indeed, predation on *P. platurus* appears practically nonexistent (Rubinoff and Kropach 1970), and the species rarely dives due to disturbances at or above the surface (Dunson and Ehlert 1971; Tu 1976), suggesting there is limited, if any, predation pressure from that direction (Kropach 1975). Unicolor snakes have been considered very rare, merely noted in the Western Hemisphere (Leenders 2001; Mattison 2007; Solórzano 2004; 2011). Smith's (1926) seven color forms did not include an all-yellow variety and Kropach offered the first definitive description (Pickwell and Culotta 1980) after seeing individuals of the variety in both Golfo Dulce and the Gulf of Panama. During a 1970 expedition, Kropach (1971b; 1975) observed 278 *P. platurus* inside Golfo Dulce. Nine of the specimens, about 3%, were of the all-yellow variety. In 1973, Bolaños et al. (1974) captured 102 specimens of *P. platurus* in five localities along the northern Pacific coastline of Costa Rica, including one snake that was "yellow with a few black dorsal dots." Tu (1976) later reported collecting 3077 pelagic sea snakes on the Pacific Coast of Costa Rica. Of that sample, four specimens, approximately 0.1%, were all-yellow. Tu (pers. comm.) confirmed he did not find any of his snakes in or near Golfo Dulce. Those findings show that all-yellow individuals along coastal Costa Rica are not limited to the waters of Golfo Dulce and may naturally represent a small percentage of the population-at-large.

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During previous work on the Osa Peninsula (Bessesen and Saborío-R. 2009), local residents described to me a population of all-yellow specimens of *P. platurus* living in Golfo Dulce. Based on that information, a marine sighting survey was designed to collect baseline distribution data for the yellow sea snakes during the dry season of 2010. These findings, which suggest a separate and behaviorally distinct xanthic (defined here as all-yellow or primarily yellow) colony, are reported here.

METHODS

With the aid of a Costa Rican research assistant/boat captain, 82 preliminary interviews were conducted with local fishermen and tour boat guides. Interviewees were asked to estimate the frequency with which they saw pelagic sea snakes inside Golfo Dulce (never, rarely, occasionally, frequently or always) and the color of those snakes. Photographs were made available but all interviewees seemed familiar with the snakes.

After interviews, 30 daily on-water surveys were undertaken, systematically investigating surface waters around the entire Gulf to document first-hand sightings of *P. platurus*. January–February study dates were selected in part because local sources reported pelagic sea snakes as being seen more frequently at the surface during the dry season, an observation also noted by researchers in other areas of Costa Rica (Bolaños et al. 1974).

The embayment was divided into four geographical areas, labeled GA1–4. GA1 and GA4 were designed smaller to account for distance from the operations base of Puerto Jiménez and additional time spent in GA2 and GA3 as corridors. The boat captain selected delineating landmarks he found clear and familiar, resulting in GA3 being slightly larger than intended. Each day we concentrated on a single area, traversing its full breadth in a large loose pattern, e.g., perimeter, figure-eight, zigzag, to ensure time near each coast and in the midwaters. A rotation of GA1, GA3, GA2, GA4 was generally employed. Waters outside the embayment, designated as GA5 (Fig. 1), were not actively surveyed; however, some sea snake sightings occurred in that area after inadvertently crossing the boundary of GA4. Typically we departed Puerto Jiménez just after sunrise and traveled 65–80 km per day, with daily observation periods lasting an average of 7 h and 46 min. We carried out three night surveys in GA1 and GA2 to observe yellow sea snakes in low-light conditions.

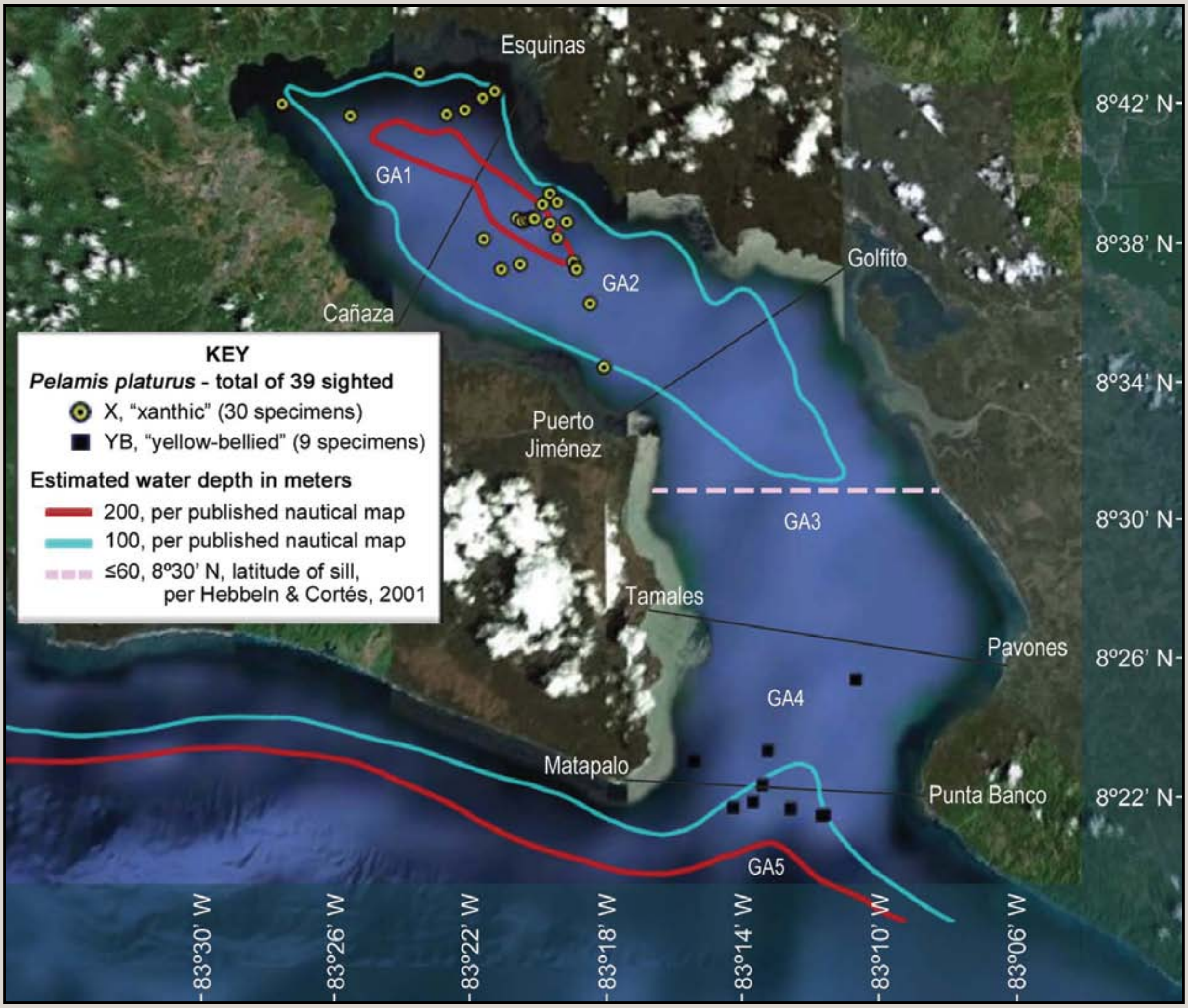

Fig. 1. GPS points for 39 first-hand sightings of *Pelamis platurus,* represented by 30 Xanthic sea snakes (yellow dots) and 9 Yellow-bellied sea snakes (black squares). Note the significant spatial gap that coincides with the graphic demarcation of the inner basin sill. Also shown, delineation of survey areas (grey lines).

GA1 = ↑ Cañaza 8.5948°N, 83.4006°W / Esquinas 8.7208°N, 83.3316°W;

GA2 = ↑ PJ 8.5425°N, 83.3038°W / Golfito 8.6217°N, 83.1821°W;

GA3 = ↑ Tamales 8.4521°N, 83.2820°W / Pavones 8.4203°N, 83.1086° W;

GA4 = ↑ Matapalo 8.3742°N, 83.2906°W / Pt Banco 8.3663°N, 83.1456°W;

GA5 = ↓ GA4 (outside gulf).

Fig. 2. Two typical Xanthic sea snakes found in upper Golfo Dulce. (A) This specimen was identified by two small black marks caudal and slightly medial to the supraocular scales (arrows). (B) Although predominantly yellow, some individuals retain larger black spots along the dorsal ridge. This sinusoidal posture was commonly seen when approaching at night. The slight halo effect was caused by the camera flash on the water.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

Table 1. Geographical areas in Golfo Dulce with surface size, survey effort, and quantitative sighting distribution for Yellow-bellied and Xanthic specimens of *Pelamis platurus*.

Geographical areas		Survey effort		Snakes by color variation	
Location	Estimated surface size	Days of rotation	Approximate survey hours	Xanthic	Yellow-bellied
GA1, highest sector of gulf	130 km^2	7.25	55.50	6	0
GA2, mid-upper gulf	192 km^2	8.25	65.75	24	0
GA3, mid-lower gulf	256 km^2	7.25	63.25	0	0
GA4, lowest sector of gulf	147 km^2	7.25	47.50	0	4
GA5, outside gulf	—	—	01.00	0	5

Sightings were recorded using Global Positioning System (GPS; Garmin handheld GPS III) with 72% of sea snakes right next to the boat and none further than 5 m away. Typical bi- or tricolored *P. platurus* with black and yellow striae were logged as Yellow-bellied while all-yellow or primarily yellow individuals were logged as Xanthic. Two cameras, a Nikon D50 SLR digital camera and a Canon GL-1 mini DV video camera, were used to obtain photographic records. Daily solar and tidal charts were logged and time was recorded at the start and end of each observation period, along with environmental conditions, including air and sea surface temperatures, Beauford Wind Force, visibility and prevailing weather.

RESULTS

Interviews.—Of the 82 interviewees polled during this study, 72% (59) were professional fisherman (commercial and/or sport-tourist), 13% (11) worked in nonfishing tourism (boat tours/excursions), and 15% (12) of the subjects did both. The number of years experience in Golfo Dulce ranged from 1–40 with the average at 12 years. Average number of work days per week was 5. When asked how often pelagic sea snakes were seen inside Golfo Dulce, 44% reported that they were "rarely" seen, 18% answered "occasionally," 21% said "frequently," and 11% said "always." Only 6% of the interviewees had "never" seen *P. platurus* inside the Gulf.

Interviewees consistently reported that Xanthic sea snakes were found in the upper, deep water regions of Golfo Dulce, while Yellow-bellied sea snakes were down near Matapalo at the inlet's entrance, and that this was not a seasonal phenomenon. Some interviewees from the pueblo of Pavones on the southeastern shores of Golfo Dulce, who worked solely in the lower half of the Gulf, had never seen a Xanthic sea snake. The project's research assistant (Largaespada, pers. comm.) had observed Xanthic snakes in the upper Gulf for more than 35 years and never a Yellow-bellied snake in that region. Two resident biologists (Boston, pers. comm.; Bernal, pers. comm.) confirmed witnessing only Xanthic snakes around the inner basin, including possible reproductive aggregations in the month of July. Boston also reported never seeing a Xanthic sea snake in a drift line.

Field counts.—Between the dates of 13 January and 24 February 2010, a total of 233 observation hours was logged across all areas of Golfo Dulce (Table 1); most (89%) were conducted during daylight hours. In general, weather conditions presented minimal precipitation, relatively calm water and average visibility greater than 15 km. Daily temperatures, recorded near the marina of Puerto Jiménez, averaged 28.6°C for air and 30.5°C for sea surface. (The upper lethal temperature for *P. platurus* is from 33°C [Dunson and Ehlert 1971] to 36°C [Graham et al. 1971].)

A total of 39 pelagic sea snakes were documented, divided as 30 Xanthic and 9 Yellow-bellied. For the Xanthic variety, 80% (24) were seen in GA2 with the remaining 20% (6) found higher up in GA1. All Yellow-bellied snakes were seen within 7 km of the Gulf entrance, most near the border of GA4/GA5, although one individual was recorded a little further into the embayment. The distance between the southernmost Xanthic and northernmost Yellow-bellied specimens was 21.6 km. No pelagic sea snakes were found in GA3 (Table 1, Fig. 1).

Overall, sea snakes were infrequently seen; however, if one was sighted, others usually were seen, sometimes several in a short stretch of time, suggesting certain days and/or conditions were more conducive for surfacing. One example occurred under a full moon on 30 January, when 8 Xanthic snakes were sighted within an hour (2017–2110 h), no more than 300 m apart. In another instance, 5 Xanthic specimens were sighted over a span of about 4 km in only 23 min (1618–1641 h; 20 February). Although snakes were sometimes seen swimming across the water, most were found simply floating at the surface.

We were able to collect photographs and/or video footage in 77% of our total sea snake sightings, allowing for identification of individuals. Individual Yellow-bellied snakes were easy to recognize by the unique configuration of their markings and it was confirmed that nine different Yellow-bellied snakes were encountered. Although Xanthic specimens appeared unicolored and were consistently yellow with neither lateral demarcations nor prominent tail patterns, photos revealed that most had at least one black speck on the head or body. A few individuals (1–2% of the total Xanthic sampling) had one or more larger black spots (estimated <5 mm in diameter) along the dorsal ridge. One specimen had decidedly heavier dorsal markings, yet none of its spots were estimated at >20 mm. Using markings, it was determined that every Xanthic snake photographed during the investigation was also a distinct individual (Fig. 2A, B).

Behavioral observations.—Photographs were taken for 100% of the nine Yellow-bellied sightings, all of which took place during daylight hours. All of the Yellow-bellied snakes reliably remained on the surface while approached for documentation; two surfaced next to the boat when the motor was off; and 6 snakes were still on the surface after departure. On the two separate occasions that we touched the tails of Yellow-bellied snakes facing away from us, they both turned back and struck at the boat hull. Neither dove. All Yellow-bellied sea snakes were seen in relatively still water or smooth rolling waves and two snakes (22%), were floating in or near a defined drift line.

Photographing Xanthic snakes proved a greater challenge. They never surfaced near the boat and, in daylight conditions, tended to dive if we slowed down anywhere near them. Despite clear views at every sighting, photographs of Xanthic snakes were captured only 50% of the time (5 of 10) in full daylight. Low-light conditions increased the success rate. For evening sightings from 1400–1600 h, photos were collected for 71% (5 of 7) of Xanthic sightings. During night surveys conducted after 1800 h, 85% (11 of 13) were photographed. Because the Xanthic snakes did not dive as readily at night, it was possible to directly approach and obtain close-range photographs and videotape using flashlights. However, the snakes often assumed a tight sinusoidal shape (Fig 4B; this posture was not observed in Yellow-bellied snakes). On the one occasion we touched a Xanthic snake, it did not respond by striking but immediately dove. Most Xanthic snakes were recorded in choppy water; a few were seen in slightly calmer morning and evening waters; none was found in smooth water. We occasionally saw drift lines in the upper half of the embayment; however, only one Xanthic snake was observed several feet outside a slick of floating scum and debris. The occurrence rate of drift lines in the upper and lower regions of the Gulf is unknown. One Xanthic snake was also videotaped while shedding its skin, using the knotting behavior described by Pickwell (1971, 1972).

DISCUSSION

After many interviews with local biologists, fishermen, and tour boat guides, and an expansive on-water survey of Golfo Dulce during the dry season, we have determined that all the sea snakes above about mid-Gulf appear bright canary yellow. The consistently yellow skin coloring of sea snakes found in the northern region of the Gulf and absence of yellow snakes below the sill suggest this population may be genetically disjunct from those in the Pacific. The data show clear geospatial, morphological, and behavioral distinctions between the Xanthic and Yellow-bellied populations, and phylogenetic studies would be of significant interest to determine if morphology has given rise to a distinct form of *Pelamis platurus* in Golfo Dulce.

Golfo Dulce's topography may help explain the almost 22 km gap between the Xanthic and Yellow-bellied populations and complete lack of sea snake sightings in GA3. Although the Xanthic colony appears to reside high up in the inner basin and no sea snakes were sighted near the sill, shallower waters south of the sill may play a role in habitat boundaries.

Hecht et al. (1974) listed several limiting factors for the establishment of resident populations of pelagic sea snakes, including annual range of surface temperatures, depth of water, prevailing currents, and storm pathways. They suggested that, demarcated by the 26°C isotherm correlated with the 100 m isobath, permanent breeding colonies should occur in many areas worldwide, including the western coast of Central America. Given the favorable yet insulated bathymetrics of Golfo Dulce, the idea of one such breeding population becoming sequestered, possibly by shifts in currents, is conceivable. Furthermore, the pelagic sea snake's nonspecialized food habits and ability to thrive in lower saline conditions would have allowed the original colonizing snakes to inhabit the fiord-like waters. Because *Pelamis platurus* spends about 87% of its time submerged (Rubinoff et al. 1986), and respires partially through its skin, meeting 12–33% of its oxygen requirements and excreting carbon dioxide by that mechanism (Graham 1974b), it would be interesting to investigate whether and/or how the Gulf's periodic anoxia affects the resident snakes.

Kropach (1971a, b) first reported the all-yellow variety of pelagic sea snake after conducting a one-year study of *P. platurus* in the Gulf of Panama, where "regular trips were made in the northern part of the [gulf]." Although the yellow variety was seen during that study, Kropach made no indication that the number of yellow specimens made up a greater concentration than the 3% he reported in Golfo Dulce. This decreases the likelihood that yellow snakes are predominant in the Gulf of Panama or are in any way isolated from the prevailing color varieties in that embayment, and suggests the Golfo Dulce population may be unique.

What are the adaptive advantages of xanthic coloring in Golfo Dulce when that variety exists in only a small percentage of the general population? Solorzano (2011) suggests temperature might play a role. Because *P. platurus* naturally collects solar energy while basking (Graham et al. 1971; Graham 1974a) and sea surface temperatures in Golfo Dulce are higher than other areas within the species' range (Hecht et al. 1974), perhaps lighter dorsal coloring reduces chances of overheating at the surface where it feeds.

Xanthic sea snakes were commonly found in rougher water than expected for *P. platurus*. Such conditions might play a role in surfacing and/or detectability. Xanthic snakes were also more likely to dive when approached, especially during daylight hours, and often took a seemingly defensive sinusoidal posture. Boat traffic and other human activity may influence sea snake behavior within the embayment and/or all-yellow coloring may not be entirely aposematic in Golfo Dulce. It also appears that Xanthic snakes make limited, if any, use of drift lines.

The findings of this study raise several interesting questions about the Xanthic sea snakes residing in Golfo Dulce and there remains much to learn about this unique colony.

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Headwaters and Headlamps: A Comparison of Nocturnal and Diurnal Surveys to Estimate Richness, Abundance, and Detection of Streamside Salamanders

Salamanders are sensitive to environmental stressors and are increasingly being used in monitoring programs (Davic and Welsh 2004). Surveys for salamanders commonly take place in conjunction with other biological surveys, such as fish and benthic macroinvertebrate sampling (Kazyak 2001). These surveys are often conducted during the day. Consequently, predominantly nocturnal individuals and species may go entirely undetected. Salamanders are thought to be primarily nocturnal, their activity on the ground surface increasing with relative humidity (Petranka 1998). This suggests that the optimum time to study or survey salamanders is at night. However, Southerland (1986a) demonstrated that *Desmognathus monticola* tends to move away from the stream margin at night, suggesting that surveys of the immediate streambank would be more effective during the day.

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Salamander surveys have been conducted during the night (Grover 1998; Hairston 1980; Petranka and Murray 2001), during the day (Foley and Smith 1999; Jung et al. 2000; Smith and Petranka 2000; Southerland et al. 2004), and during both day and night (Burton and Likens 1975; Hyde and Simons 2001; Southerland 1986b). If biases in relative abundance or detection probabilities exist due to differences in sampling time, then results from these studies may not be comparable. Few studies have examined this problem (Hyde and Simons 2001; Keen et al. 1987; Orser and Shure 1975) and our objective was to determine if species richness, abundance, and species-specific detection probabilities differ between diurnal and nocturnal streamside salamander surveys.

METHODS

Site selection. —We established paired sites at 12 headwater streams in small catchments (draining <120 ha) of relatively uniform habitat and gradient in the Savage River watershed (Fig. 1). This watershed is in the Appalachian Plateau region of Maryland and one of the most heavily forested regions in the state (Boward et al. 1999). Streams of this region generally have vegetated riparian zones, rocky substrates, steep gradients, low nitrate concentrations, and relatively high levels of dissolved oxygen (Boward et al. 1999). The canopies are dominated by Eastern Hemlock (*Tsuga canadensis*) and Yellow Poplar (*Liriodendron tulipifera*), and the understory is dominated by *Rhododendron* spp. The substrate along the streambank consists of boulders, cobbles, and leaf litter.

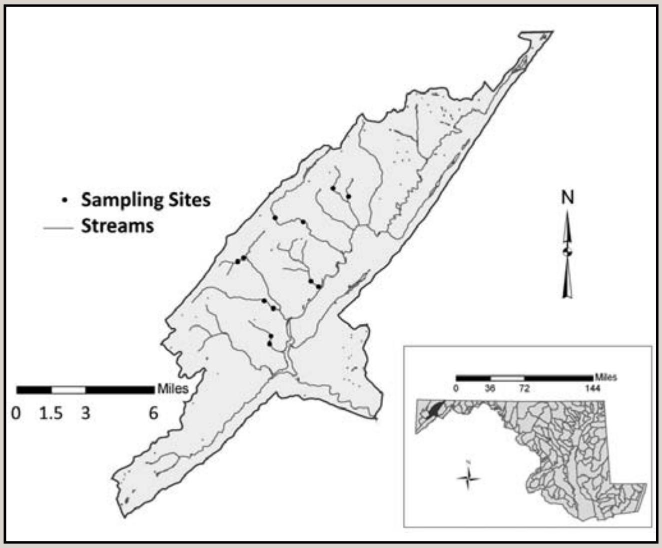

Fig. 1. Savage River watershed in Garrett County, Maryland, with locations of study sites.

Each paired site consisted of two 25 × 1 m transects, originating at the stream margin and running parallel to the stream. These transects were established along the same reach of stream, separated by ≥10 m. We took care to select two 25 m sections that were as similar as possible by visually estimating numbers of pools and riffles and relative proportions of boulders, cobbles, and leaf litter along the streambank (pairings were deemed suitable if they were >90% similar with respect to these attributes). Diurnal and nocturnal survey treatments were randomly assigned with a coin toss.

Surveys.—Salamander surveys were performed once at each site from 20–27 April 2007, with diurnal surveys conducted between 0900 h and 1200 h and nocturnal surveys conducted between 2245 h and 0130 h. Mean relative humidity was 62.6% and 71.7% and mean air temperature was 14.5°C and 9.9°C during diurnal and nocturnal surveys, respectively. No rainfall occurred during the survey or for several days preceding surveys; light fog was present during four diurnal surveys. Surveys took approximately 25 minutes to perform (min-max: 13–45 mins). When two sites were sampled on the same day, they were done so in a random order (i.e., the order in which they were sampled diurnally may not have been the order they were sampled nocturnally). The nocturnal survey time interval was chosen because it closely overlapped with the peak activity periods that Hairston (1949) reported for Appalachian salamanders, three species of which occurred in our study area (*Desmognathus monticola*, *D. ochrophaeus*, and *Plethodon glutinosus*). Diurnal and nocturnal surveys at each site were always conducted on the same day, and standard headlamps were worn during nocturnal surveys. Area constrained surveys (ACS) were used to sample salamanders. ACS consisted of two observers slowly walking in parallel along the streambank, looking for adult and juvenile salamanders on the surface and turning over all natural cover objects (excluding objects less than roughly 8 cm) to look for salamanders underneath (Crump and Scott 1994). Cover objects were returned as close as possible to their original position. All salamanders encountered were captured, identified to species, measured for snout–vent length (SVL), and released. Salamanders that eluded capture were noted and identified if possible.

Statistical analysis.—Each transect was considered an independent experimental unit, and paired t-tests were used to examine differences between diurnal and nocturnal surveys with respect to species richness and number of individuals (for each species and total; adults and juveniles were pooled within each species). Dependent variables (species richness, number of individuals) were all distributed normally with the exception of species richness of diurnal surveys; we assumed the test to be robust against this slight departure from normality.

Site occupancy models developed by MacKenzie et al. (2002; 2006) were used to estimate species-specific detection probabilities and evaluate the differences, if any, in those detection probabilities between survey types. In these models, it is assumed that sites belong to one of two states: unoccupied (the species will not be detected) or occupied (the species will be detected with a probability of less than one, MacKenzie et al. 2002; 2006). Two parameters, Ψ (occupancy) and p (detection probability) represent the probability that a site is occupied and the probability of detecting the species (given that it is present), respectively. Maximum-likelihood methods are then used to estimate the parameters for a set of sites for which presence/absence data for a species has been obtained via repeat surveys (MacKenzie et al. 2002; 2006). We analyzed data using program PRESENCE (Proteus Wildlife Research Consultants, Dunedin, New Zealand; MacKenzie et al. 2002). For this analysis, each site (which included both transects) was considered the sampling unit, and the diurnal and nocturnal transects were considered the two repeat surveys needed to estimate parameters (MacKenzie et al. 2006). For model selection, we used a single-season model with Akaike's Information Criterion adjusted for small sample size (AIC_c; Burnham and Anderson 2002). Our two candidate models for each species in this analysis were constant detection probability across surveys and variable detection probability across surveys (p(.) and p(SURVEY), respectively). Because of the short amount of time over the entire study (eight days) and between diurnal and nocturnal surveys (10–16 h), occupancy (Ψ) was assumed to be constant.

RESULTS

We encountered 348 salamanders comprising six species: *Eurycea bislineata*, *Desmognathus fuscus*, *D. ochrophaeus*, *D. monticola*, *Gyrinophilus porphyriticus*, and *Plethodon glutinosus* (Table 1). We encountered *D. ochrophaeus* in every survey; therefore the variance-covariance matrix could not be computed and thus that species was omitted from detection probability analyses. *Plethodon glutinosus* was excluded from the paired t-tests and detection probability analyses because only one individual was encountered during the entire study.

No significant differences existed between diurnal and nocturnal surveys for species richness, total number of individuals, or number of individuals of each species (Table 1). We performed post-hoc power analyses to determine our probability of avoiding type II error. A sample size of 12 and a paired difference standard deviation of 1.24 yielded a probability of detecting a 50%, 20%, and 10% difference in species richness of 0.99, 0.99, and 0.72, respectively. An increased standard deviation (5.61) for paired differences in total individuals decreased the probability of detecting a 50%, 20%, and 10% difference to 0.80, 0.20, and 0.09, respectively.

There was no overwhelming support that detection probabilities did or did not vary significantly between diurnal and nocturnal surveys: the data for *D. fuscus*, *D. monticola*, and *G.*

Table 1. Summary statistics and results of paired differences t-tests between diurnal and nocturnal streamside salamander surveys (diurnal – nocturnal) for species richness, total number of individuals, and number of individuals for each species encountered (N = 12; parentheses indicate +/- 1 SE; captures of *Plethodon glutinosus* were too low for analysis).

	Diurnal				Nocturnal					
Species	Mean	Min	Max	Total	Mean	Min	Max	Total	t statistic	p-value
Species Richness	2.75 (0.30)	1	4	5	3.33 (0.31)	2	5	6	-1.63	0.13
Total Individuals	13.6 (1.81)	3	23	163	15.4 (2.30)	4	32	185	-1.13	0.28
Desmognathus fuscus	1.5 (0.77)	0	7	18	1.3 (0.62)	0	7	15	0.31	0.76
Desmognathus monticola	1.7 (0.61)	0	7	20	1.6 (0.50)	0	6	19	0.13	0.89
Desmognathus ochrophaeus	8.2 (1.53)	3	17	98	8.4 (1.34)	2	14	101	-0.11	0.92
Eurycea bislineata	1.8 (0.52)	0	5	22	3.4 (1.14)	0	15	41	-1.59	0.14
Gyrinophilus porphyriticus	0.3 (0.18)	0	2	3	0.3 (0.19)	0	2	4	-0.36	0.72
Plethodon glutinosus	0	0	0	0	0.1 (0.08)	0	1	1	NA	NA

Table 2. Model selection analysis and parameter estimates (+/- 1 SE) of occupancy (Ψ) and detection probabilities (p) for salamander taxa between diurnal and nocturnal salamander surveys (K, number of parameters; the two estimates in the p column for Ψ(.)p(SURVEY) models represent diurnal and nocturnal survey estimates, respectively).

Species	Model	-2log-likelihood	K	ΔAICc	Akaike weight	Ψ	SE(Ψ)	p	SE(p)
Desmognathus fuscus	Ψ(.)p(.)	35.61	2	0.00	0.71	0.83	0.34	0.44	0.21
	Ψ(.)p(SURVEY)	37.41	3	1.80	0.29	0.84	0.35	0.40, 0.50	0.22, 0.25
Desmognathus monticola	Ψ(.)p(.)	29.11	2	0.00	0.70	0.78	0.13	0.80	0.11
	Ψ(.)p(SURVEY)	28.77	3	1.66	0.30	0.78	0.13	0.75, 0.86	0.15, 0.13
Eurycea bislineata	Ψ(.)p(SURVEY)	20.82	3	0.00	0.60	0.83	0.11	0.80, 1	0.13, 0
	Ψ(.)p(.)	23.59	2	0.77	0.40	0.84	0.11	0.89	0.08
Gyrinophilus porphyriticus	Ψ(.)p(.)	23.93	2	0.00	0.70	0.52	0.34	0.40	0.28
	Ψ(.)p(SURVEY)	23.59	3	1.66	0.30	0.50	0.32	0.33, 0.50	0.27, 0.35

porphyriticus were best modeled with constant detection probabilities whereas *E. bislineata* was best modeled with detection probabilities that varied between the two surveys (Table 2). However, the ΔAIC values of both models for all species analyzed were less than two, which suggests that both models have considerable support (Burnham and Anderson 2002).

DISCUSSION

We found no significant differences in richness, abundance, or detectability between day and night surveys for adult and juvenile streamside salamanders in the immediate streambank. This contrasts with Orser and Shure (1975), who found that for *D. fuscus* nocturnal density estimates using mark-recapture were always higher than corresponding diurnal estimates. They suggested the reason for this difference was due to bias related to the extent to which marked animals remixed with unmarked animals after release. Hairston (1980) sampled salamanders active on the surface at night because flipping cover objects repeatedly would result in habitat degradation. Undoubtedly, salamanders are more active at night, and individuals from nearby cover objects may be moving laterally into a study area or vertically from the larger pool of individuals underground (Hairston 1980; Petranka and Murray 2001). This possibility may have introduced bias into Orser and Shure's estimates as the assumption of population closure (Krebs 1999) may have been violated.

These types of estimates (i.e., mark-recapture, removal sampling) for streamside salamanders are problematic because model assumptions are routinely violated (Petranka and Murray 2001; Strain et al. 2009). Most agencies may not employ such intense methods because the data are simply not robust enough to warrant the high cost of obtaining them. Of course, the choice of response variable depends on management or research objectives. Metrics such as species richness and counts of individuals in different age classes or of different tolerances to degradation, which are being used in the development and refinement of a streamside salamander index of biotic integrity (Southerland et al. 2004), can be obtained with a single visit and minimal habitat alteration. The results of the present study indicate that these visits can be done during the day or at night in the immediate streambank.

Moisture level is an important limiting factor for salamanders (Hairston 1949), and we may have observed no difference in captures between day and night because heavy shading along our streams resulted in negligible differences between diurnal and nocturnal moisture levels. Streamside salamander density is severely decreased in disturbed riparian habitats (Orser and Shure 1972; Price et al. 2006), and the remaining salamanders at a site may reduce their diurnal activity due to reduced moisture levels associated the loss of shade and cover. Because of this possibility, further investigation should be undertaken to determine how applicable our results are to other regions, habitats, and land use types.

We suggest a potential mechanism behind similar counts of streambank-dwelling salamanders diurnally and nocturnally: activity levels of streamside salamanders may be higher at night, due to decreased temperatures and increased moisture levels (Hairston 1949), but abundance may not be, due partly to interspecific interactions. Individuals under the surface may be prevented from emerging by the presence of individuals already occupying surface habitats (Jaeger 1988; Jaeger et al. 1998; Southerland 1986a); this competition and predation avoidance presumably occurs throughout the day and night. Thus, counts of salamanders diurnally and nocturnally represent the surface population, and are both likely an underestimate of the subterranean superpopulation (Bailey et al. 2004a).

Salamanders are most likely never detected without error (Bailey et al. 2004b), and exploration of this topic should include the estimation of detection probabilities and temporary emigration probabilities (Bailey et al. 2004a). Our results agree with other studies that have found variable detection probabilities across species (Bailey et al. 2004b; Dodd and Dorazio 2004), but we also found indication that detection of individual species may not vary significantly between the day and night. More research is needed to confirm this.

Our study suggests the quality of data obtained from diurnal surveys of the immediate streambank may be similar to that of nocturnal surveys. However, the sample size in our study was small, especially for analyses pertaining to detection probability estimation (small vis-à-vis both number of sites and number of repeat visits; MacKenzie and Royle 2005), so this topic would greatly benefit from further research.

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Diet of Amethystine (*Morelia kinghorni*) and Carpet Pythons (*Morelia spilota*) in North Queensland, Australia

Diet plays a key role in the ecology of a species (Slip and Shine 1988a). An organism's feeding habits can directly affect life-history characteristics such as body size (Pearson et al. 2002; Shine 1991a), growth rates (Madsen and Shine 2000), life stage (Slip and Shine 1988a), thermoregulation in ectotherms (Ayers and Shine 1997), reproduction (Shine and Madsen 1997), population dynamics (Madsen et al. 2006), and activity patterns and habitat use (Heard et al. 2004; Madsen and Shine 1996). Knowledge of foraging ecology allows us to understand the niche a species occupies in a community (Shine 1991b), which in turn assists our understanding of prey population dynamics (e.g., prey behavior and resource use; Kotler et al. 1993). For instance, the role of snakes as predators may not only contribute to the control of rodent populations (Shine 1991a), but may also lead to severe declines in prey species (Wiles et al. 2003). However, although the feeding habits of snakes vary with geographical location and latitude (Luiselli 2006), most studies of snake ecology have focused on temperate species (see references in Vitt 1983). As a consequence, there are few substantial studies on the diet of tropical python species, and scientific research on the ecology of the giant snakes of the tropics, particularly Australia, is considerably lacking (Fearn et al. 2005; Shine and Slip 1990).

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Morelia kinghorni Stull, 1933 (formerly *Morelia amethistina* [Schneider, 1801]), is Australia's largest snake (total length up to 6 m, with unconfirmed reports of 8 m; Fearn and Sambono 2000; Wilson and Swan 2008). *Morelia spilota* (Lacépède, 1804) is a relatively common tropical and subtropical python species that reaches a total length of 2.5 m (Wilson and Swan 2008), although some variants can reach 3 m (Slip and Shine 1988b). While the behavior and habitat use of both species are well-documented (e.g., Fearn et al. 2005; Freeman and Bruce 2007; Freeman and Freeman 2009; Slip and Shine 1988b,c), accounts of diet are either largely anecdotal (*M. kinghorni*: Bickford 2004; Fearn 2002; Fearn et al. 2005; Martin 1995; Turner 2001), or geographically limited (*M. spilota*: Fearn et al. 2001; Shine 1991b; Shine and Fitzgerald 1996; Slip and Shine 1988a).

In this study we investigated the diets of these two python species in Northeast Queensland. We collected roadkilled specimens, examined them for stomach or fecal contents, and recorded any incidental observations of feeding. We used these data to answer several questions: 1) What is the diet composition of *M. kinghorni* and *M. spilota*? 2) What is the relationship between snake size and prey size and does this relationship differ between the two species? Knowledge of this relationship provides a basis for conjecture on the factors influencing predation in these species, such as gape size, capture ability, and prey encounter rates (Shine 1991b). 3) Do the species differ in their consumption of native versus non-native prey species? Predation on native versus non-native prey species provides some indication of the extent to which these pythons exploit human-modified habitats (e.g., *M. spilota:* Fearn et al. 2001) versus native rainforest (e.g., *M. kinghorni:* Freeman and Bruce 2007; Freeman and Freeman 2009). Consumption of a variety of non-native prey, for instance, would suggest that the predator was capable of exploiting human-modified environments where such prey thrive (Shine et al. 1999a,b).

MATERIALS AND METHODS

Study area.—We conducted our sampling in the Wet Tropics Bioregion of Northeast Queensland, which extends 450 km from Cooktown (15.4667°S, 145.2667°E) in the north to Townsville (19.2500°S, 146.7500°E) in the south. The majority of records were collected from Cardwell (18.2719°S, 146.0350°E) to the northern suburbs of Cairns (16.8967°S, 145.7161°E) and the adjacent Atherton Tablelands, with one outlier at the Bloomfield River (15.9353°S, 145.3417°E). This region supports the largest area of tropical rainforest in Queensland, and although much of it has now been fragmented or cleared for agriculture and grazing on the tablelands and lowlands, large tracts still remain on the slopes of the uplands (Tracey 1982). The Wet Tropics experience a humid tropical climate with distinct wet (between November and April) and dry (between May and October) seasons, and an average temperature range from 24 to 33°C in the wet season and from 14 to 26°C in the dry season (Trott et al. 1996).

Sampling.—We used data on the diet of *M. kinghorni* and *M. spilota* collected over an 11-year period (2000–2010). These included dietary records from both species identified through incidental sightings and roadkilled individuals studied by Freeman and Freeman (2009) or collected in 2010, and also of radio-tracked *M. kinghorni* studied by Freeman and Bruce (2007). We did not force the regurgitation of prey for any snakes nor massage snakes for fecal samples; such samples were collected opportunistically when snakes were held for measuring or transmitter insertion. For all records, the snake species, date, and identity of the prey item were recorded. For the majority of sightings and roadkilled snakes, we recorded position with a handheld Garmin global positioning system (GPS), sex, snout–vent length (SVL), total length (TL), and body mass. Some records were obtained as reports of reliable sightings from other observers, so not all records included all of these parameters. Sex was determined for 77% of samples by probing the cloaca for the presence or absence of hemipenes. SVL was determined by running a string along the backbone of the snake from the snout to the vent, and cutting and measuring the string. Tail length was measured in a similar manner. Mass was measured using a Pesola™ spring balance. Stomach samples of roadkilled snakes, and stomach and/or fecal samples of observed snakes were collected and preserved in a 70% ethanol solution until ready for analysis. These samples were rinsed with water and placed in paper bags in a drying oven (65°C) for 12–24 h. Dried samples were stored in paper bags. Bones and largely intact prey specimens were stored as wet samples in 70% ethanol.

Dietary analysis.—Whole prey items obtained as unforced regurgitations from observed snakes were identified to species using van Dyck and Strahan (2008). Hair samples were analysed using the software Hair ID 1.0 program for Australian mammals (Triggs and Brunner 2002). This program uses four key features of mammalian hair for hair identification: the hair profile, the pattern and shape of the medulla, as well as of its cross-section, and the pattern of the cuticle. These characteristics are used in combination and matched to those of the species in the Hair ID program to determine the identity of the prey animal. Most specimens were also sent to Georgeanna Story of "Scats About" (Majors Creek, NSW) for confirmation of identification.

Statistical analyses.—Each individual prey item identified was treated as an independent feeding record. When a single snake had consumed multiple prey items, such as a radiotracked individual that consumed prey items on several different occasions, we treated each item as a separate feeding record, each accompanied by the same data for that individual snake except for the different date and location. If both stomach and feces from an animal contained the same prey species on a single sampling occasion, we treated it as a single record on a single date. If there were two separate species, however, these were treated as separate feeding records for that individual for that date. For all other cases where only a single prey item was identified, we assumed that only one item had been consumed.

Data analyses were performed using JMP v. 7.0 (SAS Institute, Inc., Cary, NC). To investigate the relationship between snake SVL and mammalian prey size, we performed a linear regression on SVL and the natural log of estimated prey mass. Estimated prey masses were obtained from van Dyck and Strahan (2008), and were calculated as follows: where average mass of the species for the prey item was specified, that value was used as the estimated prey mass; if a mass range was given for each sex of the species, we combined the ranges and used the average of the lowest and highest values, regardless of sex; and if an average mass was specified for males and females of a prey species, we used the average of those two values as the estimated prey mass. We note that estimated prey mass does not account for the high variability among the masses of individuals within a species. However, this is all that is possible when using scats as data. It avoids forced regurgitations by live animals of prey items that may not be accurately weighed due to high digestion rates (Bedford and Christian 2000). To determine if the relationship between SVL and prey mass was the same for both snake species, we performed an ANCOVA on the natural log of prey mass with species as a factor and SVL as the covariate. To assess whether python sex influenced this relationship, we also ran an ANCOVA with sex as a factor and SVL as the covariate on the subset of samples (N = 40) for which sex was determined.

We used chi-squared analyses to compare species in their consumption of native vs. non-native species. These tests were performed three times: once using all prey records, once for mammal prey items only, and once using only prey items from snakes for which we had SVL measurements. The three separate tests were done to check for a potential effect of possible prey misidentification, which would be least likely in data collected from measured snakes, which had their stomach contents confirmed via hair identification. The results were the same in all three analyses.

RESULTS

The identity and frequency of prey records for *M. kinghorni* (N = 23) and *M. spilota* (N = 29) are shown in Table 1. There were three records of non-mammalian prey; two instances of *M. kinghorni* feeding on Domestic Chickens (*Gallus gallus*), and one of *M. spilota* feeding on a Bourke Parrot (*Neopsephotus bourkii*) and the eggs of house canaries. These are not considered further in this paper. Feeding records of *M. spilota* consisted mainly of rodents (N = 24, 83% total prey items), primarily House Mice, *Mus musculus* (N = 10, 34% total prey items), whereas those of *M. kinghorni* contained a high frequency of larger marsupials (N = 14, 61% total prey items). These were primarily Red-legged Pademelons (*Thylogale stigmatica*), Northern Brown Bandicoots (*Isoodon macrourus*), and Long-nosed Bandicoots (*Perameles nasuta*).

There was a significant positive relationship between SVL and the natural log of estimated prey mass ($F_{1,35}$ = 35.4, P < 0.0001, R^2_{adj} = 0.489; Fig. 1). ANCOVA showed that the slope of this relationship did not differ between the two species (Interaction term: F = 0.887, df = 1, P = 0.353; Fig. 1), nor did it differ between sexes when species were pooled (Interaction term: F = 0.091, df = 1, P < 0.765). Snout-vent length of measured snakes ranged from 155–316 cm (mean = 258.9, SD = 16.0) in *M. kinghorni* (for sexed males: 208.5–316 cm, N = 10; females: 190–313.5 cm, N = 5) and from 94.5–225.5 cm (mean = 135.2, SD = 5.2) in *M. spilota* (for sexed males: 103–173 cm, N = 7; females: 94.5–225.5 cm, N = 18).

Finally, there was no relationship between snake species and prey origin (χ^2 = 1.401, P = 0.237, N = 55, df = 1). Both species took similar proportions of native (*M. kinghorni*: N = 18, 72%; *M. spilota*: N = 17, 56.7%) and non-native (*M. kinghorni*: N = 7, 28%; *M. spilota*: N = 13, 43.3%) prey, representing a total of 35 native (63.6%) and 20 non-native (36.4%) prey items.

Table 1. Prey items identified from stomach and fecal samples, as well as observations of feeding, of *Morelia spilota* (MS) and *Morelia kinghorni* (MK) in northeast Queensland. The origin (N = native, NN = non-native) and number of feeding records are given for each prey item in order of decreasing estimated prey mass. Non-mammalian prey items were excluded from the prey size analysis.

Prey	Estimated prey mass (g)	MS	MK	Origin
Agile Wallaby (*Macropus agilis*)	15000	0	2	N
Red-legged Pademelon (*Thylogale stigmatica*)	4600	0	6	N
Domestic Cat (*Felis catus*)	4000	0	1	NN
Brushtail Possum (*Trichosurus vulpecula*)	2850	0	1	N
Northern Brown Bandicoot (*Isoodon macrourus*)	1600	2	1	N
European Rabbit (*Oryctolagus cuniculus*)	1580 (adult);	1	0	NN
	960 (juv)	1	0	
Long-nosed Bandicoot (*Perameles nasuta*)	925	0	4	N
Spectacled Flying-fox (*Pteropus conspicillatus*)	725	0	2	N
Black Flying-fox (*Pteropus alecto*)	725	0	1	N
Black Rat (*Rattus rattus*)	280	0	2	NN
Sugar Glider (*Petaurus breviceps*)	127.5	1	0	N
Canefield Rat (*Rattus sordidus*)	118	7	0	N
Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*)	81.5	2	0	N
Fawn-footed Melomys (*Melomys cervinipes*)	76	2	0	N
Grassland Melomys (*Melomys burtoni*)	75	2	0	N
Pale Field Rat (*Rattus tunneyi*)	66	0	1	N
Tree Mouse (*Pogonomys* sp.)	66	1	0	N
House Mouse (*Mus musculus*)	16.5	10	2	NN
Domestic Chickens (*Gallus gallus*)		0	2	NN
Bourke Parrot (*Neopsephotus bourkii*)		1	0	NN
House canary eggs		1	0	NN

DISCUSSION

The correlation between predator size and prey size in *M. spilota* and *M. kinghorni* is supported by a wide body of literature documenting a positive relationship between snake and prey size in various snake families (Godley et al. 1984; Shine et al. 1998; Voris and Moffet 1981), but not in all (Shine 1987; Shine et al. 1999a). While previous studies have found that larger *M. spilota* take larger prey items (Fearn et al. 2001; Pearson et al. 2002; Slip and Shine 1988a), our study is the first to explore relationships between the size of *M. kinghorni* and its prey. Shine (1991b) proposed several reasons for a positive correlation between predator size and prey size in snakes, including biases in encounter rates between predator and prey, in prey choice, in capture rate, or in prey-handling and swallowing ability. The potential for retaliation by large prey can also influence this predator-prey relationship (Bonnet et al. 2010). Although *M. kinghorni* tended to take larger prey than *M. spilota*, the latter also took a few large items (e.g., *Isoodon macrourus*) and *M. kinghorni* took several small rodents (e.g., *Mus musculus*). Moreover, within each species, there were cases in which individuals of nearly the same SVL took large and small prey (Fig. 1). These results suggest that the same prey items were available to both large and small snakes, and the trend may have been driven by the inability of small snakes to capture, handle, or swallow larger prey items, or additionally, by the inefficiency of large snakes in capturing small prey. However, Shine (1991b) concluded that the lack of large prey items taken by small *M. spilota* in his study was neither a result of limited gape size in small snakes (which consumed large prey items in the laboratory) nor of capture and handling ability (which is facilitated by constriction), but was rather an indication of active prey size selection. Furthermore, *Pseudechis porphyriacus*, which consumes small prey across all body sizes (Shine 1991b), were not gape-limited but selected smaller prey because they consumed such items more efficiently (Shine 1991b). Thus, *M. spilota* and *M. kinghorni* individuals in our study may have been actively selecting prey sizes that allowed for most efficient consumption.

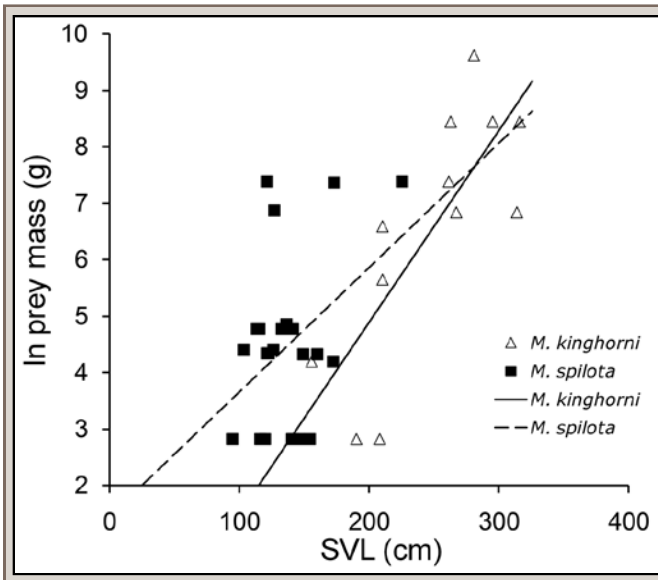

Fig. 1. The relationship between snout–vent length (SVL) and ln prey mass for *Morelia kinghorni* and *Morelia spilota.*

Our results showed no indication that either species selected more native or non-native prey. Therefore we cannot conclude that one species appears to use more artificial or natural habitats than the other species. Although these results may have been a reflection of the relatively small sample size, for *M. spilota* this is consistent with observations of this species in both urban and natural habitats. *Morelia spilota* has been previously documented to consume both native and non-native prey (Fearn et al. 2001; Shine and Fitzgerald 1996), including invasive non-native species (e.g., rabbits: Myers et al. 1989). Versatility in diet has been found in other species; for instance, in suburbia *Python sebae* prey upon animals such as dogs, goats and poultry, while in natural habitats they prey upon various mammals and reptiles (Luiselli et al. 2001). In Asia, smaller *Python reticulatus* individuals benefit from human habitat modification that increased rodent density (Shine et al. 1999b). Similarly, *Python* *brongersmai* has successfully exploited disturbed agricultural habitats (Shine et al. 1999a). However, the consumption of both native and non-native prey by *M. kinghorni* is somewhat surprising given its preference for closed canopy rainforests and vine thickets (Freeman and Bruce 2007; Freeman and Freeman 2009). Freeman and Freeman (2007) suggested a preference in *M. kinghorni* for bandicoots (*I. macrourus* and *Perameles nasuta*) and Red-legged Pademelons (*Thylogale stigmatica*), while Fearn et al. (2005) reported regurgitations of a bird, a Bush Rat (*Rattus fuscipes*) and two Northern Brown Bandicoots (*I. macrourus*). But *M. kinghorni* has also been found, to a lesser degree, in sclerophyll forests and open habitats (Freeman and Freeman 2007, 2009), and has occasionally been observed to consume household pets or other non-natives in human environments (Bateman 2010; Squires 2008).

This study provides important initial insight into the feeding ecology of these python species in the Australian Wet Tropics. It forms the basis for more detailed research that is needed to elucidate their foraging ecology and predator-prey relationships, particularly with regard to *M. kinghorni*. Although we found no effect of sex on the relationship between python size and prey size in both species, future studies should obtain much larger sample sizes and more rigorously examine the potential role of sexual dimorphism in the feeding ecology of each species (Fearn et al. 2005; Pearson et al. 2002). Additional questions for future research include: Does either species prefer certain prey items when offered different items in an experimental setting? Do the two species compete for prey? What role do they play in the control of non-native species as suggested by their consumption of non-native species (e.g., *M. musculus*)? Available habitat and dietary data suggest that *M. spilota* may confer a significant economic benefit to farmers in rural Australia through predation on non-native species and on high-density populations of rodents (Shine and Fitzgerald 1996), thus removing agricultural pests. Conversely, incidental feeding observations of *M. spilota* suggest that introduced fauna, such as the Cane Toad (*Bufo marinus*) may have a negative impact on populations of their snake predators (Covacevich and Couper 1992; Shine 1991a). Studies investigating prey selection would be particularly useful in elucidating the role of these pythons as biological controls of non-native species. Future studies could estimate prey abundance and compare these data to the frequency with which prey species are eaten. These studies would also provide information on whether dietary differences in two species are in fact due to unequal distribution of prey items in the environment (Pearson et al. 2002), and whether prey selection influences body size. Answers to these important questions will further our understanding of the significance of these snakes as predators in the tropical rainforest ecosystem and of their place in regional conservation efforts.

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Measuring Body Lengths of Preserved Snakes

Preserved museum specimens of snakes offer an important source of information on morphology (e.g., scalation, body proportions) and ecology (gut contents, reproductive traits) (Plummer 1985; Shine 1989; Shine and Slip 1990). To interpret variation in such traits, it is important to know the overall body size of the specimen. Investigators working on live snakes have long recognized the need to standardize measurement techniques, because the elasticity of a live animal's body can introduce substantial error into any estimate of body length (especially for large muscular snakes: Madsen and Shine 2001; Blouin-Demers 2003; Setser 2007). Intuition suggests that such issues should be minor for preserved snakes, because they lack elasticity. Nonetheless, our studies on preserved snakes have revealed surprisingly large discrepancies between measurements of body length, suggesting that investigators need to carefully consider (and explain) their methods of quantifying this variable. The present paper was motivated by recent re-measurement of specimens of two python species (*Morelia viridis* and *Leiopython albertisii*) held in the collections of the Australian and Queensland Museums, that had been measured 27 years earlier. The two sets of measurements differed considerably from each other (and from sizes predicted by head-body size allometries in live snakes), with significant consequences for estimating traits important in conservation (e.g., minimum body size at maturity).

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Methods.—Eighteen *Morelia viridis* and 10 *Leiopython albertisii* in the collections of the Australian and Queensland Museums were measured by D. J. Slip and RS in 1984, and by DJDN in 2010. Many of the specimens were coiled and stiff, making it impossible to straighten them for measurement against a ruler. Thus, both sets of investigators measured SVLs (snout–vent lengths) by using a non-elastic string to trace the spine (DJDN) or the ventral midline (DJS and RS) and measuring the resulting length against a steel ruler. Digital calipers were used to measure the length of the head from the tip of the snout to the base of the skull.

To clarify the relationship between measured lengths of preserved snakes versus live animals, we can compare the relative sizes of body components whose dimensions may be affected by preservation (e.g., SVL) to elements unlikely to be affected (e.g., head length). Thus, DJDN also made field measurements on 205 live *Morelia viridis* and 100 live *Leiopython albertisii* captured in Australia and West Papua, Indonesia. To measure SVL one researcher restrained the head while another held the snake by placing a hand either side of the cloaca and gently stretching the body along a steel ruler. Each snake was allowed to stretch and contract until it was relaxed and fully stretched. We used calipers to measure head lengths, as for preserved specimens.

Results.—The two sets of measurements of the museum specimens were highly correlated ($r^2 = 0.85$, $P < 0.001$), but the earlier set averaged 22% (range 2–56%) lower than the recent measurements. In both sets of measurements, the SVL was lower relative to head length than expected from our data on live snakes (paired t-tests, all P-values < 0.001).

Discussion.—Measuring the body length of a preserved snake seems like a simpler task than measuring a live animal, but our data show remarkably high levels of divergence between investigators, and suggest that neither set of measurements provided estimates as high as the body length of a live animal. In his study of preservation effects on length measurements, Reed (2001) reported errors of up to 27%; our study found much larger errors (of up to 56%) of the body length of some snakes. The divergence among investigators cannot be attributed to continued shrinkage over time, because the disparities were too great, and unrelated to the length of time since the animal was first collected (unpubl. analyses). Neither can the disparities be attributed to imprecision on the part of one set of investigators, because the two sets of measurements were highly correlated with each other (and were equally highly correlated with head lengths). The shorter lengths obtained by measuring along the ventral (rather than dorsal) midline may reflect a lack of clear morphological indicators (unlike the protuberant ridge of the spine), thus encouraging investigators to "cut corners" across highly coiled parts of the snake's body.

So long as measurement techniques are consistent, any given study (or related studies by the same investigator) should not be severely affected by this methodological issue. However, it will be difficult to compare the results of studies conducted by different investigators using different methods. The other problem arises when data from studies on museum specimens are extrapolated to the field, to make conservation recommendations about free-living animals. For example, Slip and Shine (1990) reported minimum sizes at sexual maturation of *Morelia viridis* to be 84 cm and 99 cm SVL in males and females, respectively. The conservation-focused analyses of Wilson and Heinsohn (2007) and Natusch and Natusch (2011) used these body-length measurements to estimate the number of mature individuals in a wild population. Re-measured by DJDN, the same animals had SVLs of 114 cm and 123 cm, suggesting that analyses based on the earlier (shorter) lengths would overestimate the number of adults in a population of this species (which has an average adult SVL of 120 cm; DJDN, unpubl. data).

What can we do to minimize such errors? We suggest that investigators should carefully compare the results of measurements using slightly different methods, and ideally should compare their estimates to the same measurements taken on live animals (either by measuring animals before versus after preservation, or by comparing allometric relationships between SVL and other body components [head size, tail length] less liable to error or to modification by preservation techniques). Even apparently trivial differences in methods of measurement may result in unacceptably high levels of error in SVL estimates. Having decided on a consistent method, investigators should describe that method in any publications. The growing availability of online data repositories also should make it easier for investigators to lodge their actual length measurements with specimen registration numbers, thereby allowing future studies to evaluate the magnitude of any measurement discrepancies.

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Intraspecific Density Dependence in Larval Development of the Crawfish Frog, *Lithobates areolatus*

The Crawfish Frog, *Lithobates areolatus*, is listed as state-endangered or rare in six of the 12 states within its range. Prior to 1970, *L. areolatus* were locally plentiful, but has declined markedly since that time (Minton 2001; Parris and Redmer 2005). Reasons for their decline are not well understood, but have been attributed to habitat loss, disease, introduction of predators, and failed juvenile recruitment (Palis 2009; Parris and Redmer 2005). Because of its secretive nature, we lack critical information on *L. areolatus* life-history and population demographics. A fundamental component to population stability is that recruitment equals mortality. Due to limited resources, larval-amphibian recruitment is affected by larval density (e.g., Altwegg 2003; Scott 1994). Overcrowding can delay or inhibit larval development (Adolph 1931; Morin 1986; Parris et al. 1999), resulting in increased mortality rates by predation (Caldwell et al. 1980; Travis et al. 1985), or desiccation from inadequate hydroperiods in breeding ponds (Rowe and Dunson 1995; Seigel et al. 2006). Parris and Semlitsch (1998) examined *L. areolatus* density dependence in artificial tanks and reported that interspecific competition reduced larval performance. They also examined intraspecific competition, but did not find a significant relationship between *L. areolatus* density and any of their response variables (i.e., body mass, larval-period length, survivorship; Parris and Semlitsch 1998). Therefore, the relationship between *L. areolatus* larval performance (i.e., growth and survivorship) and intraspecific larval density is not well understood. Further, the degree that density affects *L. areolatus* larval development in natural ponds is unknown. Although artificial tanks (as in Parris and Semlitsch 1998) provide insight on cause and effect relationships, field enclosures placed directly in breeding ponds include relevant environmental factors and incorporate greater realism (Semlitsch and Boone 2010; Semlitsch and Bridges 2005).

Thus, to better understand how larval-stage density affects juvenile recruitment in *L. areolatus*, we examined cohort density (i.e., intraspecific) dependence on size and time characteristics of larval development using field enclosures placed in five known *L. areolatus* breeding ponds, and one potential breeding pond. Our objectives were (1) to examine the extent at which metamorphosis was delayed or inhibited in high density treatments, and (2) to examine the efficacy of field enclosures as a management tool for repatriation efforts of *L. areolatus*. We hypothesized that larvae in low-density treatments would metamorphose earlier, and would be larger than high-density treatments. We also hypothesized that field enclosures would dramatically increase the survival rate in *L. areolatus* larvae, compared to natural populations, and would provide a valuable tool for managing this declining species.

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Methods.—We selected six temporary ponds on Big Oaks National Wildlife Refuge (located in southeastern Indiana, USA), for our study ponds. The ponds had similar size and depth characteristics (<0.15 ha, and <1 m deep). Five of the six ponds were known crawfish frog breeding ponds (i.e., male frogs were observed calling during previous breeding seasons). In each pond we placed two 378 L field enclosures (76.2 cm × 41.9 cm × 121.9 cm; Apogee, Dallas, Texas 75244, USA) side-by-side, in 20–30 cm of water. Field enclosures were orientated with the long end in the north–south direction. We placed 200 g (wet weight) of *Andropogon virginicus* (Broomsedge Bluestem) in each field enclosure for larval food and substrate. We collected the *A. virginicus* from a single site and then randomly placed it within each enclosure.

We collected one *L. areolatus* egg mass from a breeding pond at Big Oaks National Wildlife Refuge on 3 April 2010. To introduce larvae to the field enclosures we acclimatized them using a three-step process. First, we held the egg mass in a plastic circular pool (diameter = 1.2 m, depth = 15 cm), near the collection site from 3–9 April 2010. We did this to allow the larvae to disperse from the egg mass. Second, after the larvae dispersed (9 April 2010), we divided the larvae into six groups of approximately equal numbers of individuals and moved each group to plastic circular pools located within 5 m of each of our study ponds. The plastic pools were filled with water collected from their respective study pond. We held them in plastic pools near the study pond to allow larvae to acclimatize to the different water chemistry and to grow large enough to be held in the field enclosures. Third, on 4 May 2010, we haphazardly selected larvae with approximately the same size and vigor (i.e., the speed and amount of travel within the pools) for the field enclosures. Larvae were placed in one of two different field-enclosure treatments: low density (20 larvae), and high density (60 larvae); thus, we had 480 total larvae in our experiment.

The treatments were randomly assigned to the field enclosures with one low-density and one high-density treatment in each pond. Prior to being placed in the field enclosures, we measured the volume of each larva using water displacement, and estimated it to be negligible (mean difference <0.01 mL) between treatments and among ponds. Thus we had 12 total field enclosures that included six replicates of two treatments. One of our replicates was destroyed during rain runoff on 12 May 2010. We selected another study pond that was a known *L. areolatus* breeding site and added two more field enclosures with larvae on 14 May 2010. Although this replicate was initiated 10 days after our initial replicates, we followed the same protocols to introduce larvae to the treatments and therefore included it in our study. We monitored field enclosures twice weekly to remove dead larvae and to identify stages of metamorphosis. After the first frog completed metamorphosis (i.e., Gosner Stage 45 or 46; Gosner

1960), we began to monitor field enclosures daily to release frogs that completed their metamorphosis. We released frogs within 2 m of the field enclosures. We measured the mass and snout-vent length of larvae after they completely metamorphosed. We also recorded the date of complete metamorphosis. Additionally, to estimate body condition, we fit a linear regression equation between mass and snout-vent length and used the residuals.

We compared the mass, snout–vent length, date of metamorphosis of frogs, survival, and the relative body condition between the two treatments using paired 2-sample t-tests. We examined the relationship between larval mass at metamorphosis and time of metamorphosis by fitting a linear regression equation. We fit this equation at three different levels: (1) all of the combined data, (2) the pooled density estimates (low and high) for each pond (to compare a pond effect), and (3) to the pooled pond estimates for each density (to compare a density effect). We examined the regression coefficient for the slope to assess if there was a relationship between the size of the juveniles and the date they completed metamorphosis.

To examine for potential differences between ponds we measured pond chemistry and temperature weekly. We measured pond chemistry (ammonia, nitrate, nitrite, iron, dissolved oxygen, pH, sulfate, and phosphorus) using a colorimeter (LaMotte Company, Chestertown, Maryland 21620, USA). We measured pond temperature on the south side of the field enclosures. We randomized the time and the order we visited ponds. We compared pond chemistry and temperature of all the sample ponds using a single-factor analysis of variance for each metric. Additionally, we tested all metrics simultaneously using a multivariate analysis of variance (MANOVA), in which our sample ponds were the groups, and the chemistry metrics were the dependent variables.

Results.—Two hundred twenty-eight of the original 480 juvenile *L. areolatus* survived and were released from our field enclosures (overall survivorship = 48%); 85 of 120 were released from the low-density treatment, and 143 of 360 were released from the high-density treatment. The mean survival percentage in field enclosures was 68% (s = 18%) in low-density treatments and 38% (s = 29%) in high-density treatments, although this difference was not significant (t-test: P = 0.11, t = 1.89, df = 5). Two hundred fifty-two died in the field enclosures. Fifty-nine of these 252 died later in the summer after three of the six study ponds completely dried. All 59 were in high density treatments. Mean snout–vent length of larvae in the low-density treatment was 2.57 cm (s = 0.23 cm) and was 1.14 times longer (t-test: P = 0.0045, t = 4.89, df = 5) than the high density treatment ($\bar{x}$ = 2.26 cm, s = 0.22 cm). Mean mass of larvae in low-density treatments was 1.36 g (s = 0.35 g), and was 1.42 times larger (t-test: P = 0.013, t = 3.75, df = 5) than larvae in high-density treatments ($\bar{x}$ = 0.98 g, s = 0.25 g). Larvae emerged 17 days earlier (t-test: P = 0.0023, t = -5.70, df = 5) in low density treatments ($\bar{x}$ = 13 July 2010, s = 13 days) than high density treatments ($\bar{x}$ = 30 July 2010, s = 10 days). There was no difference in the body condition between treatments (t-test: P = 0.81, t = -0.25, df = 5); the mean residual distance for low-density treatments was 0.01 g (s = 0.06 g) and high-density treatments was 0.02 g (s = 0.07 g). The replicate with the earliest emergence dates, and largest juveniles for both the low- and high-density treatments was located in the one pond that had no record of *L. areolatus* calling.

None of the pond chemistry metrics or temperatures differed among ponds (ANOVA: P > 0.05; df = 5, 86; MANOVA: P = 0.22; approx. F = 1.24; df = 5, 65). The mean values of the pooled spatial and temporal chemistry data were: ammonia = 0.54 ppm (s = 0.66 ppm); nitrate = 0.11 ppm (s = 0.15 ppm); nitrite = 0.00 ppm (s = 0.02 ppm); iron = 1.86 ppm (s = 1.74 ppm); dissolved oxygen = 4.80 ppm (s = 2.48 ppm); pH = 5.83 (s = 0.81); sulfate = 5.04 ppm (s = 7.37 ppm); and phosphorus = 0.12 ppm (s = 0.26 ppm). The mean water temperature was 27.62°C (s = 3.28°C). There did not appear to be a strong relationship (P > 0.05) between mass-at-metamorphosis and date-of-metamorphosis at any of the three levels of data we examined (i.e., all data pooled, data pooled within each pond, data pooled within each treatment).

Discussion.—Our results suggest that *L. areolatus* larval development is affected by intraspecific density, and that these effects might have consequences for *L. areolatus* fitness. When reared in high-density treatments, larvae had smaller masses and snout–vent lengths, but did not have a significant increase in body condition (suggesting the change in size was not a trade-off from fat/lipid storage to structural growth; Perrin and Sibly 1993; Scott et al. 2007; Werner 1986). These results are consistent with patterns described for intraspecific competition in other anurans (Alford 1999). In other species, larval size at metamorphosis is positively correlated with adult size, and inversely correlated with the number of years until sexual maturity (Altwegg and Reyer 2003; Semlitsch et al. 1988; Smith 1987). If the same correlation exists in *L. areolatus*, low density ponds that produce larger juveniles may positively affect population growth because (1) frogs may reach sexual maturity faster, and (2) adults may be larger, thereby producing more eggs during reproduction (Redmer 1999). Therefore, adult lifetime fitness would be affected by larval densities; low larval densities would produce fitter adults.

In addition to size characteristics, our data suggest that high intraspecific density extends *L. areolatus* development periods in natural ponds. Extended development periods can have severe consequences for *L. areolatus* because they generally select temporary breeding ponds with abbreviated hydroperiods. Population growth and larval success depend on the appropriate larval-period length relative to the hydroperiod of the breeding pond (Semlitsch et al. 1996). Fifty-nine *L. areolatus* larvae died from desiccation in three different sample ponds after the ponds completely dried; all were in high-density treatments. Similar results may occur in natural ponds, where at some minimum hydroperiod length, there is a maximum density level, after which, increased densities will increase mortality. This is particularly important during drought years when the number of breeding ponds is reduced and higher concentrations of breeding adults use the same pond.

Increased *L. areolatus* larval-period length has been shown to be positively correlated with interspecific competition (Parris and Semlitsch 1998). Parris and Semlitsch (1998) identified the poor interspecific competitive performance of *L. areolatus* as a possible explanation for their low frequency and small population size in natural communities. Our results support the hypothesis that larval competition is affecting population size and distribution because, in addition to being poor interspecific competitors, larvae in our sample were negatively affected by intraspecific competition. Thus, competition may be limiting recruitment, and therefore population levels.

Although our data provided evidence for density-dependent effects, it is important to note that they were based on one egg mass, and therefore our sample contained little genetic variation. Differences in genetic variation are associated with differential responses by anurans to insecticide (Bridges and Semlitsch 2000; Semlitsch et al. 2000) and acid tolerance (Pierce and Sikand

1985). Likewise, increased genetic variation might facilitate differential response to overcrowding by increasing niche variation, thereby reducing resource competition (Benard and Middlemis Maher 2011). Therefore, if increased genetic variation causes differential response to intraspecific density, our results may be limited. Semlitsch and Bridges (2005) proposed a hierarchical approach, incorporating individual-level, population-level, and geographic-level genetic variation in studies on ecotoxicology. A similar study design would better describe the role of genetic variation in intraspecific competition.

Our study suggests that *L. areolatus* larvae grow and survive better when raised at low densities. However, our experimental design did not allow us to identify the critical density level at which larval development is inhibited. Further examination of a gradient of densities would better describe the relationship between density and growth, which would allow managers to maximize the number of frogs produced per unit area when using field enclosures. Additionally, examination of other environmental variables (e.g., food availability) may identify the mechanism that inhibits growth in high densities of *L. areolatus*. Our study did provide evidence that using field enclosures for repatriation may be an effective management tool for *L. areolatus* (when breeding habitat is not limiting) because it has the potential to dramatically increase juvenile survival when compared to survival in natural ponds (e.g., *L. areolatus* survival in a natural pond in southwestern Indiana was 0–2.3%; V. Kinney, Indiana State University, unpubl. data). However, further research comparing long-term survival of frogs raised in field enclosures to frogs raised in natural populations would better estimate the effect of repatriation on population recruitment.

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Growth and Activity of *Sceloporus cowlesi* (Southwestern Fence Lizard)

Fig. 1. Drift fence of a trap array installed in the riparian forest along the middle Rio Grande in Valencia County, New Mexico containing native cottonwoods (*Populus deltoides wislizenii*) and exotic saltcedar (*Tamarix* spp.)

Fig. 2. Ventral view of male *Sceloporus cowlesi* captured in the riparian forest along the middle Rio Grande, Valencia County, New Mexico.

Lizards from the *Sceloporus undulatus* complex have been the subject of many studies on lizard ecology (Hager 2001; Rosenblum 2006; Rosenblum et al. 2007), behavior (Hein and Whitaker 1997; Robertson and Rosenblum 2009), and reproduction (Vinegar 1975; Robertson and Rosenblum 2010). However, genetic data (Leaché and Reeder 2002) support reallocation of the subspecies of the *S. undulatus* complex (e.g., *S. undulatus consobrinus*, *S. u. tristichus*, and *S. u. cowlesi*) as distinct species (e.g., *S. consobrinus. S. tristichus*, and *S. cowlesi*). One of these species, *S. cowlesi*, occupies a variety of terrestrial habitats spanning grasslands to montane conifer forests (Jones and Lovich 2009) over its range from central New Mexico to southwest Texas. Females lay eggs between mid-May and mid-August and clutch sizes vary from 7 to 9 eggs (Degenhardt et al. 1996). However, since much of the research on natural history of this species was published under the former species name, *S. undulatus*, there is little specific information on *S. cowlesi* from New Mexico. The purpose of this study was to estimate growth and seasonal activity for individuals marked from a population of this species in New Mexico.

Materials and methods.—We conducted the study in the riparian forest along the middle Rio Grande in Bernalillo, Valencia, and Socorro counties, central New Mexico, USA. The climate in this region is semiarid to arid (Tuan 1962). Our study sites occurred in forests (Fig. 1) containing native cottonwood (*Populus deltoides wislizenii*) and non-native saltcedar (*Tamarix chinensis* and *T. ramosissima*) and Russian Olive (*Elaeagnus angustifolia*). As part of a larger project to evaluate the effects of removal of non-native plants and fuels on herpetofauna (Bateman et al. 2008), we monitored relative abundance of lizards at 12 sites (approximately 20 ha each) spanning 140 km of river from Albuquerque (35.008380°N, 106.681805°W) to Bosque del Apache National Wildlife Refuge (33.805122°N, 106.859980°W) from 2000 to 2006.

We captured lizards using trap arrays of drift fences, pitfall traps (5-gallon, 18.9 liter buckets) with cover boards, and funnel traps. Except for a shortened trap season of only two months in 2000 to establish study sites, traps were open continuously from June to mid-September each year and were checked three days per week. Lizards were identified (by species and sex), weighed, measured (SVL and VTL), given a unique toe clip (Waichman 1992), and released.

Results.—During the seven-year study, we had 5,183 captures of 2,470 individual *S. cowlesi* (Fig. 2). Of the total captures, 41.6% occurred in pitfall traps, and 58.2% occurred in funnel traps. Lizard length (SVL and VTL), mass, and sex were determined for adults, hatchlings, and juveniles (Table 1). *Sceloporus cowlesi*

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hatchlings were active in May when we opened traps and the number of captures peaked during the beginning of September when traps were closed (Table 2). Conversely, adult activity in terms of total captures, showed an earlier trend, with peak activity at the beginning of June (Table 2).

Over 40% of marked lizards were recaptured and most sightings occurred during the summer of marking. For example, 270 lizards were recaptured within the summer of their first capture, 70 were recaptured two summers later, 14 were recaptured three summers later, and four were recaptured four summers later. One individual was recaptured five summers later. From these histories of recapture, we determined that growth rates were similar between male and female *S. cowlesi* (Fig. 3). Lizards reach adult size by their second summer, although some individuals attained 60 mm SVL at the end of their first summer (Fig. 3).

Discussion.—Growth curves for male and female *S. cowlesi* were similar, with hatchling and adult females having slightly larger SVLs than their male counterparts. Although sceloporine lizards can grow quickly after hatching (Sinero and Adolph 1994), females may not reproduce until the following year. For example, studies in Colorado found that female *S. undulatus* can attain reproductive sizes during their first summer a few months after hatching but do not reproduce until the following season (Ferner 1976; Gillis and Ballinger 1992). In this study, we documented that individual male and female lizards could reach > 50 mm SVL in their first season, corroborating results of previous studies demonstrating rapid growth in the first year. However, we could not determine reproductive status of these individuals in their second year. Interestingly, our average SVL for adult *S. cowlesi* is about 15 mm shorter than reported in Jones and Lovich (2009).

Ferguson and Snell (1986) reported that in the lab, second clutch hatchlings of *S. undulatus* had greater mass compared to hatchlings from a first clutch. In our study, hatchlings captured in June had SVL > 40 mm and hatchlings captured in August had SVL < 30 mm. However, because hatchlings captured in June were

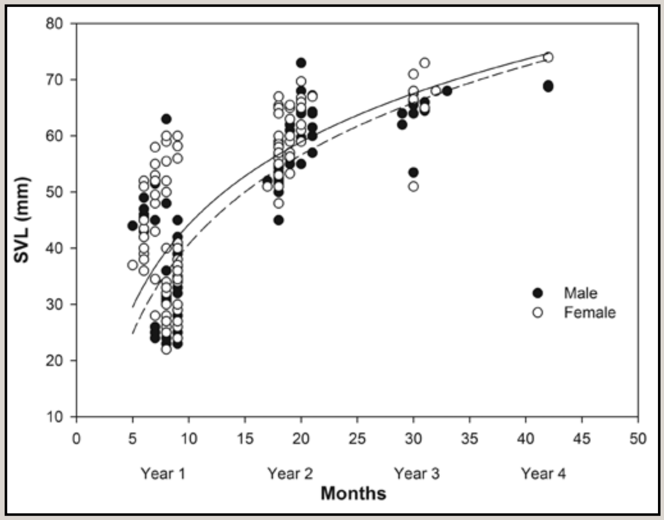

Fig. 3. Growth of male and female *Sceloporus cowlesi* captured as hatchlings from the riparian forest along the middle Rio Grande in central New Mexico. Months represent the number of months in four years, with months 0, 6, and 12 representing January, June, and December of Year 1, month 18 as June of Year 2, month 30 as June of Year 3, etc. Snout–vent length (SVL) of lizards is known from recaptures of uniquely marked individuals (63 males and 53 females) first encountered as hatchlings from 2000-2006. Individuals occur more than once in figure. Lines are fitted with a logarithmic curve (dashed line, $R^2 = 0.66$ for male; solid line, $R^2 = 0.56$ for female).

Table 1. Mean (±SE) of morphological characteristics of *Sceloporus cowlesi* captured during 2000–2006 from the riparian forest along the middle Rio Grande in central New Mexico, USA. Data are summarized by captures of individuals < 3 g mass (hatchlings) and > 3 g mass (juveniles and adults). Because the data include recaptures, individuals may be represented more than once in the table. Number of captures (N) may vary because some lizards escaped before all measurements were recorded; therefore SVL, VLT, and mass may have different sample sizes.

	Hatchling (< 3 g)				Juvenile, Adult (> 3 g)			
Sex	N	Mean SVL (mm)	Mean VTL (mm)	Mean Mass (g)	N	Mean SVL (mm)	Mean VTL (mm)	Mean Mass (g)
Female	341/341/342	29.3 (± 0.32)	37.2 (± 0.57)	0.8 (± 0.03)	2071/2070/2059	62.4 (± 0.15)	79.9 (± 0.33)	7.8 (± 0.07)
Male	365	29.8 (± 0.34)	37.9 (± 0.65)	0.9 (± 0.03)	2295/2291/2281	60.3 (± 0.13)	79.6 (± 0.35)	7.0 (± 0.04)
Unknown	11	30.1 (± 2.03)	33.8 (± 4.39)	0.9 (± 0.21)	5/5/4	43.8 (± 9.46)	59.6 (± 13.48)	7.0 (± 2.29)

Table 2. Capture activity, including mean and range for SVL, of hatchling (< 3 g) and adult (> 3 g) *Sceloporus cowlesi* from the riparian forest along the middle Rio Grande in central New Mexico. Data are summarized by captures per time period for each year from 2000 to 2006. Individuals may occur more than once in table.

	Hatchling (< 3 g)			Adult (> 3 g)		
Time Period	N (% of total)	Mean SVL (mm)	Range SVL (mm)	N (% of total)	Mean SVL (mm)	Range SVL (mm)
1–15 June	19 (3.2%)	43.3	36–48	1149 (27.1%)	60.2	41–80
16–30 June	7 (1.2%)	42.9	36–51	1077 (25.4%)	60.8	43–80
1–15 July	2 (0.3%)	34.0	24–44	419 (9.9%)	60.2	46-79
16–31 July	28 (4.7%)	26.5	22–36	507 (11.9%)	61.0	25–79
1–15 August	112 (18.8%)	25.7	21–34	343 (8.1%)	62.6	23–78
16–31 August	207 (34.7%)	27.5	21–45	442 (10.4%)	63.6	21–78
1–15 September	222 (37.2%)	30.0	21–45	306 (7.2%)	63.5	25–79

likely hatched in May when traps were not yet open, we cannot directly compare sizes of early and late season hatchlings. Little is known of field longevity for *S. cowlesi*; however, during a two-year study in Texas, Tinkle and Ballinger (1972) found that *S. undulatus* (presumably *S. consobrinus* based on distribution) rarely survived to their second growing season. From the 116 hatchlings recaptured at least one time during the period of study, only two individuals were captured during their fourth growing season, or three years later.

Because of the classification change of small-bodied sceloporine lizards (Leaché and Reeder 2002), less is known about specific natural history characteristics of *S. cowlesi*, which occupies a smaller range compared to other members of the *S. undulatus* complex. Therefore, our results provide important natural history data for growth rates, longevity, and activity patterns of *S. cowlesi*. These data can offer future comparisons of sceloporine lizards from different geographic regions and species.

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Feeding Analysis of *Hylarana cf. labialis, Leptobrachium hendricksoni*, and *Occidozyga laevis* (Amphibia: Anura) from a Lowland Dipterocarp Forest in Kedah, Malaysia

A knowledge of diet and feeding ecology is crucial to the understanding of life histories, population fluctuations, and the impact of habitat modification on frog populations (Anderson et al. 1999). Frogs are generally opportunistic feeders that target moving prey crossing their line of vision, though the size of their chosen prey is limited by their gape width (Toft 1981). Frogs are known to prey on a wide spectrum of invertebrates including annelids, arachnids, centipedes, millipedes, molluscs and especially insects (Anderson et al. 1999; Dietl et al. 2009; Hirai and Matsui 2000, 2002; Ibrahim and Nurul 2008; Santos et al. 2004; Solé et al. 2009).

Malaysia is among the "hot spots" for tropical diversity in the Indo-Malayan region and well-known for its varied and abundant assemblage of flora and fauna (Ibrahim and Nurul 2008). The Banjaran Bintang mountains in northwestern Malaysia, the

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TABLE 1. Weight (g), snout–vent length (SVL), and gape width (GW) of the frogs collected.

Species	Number of individuals	Weight (g)	Weight (g) Mean ± SD	SVL (mm)	SVL (mm) Mean ± SD	GW (mm)	GW (mm) Mean ± SD
Hylarana cf. labialis	11	1–6	3.6 ± 2.1	20.9–53.3	37.0 ± 10.8	6.4–28.6	13.6 ± 6.3
Leptobrachium hendricksoni	30	1–10	3.9 ± 2.7	8.4–34.2	34.2 ± 8.4	8.7–22.9	13.0 ± 3.9
Occidozyga laevis	22	1–7	2.9 ± 1.9	17.0–42.9	26.2 ± 6.3	4.9–19.0	8.5 ± 3.1
TOTAL	63						

TABLE 2. Stomach contents of the frogs collected, the frequency of occurrence of the prey item (Fi), and niche breadth. N = number of individual, ni = number of stomachs, A = percentage (%).

Taxon Class: Order: Family	*H. cf. labialis* N = 11		*L. hendricksoni* N = 30		*O. laevis* N = 22		
	ni	A	ni	A	ni	A	Fi
Insecta							
Blattodae							
Blattellidae	0	0	2	6.3	0	0	4.44
Termitoidae	1	10.0	1	3.1	2	14.3	8.89
Coleoptera	0	0	5	15.6	1	7.1	13.33
Diptera							
Culicidae	1	10.0	0	0	0	0	2.22
Unidentified	1	10.0	3	9.4	0	0	8.89
Hymenoptera							
Formicidae	1	10.0	4	12.5	4	28.6	20.00
Unidentified	2	20.0	1	3.1	0	0	6.67
Lepidoptera	0	0	2	6.3	0	0	4.44
Orthoptera	2	20.0	0	0	1	7.1	6.67
Arachnida							
Araneae	0	0	2	6.3	1	7.1	6.67
Oligochaeta							
Haplotaxida	0	0	0	0	1	7.1	2.22
Other							
Plant	0	0	2	6.3	0	0	
Mineral	1	10.0	5	15.6	0	0	
Unidentified	1	10.0	5	15.6	4	28.6	22.22
Empty	2	-	8	-	8	-	
Niche breadth (B)		8.33		15.97		8.16	
Total stomachs (63)							
Total stomachs with contents (45)							

TABLE 3. Organisms collected in 1 m² of forest floor litter of Gunung Inas Forest Reserve.

Class	Order	Family	No. of individuals	Percent of total
Insecta	Blattodea	Blattellidae	1	2.0
		Termitoidae	2	4.1
	Hymenoptera	Formicidae	14	28.6
		unidentified	3	6.1
	Coleoptera		11	22.4
	Diptera		2	4.1
	Orthoptera		1	2.0
	Embioptera		3	6.1
Arachnida	Araneae		5	10.2
	Pseudoscorpionida		1	2.0
	Subclass: Acari		1	2.0
Diplopoda			1	2.0
Chilopoda			4	8.2
Total			49	100

location of our study site, is known to harbor 43 species of amphibians (Grismer et al. 2010).

There are few publications on the diet of Malaysia frogs. We aim to (1) determine the prey items of the three abundant species of frog at the study site: *O. laevis*, *H. cf. labialis* and *L. hendricksoni*, (2) determine the dominant diet composition of these species, and (3) associate the food items of the species with their microhabitat and feeding strategies.

Materials and methods.—This study was conducted in Compartments 15 and 16 of the Gunung Inas Forest Reserve, Kedah Darul Aman (5.4197°N, 100.7997°E; Fig. 1) which are composed mainly of lowland dipterocarp forests from ca. 150 to 200 m above sea level (Ibrahim and Nurul 2008). The total forest cover of the whole Gunung Inas Forest Reserve is 37,346 ha. Sampling of frogs was carried out either weekly or fortnightly from 28 July 2009 until 6 January 2010. A plot sampling method was employed from July until October 2009 during the day from 1400 h to 1700 h. After October 2009, transect sampling was used in an effort to increase the number of individuals caught. Most sampling was conducted along a hiking track leading up to Gunung Bintang, and was carried out between 2000 h and 2200 h. Frogs were most often caught by hand, but sometimes with the aid of tools, such as nets and poles. Total search effort was 188.5 person-hours. The ambient temperature on a single representative day was 28°C at 1600 h, and 26°C at 2000 h. The average monthly cumulative rainfall was 261 mm, with an average daily rainfall of 12 mm during the rainy period from August to October, and 3 mm during drier months (Anon. 2010). The forest floor was almost wholly covered by leaf litter, and the leaf litter mass from a single representative 1 m² of forest floor was 1917 g, and the litter depth was 5 cm. Invertebrates on the forest floor were collected by sieving and the Tullgren funnel method (Sakchoowong et al. 2007).

Frogs were identified based on Berry (1975) and the species names were updated according to Frost (2011). Frogs were categorized into adult and subadult according to their snout–vent length (SVL). Males were identified based on the presence of vocal sacs. We used the adult SVL ranges of Berry (1975) to assign individuals to adult or sub-adults. *L. hendricksoni* males were identified as adult above 40 mm and females above 50 mm; *O. laevis* males were considered adult at above 20 mm and females at above 30 mm; for *H.* cf. *labialis*, males were considered adults at above 32 mm SVL and females above 44 mm SVL.

Frogs were euthanized with an injection of 70% benzocaine before 10% percent formalin was injected into their stomachs, to minimize digestion activities and to preserve stomach contents. SVL and gape width (GW) were measured using Vernier callipers to the nearest 0.1 mm. Frog body weight was measured using Acculab VI-400 digital scale to the nearest 1 g. Stomachs were then removed and dissected according to the standard procedure of frog dissection (Walker 1967). Stomach contents were washed with distilled water and then observed under a light microscope to identify the prey items. Stomachs were categorized as empty, or containing: unidentified item, plant, mineral, Arachnida, Oligochaeta, and/or nine groups within the Insecta (Blattellidae, Termitoidae, Culicidae, unidentified Diptera, Formicidae, unidentified Hymenoptera, Lepidoptera, and Orthoptera). Taxonomic identification of invertebrate prey items follows White and Borror (1970) and Hickman et al. (2008). Stomach content analyses performed were the Numerical Methods (Hyslop 1980), frequency of occurrence (Lima-Junior and Goitein 2001) and niche breadth using Simpson's index of diversity (Pianka 1973).

Results and discussion.—This study provides the first data on the diet of *Occidozyaga laevis*, *Leptobrachium hendricksoni*, and *Hylarana cf. labialis* from Malaysia. A total of 63 individual frogs were examined, comprising 11 *H. cf. labialis*, 30 *L. hendricksoni*, and 22 *O. laevis*. Of these, only 9 *H. cf. labialis*, 22 *L. hendricksoni*, and 14 *O. laevis* had prey items in their stomachs. The degree of digestion of the stomach contents ranged from freshly eaten to amorphous substances. Six male and five female *H. cf. labialis* were sampled, and among them were three sub-adults (SVL ≤ 30 mm). The 14 male and 16 female *L. hendricksoni* sampled consisted mostly of juveniles and sub-adults, as 24 of them had a SVL ≤ 40 mm. Of the 16 male and seven female *O. laevis*, only one was classified as sub-adult (SVL = 17 mm). Summary statistics for body weight, SVL and gape width in sampled frogs are shown in Table 1.

Diet composition varied among the three species studied (Table 2). The dominant prey of *H. cf. labialis* are insects. Other items found were mineral, such as a piece of stone, which most probably was incidentally ingested during prey capture (e.g., Santos et al. 2004). There were four main insect groups that *H. cf. labialis* fed on, namely Hymenoptera (30.0%), Diptera (20.0%), Orthoptera (20.0%), and Blattodea (10.0%) (Table 2). The high frequency of hymenopterans found in *H. cf. labialis* may simply be associated with the fact that Hymenoptera dominates the vegetation fauna of tropical lowland rain forests (Floren et al. 2002), and *H. cf. labialis* is likely to be a generalist feeder. Indeed, the availability of prey in the habitat is an important element for predators with a limited feeding territory (Dietl et al. 2009).

The stomach contents of *Leptobrachium hendricksoni* contained a wide variety of food items, mainly insects (56.3%), but also other terrestrial invertebrates, such as Araneae (6.3%) (Table 2). The dietary composition of *L. hendricksoni* and the large niche breadth value (B = 15.97) indicate that it feeds on a variety of preys items in similar proportions as found in the environment, and is therefore a generalist feeder. This correlates with the findings of Dietl et al. (2009) in another leaf-litter frog, *Ischnocnema henselii* in *Araucaria* rain forests on the Serra Geral of Rio Grande do Sul, Brazil, which is also a generalist feeder. Observations during this study suggest that *L. hendricksoni* is a cryptic "sit-and-wait" predator. *L. henricksoni* is a wide-mouthed predator, with an average gape width approximately 40% of its body length. Therefore, it is possible for *L. hendricksoni* to ingest

Fig. 1. Map showing location of our study site in Gunung Inas Forest Reserve, Kedah Darul Aman, Malaysia.

larger invertebrates, including large arachnids, homopterans, orthopterans, and coleopterans. In one *L. hendricksoni* stomach, a stone measuring 8.6 mm was found in a frog with GW of 9.1 mm. The sharp edge of the stone had cut through the stomach of the frog. It is not known if the ingestion of this stone was accidental or intentional feeding. Although consumption of plant material was recorded, *L. hendricksoni* should not be considered omnivorous, as plant material comprised less than 10% of the stomach contents (Cooper et al. 2002), and we believe that the plant material was likely ingested incidentally with prey.

We found that the *O. laevis* at our study site were insectivorous, with ants the dominant prey item (28.6%) (Table 2). Our results differ from those of Ates et al. (2007), who recorded the main diet of *O. laevis* in Terminalia Forest, Mindanao Island, Philippines being hemipterans, items not recorded by us in *O. laevis*. The likely explanation for this is differences in microhabitat and associated invertebrate fauna at study sites (Table 3). Hemipterans are few on the forest floor in localities where *O. laevis* were caught during this study (Yap and Ibrahim, pers. obs).

Dietary composition did not vary considerably among species, perhaps as all three species were observed to forage within a few meters of each other. The small difference in the prey items observed may reflect fine-scale difference in the microhabitat use. *Hylarana cf. labialis* were observed at lower levels on trees and shrubs, and the main prey items of *H. cf. labialis* can be obtained easily in this microhabitat (Floren et al. 2002). Although the microhabitat of *O. laevis* includes aquatic habitat such as shallow pools and muddy puddles, our study showed that the main dietary components of *O. laevis* were terrestrial arthropods. This finding corresponds with the study of Solé et al. (2009) that terrestrial invertebrates usually dominate the diet of most frogs even in aquatic or semi-aquatic species. Our results indicate that data on diet composition can support ecological and behavioral field studies (Toft 1981).

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A Quantitative Comparison of Two Common Amphibian Sampling Techniques for Wetlands

Obtaining reliable survey data is critical for amphibian conservation and management. Many techniques are established for collecting quantitative survey data, including call surveys, pitfall arrays, drift fences, box sampling, seining, dipnetting, and aquatic funnel traps (Heyer et al. 1994; Skelly and Richardson 2010). Multiple techniques are often used in management and research to account for different species and life stages (Ryan et al. 2002). These techniques can be passive (pitfalls, aquatic traps, call recording) or active (seining, dipnetting, searches).

In lentic habitats, the most widely used sampling technique is dipnetting (Shaffer et al. 1994), an active sampling technique. Dipnetting is often standardized by unit effort such as time or number of dipnet sweeps. Another common technique for surveying aquatic amphibians is funnel trapping (Heyer et al. 1994), which is passive. Many types of aquatic funnel traps, both commercially available and hand-made, have been used and evaluated, including those made from galvanized wire (Fronzuto and Verrell 2000), collapsible nylon mesh (Adams et al. 1997), and-PVC pipe with acrylic plastic sheeting (Smith and Rettig 1996). Augmentations to funnel traps such as aquatic fences (Willson and Dorcas 2004) and net leads (Buech and Egeland 2002) have also been implemented. Both dipnetting and funnel trapping provide capture-per-unit-effort estimates of relative density (Skelly and Richardson 2010), but differ in terms of action (passive vs. active), cost, and time investment. Crosswhite et al. (1999) compared multiple active and passive sampling methods for terrestrial reptiles and amphibians and found that passive methods captured the greatest number of individuals while active methods were the most efficient in terms of time cost. Few studies have compared active and passive aquatic techniques, but Gunzburger (2007) found that species richness was larger when using passive methods in aquatic habitat.

We compared the efficacy of a standardized dipnetting protocol with aquatic funnel trapping for capturing amphibians in 19 ridge-top ponds in the Daniel Boone National Forest (DBNF), Kentucky. We evaluated each pond using both techniques and surveyed for one, three-day period per month, May–August 2010. Dipnet sweeps were taken every five meters while walking

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the edge of each pond and the mean number of sweeps per pond ranged from 2.8–20.8. A sweep consisted of guiding a d-frame net in a 180-degree arc from the shoreline while jabbing the net into the detrital substrate. Each pond had 1–2 aquatic minnow trap arrays installed that consisted of two traps (4 mm mesh size, 46 × 26 × 26 cm dimensions, 6 cm openings) (Promar, Gardena, California; US $8.99 [TR-501]) placed on either side of an aquatic drift fence that extended perpendicularly to the pond's shoreline (Willson and Dorcas 2004). The number of traps per pond followed Adams et al. (1997): two traps (one trapping array) were placed for every estimated 25 m^2 of littoral zone. The two largest ponds (612 m^2, 440 m^2) were more than twice the area of the third largest pond (207 m^2), and two trap arrays were installed at these two ponds. The cumulative number of individuals of a species captured during a single, three-day sampling period was used as an index of abundance of that species for the month. All individuals were immediately released unmarked. We did not mark individuals because of our focus on comparing the number of captures, not the number of unique individuals. Six of the nineteen ponds sampled did not hold standing water during one or more of the sampling periods, so amphibian data from these ponds were based on fewer than three sampling events. We performed Wilcoxon signed-rank tests to compare abundance values between the two survey methods for each life stage detected of each species (Quinn et al. 2007).

The total number of captures from each method was large (minnow traps = 5435, dipnetting = 4281) and 13 species were detected (Table 1, Fig. 1). Adults of *Hyla chrysoscelis* (Cope's Gray Treefrog) and *Pseudacris crucifer* (Spring Peeper) were only detected by minnow traps, whereas larvae of *Lithobates palustris* (Pickerel Frog) and *Hemidactylium scutatum* (Four-toed Salamanders) were only detected by dipnetting. Twelve of the 13 species captured were detected at either larval or adult life stage by both methods and Four-toed Salamanders were only detected by dipnetting. Generally, dipnetting captured more caudate larvae than minnow trapping, a similar result to a previous comparison of dipnetting and funnel trapping in streams (Willson and Dorcas 2003).

Seven different technique comparisons were significantly different (Wilcoxon Sign-Rank Test, $\alpha = 0.05$; Table 1). Minnow trapping, a passive technique, was significantly more effective at capturing adult *L. clamitans* (Green Frogs) and adult *Notophthalmus viridescens* (Red-spotted Newts). Dipnetting, an active technique, was significantly more effective at capturing larval *H. scutatum*, larval *Ambystoma maculatum* (Spotted Salamanders), larval *A. jeffersonianum* (Jefferson Salamander), larval *P. crucifer*, and larval *N. viridescens*.

Some capture biases may be a product of a particular species' behaviors or morphology. Generally, those species caught in larger numbers using minnow traps were bigger and more mobile than those caught in larger numbers using dipnetting. Alternatively dipnetting may also be the preferred method for species like *H. scutatum*, which are difficult to catch in traps due to their small size, low breeding output, and relatively low larval activity pattern (Harris 2005).

Notophthalmus viridescens were often found in traps breeding in large numbers, most likely due to chemical cues released by females that attract males for reproduction (Dawley 1984), suggesting that species using chemical cues to identify potential mates may be efficiently caught using passive traps. However, if only one sex responds to the attractant, there may be a bias in the sex ratio captured. Trapping was inappropriate for species such as *Anaxyrus americanus* (American Toads), *P. crucifer*, and *H. scutatum*, which were often small enough to move through the mesh of the minnow traps, but large enough to be captured by the mesh in the dipnets. This study also suggests the difficulty in capturing adult, large frogs using dipnetting, likely due to the combination of their tendency to quickly jump away when startled and the speed with which they swim.

Because abundances for some species and life stages were not different between techniques, our study indicates that for such species (Table 1, Fig. 1), decisions about which techniques to use can be based on amount of time and equipment available to the researcher. Dipnetting is more efficient in terms of equipment and time and would often be the preferred method. However, as we have shown for a number of species, a species' attributes and life stage can bias its probability of capture by a given survey method. Hence, the behavior, size, and other aspects of life history should be considered before choosing a sampling technique.

Overall, our results reinforce the need to make species-specific decisions during the evaluation of surveying protocols. Conclusions based on aquatic trapping data alone would underestimate the abundance of ambystomatid salamanders and

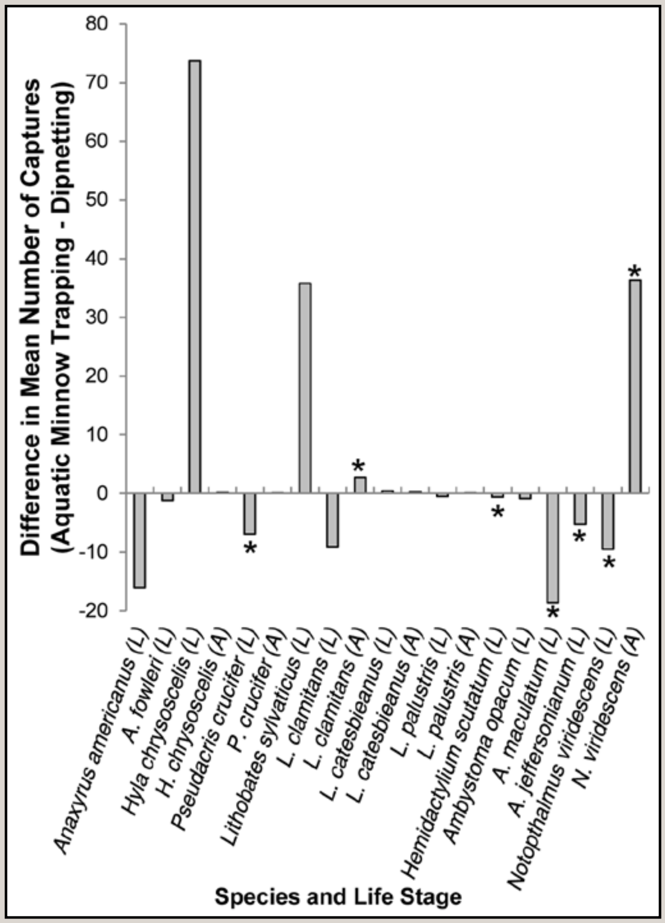

FIG. 1. Difference in mean number of amphibian captures (aquatic minnow trapping - dipnetting) from 19 ponds in the Daniel Boone National Forest, Kentucky, May–August 2010. Positive bars indicate more individuals captured using minnow trapping and negative bars indicate more individuals captured using dipnetting. Asterisks represent significant comparisons of mean number of captures between aquatic minnow trapping and dipnetting techniques using Wilcoxon sign-rank tests (Table 1). Life stage: A = adults, L = larvae.

Table 1. Mean abundance (mean no.) and standard error of 13 amphibian species by life stage among 19 ridge-top ponds in the Daniel Boone National Forest, Kentucky, May–August 2010.

	Aquatic Minnow Traps			Dipnetting			Wilcoxon[b]	
Species	n[a]	mean no.	SE	n[a]	mean no.	SE	Z	P
Anaxyrus americanus - Larvae	2	1.58	1.33	2	17.63	14.35	-1.34	0.180
An. fowleri - Larvae	2	0.32	0.23	3	1.47	1.21	-0.45	0.655
Hyla chrysoscelis - Larvae	8	84.42	77.77	7	10.68	4.51	-0.53	0.594
H. chrysoscelis- Adults	2	0.11	0.07	0	0.00	0.00	-1.41	0.157
Pseudacris crucifer - Larvae	2	0.79	0.60	6	7.68	3.69	-2.20	0.028
P. crucifer - Adults	1	0.05	0.05	0	0.00	0.00	-1.00	0.317
Lithobates sylvaticus - Larvae	4	135.26	76.74	4	99.47	59.57	-1.46	0.144
L. clamitans - Larvae	11	4.47	1.19	11	13.53	6.48	-1.51	0.130
L. clamitans - Adults	12	2.95	1.18	4	0.21	0.10	-2.85	0.004
L. catesbeianus - Larvae	8	5.16	2.02	9	4.74	1.68	-0.26	0.798
L. catesbeianus - Adults	3	0.37	0.23	2	0.11	0.07	-1.29	0.197
L. palustris - Larvae	0	0.00	0.00	2	0.47	0.38	-1.34	0.180
L. palustris - Adults	3	0.16	0.09	1	0.11	0.11	-0.38	0.705
Hemidactylium scutatum - Larvae	0	0.00	0.00	6	0.58	0.28	-2.26	0.024
Ambystoma opacum - Larvae	5	2.05	1.14	3	2.89	2.42	-0.27	0.768
Am. maculatum - Larvae	15	13.68	3.51	16	32.26	8.73	-3.07	0.002
Am. jeffersonianum - Larvae	14	3.00	0.83	13	8.21	2.55	-2.73	0.006
Notopthalmus viridescens - Larvae	8	3.84	1.68	12	13.31	7.49	-2.94	0.003
N. viridescens - Adults	17	48.32	13.63	13	11.95	2.82	-3.62	<0.001

[a.] Sample sizes (n) represent the number of wetlands of the 19 total where the indicated species and life stage were detected.
[b.] Wilcoxon paired sample test Z values and probabilities are from individual comparisons of each species and life stage by capture method.

overestimate the abundance of *N. viridescens*, and conclusions based on dipnetting alone would underestimate the abundance of *L. clamitans* adults. Hence, when evaluating amphibian populations, it is appropriate to include measures of detection probability to strengthen conclusions from count data (Dodd and Dorazio 2004). Additionally, this study supports the use of active and passive survey methods together when developing long-term monitoring of entire amphibian communities as well as providing evidence supporting active or passive survey methods chosen for a specific species or life stage.

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Cephalopod Ingestion by Juvenile Green Sea Turtles (*Chelonia mydas*): Predatory or Scavenging Behavior?

Immediately after emerging from eggs on sandy beaches, most sea turtle hatchlings disperse into the sea to enter a pelagic life-phase that may last several years (Meylan and Meylan 1999). During this stage, individuals are believed to associate with convergent oceanic fronts which accumulate floating structures (e.g., debris or algal mats such as *Sargassum* or *Macrocystis*; Nichols et al. 2001) that concentrate small pelagic animals (Carr 1987). Recent studies on the diet of post-hatchling Green Sea Turtles (*Chelonia mydas*) in the Pacific Ocean found no evidence of the association of this species with algal mats, but confirmed the importance of pelagic organisms in the diet of these animals (Boyle and Limpus 2008; Parker et al. 2011).

Asides from young turtles, pelagic ecosystems are comprised of many other organisms, including roaming predators like tuna, billfish, sharks, and dolphins (Dambacher et al. 2010). Oceanic cephalopods (e.g., squids) are also important components of pelagic food chains and serve as food for most of these predators (Clarke 1996; Croxall and Prince 1996; Klages 1996; Smale 1996) as well as for opportunistic scavengers (Croxal and Prince 1994). Because Green Sea Turtles seem to act as opportunists during their open ocean stage of life (Boyle and Limpus 2008), cephalopods might constitute as a complementary food source to their normal diets of cnidarians, gastropods, and crustaceans (Boyle and Limpus 2008; Parker et al. 2011).

Pelagic cephalopods have already been reported in the Green Sea Turtle's diet (e.g., Parker et al. 2011; Seminoff et al. 2002). For example, Parker et al. (2011) considered the presence of fisheries-caught squids in the diet of oceanic Green Sea Turtles as evidence of opportunistic feeding by the turtles on fishing-gear catches. However, implications of these observations and other possible explanations of how turtles may eat pelagic cephalopods have remained poorly discussed topics in the literature.

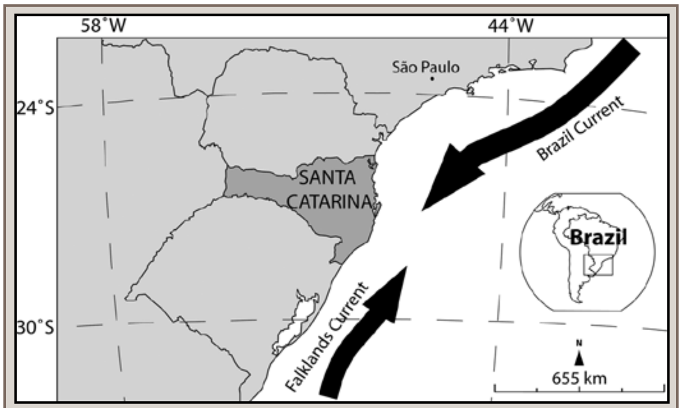

Fig. 1. Map of south Brazil indicating Santa Catarina state (dark shading), and the two converging oceanic currents, Brazil Current and Falklands Current.

The southern region of Brazil (Fig. 1) suffers direct influence of the Subtropical Convergence, an encounter of the cold-water, nutrient-rich Falklands Current with the warm-water, oligotrophic Brazil Current (Castro and Miranda 1998). Hence, the region is the southern limit of occurrence of many tropical marine species, including fishes (Carvalho-Filho 1999) and mangrove trees (Sobrinho et al. 1969). Its rocky reefs, mangroves, estuaries, bays, lagoons, and oceanic waters are also important feeding grounds for marine turtles, especially the Green Sea Turtle, *Chelonia mydas* (Almeida et al. 2011; Bugoni et al. 2003; Guebert-Bartholo et al. 2011). The only genetic assessment of a coastal green turtle juvenile population from southern Brazil indicated a mixed stock population, composed mainly from the rookeries of Ascension and Aves islands (Proietti et al. 2009).

Here we report the occurrence of cephalopod beaks in the gastrointestinal tracts of stranded juvenile *Chelonia mydas* in South Brazil and discuss possibilities regarding when and how the turtles ingested the cephalopods. To achieve this objective we consider how life-history traits could have influenced the

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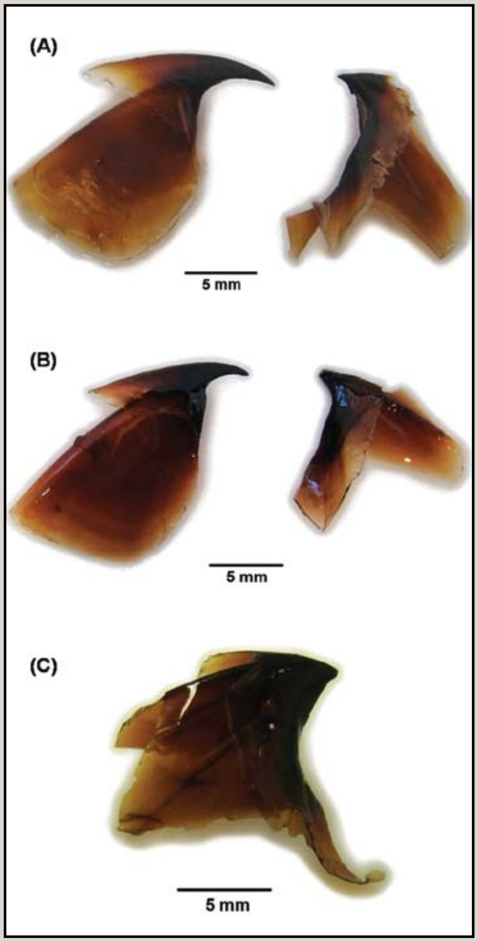

Fig. 2. Cephalopod beaks found in the guts of Green Sea Turtles in South Brazil. (A) Upper (left) and lower (right) beaks from *Chiroteuthis* sp. 1; (B) Upper and lower beak from *Chiroteuthis* sp. 2; (C) Lower beak from *Histioteuthis atlantica*. (©Roberta Santos).

possibility of these organisms coming into contact and whether this interaction occurred with the cephalopods alive (i.e., predation) or dead (scavenging).

Materials and methods.—A total of 27 Green Sea Turtles were found stranded along the coast of Santa Catarina State, southern Brazil, during a dietary study between 2006 and 2009. Gut contents were collected and dietary items were analyzed. Cephalopod beaks were encountered and singled out for this study. All beaks were identified at least to the genus level, based on beak morphology only, since there were no tissues remaining around any of the beaks (Fig. 2). Lower rostral length (LRL) and upper rostral length (URL) were measured to estimate the cephalopod's mantle length (ML, in mm) or ML and body mass (in g) using the regression equations of Clarke (1986) and Lu and Ickeringill (2002). All necropsied turtles had their curvilinear carapace length (CCL in cm) measured.

Results and discussion.—A total of 19 cephalopod beak pairs were found in the stomachs of three turtles and intestines of three others out of the 27 turtles analyzed (22%). Although some of them were cracked, most beaks were in relatively good condition and could be measured. All beaks pertained to six different morphospecies of squids (Cephalopoda: Teuthida) from two genera, *Chiroteuthis* (Chiroteuthidae) and *Histioteuthis* (Histhioteuthidae; Table 1). *Chiroteuthis* spp. had an average ML of 114.6 mm (SD 7.7 mm) and an average mass of 38.8 g (SD 8.0 g), according to the regression by Clarke (1986). *Histioteuthis* spp. had an average ML of 123.4 mm (SD 60.7 mm), although mass was estimated only for two individuals which were identified at the species level (Table 1), according to the regression by Lu and Ickeringill (2002).

The families Chiroteuthidae and Histioteuthidae are comprised of oceanic medium-depth to deep-water gelatinous squids (Young and Roper 1998; Young and Vecchione 2007). Both have ammonia-mediated fluctuation mechanisms (Voight et al. 1994), apparently undergoing ontogenetic and diel vertical migrations in the water column of offshore habitats (Roper and Young 1975). These animals are commonly found in the diet of pelagic predators such as tuna (Salman and Karakulak 2009), swordfish (Hernández-Garcia 1995), blue and short-fin mako sharks (Vaske-Júnior and Rincón-Filho 1998), petrels (Klages and Cooper 1997), albatrosses (Croxall and Prince 1994), and porpoises (Ohizumi et al. 2003). However, this is the first record of these families of cephalopods in the diet of Green Sea Turtles.

Table 1. Information regarding cephalopod beaks found in the diet of stranded Green Sea Turtles in Santa Catarina, southern Brazil. CCL = curvilinear carapace length; ML = mantle length.

Individual	CCL (cm)	Gut region	Species identified	ML (mm)	Mass (g)
CT03	29.5	Stomach	*Chiroteuthis* sp. 1	–	–
			Chiroteuthis sp. 2	109.2	33.2
CT05	33	Stomach	*Histiotethis atlantica*	86.3	158.9
			Histioteuthis corona corona	79.6	137.3
CT08	23.5	Intestine	*Chiroteuthis* sp. 1	–	–
CT12	32.5	Stomach	*Chiroteuthis veranyi*	116.6	40.3
			Chiroteuthis veranyi	123.9	48.4
			Chiroteuthis veranyi	114.1	37.9
			Chiroteuthis veranyi	104.3	28.9
			Chiroteuthis veranyi	119.0	42.9
			Chiroteuthis veranyi	109.2	33.2
			Histioteuthis sp. 1	115.3	–
			Histioteuthis sp. 1	109.0	–
CT13	28.3	Intestine	*Histioteuthis* sp. 1	105.9	–
			Chiroteuthis veranyi	109.2	33.2
			Chiroteuthis veranyi	114.1	37.9
			Chiroteuthis veranyi	128.8	54.3
			Chiroteuthis veranyi	106.8	31.0
S/CT	–	Intestine	*Histioteuthis* sp. 1	244.1	–

We hypothesize three possibilities regarding how turtles that ate oceanic cephalopods were found along the coast of Santa Catarina: 1) that turtles died while in the pelagic life-stage and were carried by oceanic currents to the shore; 2) that turtles were already recruited to the coast when they died, but the squids were ingested when they were still in the pelagic habitat; and 3) that these turtles manifest the uncommon life-history pattern in which individuals move constantly between coastal and pelagic habitats. This last pattern has recently been observed for Green Sea Turtles in the Pacific (Hatase et al. 2006; Parker et al. 2011; Seminoff et al. 2008) but so far there is no evidence that it may also occur in the South

Atlantic. Thus our discussion is based on the first two possibilities, of which the second one seems to be supported by two independent lines of evidence. First, cephalopod beaks are composed of chitin, which is almost indigestible to stomach acids, in contrast to the soft tissues that are rapidly digested; thus beaks may accumulate for months or years in the stomachs of vertebrates (Hernández-Garcia 1995). Therefore, these beaks might have accumulated in the turtles' stomachs while they inhabited pelagic waters, long before stranding. Second, the turtle's carcasses were not extensively decomposed, attesting that they died shortly before stranding.

Given that these squids were probably eaten before the turtles recruited to the coast, another question arises: whether these events occurred as scavenging or predation events? Other sea turtles, like the Loggerhead (*Caretta caretta*), are known to scavenge, for example, on dead fishes (Limpus et al. 2001; Limpus et al. 2008). Swimming organisms like fishes and squids have already been found in Green Sea Turtles' diets elsewhere (Bugoni et al. 2003; Parker et al. 2011; Seminoff et al. 2002) and in addition, this turtle species is known to opportunistically eat objects that float, as evidenced by the enormous amount of floating debris ingested by turtles in different places around the world (e.g., Guebert-Bartholo et al. 2011; Plotkin and Amos 1990). As a result, it is plausible that these animals, when inhabiting oceanic habitats, could eat floating carcasses of fishes or squids. It is noteworthy that squids from the families Chiroteuthidae and Histioteuthidae reproduce in large aggregations with post-spawning mass mortality (Jackson and Mladenov 1994; Rocha et al. 2001), circumstances in which they serve as an important food source for pelagic animals such as albatrosses (Croxall and Prince 1994). Whether or not these events result in floating dead squids at the surface is still unclear (Croxall and Prince 1994).

It is also important to consider the association of squids and sea turtles with commercial fishing practices in the open ocean. Individuals of *Histioteuthis* are relatively common by-catch in deep-water trawling operations in southeast and south Brazil (Perez et al. 2004) and may be discharged into the open sea. In addition, gut contents from eviscerated predatory fishes caught in long-lines may be a source of pelagic cephalopods for Green Sea Turtles (Vaske-Júnior and Rincón-Filho 1998). These fishes have the ability to dive deeply, swim rapidly, and locate prey and therefore are very efficient in capturing large numbers of pelagic squids (Hernández-Garcia 1995).

Regarding the possibility of predation, it is known that captive green turtles are capable of preying upon slow-swimming animals, such as cnidarians and ctenophores (Heithaus et al. 2002), injured fishes (G. O. Longo, pers. obs.), and even octopuses (Caldwell 2005). *Chiroteuthis* spp. and *Histioteuthis* spp. are slow-swimming squids with fragile muscles and bioluminescence (Young and Roper 1998; Young and Vecchione 2007). Despite inhabiting deep-waters during the day, during the night these organisms may be found in shallow waters (Roper and Young 1975). In fact, Green Sea Turtles are more active during the day (Hays et al. 2000, 2002), but there are records of nocturnal deep dives with unknown function (Rice and Balazs 2008) as well as records of individuals foraging at night (Jessop et al. 2002). This suggests that small juvenile Green Sea Turtles and pelagic squids might encounter one another during their lives and, therefore, that these cephalopods could be actively preyed upon by Green Sea Turtles.

Given the lack of information on the natural history of squid from the families Chiroteuthidae and Histioteuthidae and the pelagic life-stage of *Chelonia mydas* in waters of the Southwestern Atlantic, it is not possible to determine if individuals are scavenging or actively pursuing prey. We therefore suggest that studies focusing on the diet of Green Sea Turtles caught in oceanic fisheries (e.g., long-lines) and on the species foraging over eviscerated guts of fishes may yield important insights about the real importance of this interaction.

Pelagic deep sea squids are indispensable food sources for some marine pelagic predators (e.g., Clarke 1996; Croxall and Prince 1996). Although the number of analyzed turtles (27) is relatively small compared to the total number of stranded turtles in the region (147 animals from 2006 to 2009; Projeto TAMAR/ICMBio, unpubl. data), at least ten other non-analyzed dead or live in-treatment Green Sea Turtles had ingested cephalopod beaks, as noted during necropsies or examinations of feces for garbage (E. T. E. Yoshida, pers. comm.). Thus the described interaction might be common in the study region and we believe it could also occur in other parts of the southwestern Atlantic. If squids are commonly ingested through active predation or scavenging behavior, pelagic cephalopods may be an important energy and nutrient source for small juvenile Green Sea Turtles inhabiting oligotrophic waters.

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Seasonality of Algal and Leech Attachment on Snapping Turtles, *Chelydra serpentina*, in Southeastern Pennsylvania

The occurrence of algal colonies and leech parasites on North American semiaquatic and aquatic turtles seems to follow a seasonal cycle. It has apparently been assumed that algae attach to aquatic turtles throughout the year, although no data are available to substantiate this. Reports on algal attachment have dealt almost exclusively with the taxonomy and geographical distribution of the epizoophytic algae involved. The genus *Basicladia* is ubiquitous on several species of turtles in North America and the species *B. crassa* has been previously reported from *Chelydra serpentina* in Michigan, Minnesota, Oklahoma, and Texas/Mexico. A second species, *B. chelonum*, has been found on *C. serpentina* in Massachusetts, Michigan, Oklahoma, Texas/Mexico, and Nova Scotia (see references in Ernst and Barbour 1972, and Ernst and Lovich 2009; as well as Chute 1949; Garbary et al. 2007; Leake 1939, 1945; McCoy et al. 2007).

Leech parasitism and its seasonality in turtles have been reported from several localities on the continent and the genus *Placobdella* is ubiquitous on many aquatic and semiaquatic North American turtle species. The species of *Placobdella* involved are *P. ali, P. multilineata, P. ornata*, and *P. parasitica*. Watermolen (1996) presented an incomplete summary table of glossiphonid leech parasitism on North American turtles and Ernst and Barbour (1972) and Ernst and Lovich (2009) include references (see also Brewster and Brewster 1986; Davy et al. 2009; Richardson et al. 2010; and Ziglar and Anderson 2002).

Chelydra serpentina was studied in the vicinity of White Oak, Lancaster County, Pennsylvania, from 1964 to 1992 during March through October of each year. The research site is described in Ernst (1971b). Snapping Turtles were collected in baited hoop traps (Ernst 1965), with a dip net, or by hand. The date of each capture was recorded and the turtle was measured (greatest carapace length, CL; plastron length, PL), weighed to the nearest gram, aged by counting growth annuli, and sexed (Ernst and Lovich 2009). The incidence of algal colonies and leeches and the number of leeches attached were also recorded. Algae scrapings were preserved and later identified with a compound microscope in the laboratory using Prescott (1954); leeches were collected, fixed, and later identified in the laboratory with the use of a binocular microscope and keys and illustrations in Eddy and Hodson (1970). All turtles were notched for future identification (Ernst et al. 1974) and released at the point of capture. Air (AT), water (WT), and surface temperatures (ST, if on land) were also recorded with each capture. Statistical tests were executed using R, Version 2.12, with the level of significance set *a priori* at = 0.05. Presented below are the seasonal algae and leech attachments recorded on snapping turtles at White Oak.

Algae.—Only *Basicladia crassa* was found growing on *C. serpentina*. It was found solely on the carapace and occurred on 39% (110 of 280) of the total snapping turtles captured. Additional algae found attached to other turtles at White Oak include: *Basicladia chelonum* (*Chrysemys picta, Sternotherus odoratus*), *Basicladia crassa* (*Glyptemys muhlenbergii*), *Cladophora kuetzingiana* (*Chrysemys picta, Clemmys guttata, Glyptemys insculpta, Sternotherus odoratus* (Ernst 1969, 1976, 1986, 2001, 2011). The incidences of algal attachment on these White Oak turtles were: *Chrysemys picta*, 69%; *Clemmys guttata*, 46%; *Glyptemys insculpta*, 17%; *G. muhlenbergii*, 5%; and *Sternotherus odoratus*, 86%.

The annual activity cycle of *C. serpentina* at White Oak is March–October (Table 1), confirming that algae attach to the species throughout the year. However, fewer individuals had algae at either end of the annual activity period. Algae were found on the carapace, but not on the plastron, in increasing percentage from April through July. Afterwards, the incidence of colonies decreased with the approach of autumn into the winter months. Winter hibernation occurred while buried completely in the soft bottom of White Oak's pond and feeding creek and brooks. This suggests that decrease in light availability for algal colonies attached to turtles completely buried in a water body during the advancing autumn and winter may have played the major role in the disappearance of most algae during this period. That algae were not found on the turtles' shaded plastrons also supports an important role of light incidence for algal growth.

During autumn and winter ATs and WTs steadily declined, which may have played a role in the decrease of algae during those months. Although AT and WT drop at the end of summer and may inhibit further algal growth, these phenomena would not be expected to cause a complete disappearance of algae on the turtles' shells, supporting a greater role of light than by environmental temperatures in the growth of algae.

Increases in light, AT, and WT in the spring probably enhanced algal growth into midsummer. This occurred in spite of a greater incidence of water surface and shoreline basking by the Snapping Turtles which would have exposed algae to increased levels of killing ultraviolet rays. Basking was observed during April–June and then decreased through the remainder of the annual activity cycle. Only one turtle was observed basking in the fall (a recent hatchling on 1 October). In the warmest month, August, fewer *C. serpentina* were captured (only one while basking, possibly due to the turtles estivating or having been attracted to trap baits, as also observed in *Chrysemys picta* at White Oak and elsewhere). After this annual warm period, as light and temperature decreased through the autumn, less opportunity for algal growth occurred. However, the possible roles of both light and temperature presented are speculative and future studies are needed to clarify their relative importance regarding algal growth on turtles.

In North American middle latitudes male Snapping Turtles mature at a PL >14.5 cm and females at a PL >14.5–15.5 cm (Ernst and Lovich 2009). A contingency table Chi-square test showed

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no significant difference in the proportion of attachment ($p = 0.9262$) of attachment between adult males (54%) and adult females (53%). However, the same test showed a highly significant difference ($p = 2.766e-13$) in algal occurrence between adult turtles (combined sexes, 34%) and immature (<14.5 cm PL, 15%). Edgren et al. (1953) also found few juveniles with algae. No *Basicladia* were found on White Oak hatchlings or immatures in September or October. Most hatching and emergence occur at the site during this period. The small turtles probably inhabit shallower, warmer waters at that time than do adults and either come into less contact with algal spores or do not give the algae enough time to form distinct shell colonies before hibernation.

The relationship between algae and Snapping Turtles seems to be one of mutualism, with both parties gaining benefit from the others' presence (Edgren et al. 1953; Neill and Allen 1954). It is thought that turtles acquire a certain amount of camouflage through enhanced growth of algal colonies on their shell and skin, which conceals them from would-be predators, while also providing concealment from prey, allowing the turtles to use a sit-and-wait feeding strategy (Neill and Allen 1954). Adult *C. serpentina* spend much time submerged and sometimes obtain prey through ambush (Ernst and Lovich 2009). However, Edgren et al. (1953) thought camouflage of little importance in view of the general absence of natural predators upon adult turtles (especially *C. serpentina* at White Oak; Ernst, pers. obs.). Algae, in return, gain a point of attachment from which colonies can grow, a moving base providing better dissemination of spores as turtles migrate from one waterbody to another, and, possibly, protection from some small algae grazers. Unfortunately, neither of these hypotheses has been tested. A disadvantage of an algae-turtle relationship is the possibility that the algae may penetrate beneath the epidermal scutes of the shell and cause necrosis. Hunt (1958) reported a case of indirect necrosis of algal origin in the European turtle, *Emys orbicularis*.

Leeches.—The only species of leech found at White Oak was *Placobdella parasitica*, a commonly reported ectoparasite of *C. serpentina*. The occurrence of only one species of *Placobdella* at White Oak is unusual (see above references). The incidence of infestation of Snapping Turtles with leeches was 33% (92 of 280 captures). Other White Oak turtles experienced the following rates of *Placobdella* infestation: *Chrysemys picta*, 11%; *Clemmys guttata*, 12%; *Glyptemys insculpta*, 39%; *G. muhlenbergii*, 4%; and *S. odoratus*, 37% (Ernst 1971a, 1976, 1986, 2001, 2011).

Although *C. serpentina* were captured from March into October, leeches were only found attached from April through September (Table 2). Most infestation occurred during the period May through August (see below), when the incidence was more than 30% of the turtles collected during those individual months. Table 2 shows an increasing occurrence beginning in April (23%) and continuing through August, decreasing in September (12%). Colder ATs and WTs may possibly have contributed to the decrease in incidence at both ends of the turtle's annual cycle, with no leeches remaining attached during the winter months (as has been observed elsewhere; see above citations). In addition, the leech's normal behavior may contribute to their decline in the fall; it may be that more leeches that fed on the turtles became satiated, dropped off to digest their meals, and were then prevented from attaching by colder temperatures and the turtle's burying into the soft bottom. As snapping turtles hibernate most often totally buried in the soft bottom of some waterbody or buried beneath the soil on land (Ernst and Lovich 2009), a lack of oxygen at the hibernation site (Ultsch and Reese 2008) may also play a role in ridding the turtle of aerobic leeches.

As environmental temperatures increase with the advance of spring, the turtle emerges and comes once again in contact with leeches. Although relatively rare, *Chelydra* do bask out of water on occasion (Ernst and Lovich 2009). During aerial basking, attached leeches are sometimes observed to drop off (Saumure and Bider 1996; Saumure and Livingston 1994; Ernst, pers. obs.).

Table 1. Seasonal incidence of algal colonization on *Chelydra serpentina* at White Oak, Lancaster County, Pennsylvania; percent incidence of turtles in parentheses. Total captures reflects the total numbers of turtles captured; some individuals of both sexes were captured more than one time.

Month	Total turtle capture	Male turtles	Female turtles	Immature turtles
March	12 (8)	1 (11)	0	0
April	31 (23)	6 (46)	0	1 (33)
May	48 (48)	17 (77)	6 (50)	0
June	101 (45)	20 (51)	18 (56)	8 (27)
July	42 (57)	15 (63)	5 (71)	4 (36)
August	15 (33)	3 (50)	1 (50)	1 (14)
September	25 (12)	2 (50)	1 (100)	0
October	6 (17)	0	1 (100)	0
Total	280 (39)	64 (54)	32 (53)	14 (15)

Table 2. Seasonal incidence of leech infestation on *Chelydra serpentina* at White Oak, Lancaster County, Pennsylvania; percent of turtles infested in parentheses. Total captures reflects the total numbers of *C. serpentina* captured; some individuals of both sexes were captured more than one time.

Month	Total turtle captures	Male turtles	Female turtles	Immature turtles	Total leeches	Leeches per turtle
March	12(0)	9 (0)	3 (0)	0	0	0
April	31 (23)	4 (31)	1 (33)	2 (33)	26	3.7
May	48 (35)	14 (64)	3 (25)	0	164	9.6
June	101 (32)	15 (38)	8 (25)	9 (30)	236	7.4
July	42 (38)	9 (38)	3 (43)	4 (36)	238	14.9
August	15 (33)	2 (33)	1 (50)	2 (29)	33	6.6
September	25 (12)	2 (50)	1 (100)	0	13	4.3
October	6 (0)	0	0	0	0	0
Total	280 (33)	55 (47)	20 (35)	17 (28)	710	7.8

According to Hall (1922), *Placobdella parasitica* can withstand exsiccation to 70.4% of its body weight (or approximately 92% of total body water). Continuous leech reinfestation must occur during at least May through August, as the turtle's habit of foraging in shallow waters probably brings them often into contact with the annelids (Readel et al. 2008).

A contingency table Chi-square test showed no significant difference (p = 0.19) between the rate of attachment on the two adult sexes, but the same test revealed a highly significant difference (p = 0.0009) between the rate of leech attachment on adults (sexes combined) versus that of immatures. The difference in numbers of leeches attached between adults and juveniles is probably at least somewhat explained by the smaller turtles' preference for shallow, warmer waters, and the recent hatchlings' habit of hiding on land while migrating from the nest site to water. In addition, the hatching period at White Oak is September-October and the increased number of hatchlings then entering the population contributed to the smaller overall percentage of infested immatures. The rate of attachment may also be related to the difference in surface area for attachment between adults and immatures. The mean number of leeches attached on those *C. serpentina* harboring them was 7.8, with the greatest numbers occurring in all sexes and age classes during June and July.

Problems may arise from leech parasitism. As *P. parasitica* take blood from a turtle, it is possibly weakened, which may contribute to a greater chance of it being depredated at White Oak, especially in smaller individuals. If the leech load is great, exsanguination theoretically could occur to such a degree that the turtle dies (but unreported), a greater potential problem in hatchlings or small immatures than for adults. The maximum numbers of leeches attached to White Oak *C. serpentina* were found on adults: 61 (male, 31.7 cm CL) and 40 (female, 31.7 cm CL). These patches of leeches were largely composed of a hermaphroditic adult and several small, recently hatched worms and probably caused little damage to adult turtles. Leeches of the genus *Placobdella* exhibit a specific pattern of parental care that definitely contributes to the parasite load of a turtle. After mating, the leech deposits a cocoon containing fertilized eggs on a solid surface, often a turtle's shell. The cocoon is cared for by the adult leech until the young emerge when the adult carries them to their potential first blood meal. In correspondence with the worm's life cycle, the leech load probably increases on turtles during April–July as more young emerge and the adults bring them to their first turtle-provided blood meal.

A second greater threat is from the leeches acting as vectors for parasitic protozoans from turtle to turtle. Leeches of the genus *Placobdella* are known intermediate hosts of several species of the sporozoan genera *Haemogregarina* and *Haemoproteus*, as well as the flagellate species *Trypanosoma chrysemydis*. *Placobdella parasitica* can transmit these parasites from an infected turtle to an uninfected one and between species of turtles within a turtle community (Siddall and Desser 1991, 1992, 2001; Woo 1969), much as *Anopheles* mosquitoes transmit malaria from human to human. Ernst and Ernst (1979) reviewed protozoan parasitism in North American turtles; see also the more recent papers by Siddall and Desser (1991, 1992) and Strohlein and Christensen (1984).

Snapping Turtles normally have a greater incidence of haemogregarine parasitemia than other sympatric turtle species (McAuliffe 1977; Siddall and Desser 1992). This has been attributed to the turtle's life style (Readel et al. 2008). It spends most of its time buried in mud in shallow water with only its eyes and nostrils exposed to air and often basks just beneath the surface of the water as opposed to more frequent aerial baskers, such as emydid turtles, whose longer periods of basking probably contribute to the removal of attached leeches (McAuliffe 1977).

Collection of data concerning attachment of both algal colonies and leeches should be included in future ecological and behavior studies of *Chelydra serpentina*. This is especially important as the incidence of leech attachment may be an indicator of the amount of protozoan parasitemia in a population.

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TECHNIQUES

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Effectiveness of Leaf Litterbags for Sampling Stream-breeding Anurans: Tadpole Distribution, Composition, and Use

Amphibian population declines highlight the need to understand the limitations of sampling techniques and develop more effective means of assessing and monitoring. Leaf litterbags attract larval amphibians by mimicking natural substrate, while the bag's permeable exterior allows animals to pass freely in and out. Use of leaf litterbags in herpetofaunal surveys has been limited to sampling larval salamanders in the United States (e.g., Chalmers and Droege 2002; Nowakowski and Maerz 2009; Talley and Crisman 2007; Waldron et al. 2003). Leaf litterbags were used as early as the 1960s for examining benthic invertebrates (e.g., Anderson and Mason 1968; Crossman and Cairnes 1974; Hilsenhoff 1969). However, their employment has gained momentum in herpetofaunal research to improve our understanding of aquatic amphibians and larvae (e.g., abundance, as in Nowakowski and Maerz 2009) and reduce inter-observer differences that can affect visual encounter rates of more traditional sampling methods (e.g., dipnet sweeps: Shaffer et al. 1994). Additionally, litterbags can capture secretive or uncommon species that would be missed with more traditional sampling methods (Skelly and Richardson 2010).

Typically, tadpoles are sampled with dipnet sweeps, time-constrained searches, or opportunistic searches (Shaffer et al. 1994; Skelly and Richardson 2010). The usefulness of these techniques differs among observers based on effort and ability. Leaf litterbags minimize this type of error because investigators empty bag contents in the same way (Talley and Crisman 2007) or are trained to shake-out individuals without opening the bag using the same methodology between observers (see methods of Mackey et al. 2010). Therefore, scientists who are using untrained field assistants, or have a high turnover rate of field assistants may find their results more comparable among assistants when litterbags are employed versus another technique with a higher degree of inter-observer bias (e.g., dipnet sweeps: Shaffer et al. 1994).

Leaf litterbags create an artificial habitat to attract larval amphibians by mimicking natural leaf packs on the stream bottom (Skelly and Richardson 2010). Larvae are free to come and go from the litterbags, as long as their body size does not exceed bag mesh size. Mesh sizes vary among studies, and can bias results based on exclusion of larger larvae, prey, and predators when the mesh size is small (Waldron et al. 2003). The use of leaf litterbags has been limited to temperate zone stream-breeding salamanders (e.g., Chalmers and Droege 2002; Jung et al. 2000; Mackey et al. 2010) likely because it is a relatively new technique. Its application in the tropics may be useful in understanding anurans that breed in rocky streams where dipnet sweeps may miss tadpoles that retreat into crevices and naturally-formed leaf packs.

This study is the first to examine whether leaf litterbags can be used to sample tadpoles. We describe how tadpoles are distributed through time and space and among litterbags, including maximum densities recorded per litterbag. We use results of opportunistic searches for terrestrial adults to identify whether species composition resultant from tadpole-litterbag surveys yield reliable presence/absence composition estimates. Developmental stages are reported for the most abundant species so that biases for age-related selection using this method can be identified.

Site Description.— Cusuco National Park (CNP) is located in the Sierra de Omoa in northwestern Honduras. The Río Cusuco (15.494317°N, 88.2147°W) was sampled near the Visitor's Center at elevations from 1530–1560m. Water temperatures varied from 16–18°C during sampling events. River substrate is dominated by rocks, large boulders, and some sandy-bottom splash pools, with channel bends providing pools with low-flow areas where natural leaf litter and debris collects. Surrounding forest is Transitional Cloud Forest composed of *Pinus* and *Liquidambar* (Townsend and Wilson 2008), in the Lower Montane Wet Forest formation (Holdridge, 1967; McCranie and Wilson 2002). Most rainfall occurs from May/June through October/November, with April typically being the driest month (McCranie and Wilson 2002). Four anuran species within the study area could be encountered with leaf litterbags because they breed in streams (*Duellmanohyla soralia*, *Plectrohyla dasypus*, *Plectrohyla exquisita*, and *Ptychohyla hypomykter*; McCranie and Wilson 2002).

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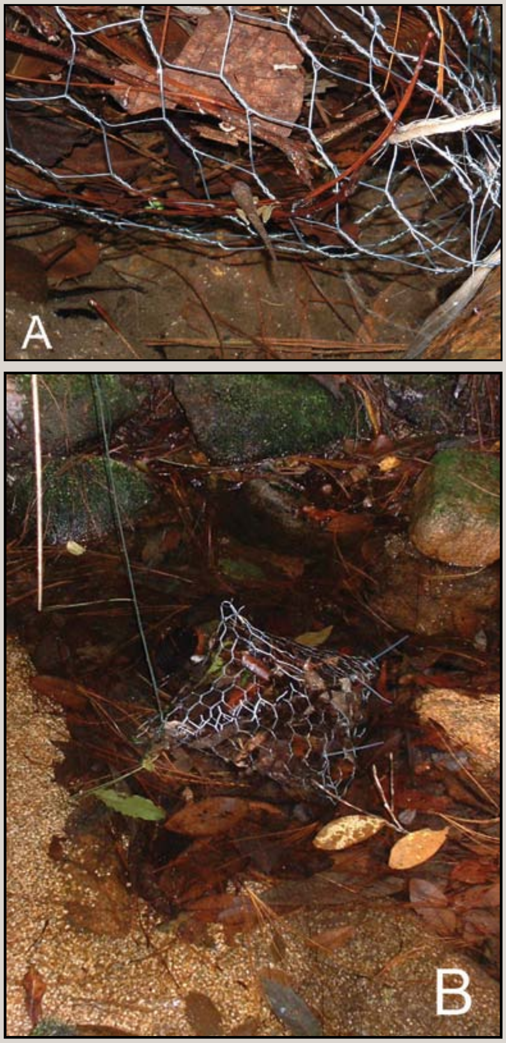

Fig. 1. A) A *Ptychohyla hypomykter* metamorph clings to vegetation at the edge of the leaf litterbag. Note the size of the metamorph relative to the mesh size of the litterbag. B) A leaf litterbag is visible in the middle of the photo, placed where leaf litter accumulates, secured to the bank with a piece of string.

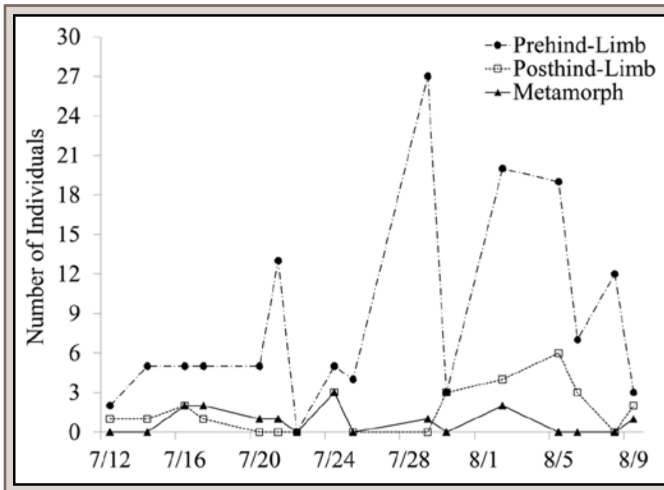

Fig. 2. Prehind-limb, posthind-limb, and metamorph developmental stages are represented in leaf litterbag samples for *Ptychohyla hypomykter* tadpoles.

Another stream-breeding anuran, *Lithobates maculatus*, has not been found in the park for several years, and is likely extirpated from the park (Townsend and Wilson 2008).

MATERIALS AND METHODS

The herpetological sampling expedition to Cusuco National Park had three overarching scientific objectives: daily monitoring of pitfall traplines for fossorial snakes, opportunistic searching to document all herpetofauna, and using leaf litterbags to document their effectiveness for sampling tadpoles. Pitfall traplines did not yield any stream-breeding adult anurans, so the specific methodology and results of that survey will not be discussed. Daily hikes through the forest to and from these traplines, however, were used to extend the stream-breeding adult frog species list when possible. Additionally, nighttime hikes were performed nearly every night (23 June–22 August 2005) to look for herpetofauna.

Leaf litterbags.— We designated five sample reaches in the Río Cusuco for litterbag placement. Six leaf litterbags were placed along each sample reach, with a total of 30 litterbags deployed in the river. Sample reaches were separated by approximately 35 m, and litterbag placement within sample reaches spanned approximately 20 m. Litterbags were not evenly dispersed within sample reaches because they were employed only in areas where there were pre-existing pools for leaf litter accumulation. Leaf litterbags were checked every 3–5 days from 11 July–8 August 2005, or exactly nine times for each leaf litterbag. This 3–5 day interval between sampling events allowed time for recolonization by tadpoles.

We constructed litterbags using easily obtainable materials (i.e., "chicken wire"). Additionally, we knew that our target species maximum larval size would not exceed the mesh size of the chicken wire (e.g., Fig. 1a), and, therefore, would not be excluded based on body size. Leaf litterbags were constructed by cutting 0.45 × 0.45 m (1.5 × 1.5 ft) squares, securing the corners together with plastic ties to form an 'envelope' shape ($V \cong 0.0054\ m^3$). Litterbag size was based on Waldron et al. (2003), who found medium and large litterbags to be most effective in small streams. The bag interior was filled with litter debris from the stream edge and bottom. To secure leaf litterbags in place, rocks of approximately equal mass were placed in the interior to weight the bags. Using twine, each leaf litterbag was tied to a nearby tree to prevent displacement and loss. During the 2004 field season, litterbags were not secured to the banks, and were displaced during a heavy storm. Leaf litterbags were placed in the river where debris naturally accumulated (Fig. 1b).

Upon retrieval, litterbags were rapidly pulled from the stream and placed into a plastic container to prevent escape of tadpoles. No tadpoles were ever observed escaping before the litterbags were placed in the plastic tub. Leaf litterbag contents were then placed in a dipnet to drain water. Tadpoles were placed in water-filled plastic bags for field identification. Tadpoles were identified in the field with a hand lens to determine species (based on McCranie and Wilson 2002) and Gosner (1960) developmental stage. Tadpoles with mouthpart malformations and those for which species identification was not certain in the field were collected and preserved for further analysis (N = 39); they will be deposited at Florida Museum of Natural History upon completion of future genetic analyses. All captured anuran larvae were classified into prehind-limb (Gosner Stage 25), posthind-limb (Gosner Stages 26–41) or metamorph (Gosner Stages 42–46) developmental stages.

Terrestrial Surveys.— Opportunistic searching during daytime and nighttime hikes was used to determine the presence or absence of adults of each species. All trails mentioned in Townsend and Wilson (2008) were used for daytime and nighttime hikes, as well as hiking along the Río Cusuco itself. As a minimum estimate, at least 6 h per 24 h day were spent searching for herpetofauna (morning trapline work: 3 h, afternoon litterbag surveys: 2 h, and night hikes: 1–2 h). Methodology included visually searching for herpetofauna in vegetation, beneath fallen logs and rocks, within the upper layers of soil, on boulder surfaces in the Río Cusuco, and within overhanging vegetation near river edges. We use qualitative comparisons of presence/absence data for adult species from terrestrial opportunistic visual encounter surveys with tadpole species presence/absence data from leaf litterbag surveys.

RESULTS

Tadpole distribution.—All but four litterbags yielded at least one individual. On average, 4.6 tadpoles (+/- 0.3 SE; range 0–16) were captured during 40 litterbag sampling events, where a sampling event is equivalent to checking an entire litterbag reach. Of the litterbag checks, where examination of one leaf litterbag equals one "litterbag check," most yielded zero (61.3%) or one tadpole (20.8%) (Table 1).

Adult and larval species composition.—Of the stream-breeding anurans in Cusuco National Park, the adult opportunistic survey found four of five possible species: *D. soralia*, *P. dasypus*, *P. exquisita*, and *P. hypomykter*. We found tadpoles of these same four anuran species in the litterbags (*D. soralia* [N = 1], *P. dasypus* [N = 4], *P. exquisita* [N = 1], and *P. hypomykter* [N = 175]) (Table 2). We did not detect one of the stream-breeding frog species known to occur in Cusuco National Park, *L. maculatus*, in any of our surveys. The visual encounter survey (VES) lasted for eight weeks, while the corresponding leaf litterbag survey (LLS) lasted for five weeks (Table 2). For both VES and LLS, *D. soralia* and *P. exquisita* were found at low frequencies. In contrast, *P. dasypus* and *P. hypomykter* were found with greater frequencies (Table 2). We were unable to identify one tadpole to species because of severe mouthpart malformations.

Developmental stage composition.—We collected only one tadpole of both *D. soralia* and *P. exquisita*. We found all three developmental categories of *P. dasypus* throughout the study. The majority of *P. hypomykter* tadpoles captured belonged to the prehind-limb developmental stage (N = 136), followed by posthind-limb (N = 26) and metamorph (N = 13) stages (Fig. 2).

DISCUSSION

We used leaf litterbags in a swift-flowing montane stream in Honduras to sample tadpoles of four stream-breeding species. As with previous larval salamander litterbag survey results (Talley and Crisman 2007), we found most litterbag checks contained no tadpoles. On the other hand, nearly 40% of the litterbag checks contained at least one individual (Table 1). Although the litterbag volume we used in this study ($V \cong 0.0054$ m^3) was greater than that used by Talley and Crisman (2007) ($V \cong 0.0018$ m^3), the number of individuals we found per litterbag was similar. If a litterbag contained at least one individual during a litterbag check in either study, it typically yielded only one or two individuals, with a maximum of nine salamander larvae (Talley and Crisman 2007) and seven tadpoles in this study (Table 1). The social biology of these species has not been studied, but *D. soralia* is the only species we detected known to aggregate, swimming upside down at the surface (McCranie and Wilson 2002), while at other times found separately on the stream bottom (Townsend and Wilson 2008). Because the other species are not known to aggregate, and were not observed aggregating in this study, the number of individuals we captured might simply represent natural tadpole densities for the given litterbag size. Additionally, these capture values might be affected by the amount of colonizable area and territory size requirements, inter- and intra-specific competition, and food source availability (Chalmers and Droege 2002; Fraser 1976; Talley and Crisman 2007; Waldron et al. 2003) because litterbag design mimics natural conditions.

Tadpoles of the four anuran species differed markedly in frequency of occurrence in litterbags, perhaps resulting from different larval periods, alternate microhabitat uses, or an over-abundance of the most common species. Honduran tadpoles typically metamorphose into adults at the end of summer months, with timing of emergence from water varying among species (McCranie and Wilson 2002; Townsend and Wilson 2008). The most commonly observed treefrog in Cusuco National Park is *P. hypomykter* (Townsend and Wilson 2008). Calling males, amplectant pairs, and tadpoles have been found in March, April, June, July, August, and September (Townsend and Wilson 2008). *Ptychohyla hypomykter* tadpoles made up 96.2% of those encountered in this study. Previous studies with larval salamanders found

Table 1. Tadpole distribution among leaf litterbags indicates that nearly half of those litterbags checked contained at least one tadpole, and as many as seven.

Individuals per litterbag	Number of litterbag checks	Percent of total litterbag checks (%)
0	147	61.3
1	50	20.8
2	24	10.0
3	8	3.3
4	3	1.3
5	3	1.3
6	2	0.8
7	3	1.3
Total	240	

Table 2. Species presence determined by terrestrial visual encounter surveys (VES) of adults and metamorphs, and leaf litterbag surveys (LLS) of tadpoles and metamorphs. 'X' denotes species presence. Shaded areas indicate survey weeks when litterbags were not sampled. The first survey week was 23–30 June, the rest following without interruption.

		Survey Week							
Species		1	2	3	4	5	6	7	8
D. soralia	LLS				X				
	VES	X							
P. dasypus	LLS				X		X		
	VES	X	X	X		X	X	X	X
P. exquisita	LLS						X		
	VES						X		
P. hypomykter	LLS			X	X	X	X	X	
	VES	X			X	X	X	X	X

similar distinctions in capture rates between species, with 95% of the total captures being larvae of a single salamander species (*Eurycea cirrigera*) (Talley and Crisman 2007). The relatively short duration (11 July–8 August 2005) might have contributed to the lower capture rates of some species if this study period did not encompass their larval periods. For example, Townsend and Wilson (2008) reported transformed *P. dasypus* on streamside boulders and vegetation during June and July; this indicates that the startup date of our study in mid-July was on the tail end of the larval period for *P. dasypus*. The likelihood of finding tadpoles in litterbags is reduced when their natural behavior does not favor leaf-pack colonization. For example, tadpoles of *P. dasypus* and *P. exquisita* often are observed on rocks in fast-flowing portions of stream, whereas *D. soralia* tadpoles tend to school near the surface or in the water column in deeper pools (McCranie and Wilson 2002; Townsend and Wilson 2008). Therefore, tadpoles of these three species might not normally utilize submerged leaf litter as preferred microhabitat. The prevalence of *P. hypomykter* tadpoles in our samples might be explained by any or all of these factors.

We determined that leaf litterbags contained tadpoles of all anuran species presumed to use the Río Cusuco based on prior knowledge of their reproductive strategies (Townsend and Wilson 2008) and the results of opportunistic terrestrial surveys conducted in this study. Based on presence/absence assessment of tadpole and adult species, we found that our study identified tadpoles in the leaf litterbag survey of the same species as adults in the terrestrial survey (*D. soralia*, *P. dasypus*, *P. exquisita*, and *P. hypomykter*) (Table 2). Previous studies dealing with salamander species presence/absence composition in leaf litterbags also found the same larval species as adults known to the area (e.g., Pauley and Little 1998; Chalmers and Droege 2002; Talley and Crisman 2007; Waldron et al. 2003).

We found representatives of all three major developmental stages (prehind-limb, posthind-limb, and metamorph) in our litterbag samples throughout the duration of our study period for *P. hypomykter* tadpoles (Fig. 2). The prehind-limb developmental stage (S 25) was most common (78%) in the tadpoles of *P. hypomykter* sampled, which likely reflects the abundance of this stage in the entire population. The distribution of tadpole stages (Fig. 2) does not appear to reflect an aging trend, where younger (prehind-limb) tadpoles were collected earlier in the survey and older (posthind-limb and metamorph) tadpoles were collected later in the survey. Therefore, the difference in relative abundance among developmental states is due either to bias in the capture probabilities from the sampling technique or is reflective of real differences in tadpole developmental stage structure.

Because our sample sizes were limited for some species, a decreased sampling effort could have missed *D. soralia* and *P. exquisita* tadpoles all together. Future studies employing leaf litterbags should first address whether tadpole species of interest are likely to be found in leaf litter. Additional sampling methods might be necessary for species that are difficult to detect, particularly if they are of critical conservation concern. Next, future researchers should choose sample sites that have natural leaf litter accumulation. Finally, they should pick the number of litterbags deployed, and duration of litterbag deployment based on the needs of their study. For example, if only a handful of tadpoles are desired for study, then fewer litterbags could be used. We found unequal litterbag occupancy between stream reaches, but know that when six litterbags were used, we detected an average of 4.6 tadpoles within that reach.

We provide information on the reliability and use of leaf litterbags, a technique typically used to monitor larval salamanders, for sampling tadpoles in the tropics. Use of this sampling technique on a wide range of other stream-dwelling amphibians worldwide could contribute to assessment of natural populations since amphibians are declining worldwide (Stuart et al. 2004). We demonstrate herein that leaf litterbags can be used to sample stream-breeding tadpoles in a swift-flowing montane stream. If a tadpole's association with natural leafpacks in the stream is unknown, the species is of particular conservation significance, or leaf litterbags do not yield any encounters, then an additional sampling method may be necessary.

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A Device for Restraining Gopher Tortoises (*Gopherus polyphemus*) During Blood Extraction

Collection of blood or other biological samples from Gopher Tortoises (*Gopherus polyphemus*) is necessary for assessments regarding health status, disease, and genetics. Researchers use a variety of techniques for restraining tortoises during sample collection, sometimes having one person draw the blood while a second person holds the tortoise. However, budget and manpower constraints do not always allow for two people to be present during blood extraction, especially in remote field situations. Some researchers place the tortoise on a large metal coffee can while drawing blood from the brachial vein in the forelimb (G. McLaughlin, pers. comm.); others restrain the tortoise in their lap or on a truck tailgate while extracting blood subcarapacially (P. Moler, pers. comm.). These techniques can be effective if the tortoise is not excessively active. The need for one person to be able to quickly and effectively extract blood under field conditions from gopher tortoises of varying activity levels was the impetus for constructing a portable tortoise restraint device (TRD).

The TRD is designed to be used with a pickup truck but can be modified for placement on other surfaces such as a portable field table. Two 12-in. lengths of pressure-treated two-by-two (a standard U.S. lumber product that actually measures 1.5 × 1.5 in.) are laid perpendicular to the back edge of the open tailgate, so that the tips are flush with the tailgate's edge. The outside distance between these parallel wood pieces is 13.5 in. Measurements are given in English units to correspond with lumber and fastener sizes in U.S. hardware stores. Two holes (3/8-in. diameter) are drilled through the side of each of the lengths of two-by-two (approximately 2 in. from each end) to facilitate attachment of the TRD to the truck (see below; Fig. 1). Two additional 3/8-in. holes are drilled from the top through each of the two lengths of two-by-two (approximately 1 in. from each end), with corresponding pilot holes drilled in the tailgate so that the wood can be secured to the tailgate with 2-in. long sheet metal screws. This completes the tailgate mount and support for the TRD (Fig. 1). To avoid drilling holes into a truck tailgate, C-clamps or cargo straps could be used to secure the TRD; alternatively, the TRD platform could be attached to a heavier base for use on tables, counters, or tailgates.

The outside distance (13.5 in.) between the two lengths of two-by-two mounted on the truck tailgate provides the basis for the dimensions of the TRD platform. Two 12-in. lengths of two-by-four (another U.S. standard lumber product, measuring 1.5 × 3.5 in.) lying on their shorter edge and positioned 13.5 in. apart at the inside, serve as the base of the platform (Fig. 1). Four holes (3/8-in. diameter) drilled into the sides of the base correspond to the four holes drilled into the two lengths of two-by-two previously attached to the truck. Four 4-in. bolts pushed through these holes secure the TRD to the truck during use (Fig. 1). A piece of ¾-in. plywood is cut to a width of 12 in. and a length of 16.5 in., laid atop the pieces of two-by-four flush to its ends and outer edges, and attached to them with decking screws. Two additional lengths of two-by-four, each 16.5 in. long, are sawed into trapezoids that have an outer angle of 60° and placed on edge atop the plywood base along the 16.5-in. side (Fig. 1). These pieces are attached through the bottom of the plywood with decking screws. Another piece of ¾-in. plywood measuring 12 × 12.5 in. is then attached to the top of the trapezoidal pieces with decking screws (Fig. 1). This completes the basic TRD platform. If desired, 3/8-in. holes may be drilled into the rear left quadrant of the upper plywood platform to provide storage for the four bolts when the TRD is not installed on the tailgate. Additionally, metal handles may be attached to each side of the TRD base to facilitate its placement and removal.

An 8-in. block of four-by-four serves as the pedestal on which the tortoise is placed during blood extraction (Figs. 1, 2). This block supports the center of the plastron and prevents

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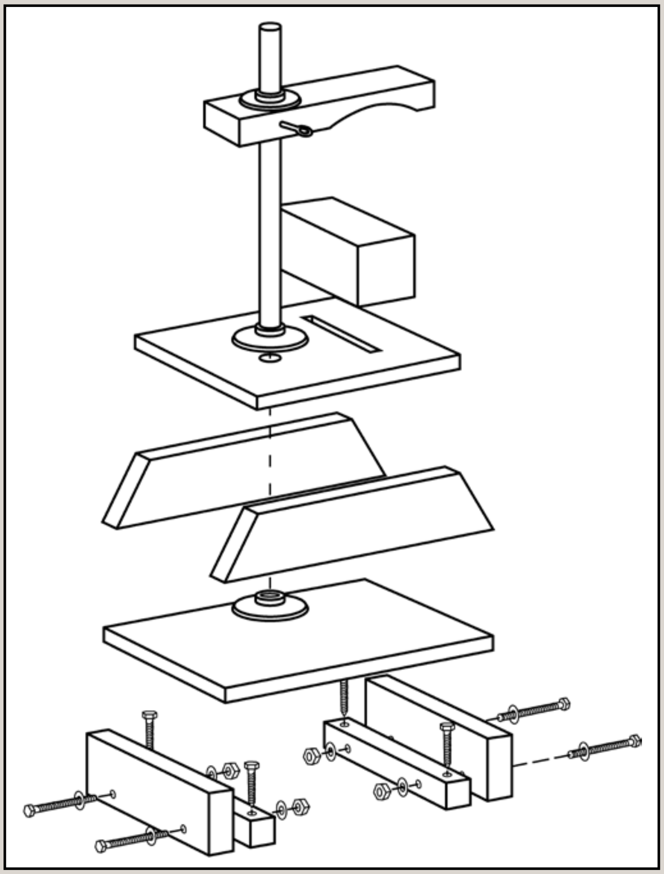

Fig. 1. Schematic illustration showing how parts of the tortoise restraint device come together.

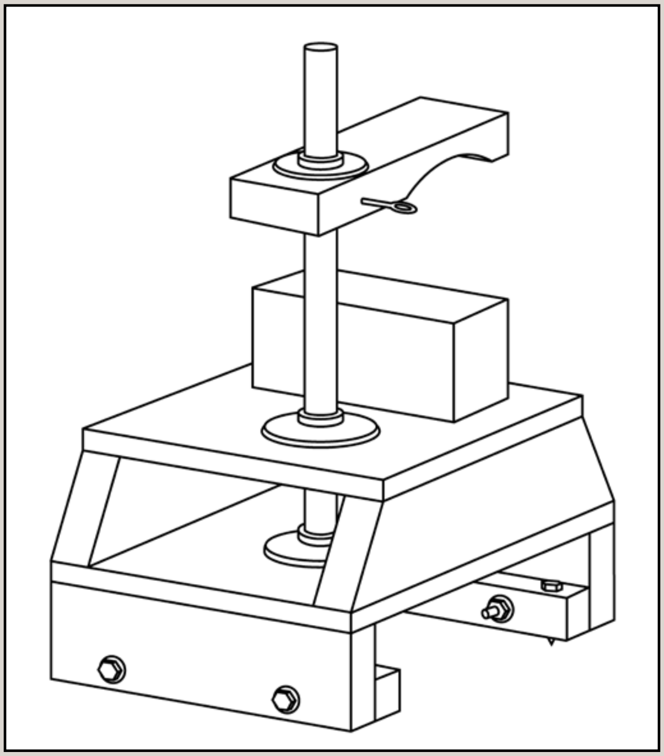

Fig. 2. The tortoise restraint device, lateral view.

Fig. 3. Radio-instrumented Gopher Tortoise in the restraint device. Note both the eye bolt that allows vertical adjustment of the clamp to fit individual tortoises and the bungee cord that goes between eye screws on the clamp and base to further secure the tortoise.

the tortoise from gaining traction with its feet (Fig. 3). Because of variation in the size of tortoises, the pedestal must be adjustable in relation to the fixed clamp that holds the tortoise in place (described below). A 3/8-in.diameter double-ended screw/bolt is placed in the center of the bottom of the block of four-by-four (the threaded end screws into the block, leaving the bolt end exposed). A 7-in. slit slightly wider than the bolt is cut into the top of the TRD platform 3 in. from the right side (Fig. 1). By inserting the bolt through the slit and securing it with a washer and wing nut, the block can be positioned fore and aft of the clamp. A block of four-by-four 6 in. long may be cut if desired to a width of 2.5 in. to accommodate smaller tortoises. Foam rubber pads, about ¼-in. thick, are hot-glued to the tops of these blocks to reduce slippage of the tortoise.

To create the clamp that holds the tortoise in place, a 1-in. diameter hole is drilled through the top of the TRD platform approximately 4 in. from the left side and 5 in. from the front. A ¾-in. galvanized female pipe stand is secured with screws to the bottom piece of plywood directly under the hole in the TRD platform. A ¾-in. diameter pipe approximately 18 in. long and threaded at both ends is inserted through the hole and screwed into the pipe stand (Figs. 1, 2). The top part of the clamp is made from a 15-in. length of two-by-four through which a 1-in. hole has been drilled in the center of the broad edge (approximately 3 in. from one end). The wood is placed on the pipe, inserting it through the hole and moving it down until it comes to rest on the block. An arc that approximates the shape of a tortoise shell is sketched on the narrow edge of the 15-in. piece, with the highest point of the arc falling directly over the center of the block (Figs. 1, 2). The arc is then cut out of the 15-in. piece with a scroll saw, leaving the wood thick enough (at least 5/8 in.) that it is not weakened. Because the area within the arc will be contacting the tortoise's shell, it is lined with soft foam hot-glued to the wood. Three additional 1-in. female pipe stands are fastened with screws to reinforce the pipe, one above the hole in the 15-in. piece, one below that hole, and one on the top tier of the platform (Figs. 1, 2).

With a ½-in. drill bit, a hole is drilled between the narrow edge of the 15-in. clamp and the 1-in. pipe hole. A threaded bolt insert is screwed into this hole and a large 3/8-in. eye bolt is screwed into the insert. When threaded completely through the hole, the bolt makes contact with the pipe and allows the clamp to be secured in any vertical position along the length of the pipe (Fig. 3). Medium eye screws are fastened to the right end of the clamp and the lower right two-by-four of the base of the TRD platform. A bungee cord stretched between these two eye screws adds further strength to the clamp when a tortoise is in the TRD (Fig. 3).

The TRD should be coated with a water sealer to keep urine, feces, and blood from soaking into the wood. Additionally, the TRD should be rinsed with water to remove organic debris and then cleaned with a mild bleach solution (1:20 dilution of 5% household bleach in water) or a disinfectant such as Trifectant after each tortoise is sampled.

Although originally designed for extracting blood from the brachial vein of a tortoise's forelimb, this adjustable device can be used to restrain tortoises for other types of sample or data collection, assessment of clinical signs of disease, and attachment of radio transmitters (Fig. 3). The TRD safely secures the tortoise, allowing access for sampling while precluding excessive handling and manipulation. We found the TRD to be effective, practical, and versatile.

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Retention of Paint Markings for Individual Identification of Free-ranging Basking Aquatic Turtles (Suwannee Cooters, *Pseudemys concinna suwanniensis*)

Marking animals is often essential in ecological studies (Krebs 1999), but different taxa pose various challenges in applying marks with suitable retention periods (see Silvy et al. 2005 for an overview of methods). The bony turtle carapace provides convenient opportunities for permanent individual marking, such as the shell notching technique introduced by Cagle (1939). However, basking aquatic turtles (such as *Chrysemys*, *Graptemys*, *Pseudemys*, and *Trachemys* in North America) quickly fall from their platforms into the water and swim away rapidly when approached, making it impractical to read notches.

Methods that allow for distant recognition without capture, thereby resulting in minimal disturbance to individuals, are highly desirable. Although paint marking has been used in population studies of aquatic turtles (e.g., Jones and Hartfield 1995; Kramer 1995; Selman and Qualls 2008, 2009), assumptions of paint retention that are critical in interpreting recapture sightings are frequently untested. As part of a more comprehensive study of movement patterns and habitat use, we applied paint marks to an emydid species from the southeastern USA, the Suwannee Cooter (*Pseudemys concinna suwanniensis*). These large turtles (maximum carapace length = 437 mm; Pritchard 1980) are strong swimmers and inhabit various riverine habitats, where they spend extensive time basking above water (Jackson 2006; Ward and Jackson 2008). Here, we report observations on the retention of paint marks on free-ranging Suwannee Cooters to evaluate the utility of this method for monitoring this species.

Methods.—The study site encompassed a 3.4-km stretch downstream from the US Highway 441 bridge over the Santa Fe River, ca. 4 km downstream from where the river reemerges above ground from the Floridan Aquifer (Alachua and Columbia counties, north-central Florida, USA). Most of the study site and its surroundings are managed by River Rise Preserve State Park, part of the largest publicly protected area along the Santa Fe River. Within the preserve human take of turtles is illegal. Although the river water is normally dark brown from tannins, a drought in 2006–2007 lowered the river level, substantially resulting in clear water with good visibility during the study. Kornilev (2008) and Kornilev et al. (2010) describe the study site in more depth.

From 18 to 23 May 2007, we snorkeled and hand-captured 50 Suwannee Cooters (23 males, 25 females, 2 juveniles; mean straight carapace length [SCL] = 288 mm; range 164–375; SD = 53). After recording standard morphometric measurements, we removed algae from the dorsolateral side of the carapace, dried it, and detached any shedding scutes in order to facilitate paint retention. We then painted a unique identifying number on each side (Fig. 1). We used a white, non-toxic, oil-based paint marker designed for rugged industrial use (563 Speedry, Diagraph, Marion, Illinois, USA; price: US $3/marker). The width of the paint lines was 0.5–1.0 cm and the complete 2-digit number was usually ca. 7 × 7 cm. Each marker was sufficient to mark 30–50 individuals. In addition, we attached in the field a temperature-sensitive datalogger (iButton; Maxim Integrated Products, Sunnyvale, California, USA) on the marginal scutes above the right rear leg of each turtle (Fig. 1; Kornilev 2008). We coated the iButtons in black plastic, which increased their height to ca. 9 mm and radius to ca. 11 mm. Turtles were released at the point of capture after the paint dried completely (ca. 10 min).

We conducted intensive resampling for 60 days after the turtles were marked. During 26 visits to the river, one or two

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observers surveyed the length of the field site by kayak 3–4 times per week. With the aid of compact binoculars (7 × 35 power), we searched for, observed, and attempted to identify individually both basking and swimming turtles. Since the iButtons were usually visible from a distance, we could often determine if a turtle had been previously captured even when the painted numbers had worn off. Resighted animals that could not be unambiguously identified were classified as "Unidentified."

Visits to the field site between July 2007 and April 2008 were less intensive and we present here only incidental results from that period. While attempting to retrieve iButtons, we captured 39 additional, unmarked turtles. Some numbers quickly wore off or were too small and difficult to detect, so we subsequently increased the line width of the paint marks to 1–2 cm and the overall mark size to ca. 12 × 12 cm to improve detection and paint retention. After July, additional limited sampling also was conducted in the 4 km upstream of the US 441 bridge (Kornilev 2008; Kornilev et al. 2010).

Results.—Within the two months of intensive resampling, 41 turtles (82%; 16 males, 23 females, and both juveniles) were positively identified at least once. We successfully identified turtles 191 times, excluding daily resightings. Individuals were identified more than once per day on 44 occasions, primarily during the first 30 days. Marked individuals could not be identified on 125 occasions, principally due to deterioration of the paint marks, with just a few turtles escaping prior to identification. We observed a turtle with an iButton but without distinct numbers as early as six days post-marking (Fig. 2).

The mean number of days from the initial capture to the last identification or recapture was 22.75 (range: 4–52, SD = 10.98; N = 41). No significant difference between sexes was detected (ANOVA: $F(1, 37) = 1.019$, $p = 0.319$, $= 0.05$; Kolmogorov-Smirnov & Lilliefors test for normality: $p > 0.2$ for each sex).

The use of thicker and larger paint marks applied on the additional turtles captured after July 2007 resulted in discernible marks for longer periods of time than the thin marks initially used. On 31 March 2008, YK observed two turtles with faint paint marks but failed to identify them before they entered the tannin-stained water. The last date on which we painted marks was 28 September 2007; therefore marks could be retained for at least 186 days (>6 months).

Numbers on basking turtles could be identified from 20–30 m with the use of the compact 7 × 35 binoculars. Although water clarity varied slightly across the study site and period, swimming turtles often could be identified up to 3–4 m horizontal distance away from the observer and at depths of 2.5 m. Swimming turtles were occasionally detected because the paint number was observed prior to the turtle itself being visible.

Discussion.—Our results on paint mark retention are concordant with published reports of similar studies on freshwater turtles. Kramer (1995) reported paint mark retention for 1–3 months on Florida Redbellied Turtles (*P. nelsoni*) using rubberized or epoxy paint. Jones and Hartfield (1995) also reported retention rates of up to three months for *Graptemys oculifera*. Selman and Qualls (2008, 2009) did not address the question of mark retention in estimating population size of *G. flavimaculata* and *G. gibbonsi*; they did note flecks of paint on several individuals recaptured 8–14 months after applying a fluorescent spray paint, but the paint was probably not enough for a successful "resighting" (W. Selman, pers. comm.). However, all of the *Graptemys* studies noted that mark-resight surveys were completed within two weeks of the first individual being paint marked in order to prevent losing marks; similar population estimates across years for these studies indicate that paint marks were persistent shortly after application and that mark-resight is a valid population estimation tool. The differences in paint retention between the studies could be attributed to varying ecological factors (e.g., water chemistry, species behavior) as well as the properties of the assortment of brands of paint used. Similar to previous results, our study suggests that wide paint marks can be used for more than 1 month to monitor at least some individual turtles with minimal disturbance, but that decreased paint retention limits the effectiveness of this technique for longer-term studies.

Fig. 1. Representative paint mark and iButton (circled) on a female Suwannee Cooter (SCL = 365 mm). The inset shows an enlarged coated iButton (ca. 11 mm) next to a US quarter coin.

In our study, abrasion, shedding of scutes, and rapid algal growth on the carapaces of some individuals reduced paint retention and detection. However, the width of the paint lines was not the only determining factor for the rate of paint loss. For example, individual #23 had thinner number lines painted than other turtles, but its marking lasted for 52 days, longer than on most other individuals. Although we documented extended retention for paint marks especially applied after July, this might have reflected decreased turtle activity (leading to less abrasion of the paint against floating vegetation, tree logs, etc.) and scute shedding during the cooler fall months when growth is slower than in summer (Huestis and Meylan 2004). The extent of algal colonization and shedding of scutes as well as the propensity to disperse likely reflect individual differences among turtles (Kornilev et al. 2010).

Suwannee Cooters are strong swimmers and dispersal beyond the study site may have led to our inability to observe some marked turtles (see Kornilev et al. 2010). For example, the paint marks on individual #44 started to fade when last seen 45 days after capture; on individual #46, the numbers were still well preserved and easy to read on the last observation 33 days after paint was applied. However, both individuals presumably emigrated from the field site since they were never observed or captured again even during several surveys outside of the study site.

The choice of paint color that provides the best visibility should be considered carefully. In our experience the white

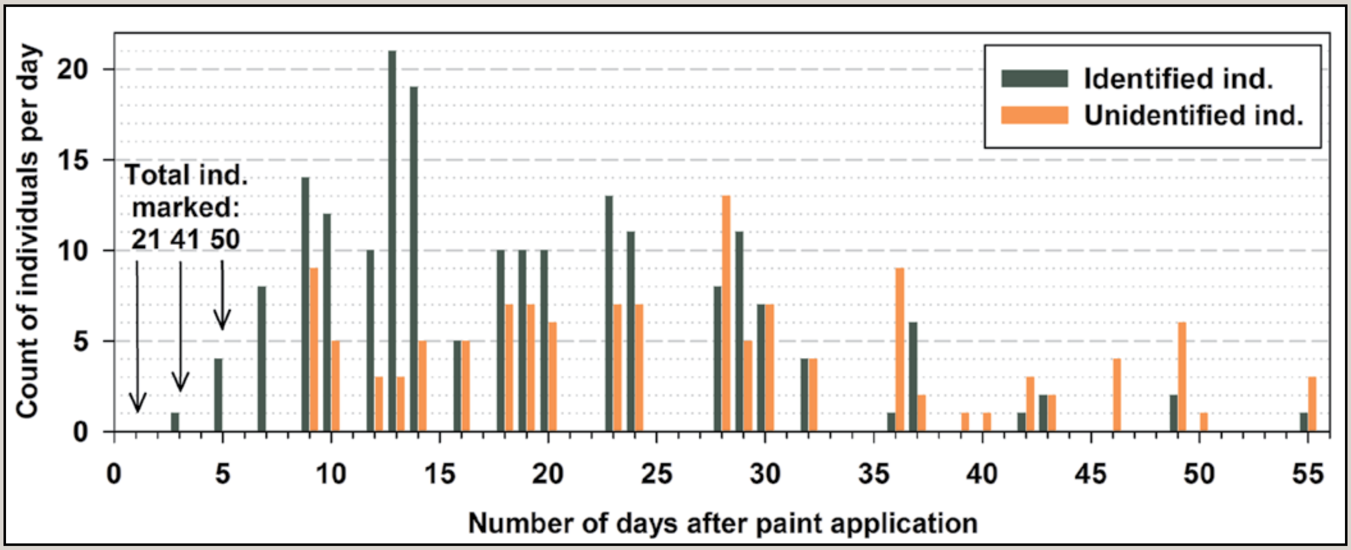

Fig. 2. Daily counts of identified individuals and unidentified but marked turtles based on double marking (individual paint marking and external temperature logger) of 50 turtles. "Unidentified" turtles lacked a clear paint mark but had a visible iButton or in a few instances escaped before a positive identification could be made. Turtles were marked 18–23 May 2007 (days 0–5).

paint was clearly visible in most instances against the contrasting black carapace of the *P. c. suwanniensis*. However, the glare from a dry carapace painted with orange made turtle identification problematic in full sunlight; blue or green marks could be difficult to distinguish against a background of vegetation along the river (R. Jones, pers. comm.).

The potential of differential fleeing responses by basking turtles to watercraft or observers on the bank should be considered and/or tested in mark/resighting studies or surveys. Habituation to boat traffic, interspecific differences, or stress caused by the marking procedure might skew the results, even when comparing data on a single species among sites within the same river (R. Jones, pers. comm.). In our study, turtles exhibited a range of behavioral responses, sometimes allowing us to approach them to less than 2 m, while at other times fleeing when observers were more than 50 m away. Observers might also be biased and initially focus their attention on counting marked turtles while conducting boat surveys, during which time unmarked turtles might escape without being recorded. Combining both spotting scope surveys from a hide with boat observations could minimize observer bias, increase detection probability, and provide for more accurate estimates of population parameters.

To improve mark retention and resightability, we suggest that researchers 1) completely remove algae and loose scutes from the carapace prior to marking, 2) thoroughly dry the shell before painting, 3) use wide paint marks with more paint, and 4) combine appropriate paint colors on the same individual while varying the position of the number on the carapace to facilitate identification even under suboptimal conditions.

A question not addressed by our study is whether the presence of highly visible marks increased depredation either directly on adults or indirectly on nests or females while depositing eggs. We do not have reason to suspect increased predation or take by humans on individuals during our study. Only a few basking alligators were observed diurnally, when marks were most detectable and turtles were susceptible to visual predators. Although alligator tooth marks have been observed on a few turtles in the river, none of our paint marked turtles bore fresh tooth marks or wounds that post-dated original capture and paint application. Still, we advise against application of paint on hatchlings and juveniles (SCL < 100 mm), since they favor spending time in cryptic microhabitats as an antipredatory strategy (Jackson and Walker 1997; Kornilev 2008).

Aside from the scientific information we collected, the visible paint numbers sparked the interest of recreational boaters on numerous occasions on the river and led to a short note in a local newspaper (Reinink 2008). The potential for publicity to serve a negative purpose, such as facilitating human harvest, should be considered prior to marking animals (e.g., Heinrich et al. 2010). However, publicity may also serve a positive purpose by raising public awareness of conservation issues. If properly planned, citizen scientists might even be trained to increase the amount of data collected.

Our experience supports the view that individual paint marking is suitable for short-term collection of ecological data and monitoring of basking turtles. It also provides an inexpensive tool for successful management and conservation, but retention, behavioral responses, and length of study need to be considered thoroughly before applying this technique and interpreting results.

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Blood Sampling in Testudinidae and Chelidae

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Blood sampling is among the most common procedures in vertebrate studies. When done correctly, it may be less invasive than taking other tissues. In the case of DNA analysis, rather small amounts of blood are necessary, although the required amount may be larger for physiological studies.

An easy sampling technique is important for obtaining blood from chelonians for a variety of purposes, such as genetic analyses and clinical pathology diagnostics. Several blood sample sites have been described in chelonians, including heart, veins (jugular, brachial, ventral, femoral, coccygeal, or scapular), brachial artery, orbital sinus, a sub-carapacial venipuncture site, retro-orbital space, and trimmed toe-nails (Avery and Vitt 1984; Bulté et al. 2006; Dessauer 1970; Hernandez-Divers et al. 2002; Jacobson 1987; Rogers and Booth 2004; Stephens and Creekmore 1983; Ulsh et al. 2001). Some sampling methods have disadvantages, such as higher risk of infection (Strik et al. 2007). The orbital sinus has been used for collecting small volumes of blood through capillary tubes (Nagy and Medica 1986), however, this method results in dilution of the blood sample with extracellular fluids and secretions, which may alter the composition of plasma, affect the volume of cellular components, and result in incorrect interpretation of biochemical data. Because lymphatic systems are well developed in chelonian forelimbs and tails (Ottaviani and Tazzi 1977), obtaining blood samples from sites near the lymphatic system may result in hemodilution with lymph (Rohilla and Tiwari 2008).

Most published techniques have been applied in long-tailed species such as *Graptemys geographica*, *Trachemys scripta*, *Macrochelys temminckii*, and marine turtle species (Bennett 1986; Bulté et al. 2006; Roman et al. 1999; Ulsh el al. 2001; Wibbels et al. 1998). However, the tail is very short in some species, e.g., in the genera *Chelonoidis* and *Phrynops*. This may cause some practical problems in blood sampling when utilizing the tail vein, such as sample contamination, because of the fecal discharge used as a defense mechanism and because animals may be difficult to hold firmly with recommended devices, such as those described for *Trachemys scripta* (Ulsh et al. 2001). Also, the amount of blood obtained from such sites is very low and sometimes not enough for lymphocyte separation and culture.

We collected blood samples from the testudinids *Chelonoidis carbonaria* and *C. denticulata* and the chelids *Phrynops*

PHOTO BY TIAGO LUCENA DA SILVA

Fig. 1. A) Blood sampling from the marginal costal vein for *Chelonoidis carbonaria* (Testudinidae; inset enlarged to show the exact position). B) Blood sampling from the external jugular vein for *Phrynops geoffroanus* (Chelidae; inset enlarged to show the exact position).

geoffroanus and *P. hilarii* (10 adult animals for each species). The animals were from the "Reginaldo Uvo Leone" breeding farm in Tabapuã, São Paulo, Brazil (20.9965°S, 49.12128°W).

The sampling site was first cleaned with distilled water and 70% ethanol. For testudinids, the marginal costal vein, lateral to the longitudinal axis of the animal, was used as a blood sampling site. An insertion of 5 mm is necessary and should access close to the forelimb (Fig. 1A). Some adjustment in angle, insertion, and position of the needle may be necessary.

In chelids, the external jugular vein is relatively dorsal and superficial in the neck. The biventer cervical and transverse cervical muscles are good dorsal landmarks for the external jugular. These muscles are externally obvious and are to either side of the vessels; the external jugular is located deep and between them and medial to the transverse cervical muscle. Correct insertion of needle requires a 90° angle downward, right before the cranium base, and a 2 mm deep insertion is necessary (Fig. 1B). However, the correct access depends on the size of the animal. The syringe was withdrawn slowly to create a vacuum for easy sampling.

The marginal costal and external jugular veins are located in the peripheral part of the body, hence there is no chance of injury to vital organs and sufficient blood can easily be withdrawn from adult animals. Some adjustment in the needle size may be necessary for hatchlings. The volume of blood taken from a healthy animal should be no more than 1% of its weight (Fudge 2000).

After blood collection, the skin was again swabbed with 70% ethanol to prevent microbial infection and the turtles were left in plastic boxes for observation for four hours. None of the animals used in this study showed any ill effects related to blood sampling.

Our procedure on these species allows collecting enough blood for several studies. The methods demonstrated do not require anesthesia and can be adopted for several other turtles, facilitating the study of this important vertebrate group.

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Herpetological Review, 2012, 43(1), 66–68.

A Fully Adjustable Transmitter Belt for Ranids and Bufonids

Tracking free-ranging amphibians with radio telemetry yields invaluable data, but is difficult and laborious. Frogs and toads generally weigh <100 g, have thin, delicate skin without a protective covering, and a challenging body form for radio transmitter attachment. Because of these features, investigators must use small (<10 g) radio transmitters with limited range and battery life, and travel to the field on a regular basis to relocate each animal. For all this work and labor, the investigator needs a device that secures the radio transmitters to the animal without damaging its skin or otherwise harming it.

Transmitters can be either implanted (e.g., Carey 1978) or attached externally to anurans. Because external attachment generally has caused little or no effect on behavior or weight gain in anurans (Bartelt and Peterson 2000; Rowley and Alford 2007; Indermaur et al. 2008; Sullivan et al. 2008), and given the much less stress caused to the animal, it is the recommended approach for most study needs (Indermaur et al. 2008). A variety of attachment designs have been used to meet all the requirements of telemetry for anurans (e.g., beaded chains, Rathbun and Murphey 1996; 1 mm outside diameter plastic belts, Bartelt and Peterson 2000; nylon ribbons, P. Ritson and D. Pilliod, pers. comm.; see Bull 2000 for review). Some designs have worked better for certain species, study areas, or investigators. For example, plastic belts and nylon ribbons have worked well in some studies, but caused deep wounds on frogs and toads that we study in the Midwest; beaded chains, while working well for larger frogs, can be rather heavy for medium sized (20–30 g) frogs and their relatively widely spaced beads limits fine size adjustments; on toads, beaded chains tend to collect and hold dirt that then cuts into their rough, drier skin (F. Anderka, Holohil Systems, Ltd., pers. comm.). Other belts (e.g., Muths 2003; Rowley and Alford 2007) were designed for relatively short study periods (few weeks to a month) or included small beads that would seem to have a similar effect on toads as beaded chains. A "common" design (i.e., one that works well for both frogs and toads) could help simplify materials needed for telemetry. In addition, a belt that can be easily and finely adjusted to fit the animal as it grows throughout the season may help reduce the problem of skin sores. We developed a fully adjustable belt for our current study of Northern Leopard Frogs (*Lithobates pipiens*) and American Toads (*Anaxyrus americanus*). We describe its design and evaluate its performance over two seasons of study in north-central Iowa.

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Methods.—We attached 1.8 g model BD-2 radio transmitters (Holohil Systems, Ltd., Carp, Ontario) to post-breeding adult frogs and toads during the 2009, 2010, and 2011 (current) field seasons. These radio transmitters have an expected battery life of 14 weeks and, based upon our field measurements, a typical detection range of 400–650 m. The waist belt was made from two sizes of flexible tubing and a length of thin (0.28 mm diameter), copper wire. Holohil Systems imbedded a 1 mm inside diameter (ID) plastic tube within the epoxy of the transmitter. The length of copper wire, approximately equal to the circumference of the animal's waist, was passed through this tube. Two lengths of dark gray, flexible PVC tubing (PVC 105–18, 1.0668 mm outside diameter (OD); Alphawire, Elizabeth, New Jersey), each equal to about one-third the animal's waist circumference, were slipped over the ends of the copper wire (one length on either side of the transmitter). We secured these lengths of PVC tubing against the transmitter by bending the ends of the copper wire over their ends (Fig. 1). The belt is secured around the animal's waist by passing the ends of the PVC tubing into a length of silicone tubing (1/16" ID and 1/8" OD; Cole Parmer Instrument Company, Vernon Hills, Illinois), cut to approximately one-half the circumference of the animal's waist (Fig. 2). The belt was adjusted for fit by changing the amount of PVC tubing extending inside the silicone tubing. Because the OD of the PVC tubing was very close to the ID of the silicone tubing, friction held the belt together (i.e., similar to a Chinese finger trap). The average ($\pm$ SD) weight of twelve finished belts was 0.274 $\pm$ 0.041 g.

Results.—We used this belt on a total of 14 frogs and 20 toads during the 2009 and 2010 seasons, and seven frogs and 34 toads during the 2011 season. Making and attaching the belt required 5–10 minutes and the double-tube design made it easy to make fine adjustments in the field in less than one minute. During 2009–2010, frogs weighed an average ($\pm$ SD) of 38.3 $\pm$ 11.0 g (range = 20–65 g); toads weighed an average of 34.6 $\pm$ 7.7 g (range = 22.5–55.5 g). The average length of time that frogs and toads wore the belt was 29 $\pm$ 24 and 34 $\pm$ 16 days, respectively. Factors limiting the time of telemetry with these animals included escaping the belt (~50%), predation (~20%), lost signal (~9%) and death (~9%) (Table 1). Six of the 20 toads and two of the 14 frogs developed minor skin abrasions that were easily and effectively treated in the field by applying Vitamin E to the sore and adjusting the belt; two additional toads developed more serious abrasions that required removal of the belt. Half (N = 8) of those animals that escaped did so after the long whip antenna became entangled in dense herbaceous vegetation. We eliminated this problem by shortening the whip antenna from a length of 15 cm to 10 cm.

During 2011, frogs weighed an average of 3.2 $\pm$ 8.7 g (range = 27–52 g); toads weighed an average of 35.9 $\pm$ 6.9 g (range = 22–52 g). Additional experience with this belt resulted in fewer lost animals and much longer tracking periods (Table 2). At the time of this writing (mid-July 2011), no animals have been lost due to antennas becoming entangled in herbaceous stems. We have released only one animal due to skin wounds and only four others have escaped the belt. Fates of others include predation (~32%), death (~20%), and lost signal (~7%).

Discussion.—This belt is light-weight (i.e., adds < 0.3 g to the radio transmitter), was easily attached and adjusted in the field

Table 1. Average weight, fate, and number of days tracked for Northern Leopard Frogs (NLF) and American Toads (AT) during 2009 and 2010 field seasons. Half of those that escaped did so when the antenna of their radio transmitters became entangled in dense vegetation; shortening the antenna eliminated this problem.

No. of NLF	Avg. Wt.	Fate	No. Days Tracked
3	36.0 ± 9.1	released	49.0 ± 13.8
7	40.1 ± 13.7	escaped	26.7 ± 16.1
2	32.2 ± 3.2	predation	19.5 ± 13.4
1	50	died	7
1	33	signal lost	27
No. of AT	Avg. Wt.	Fate	No. Days Tracked
2	34.5 ± 0.7	released	78.5 ± 31.5
9	35.2 ± 6.9	escaped	23.2 ± 13.3
5	36.3 ± 12.7	predation	29.0 ± 9.7
2	28.0 ± 4.0	died	31.5 ± 0.71
2	34.5 ± 2.1	signal lost	54.5 ± 23.5

Table 2. Average weight (Avg. Wt.), fate, and number of days tracked for Northern Leopard Frogs (NLF) and American Toads (AT) during the 2011 field season (as of mid-July 2011).

No. of NLF	Avg. Wt.	Fate	No. Days Tracked
4	35.4 ± 11.6	predation	26.5 ± 9.6
3	30.3 ± 2.1	died	25.3 ± 12.8
No. of AT	Avg. Wt.	Fate	No. Days Tracked
9	34.5 ± 0.7	still tracking	> 70
1	47	released	25
4	32.3 ± 4.5	escaped	10.5 ± 10.3
3	30.3 ± 15.6	belt broke	61.9 ± 10.7
9	35.0 ± 7.6	predation	20.1 ± 12.4
5	33.8 ± 8.3	died	26.6 ± 9.0
3	37.3 ± 2.1	signal lost	34.7 ± 29.7

by one individual in under five minutes, seemed to be minimally invasive (affected normal behavior little and caused minimal injuries), and released the animal when it became entangled in dense vegetation. Two other attachment methods (a plastic belt, Bartelt and Peterson 2000, and a nylon ribbon, Pilliod and Ritson, pers. comm.) caused deep skin wounds on 19 of 30 animals. The smooth, rounded, larger diameter tubing of this belt distributed the point of contact over a larger area of the delicate skin. Its ease of attachment minimized the amount of time each animal was handled, lessening stress to the animal, and its ability to be finely adjusted throughout the season helps reduce skin sores.

The belt did not seem to interfere with normal, daily movements and behavior, or amplexus. Perhaps the biggest problem we encountered was when the long whip antenna became entangled in the dense growths of vegetation of restored prairies. The shortened antenna reduced the detection range of the radio signal by 50 m, or 10–15% of its previous detection range, but for this study the elimination of entangled antennas made this shortened range worthwhile. However, the shortened antenna may not be appropriate for tracking species that make longer distance movements, or use habitats that reduce detection ranges.

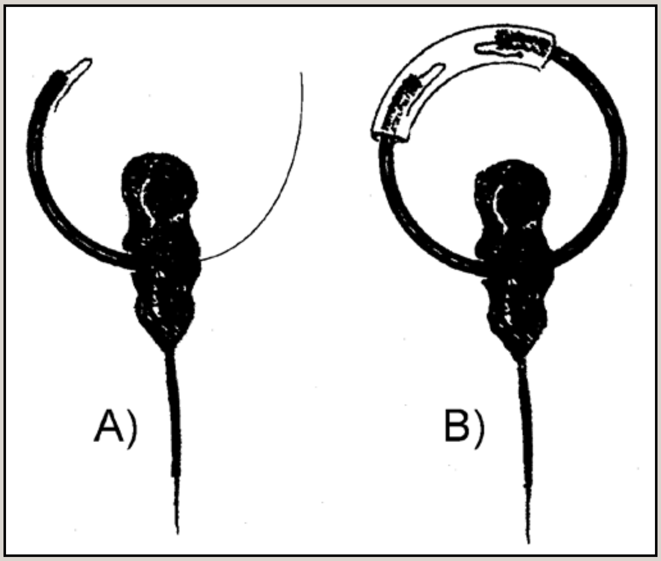

Fig. 1. Details of this belt design. A) Belt showing copper wire extending through one length of PVC tubing and 1 mm tube imbedded within the transmitter epoxy. The copper wire is bent over an end of the PVC tubing. B) Finished belt affixed to a radio transmitter. Both lengths of PVC tubing are held firmly against the transmitter by the copper wire. A length of silicone tubing fits snugly over each end of the PVC tubing and allows for easy and fine adjustments around the waist of a frog or toad. (A slight angle to this drawing makes the silicone tubing appear slightly off center.)

Fig. 2. Details of the belt attached to a Northern Leopard Frog. The length of silicone tubing, visible in the middle of the belt, makes the belt fully adjustable.

Belts with a feature that allows the radio transmitter to fall off the animal after many weeks helps ensure any animal whose signal is lost will not permanently carry the radio transmitter. We have recently discovered (2011) that the thin copper tends to break after 9–12 weeks of wear in the field (= approx. battery life of the transmitter); we cannot yet claim this will happen consistently, but five have fallen off tracked toads (two radio transmitters were lying directly adjacent to the toads and reattached). If one needs to ensure the radio transmitter remains on an animal longer, a slightly thicker wire may be used, or the wire may be replaced with a continuous length of PVC tubing (the radio transmitter manufacturer will need to embed a tube with an ID of 1.1 mm). The weight of the 0.28 mm copper wire is approximately equal to the additional length of PVC tubing, so total transmitter weight would remain the same.

We tested this belt only on Northern Leopard Frogs and American Toads, but think it would be suitable for other medium to large species of ranids and bufonids for long-term (i.e. 3–5 month) studies. Like all other attachment methods, experience with this belt improved its success. We caution researchers to choose tubing colors that blend into the animals' natural habitats, check the animals frequently (e.g., once/week) for any sores or health problems, and to remove dead skin from the belt (dead skin clinging to belts seems to facilitate skin sores). This diligence can greatly diminish skin and health problems.

Acknowledgments.—We thank C. Lange, I. Bartelt, and A. March, and for their contribution of ideas and assistance in the field during this study. K. Carlson illustrated the belt and transmitter. R. Klaver provided helpful comments on an earlier draft of this manuscript. This study was funded by a U.S. Geological Survey grant to R. Klaver. This study satisfied all Animal Care guidelines of Waldorf College. Any mention of trade, product, or firm names is for descriptive purposes only, and does not imply endorsement by the U.S. Government.

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HERPETOCULTURE

Herpetological Review, 2012, 43(1), 69-70.

Utilizing a Slide to Move Heavy-bodied Snakes

Fig. 1. Slide attached to exhibit with door open.

Fig. 2. Removing Gaboon Viper (*Bitis gabonica*) from exhibit with slide.

The manipulation of heavy-bodied snakes using traditional methods and tools can present difficulties for both the snake handler and the snake. The weight of a large animal feels substantially amplified at the end of a 36-inch (91.4 cm) snake hook and this increased weight can present a serious safety challenge with larger snakes.

For many heavy-bodied snakes that are primarily ground dwellers, being draped over a snake hook is very unnatural and will often result in excessive struggle leading to injury. In the process of manipulating these animals on traditional snake hooks, they commonly sustain rib fractures and less commonly spinal fractures (Altimari 1998). One technique to mitigate this challenge is to employ the use of two hooks to balance the weight

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Fig. 3. Metal lip used to attach slide to steel track of exhibit.

Fig. 4. Gaboon Viper (*Bitis gabonica*) inside holding cooler after being moved on the slide, prior to lid being secured.

of the animal more evenly (Altimari 1998). In addition, the preferred hooks to use when manipulating various species of heavy-bodied snakes are more flattened, rather than round to further support the animal with minimal injury (Altimari 1998).

Another technique that is commonly used for the manipulation of heavy-bodied snakes is termed "tailing." This method involves the use of one snake hook and then restraining the snake by holding the tail with a hand. For our department it was decided not to utilize this type of manipulation in order to avoid any unnecessary risks inherent with this method of venomous snake handling.

The method utilized to move Gaboon Vipers (*Bitis gabonica*) in and out of exhibit space at the National Zoo involves a "slide" in conjunction with a snake hook (Fig.1). The slide supports the majority of the snake's weight during the move, with the snake hook used only for guidance and minimal manipulation (Fig. 2). The slide is constructed of pine plywood, sanded and varnished to prevent splintering. At the top of the slide a piece of angled sheet metal (1 in. × 7/8 in; 2.5 cm × 2.2 cm) was installed and bent to fit securely into an existing steel track attached directly under the exhibit door (Fig. 3). The slide is 42 in. (106.7 cm) long and wider at the top (20.5 in.; 52.1 cm) where it attaches to the steel tract and tapers more narrowly at the base (13.5 in.; 34.3 cm). Rails (3 in. W × 42 in. L; 7.6 cm × 106.7 cm) were installed on each side of the slide to prevent the animal from falling off the edge. In addition to the sheet metal lip locking into the track of the concrete wall the slide is supported by two legs measuring (2 in. W × 24 in. L; 5.1 cm × 61 cm) that fold for easy storage. A 24-gallon (91 liter) cooler is placed at the base of the slide as a holding container. An eye hook was attached to the lid of the cooler, which allows the lid to be properly secured with a snake hook while remaining out of the snake's striking range. The snake can easily be manipulated with a snake hook onto the slide and slowly guided downward into the container (Fig. 4). Once secured within the container, the exhibit is worked safely and the snake is returned to the exhibit using the slide yet again. This method of moving *B. gabonica* and other heavy-bodied species of snakes has been employed for many years at the National Zoo with no spinal injuries or other health problems for the snakes involved.

Acknowledgments.—We thank Béla Demeter for the concept and design of this piece of equipment. Photographs were taken by Mehgan Murphy, photographer, Smithsonian National Zoological Park.

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HERPETOCULTURE NOTES

SQUAMATA — LIZARDS

***LIOLAEMUS FORSTERI* (NCN). CANNIBALISM.** Cannibalism in lizards belonging to the genus *Liolaemus* has been reported previously (Rocha 1992. Herpetol. Rev. 23:60; Ripoll and Acosta 2007. Herpetol. Rev. 38:459, Kozykariski et al. 2009. Herpetol Rev. 40:89). This is the first report of cannibalistic behavior in *L. forsteri*, a species endemic to the higher elevations (4300–4900 m) of Bolivia (Baudoin and Pacheco 1991. *In* E. Forno and M. Baudoin [eds.], Historia Natural de un Valle en Los Andes, pp. 438–439. Instituto de Ecología, Universidad Mayor de San Andrés, La Paz).

On 9 August 2011 we observed a captive adult male *L. forsteri* (80 mm SVL) attack and eat a recently hatched individual of the same species (hatchlings have mean SVL = 34 ± 0.8 mm, N = 4). The attack occurred quite rapidly and concluded with the adult swallowing the whole body of the hatchling (Fig. 1). The adult male was evaluated using radiography 48 h after the event, but there was no visible evidence of the hatchling in the digestive track. However, fecal analysis confirmed the presence of skin remnants.

The species reported here as *L. forsteri* was considered as *L. signifer* until a recent taxonomic review (Aguilar-Kirigin 2011. Revisión Taxonómica y Sistemática del Género *Liolaemus* (Iguania:

PHOTOGRAPH TAKEN FROM VIDEO COURTESY OF MATÍAS BARCELÓ.

Fig. 1. Adult male *Liolaemus forsteri* swallowing a hatchling conspecific.

Liolaemidae) en el Altiplano y Valles Secos Interandinos del Departamento de La Paz-Bolivia. Licenciatura thesis. Univ. Mayor de San Andrés, La Paz. 106 pp.).

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***TROPIDURUS ITAMBERE*. ESCAPE BEHAVIOR.** Despite its wide distribution in Brazil (Rodrigues 1987. Arq. Zool. 31:105–230), there are few studies on the behavior of *Tropidurus itambere*. Escape behavior is expected to be under strong natural selection as predation is probably one of the most pervasive selective agents for most organisms. It is considered a secondary defense mechanism, and is used when errors occur in primary defense mechanisms (Edmunds 1974. Defense in Animals. Longman Group. New York. 357 pp.). Lizards can remain on their initial substrate type or escape to "preferred" substrates (Vanhooydonck and Damme. 2003. Funct. Ecol. 17:160–169.). Thus, specific locations and soils may increase an animal's chance of surviving a predatory attack (Vanhooydonck et al. 2007. Integr. Comp. Biol. 2007:1–11). Locomotor escape behavior is a defense mechanism widely used in lizards. Some species burrow into the substrate where they live or dive into sand (Greene 1988. *In* Gans and Huey [eds.], Biology of the Reptilia, pp. 1–50. Alan R. Liss, Inc., New York; Rocha 1993. Cienc. Cult. 45:116–122). To date, burial escape behavior in *T. itambere* has not been reported.

On 14 February 2010, we collected an adult male *T. itambere* (7.08 mm SVL) in Reserva Biológica Unilavras – Boqueirão (44.9172°W, 21.4011°S; 1250 m elev.), in a rocky field within Cerrado, in the municipality of Ingaí, state of Minas Gerais, Brazil. The behavior of this specimen was studied for 30 min. under laboratory conditions, using the focal animal method (Altmann 1974. Behaviour 49:227–267). The specimen was placed in a terrarium with sandy soil, with water, rocks, and natural vegetation obtained at the collection site. In the terrarium the lizard burrowed into the sand head first, using its forelimbs in fast, alternate movements of excavation. The lizard immediately curved its body into an "S" configuration and completed the burial using its hindlimbs, leaving only its head above the surface. In Cerrado areas, *T. itambere* is associated with rock fields (Rodrigues, *op. cit.*) and in Ingaí, these areas consist of rocky outcrops, usually in sandy soils (Pereira and Volpato 2005. Pro Hom. 4:27–34). *Tropidurus* is widely distributed geographically with both saxicolous and psammophilous forms, *T. itambere* being saxicolous (Faria and Araújo 2004. Braz. J. Biol. 64:775–786). It may be that burial escape behavior is an ancestral trait within *Tropidurus* that has been retained in the genus as speciation occurred across different substrate types.

The current study reports burial behavior exhibited by *T. itambere* from Brazil for the first time. The specimen (CRLZ 000178) was deposited at the Coleção de Répteis do Laboratório de Zoologia, Centro Universitário de Lavras - UNILAVRAS, municipality of Lavras, Minas Gerais, Brazil.

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SQUAMATA — SNAKES

***BOGERTOPHIS SUBOCULARIS* (Trans-Pecos Ratsnake). UNUSUAL BEHAVIOR DURING FEEDING.** On 14 November 2006, I observed a long-term captive adult male *Bogertophis subocularis* exhibiting an interesting tail movement behavior herein termed "pre-prandial caudal flicking." I have observed this behavior multiple times over the past five years in both wild caught and captive bred individuals of this species and in a captive bred *Pantherophis bairdi* (Baird's Ratsnake).

In each case, laboratory mice (*Mus musculus*) were offered as live prey or previously euthanized (frozen and thawed). All mice were placed behind cage furniture (e.g., a section of cork bark), which obstructed the view of the snakes to the prey item. It was apparent by the snakes' behavior (alertness, repeated tongue flicks and searching) that they were fully aware of the proximity of the prey item. After approximately 10 seconds of searching behavior, each snake would remain nearly motionless but rigid with only the tail moving. The movement of the tail is best described as intermittent bouts of rapid, spontaneous flailing in a wide-ranging motion. Each burst of movement was characterized by a thrashing or whipping action of the tail lasting approximately 2 seconds with periods of no movement lasting 4–6 seconds. As soon as the mice were located they were quickly seized and constricted.

The type of movement described most resembled the frantic caudal trembling exhibited by many eublepharid geckos just before a predatory strike directed towards an invertebrate prey item (Kaverkin 2005. *In* A. Kirschner, H. Seufer, and Y. Kaverkin [eds.], Eyelash Geckos: Care, Breeding and Natural History, pp. 127–132. Kirschner & Seufer Verlag, Karlsruhe). However, it differed from this behavior in that all caudal movement ceased when the prey objects were visually located by the snakes. The observed behavior is very different from the caudal luring behaviors described for New World pit vipers, (Sazima 1991. Copeia 1991:245–248) and the Green Tree Python (*Morelia viridis*; Murphy et al. 1976. J. Herpetol. 12:117–119; Maxwell 2003. The Complete Chondro: A Comprehensive Guide to the Care and Breeding of the Green Tree Python. ECO Herpetological Publishing, Lansing, Michigan. 247 pp.) where the tip of the tail is raised and moved in a slower "inch worm"-like motion. This is also vastly different from the tail buzzing or vibrating behavior that many species of snakes, including *B. subocularis*, use as a defensive, warning behavior when threatened by a predator (Rhoads 2008. The Complete Suboc: A Comprehensive Guide to the Natural History, Care, and Breeding of the Trans-Pecos Ratsnake. ECO Herpetological Publishing, Lansing, Michigan. 291 pp.).

I thank Jack W. Sites and James B. Murphy for help with this note.

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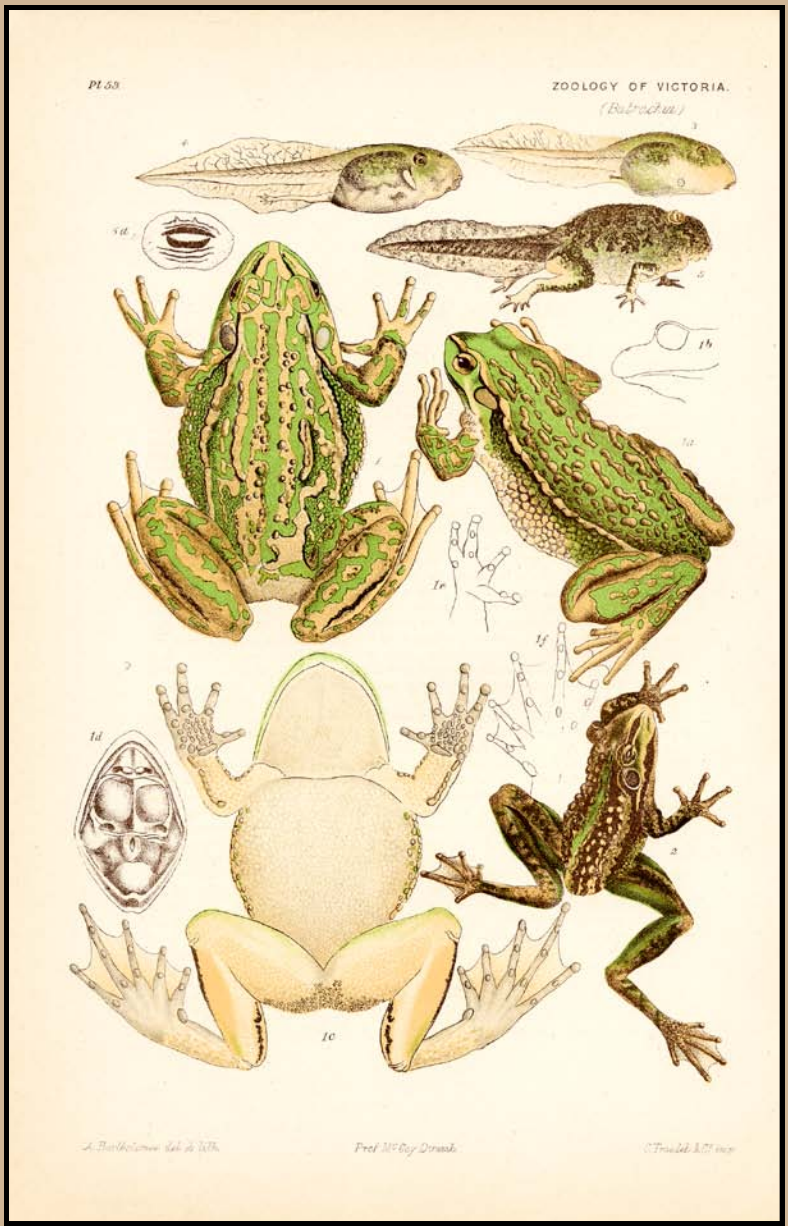
ART IN HERPETOLOGY



The illustration at left originally accompanied an article titled: "Ranoidea aurea, The Green and Golden Bell-Frog," *published in 1881 within the pages of Prodromus of the Zoology of Victoria; or Figures and Descriptions of the Living Species of All Classes of the Victorian Indigenous Animals*. This periodical, published in twenty parts from 1878 to 1890 by the National Museum of Melbourne was met with critical acclaim and wide popular support. John McCoy (1823–1899), director of the National Museum of Melbourne, wrote the text and employed a number of artists to illustrate his work, including Arthur Bartholomew, the illustrator and lithographer of this piece. Bartholomew was born in Bruton, Somerset Shire, England in 1834. In 1852, at 18 years of age, he left his homeland and moved to Australia. Not long after his arrival in Melbourne, he set forth to explore the Australian bush and ventured to Tasmania where he met his wife, with whom he had two children.

Bartholomew returned to Melbourne with his family where, in 1859, he was appointed Attendant in Melbourne University's department of Natural History. It was here he met McCoy, who recognized Bartholomew's artistic abilities. McCoy hired Bartholomew to complete a series of zoological and geological illustrations for several projects, including the *Prodromus*. Bartholomew was known to illustrate living specimens, which included several frog species that he tended to keep in the laboratory adjacent to McCoy's lecture room. A characteristic of Bartholomew's work is the use of line drawings within his illustrations to provide diagnostic features of each species. Examples of these line drawings can be seen in this piece. This is the first illustration showing the natural colors of the species, now known as *Litoria aurea*.

Bartholomew's career as a biological illustrator spanned 40 years, a period of time that would see him illustrate over 700 zoological specimens and an as-yet undocumented number of geological and paleontological specimens. He died in Melbourne in 1909. Additional information can be found at http://museumvictoria.com.au/caughtandcoloured/.

—Contributed by Will Brown
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AMPHIBIAN DISEASES

Herpetological Review, 2012, 43(1), 73–75.

Chytrid Fungus, *Batrachochytrium dendrobatidis* (*Bd*), Detected at Lower Elevations in Puerto Rico: Implications for Conservation of Puerto Rican Crested Toad (*Peltophryne lemur*)

The Puerto Rican Crested Toad, *Peltophryne lemur*, is federally listed as Threatened (U.S. Fish and Wildlife Service 1992) and Critically Endangered by the International Union for Conservation of Nature and Natural Resources (IUCN 2011). It is the only native toad of Puerto Rico and is a representative of an ancient and distinctive clade of Bufonidae that is distinguished from other species by its unique elongated snout and pronounced cranial crest (Pramuk 2006; Pramuk et al. 2007). Once widespread throughout the karst regions, the last remaining wild population has been reduced to a small area within the southwestern part of the island and fluctuates between 300 and 3,000 individuals (M. Canals, unpubl. data).

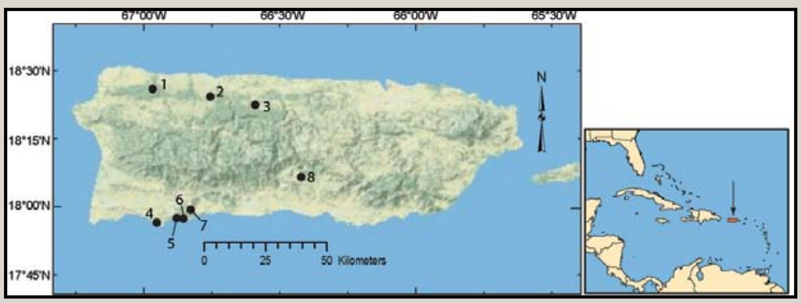

Fig. 1. Map of Puerto Rico. Numbers correspond to the following collection sites: Quebradillas (1), Arecibo (El Tallonal) (2), Rio Encantado (3), Manglillo (4), Aroma (5), Tamarindo (6), Ventana (7), Coamo (Gabia) (8).

Recovery efforts for this species include a reintroduction program directed by the United States Fish and Wildlife Service (USFWS), the Puerto Rican Department of Natural and Environmental Resources (PRDNER), and the Association of Zoos and Aquariums Puerto Rican Crested Toad Species Survival Plan (PRCT SSP). Since intensive reintroduction began in 1992, more than 179,000 tadpoles produced from captive-bred toads held primarily in North American zoos have been released onto the island. These efforts have resulted in the establishment of three new breeding populations. In recent years, monitoring efforts have increased at all current known toad localities, as well as historic and potential reintroduction sites. Random sampling for the chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), began in 2006 (Table 1) in order to assess the overall health of the wild *P. lemur* populations and mitigate threats that might be introduced via disease from other amphibian species.

The earliest record of chytridiomycosis detected in Puerto Rico was from preserved *Eleutherodactylus* specimens collected in 1976 (Burrowes et al. 2008). *Bd* has been reported from 7 of 15 localities surveyed within the island, all of which were found at elevations above 600 m (Burrowes et al. 2008). Herein, I report the detection of *Bd* at two additional sites within Puerto Rico at lower elevations than previously reported (Table 1). These recent findings are important to consider relative to future *in situ* and *ex situ* conservation management strategies developed for *P. lemur*.

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Random samples were taken of live amphibian species opportunistically while visiting known *P. lemur* sites and one potential new reintroduction site from 2006 to 2011 (Fig. 1). All *P. lemur* samples were taken from wild specimens (not recently metamorphosed from a reintroduction program). Juvenile and adult anurans were captured by hand. Latex gloves were worn and changed between each sampling event. Standard preventative measures were taken while processing specimens to prevent the risk of disease transmission and sample contamination. The ventral skin surface of each anuran was swabbed 25 times around the forelimbs, stomach, pelvic region, legs and toes using a sterile cotton swab. Each sample was stored in an individual vial containing 70% ethanol until processed. All samples were processed at Pisces Molecular LLC (Boulder, Colorado, USA) using a Polymerase Chain Reaction assay method developed by Seanna Annis, which was modified for greater specificity and sensitivity. A total of 157 samples were processed representing seven species at eight sites.

All samples were negative, with the exception of two samples rated as "strongly positive" by Pisces. *Bd* was confirmed from an *Eleutherodactylus antillensis* collected in 2010 from a potential new release site for *P. lemur* in Rio Encantado at an elevation of approximately 192 m. The second *Bd*-positive sample was collected from an *Eleuthrodactylus coqui* at a current reintroduction site in Arecibo at an elevation of close to 82 m (Table 1).

Table 1. Localities in Puerto Rico where amphibians were sampled for *Batrachochytrium dendrobatidis* (*Bd*). Site numbers correspond to locations illustrated in the map (Fig. 1).

Site no.	Location	Elevation (m)	Sample date (mo/yr)	Species	No. sampled	No. *Bd* +	No. *Bd* −
1	Quebradillas (Bo. Cocos) 18.46767°N 66.91843°W	95	12/06	*Rhinella marina*	4	0	4
			12/06	*Eleutherodactylus antillensis*	1	0	
			12/06	*Osteopilus septentrionalis*	5	0	5
2	Arecibo (El Tallonal) 18.40677°N 66.73087°W	82	12/06; 12/07; 04/08 02/10; 05/10; 10/10 05/11	*R. marina*	20	0	20
			05/10; 05/11	*Leptodactylus albilabris*	6	0	6
			04/08; 05/10 ; 05/11	*E. antillensis*	4	0	4
			04/08; 05/11	*Eleutherodactylus coqui*	2	1	1
			04/08; 05/10; 05/11	*Peltophryne lemur*	8	0	8
			05/11	*Lithobates catesbeiana*	3	0	3
3	Rio Encantado 18.35718°N 66.53706°W	192	02/10	*E. antillensis*	2	1	1
4	Manglillo 17.93454°N 66.94710°W	6	12/06; 12/08	*R. marina*	4	0	4
			12/06; 12/07	*P. lemur*	5	0	5
5	Aroma 17.95473°N 66.85080°W	3	12/08	*P. lemur*	6	0	6
6	Tamarindo 17.95433°N 66.84838°W	2	12/06; 12/07; 10/10	*R. marina*	15	0	15
			12/07; 10/10	*P. lemur*	26	0	26
7	Ventana 17.96567°N 66.81408°W	2	12/08	*L. albilabris*	3	0	3
			12/08; 12/10	*P. lemur*	21	0	21
8	Coamo (Gabia) 18.03769°N 66.37582°W	55	12/06; 12/08; 05/10	*R. marina*	5	0	5
			12/07; 12/08; 05/08	*L. albilabris*	7	0	7
			05/10	*E. antillensis*	1	0	1
			05/10	*P. lemur*	8	0	8

Bd has been attributed to the possible extinction of at least three species of coqui (*Eleutherodactylus karlschmidti*, *E. jasperi*, and *E. eneidae*) in Puerto Rico (Longo and Burrowes 2010). It is unknown if *Bd* has contributed to the decline of *P. lemur*, or if it will affect populations in the future. The last known wild population inhabits dry, scrub forest, which might be too inhospitable for the pathogen due to high diurnal temperatures and lack of moisture. However, reintroduced *P. lemur* populations now exist in historic areas of karst habitat within moist rainforests, which are more favorable conditions for *Bd* persistence (Lips et al. 2008; Woodhams et al. 2008). Preliminary studies of skin peptides in a small sample of captive *P. lemur* suggest that they do not possess peptides with antimicrobial activity (J. D. King, pers. comm. 2009). Although these peptides often are present in species of amphibians that exhibit a natural immunity to *Bd* (Rollins-Smith et al. 2003; Rollins-Smith and Colon 2005), not all species secrete them (Conlon et al. 2009; Conlon 2011). Therefore, the susceptibility of *P. lemur* to an outbreak of *Bd* remains unknown. Studies are currently underway using non-genetically essential captive *P. lemur* to determine if this species can tolerate exposure to *Bd*. These findings have bearing on future reintroduction efforts and management decisions for wild populations of *P. lemur* within Puerto Rico.

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Current State of *Bd* Occurrence in the Czech Republic

Chytridiomycosis, a relatively new amphibian disease caused by the chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) (Berger et al. 1998; Longcore et al. 1999), is recognized as a global threat to amphibian biodiversity. The presence of *Bd* has had the worst impact on amphibia in Australia and the Neotropics. Other areas with intensive research and *Bd*-mediated population declines are North America and Western Europe. To date, Eastern Europe and Asia are among those areas with the least research in relation to *Bd* (Fisher et al. 2009).

The first results of broadscale *Bd* detection from Central Europe are just emerging (Ohst et al. 2011; Sztatecsny and Glaser 2011). According to these findings, *Bd* seems to be broadly distributed and quite unspecific in the hosts it infects. Although Central Europe is home to many amphibian species potentially susceptible to the disease, no adverse impact on populations or *Bd*-mediated deaths have been observed so far. Considering *Bd*'s recent emergence, we still have limited information as to its impact on species and populations here. In the Czech Republic, only negative results from limited sample sets were available until 2007 (Garner et al. 2005; Ouellet et al. 2005). Herein, we present recent results of *Bd* sampling done in the Czech Republic.

In 2010, a systematic large-scale sampling design was implemented among the diverse regions of the Czech Republic. *Bd* samples were collected primarily during spring and summer months by skin swabbing of live amphibians. This is a nondestructive method used by most chytridiomycosis researchers in the world (Hyatt et al. 2007). At each locality, we endeavored to reach a minimum of 30 samples per species/life stage in order to be able objectively assess *Bd* occurrence (Garner in litt. 2008). Individuals were captured by hand wearing disposable gloves or by dip net. All prescribed hygienic precautionary measures were taken (Wellington and Haering 2008). Sampled individuals were photographed and returned to their place of capture. In the case of dead individuals found, the last two toes from one leg were collected and preserved in 95% ethanol for future analysis. *Bd* detections were made using Taqman real time qPCR (Boyle et al. 2004), in part at the Institute of Zoology (Zoological Society of London) and in part at the Department of Biology and Wildlife Diseases (University of Veterinary and Pharmaceutical Sciences Brno, Czech Republic).

We detected *Bd* in 41 of 466 (9%) animals sampled overall, in 4 of 10 species sampled, and at 8 of 11 sites sampled (Table 1). In 2008, *Bd* was detected for the first time in the Czech Republic in the Common Toad, *Bufo bufo,* and water frogs of the genus *Pelophylax* (Baláž et al. 2009). In 2010, we found *Bd* in the

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Table 1. *Batrachochytrium dendrobatidis* sampling from specimens collected in the Czech Republic in 2010. Lat. = latitude, Long. = longitude, Elev. = elevation, Ad = adult animals, Sub = subadult animals, Tp = tadpoles, J = juveniles, Species (no. test. / no. pos.) = species and the number of tested and positive animals, **Bold** indicates *Bd*-positive samples, Bv = *Bombina variegata*, Bb = *Bufo bufo*, Bo = *Bombina bombina*, Ha = *Hyla arborea*, Ia = *Ichthyosaura alpestris*, Lv = *Lissotriton vulgaris*, Pf = *Pelobates fuscus*, Pr = *Pelophylax ridibundus*, Ps = *Pelophylax* sp., Pv = *Pseudepidalea viridis*, Rd = *Rana dalmatina*, Rt = *Rana temporaria*, Ss = *Salamandra salamandra*, Tc = *Triturus cristatus*, Prev. (95%) = prevalence by site with 95% confidence interval in brackets, Synt. sp. = syntopic species at a locality, GE = mean of genomic equivalent (amount of zoospores in sample tested).

Site	Site description	Lat. °N	Long. °E	Elev. (m)	Life history	Species (no. tested / no. pos.)	Prev. (95%)	Synt. sp.	GE
Most	Kopistská spoil bank	50.53913	13.59556	250	Ad (4) Sub (45) J (8)	Rd (23/0) Tc (4/10) **Bo (30/2)**	0.04 (0.01–0.12)	Lv	1.43; 0.77
Most	Růžodolská spoil bank	50.58246	13.62308	225	Ad (3) Sub (30) J (9)	**Bo (39/3)** Pr (3/0)	0.07 (0.02–0.19)	Lv, Tc	0.39; 0.50; 0.62
Most	Hornojiřetínská spoil bank	50.57635	13.57967	260	Sub (40)	Bb (40/0)			
Bojanovice	Hillside near a stream	49.84570	14.36443	260	Ad (10)	Ss (10/0)		Bb, Rt	
Temelín	Pond near a nuclear power plant	49.18041	14.36792	500	Sub (30)	**Bo (30/9)**	0.30 (0.16–0.48)		
Karlovy Vary	Albeřické fish ponds	50.15873	13.18304	603	Ad (30)	**Bo (30/2)**	0.07 (0.01–0.21)		0.89; 1.1
Karlovy Vary	Teleč pond	50.12191	13.05690	644	J (36)	**Bo (36/1)**	0.03 (0.00–0.15)	Pf, Ps	73.45
Chřiby Mt.	Municipal fire-fighting reservoir	49.14128	17.36536	250	Ad (18) J (43)	**Bv (61/11)**	0.18 (0.10–0.29)	Rt, Bb, Pv	0.4–8.8
Chřiby Mt.	Flooded track	49.15540	17.35579	300	Ad (25)	**Ia (25/1)**	0.04 (0.00–0.20)	Rt	
Moravský Písek	Flooded field	49.01034	17.34299	178	Ad (38) Sub (4) J (19) Tp (31)	**Bo (61/12)** Pf (31/0)	0.13 (0.07–0.22)	Pv, Ps, Ha, Lv	0.2–104
Staré Město	Pool in urban area	49.07396	17.45144	180	Ad (18) J (25)	Pv (43/0)		Ha, Ps	

positive samples had GE values close to the detection limit of the method and only a few reached a magnitude of 10^1, but their fluorescence increase curves showed no problems with the qPCR reaction. Therefore, our results likely show low prevalence and low intensity of infection in the specimens carrying the pathogen. This is also supported by the fact that although all sampled individuals were photographed in detail, no visual symptoms of chytridiomycosis were found in *Bd*-positive animals. All dead and suspicious specimens (lethargic, abnormal sitting posture, fearless, half-closed eyes, etc.) sampled were *Bd*-negative.

In Europe to date, *Bd* has been found in more than one-third (29) of Europe's amphibian species in 13 countries (Austria, the Czech Republic, Denmark, France, Germany, Great Britain, Hungary, Italy, Luxembourg, Poland, Portugal, Spain, Switzerland) (Ohst et al. 2011; Sztatecsny and Glaser 2011; Civiš et al. 2010; Sura et al. 2010; Baláž et al. 2009; Wood et al. 2009; Garner et al. 2005; Vörös et al. unpubl.). These *Bd*-positive taxa include 19 of 21 species living in the Czech Republic.

Results from Austria (Sztatecsny and Glaser 2011), Germany (Ohst et al. 2011), Poland (Sura et al. 2010), and the Czech Republic (this paper) support the occurrence of *Bd* across Central Europe. However, the intensity of research is still notably lagging here relative to Western Europe. Thus, the data gathered to date do not allow for assessing the potential risks to Czech amphibians and their populations, which are in many cases already small and are in decline for other reasons unrelated to this disease. In the Czech Republic, therefore, at least essential precautionary steps via hygiene protocols could be established to address the disease, including approaches to mitigate its potential spread to new areas or species. Since 2010, we are conducting a more comprehensive sample, which should aid this assessment for the development of science-supported potential future management directions.

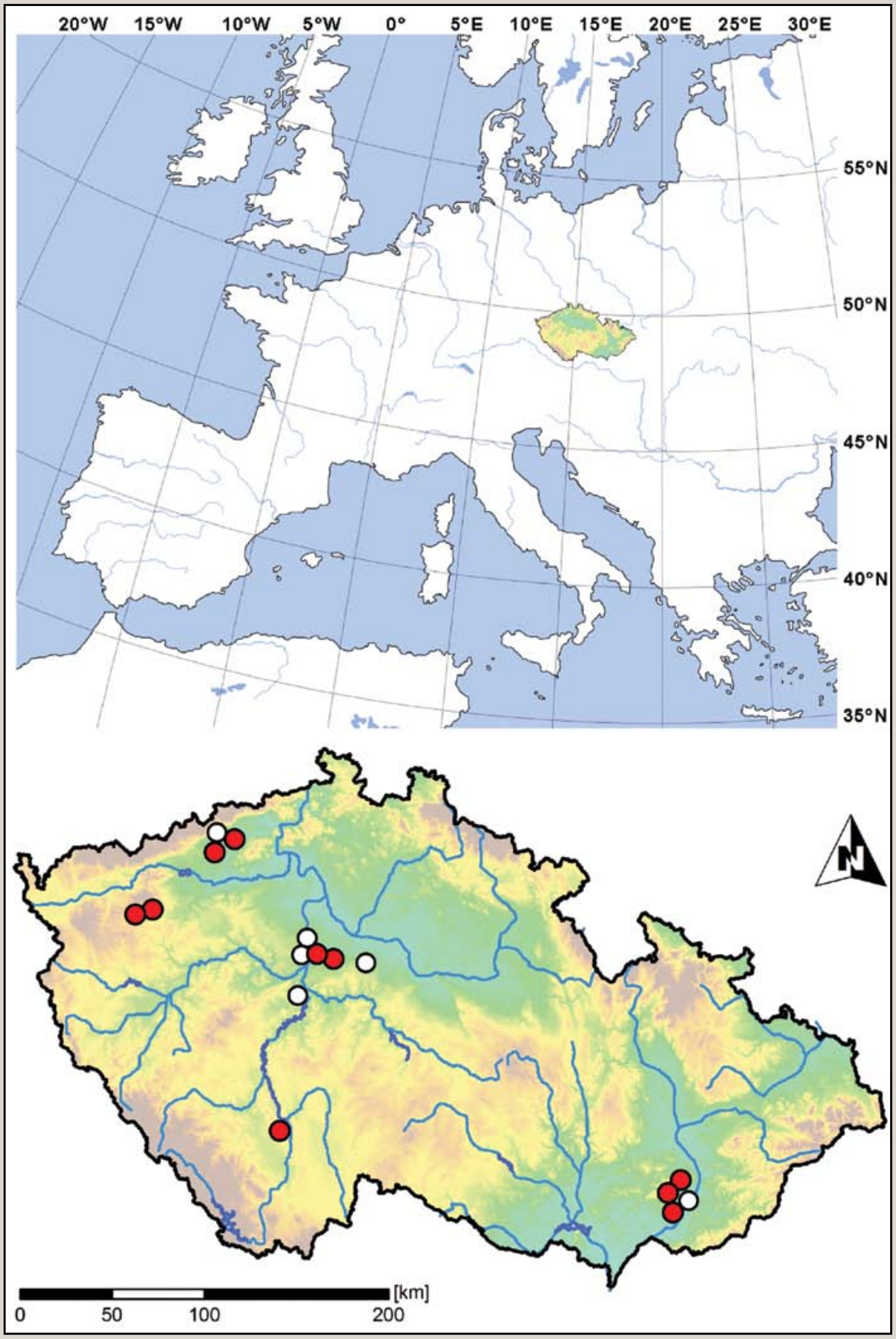

FIG. 1. Locations of amphibian populations in the Czech Republic that tested positive for *Batrachochytrium dendrobatidis* (red circles) and localities where all samples were negative (white circles). These data include the current study and unpublished data using the same methods from another six localities sampled during 2008–2009 (Vörös et al., unpubl.).

European Fire-bellied Toad, *Bombina bombina,* and the Yellow-bellied Toad, *B. variegata,* in eight discrete localities (Fig. 1, Table 1). *Bd* was most prevalent in the genus *Bombina*, however our results show very low GE values (genomic equivalent of 1 *Bd* zoospore). The observed prevalence might be underestimated because the PCR reaction that we used contained neither an internal positive control (IPC) (Hyatt et al. 2007) nor BSA (bovine serum albumin) for reduction of reaction inhibition (Garland et al. 2010). However, very similar prevalence data were already published from both Luxembourg (Wood et al. 2009) and Germany (Ohst et al. 2011), which support our observations. Several

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Survey of Ranavirus and the Fungus *Batrachochytrium dendrobatidis* in Frogs of Central Virginia, USA

The Global Amphibian Assessment found that 42% of amphibian populations are in decline, and 32% of species globally face extinction in the near future (IUCN 2008). Emerging infectious diseases, including the fungus *Batrachochytrium dendrobatidis* (*Bd*) and ranaviruses, have been responsible for mass die-offs and are considered major international threats (Daszak et al. 1999; Schloegel et al. 2010). Ranavirus has low host specificity; fish, reptiles and amphibians can be lethally or asymptomatically infected and can serve as reservoirs for other vulnerable species (Chinchar 2002; Schock et al. 2008). Surveillance of these pathogens is important for understanding their distribution and potential threat to amphibians and other animals. We used non-destructive sampling to survey for *Bd* and ranavirus in central Virginia, USA. No amphibian die-offs had been recorded in this area, although dedicated monitoring had not previously occurred.

On eleven trips from 1 April through 2 July 2010 we swabbed adult animals and collected toe clips to assess the presence of *Bd* and ranavirus, respectively, in four anuran species in three water bodies in Prince Edward County, Virginia: Briery Creek Lake in Briery Creek Wildlife Management Area (north end of the lake; 37.2005°N, 78.4497°W), and two ponds on the campus of Hampden-Sydney College (Chalgrove: 37.2428°N, 78.4639°W and Tadpole Hole; 37.2452°N, 78.4529°W). Chalgrove and Tadpole Hole are both approximately 1 ha and located 0.8 km apart. Briery Creek Lake is a 342-ha lake located 4.5 km south of the other ponds. We collected adult frogs by hand, typically between 1900–2300 h. Each frog was placed in a new plastic bag, and nitrile gloves were changed between catching individuals. While processing animals, we used a recommended protocol with two people to prevent contamination of samples (Brem et al. 2007). To sample for *Bd*, frogs were swabbed five times with sterile cotton-tipped applicators on both sides of the abdomen, ventral abdomen, ventral surface of thighs, and rear feet (Brem et al. 2007). To sample for ranavirus, the front-right toes of large species (*Lithobates catesbeianus*, *L. palustris*, *Anaxyrus fowleri*) or 1–2 hind-right toes of small frogs (*Pseudacris crucifer*, *Acris crepitans*) were collected using sterile surgical blades (St-Amour and Lesbarrères 2007). Both swab tips and tissue samples were preserved in 70% ethanol. All animals were released within 1–3 h at the original site of capture. To prevent cross-contamination between sites, all supplies and equipment were disinfected with 1% Nolvasan. Although Nolvalsan has not been tested against *Bd*, it is used as a fungicide, bactericide, and virucide, has

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been proven to inactivate ranavirus at levels that are not toxic to amphibians, and is less caustic to equipment than bleach (Bryan et al. 2009; Kennedy et al. 2000). All materials that directly contacted animals (gloves, bags, scalpel blades, swabs) were used only once and contacted no more than one individual.

Of the 140 frogs processed, 103 were tested for ranavirus and *Bd*. Only species within a site that had ≥14 individuals were tested, because of the likelihood of misclassifying as uninfected sites with small sample sizes and low prevalence (Greer and Collins 2007). Disease testing was performed by the Veterinary Diagnostic and Investigational Laboratory in the College of Veterinary Medicine at University of Georgia. In brief, genomic DNA was extracted from toes following the tissue method of a commercially available kit (DNeasy Blood and Tissue Kit, Qiagen Inc., Valencia, California, USA). Conventional PCR was then performed using the protocol and primer sets reported by Annis et al. (2004) for Bd and those found in Mao et al. (1996, 1997; primers MCP4 and MCP5) for ranavirus. The PCR products were resolved via electrophoresis on a 1.0% agarose gel. Controls for all PCR runs included two negative controls (water and tissue from a ranavirus-negative tadpole) and two positive controls (cultured ranavirus and tissue from an experimentally infected and confirmed ranavirus-positive tadpole). The PCR reactions were repeated once to confirm results.

Bd was found in three of the five species tested, and at each of the three water bodies (Table 1). Among species with positives in a site, prevalence of the pathogen ranged from 6–20% (Table 1). No obvious pathological signs or dead or moribund animals were observed during the course of this study.

While ranavirus has been detected in a number of amphibian species sampled in the southeastern United States, including species in the current study: Bullfrogs (*Lithobates catesbeianus*), Cricket Frogs (*Acris crepitans*), Pickerel Frogs (*L. palustris*), Spring Peepers (*Pseudacris crucifer*), and Wood Frogs (*L. sylvaticus*) (Gray et al. 2009), none of the toe clips from the 103 frogs screened tested positive for ranavirus. Ranavirus was, however, detected in syntopic aquatic turtles, with prevalence ranging from 5–31.6% at these three sites, in a companion study using similar sample sizes and distal tissues (Goodman et al., unpubl.), which raises the question of whether we missed infections in the anuran populations.

We are confident that we did not miss infections in the animals we screened. St-Amour and Lesbarrères (2007) found that toe tips were comparable to liver tissue samples in detecting ranavirus in Green Frogs (*L. clamitans*), and although Greer and Collins (2007) demonstrated that tail clips were less sensitive than pulverized whole body samples in detecting ranavirus in salamanders, this difference disappeared after the first week post exposure. Our sample sizes were small within species at each site. However, combining species yields samples of 34 individuals at Briery, 33 at Chalgrove, and 36 at Tadpole Hole, which are sample sizes that should (with 95% confidence) be able to detect ranavirus prevalence of 10% or greater in a site (Brem et al. 2007). Importantly, we did not sample all species in each site, nor did we sample all life stages for any species. Thus if ranavirus was present, it was at likely at low prevalence, in an alternate life stage, or in another host species. Expanded monitoring is needed to establish whether ranavirus infects frogs at these sites.

Bd occurred with low prevalence in *P. crucifer*, *L. palustris*, and *A. crepitans*, but was not detected in *L. catesbeianus* or *A. fowleri* (each collected in one site). Larger sample sizes would be needed to rule out the possibility of infection in these species, especially

Table 1. Prevalence (number positive/number tested) and associated 95% confidence intervals (CI) for *Batrachochytrium dendrobatidis* (*Bd*) occurrence in frogs from three water bodies in central Virginia. Dashes indicate that small sample sizes precluded tested for that species and location. The 95% confidence intervals with no continuity correction were calculated using a program by Lowry (2011) based on methods in Newcombe (1998) and Wilson (1927).

	Lithobates catesbeianus		*Pseudacris crucifer*		*Anaxyrus fowleri*		*Lithobates palustris*		*Acris crepitans*		Site total	
Study Site	Prev	CI	Prev	CI	Prev	CI	Prev	CI	Prev	CI	Prev	CI
Briery WMA	0% (0/20)	0.0–16.1%	14.3% (2/14)	4.0–40.0%	—	—	—	—	—	—	5.9% (2/34)	1.6–19.1%
Chalgrove	—	—	—	—	0% (0/15)	0.0 –20.4%	5.6% (1/18)	1.0 –25.8%	—	—	3.0% (1/33)	0.5–15.3%
Tadpole Hole	—	—	20.0% (3/15)	7.0–45.2%	—	—	—	—	9.5% (2/21)	2.7 –28.9%	13.9% (5/36)	6.1–28.7%
Species Total	0% (0/20)	0.0–16.1%	17.2% (5/29)	7.6–34.6%	0% (0/15)	0.0–20.4%	5.6% (1/18)	1.0 –25.8%	9.5% (2/21)	2.7–28.9%		

because of the low prevalence of the pathogen estimated for co-occurring species. *Lithobates catesbeianus* has been shown to carry *Bd* but experience low morbidity and mortality due to infection (Daszak et al. 2004) and so it is surprising that infections were not detected. *Anaxyrus* species are also susceptible to *Bd*, though some studies have found absence or low prevalence in sites where other species tested positive (Rothermel et al. 2008; Tupper et al. 2011; Venesky et al. 2011). The current study adds to a body of research showing presence of the fungus *Bd* in frog populations that are seemingly asymptomatic. However, dedicated surveillance would be necessary to determine the potential impacts of *Bd* on local amphibian health and fitness.

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Batrachochytrium dendrobatidis Detected in Fowler's Toad (*Anaxyrus fowleri*) Populations in Memphis, Tennessee, USA

In North America, amphibian declines due to *Batrachochytrium dendrobatidis* (*Bd*) infection have primarily been documented in the western U.S. (Bradley et al. 2002; Fellers et al. 2001; Muths et al. 2003), yet *Bd* infections also have been detected in several southeastern U.S. states (e.g., www.Bd-maps.net; Green and Dodd 2007; Rothermel et al. 2008), including Tennessee (Chatfield et al. 2009). *Bd* has been detected in rural Shelby County, north of Memphis, Tennessee, USA (Venesky and Brem 2008). However, *Bd* infection prevalence in urban and suburban Memphis has not been evaluated, but may be important since the city is located on the Mississippi River and notably, is transected east-to-west by two tributaries of the Mississippi River, the Wolf River and Nonconnah Creek (Fig. 1), and by numerous small urban tributaries including ditches, storm drains, and creeks. Aquatic corridors likely serve as connectivity pathways for amphibians, and hence may also serve to transmit *Bd*. The goals of our study were to determine *Bd* infection prevalence in Fowler's toads (*Anaxyrus fowleri*; formerly *Bufo fowleri*) at several Memphis locations and examine *Bd* prevalence among locations relative to proximity to major nearby waterways, which may serve as toad dispersal corridors.

We sampled for *Bd* from 11 *A. fowleri* populations located across the Memphis metropolitan area (Fig. 1) in 2009 by opportunistically collecting individual toads by hand during walking surveys adjacent to ponds and lakes. We collected 10–24 adults (males and females) from each site and also 12 post-metamorphic juveniles of unknown sex from 5 of the 11 sites (Table 1). Adult animals were sampled during the breeding season (April–June) whereas juvenile animals were sampled following metamorphosis (June–August). Fresh nitrile gloves were used when handling each toad to prevent cross-contamination of samples and we used a sterile fine-tipped swab (Catalog #MW113, Advantage Bundling / Medical Wire Co., Durham, North Carolina, USA) to swab the abdomen, pelvic patch, ventral hind limbs, and hind feet of each toad. Swabs were individually placed into a sterile 5-ml vial (model #985744, Wheaton Science Products, Millville, New Jersey, USA) and stored in darkness at 25°C until sent to the San Diego Zoo Amphibian Disease Laboratory for analysis using real-time (Taqman) qPCR as described by Boyle et al. (2004). We calculated the percentage and 95% binomial confidence interval of both *Bd*-positive adult toads and study sites with *Bd*-positive toads.

We used a handheld GPS unit (model 60CsX, Garmin International, Inc., Olathe, Kansas, USA) to record the coordinates of the approximate center of each sampling site (Table 1). We used ArcGIS (ESRI version 9.3, Redlands, California, USA) to map the location of each sampling site and to add a circular buffer around each site to identify the potential for *A. fowleri* to access major waterways that could allow greater dispersal distances (Fig. 1). The buffer has a radius of 624 m, which is twice the maximum reported movement distance of *A. fowleri* (312 m; Clarke 1974), but is a reasonable estimate of greater possible movement distances in *A. fowleri* that are comparable to the similar-sized congeners *A. americanus* (Oldham 1966) and *A. boreas* (Muths 2003). We also measured the distance (m) from each sampling site to the nearest river and used a Student's t-test (α = 0.05) to determine whether sampling sites with *Bd*-positive individuals were located closer to rivers than sites without *Bd*-positive individuals.

Eleven of 159 (6.9%; 3.9–12%) adult *A. fowleri* at 8 of 11 (72.7%; 43.4–90.2%) sites were *Bd*-positive, yet none of the 60 juveniles sampled were infected (Table 1). Notably, there were no more than two *Bd*-infected toads at any site and the qPCR Ct (Cycle threshold) values (Table 1) indicated that *Bd* infection intensities were relatively low (mean = 37.5; 95% confidence interval = 35.0–40.1). Ct values reflect the number of cycles required to amplify the *Bd* DNA to a detectable level, thus the lower the Ct value the more *Bd* DNA was initially present. Five of eight (62.5%) sites with *Bd*-positive individuals were located within 624 m of a river, yet all three sites without *Bd*-positive individuals were beyond this distance limit (Fig. 1). Despite this, *Bd*-positive and *Bd*-negative sites did not differ (t = -1.22, d.f. = 4.85, P = 0.28) in mean distance (m) to the nearest river.

Bd was present in the majority of *A. fowleri* populations sampled, however *Bd* infection was not widespread among individuals sampled from each population and was found only in adult toads (Table 1; Fig. 1). Non-detection of *Bd* in three adult populations and in all juvenile *A. fowleri* sampled must be interpreted cautiously because our sample size was low (Skerratt et al. 2008), however high *Bd*-infection prevalence can be detected with sample sizes similar to ours (e.g., McCracken et al. 2009; Zellmer et al. 2008). Moreover, *Bd* was confirmed in adult toads at four of five juvenile sampling sites (Table 1) so the potential for juvenile toads to have been infected exists, yet additional studies are needed to identify possible reasons why no juvenile *A. fowleri* in this study were infected with *Bd*. Transmission of *Bd* among individuals within each site may have been limited because *Bd*-infected toads in this study appeared to have relatively low intensity infections (depending on the efficiency of the system, qPCR Ct values > 35 are typically indicative of single digit copies of DNA; Heid et al. 1996; Table 1) and none presented clinical signs of chytridiomycosis. Other wild amphibians including *Lithobates catesbeianus*, *Litoria wilcoxii*, and *Taudactylus eungellensis*, have been shown to appear asymptomatic, yet carry light *Bd* infections (Hanselmann et al. 2004; Retallick et al. 2004). These results suggest that *A. fowleri* may mount effective immune responses to *Bd* or demonstrate seasonal variation in *Bd* infection incidence or intensity as shown in other species

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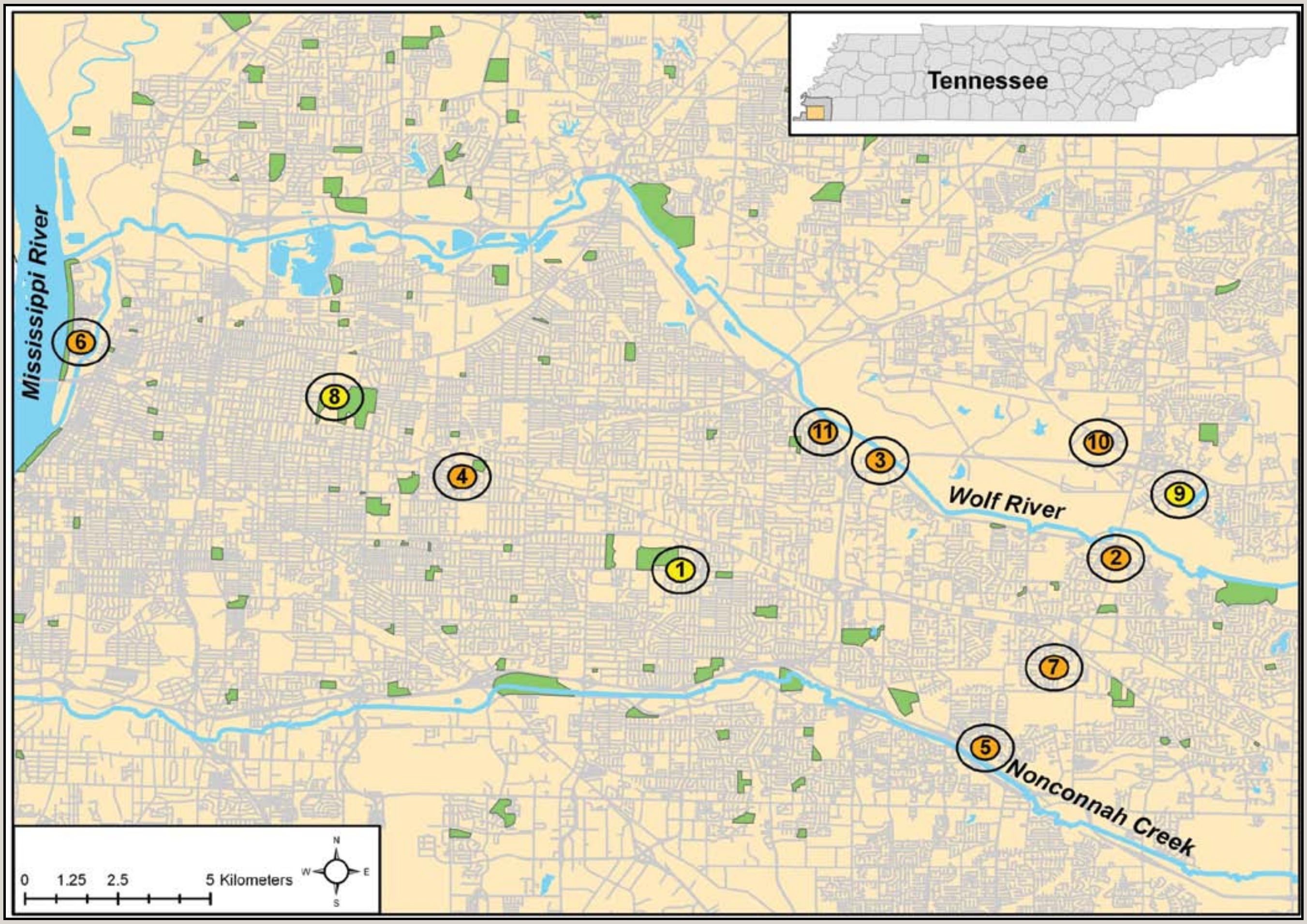

Fig. 1. Locations (N = 11) in Memphis, Tennessee, USA where adult and post-metamorphic juvenile *Anaxyrus fowleri* were sampled for *Batrachochytrium dendrobatidis* (*Bd*). *Bd*-positive adult toads were detected at eight sampling sites (orange fill) and we failed to detect *Bd* at three sites (yellow fill). The number within the circle indicates the sampling site (Table 1) and the circle around each site number represents a 624-m buffer, which was used to identify likely access to rivers that may be possible toad dispersal routes. Note that 5 of 8 sites with *Bd*-positive toads were within 624 m of a possible toad dispersal route.

Table 1. Results of *Batrachochytrium dendrobatidis* (*Bd*) sampling in adult and post-metamorphic juvenile *Anaxyrus fowleri* in Memphis, Tennesseee, USA. qPCR Ct values indicate *Bd* infection intensity, with a lower Ct value indicating a higher *Bd* level.

	Site location		Adults		Juveniles
Site No.	°N (NAD 83)	°W (NAD 83)	No. *Bd*-positive / total sampled (%)	qPCR Ct values	No. *Bd*-positive / total sampled
01	35.107	-89.908	0/10 (0)	N/A	
02	35.1099	-89.8024	2/24 (8.3)	38.6	0/12
03	35.1335	-89.8595	2/12 (16.7)	40.9	
04	35.1297	-89.9609	1/12 (8.3)	34.7	
05	35.0639	-89.8341	1/15 (6.7)	39.9	
06	35.1623	-90.0534	1/14 (7.1)	41.3	0/12
07	35.0834	-89.8173	2/24 (8.3)	38.9	
08	35.149	-89.9919	0/12 (0)	N/A	0/12
09	35.1254	-89.7869	0/12 (0)	N/A	
10	35.1379	-89.8066	1/12 (8.3)	35.5	0/12
11	35.1405	-89.8734	1/12 (8.3)	30.7	0/12

(Berger et al. 2004; Gaertner et al. 2009; Kriger and Hero 2006a, b; Richmond et al. 2009). Either mechanism would enable *A. fowleri* to be a *Bd* reservoir from which *Bd* infection could be transmitted to the local amphibian community. In order to elucidate the host-pathogen dynamics and environmental influences on *Bd* pathogenesis, further research including long-term mark-recapture studies to assess survivorship may be warranted for seemingly resistant species like *A. fowleri*.

The distance to the nearest river from most of the sampling sites with *Bd*-positive toads was less than 624 m, whereas all 3 sites without *Bd*-positive toads were > 624 m from these possible amphibian dispersal routes (Fig. 1). However, sites with and without *Bd*-positive toads did not differ significantly in mean distance (m) to the nearest river in this study. This may be attributable to a low sample size since retrospective power analysis indicated that 28 sampling sites would be required to determine whether distance to the nearest major river differs between sites with and without *Bd*-positive toads. Moreover, we did not survey small tributaries, ditches, storm drains, etc. that can support *A. fowleri* and provide potentially more continuous connectivity among locations. Regardless, adult *A. fowleri* can move up to 312 m (Clarke 1974) and we conservatively suggest that these toads are capable of traversing twice that distance since similar-sized congeners can do so (Oldham 1966; Muths 2003). Other sympatric amphibians at our study sites including *Pseudacris crucifer* (Delzell 1958) have maximum dispersal differences that are similar (573 m) to *A. fowleri*, and moreover *Lithobates pipiens* (Seburn et al. 1997) and *L. catesbeianus* (Ingram and Raney 1943) both have much greater dispersal distances (> 1 km), which make these species potentially important to long-distance transmission of *Bd*. Thus, further study is needed to understand the spatial epidemiology of chytridiomycosis and specifically, the potential for amphibians like *A. fowleri* to be *Bd* reservoirs whose movements may establish continuous connections between source populations (e.g., those at ponds and lakes) and rivers that may allow dispersal of *Bd*-infected amphibians.

The data presented herein contribute to our understanding of *Bd* spatial distribution and host ecology by documenting that *Bd* is present in Memphis, Tennessee, infection prevalence and intensity are relatively low in *A. fowleri*, and *Bd* infection status is unrelated to the distance to the nearest river (Table 1; Fig. 1). Additional studies are needed because the spatial epidemiology of chytridiomycosis and species-specific reactions to *Bd* infection are not well known, yet are vital to our understanding of possible treatment interventions for 'at risk' populations.

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First Record of *Batrachochytrium dendrobatidis* in *Physalaemus fernandezae* (Anura: Leiuperidae) for Buenos Aires Province, Argentina

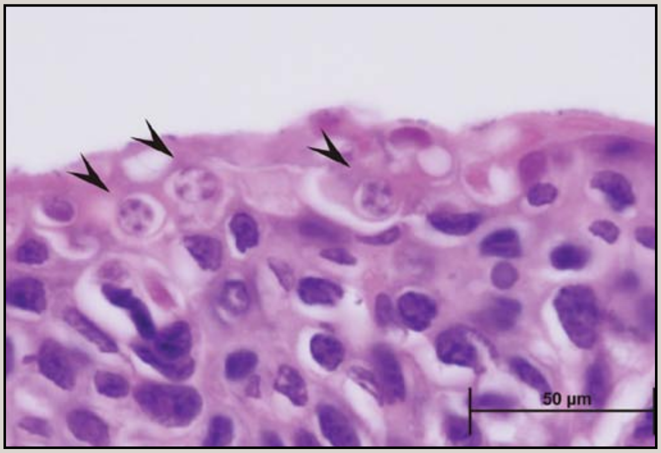

Fig. 1. Histologic section of ventral epidermis of an adult specimen of *Physalaemus fernandezae* from Punta Lara Natural Reserve, Buenos Aires province, Argentina. Arrows indicate the presence of zoosporangia of *Batrachochytrium dendrobatidis* with zoospores.

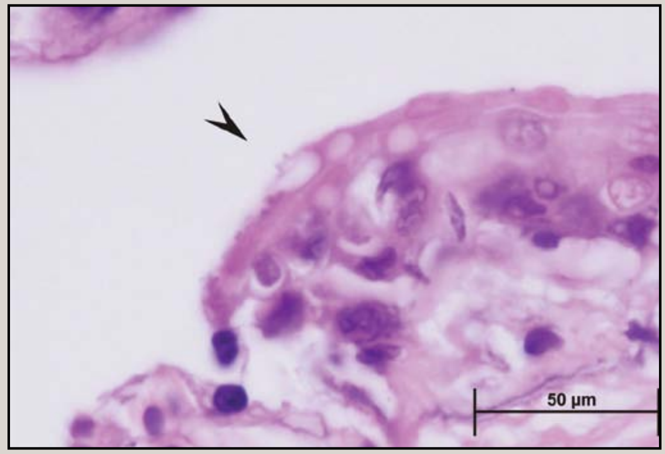

Fig. 2. Histologic section of ventral epidermis of an adult specimen of *Physalaemus fernandezae* from Punta Lara Natural Reserve, Buenos Aires province, Argentina. The arrow indicates an empty zoosporangium, with discharge tube.

In Argentina, *Batrachochytrium dendrobatidis* (*Bd*) is known from Buenos Aires, Córdoba, Misiones, Neuquén, San Luis, Salta, and Tucumán provinces (Arellano et al. 2009; Barrionuevo and Mangione 2006; Fox et al. 2006; Ghirardi et al. 2009; Gutierrez et al. 2010; Herrera et al. 2005). We provide the first record of *Bd* infection in a population of the pond-breeding anuran *Physalaemus fernandezae*, from Punta Lara Natural Reserve (34.8033˚S, 58.0099˚W), Ensenada, Buenos Aires province, Argentina.

Punta Lara Natural Reserve is located on the western bank of Río de La Plata. It has a warm-temperate climate with a mean annual temperature of 16˚C (-4˚C minimum; 42˚C maximum), and has a few days with frost, mostly in June and July. Annual precipitation is slightly over 1000 mm (SMN 2011).

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Physalaemus fernandezae is distributed in Buenos Aires and Entre Ríos provinces, Argentina, and some localities from southern Uruguay (Barrio 1964). It reproduces mainly in marshy grasslands with two reproductive events per year (Barrio, *op. cit.*). The dominant breeding season takes places between May and August (colder temperature months), but may extend until December, in many cases overlapping reproductive events with others sympatric anurans: e.g., *Hypsiboas pulchellus*, *Odontophrynus americanus*, and *Scinax squalirostris*. The second reproductive event involves fewer animals and takes place approximately between February to March, coinciding with reproduction activities of *Dendrosophus nanus, D. sanborni*, *Hypsiboas pulchellus*, *Pseudopaludicola falcipes*, *Pseudis minuta*, *Scinax squalirostris*, *S. berthae*, and *S. granulatus*. Currently, *P. fernandezae* has an IUCN conservation status of Minor Concern (IUCN 2011).

Seven adult specimens of *P. fernandezae* were collected at Punta Lara Natural Reserve in September 2007, preserved in 10% formalin and deposited in the herpetological collection of Museo de La Plata (MLP-A 5385–5391). A skin sample (length: 5 mm; width: 2 mm) was taken from the ventral zone of selected specimens, immersed in paraffin, thin-sectioned every 5 µm with a microtome (Leica, RM 2125 RT), mounted onto a microscopic slide and stained with haematoxilin and eosin, after Drury and Wallington (1980). Histological slides were analyzed for *Bd* following procedures described in Berger et al. (1999), with a binocular microscope (Olympus Optical Co. Ltd., Tokyo, Japan; model BX 50). Diagnostic images were taken with an Olympus DP 71 digital camera mounted to the scope.

The presence of *Bd* was confirmed for 3 of 7 (42.85%) skin samples analyzed. Different developmental stages of chytridiomycosis were clearly visible, namely: zoosporangia (isolated and grouped), empty and containing zoospores (Fig. 1), diagnostic characteristics such as a septum and discharge tube (Fig. 2), and hyperplasic epidermis.

It is worth mentioning that the population of *P. fernandezae* used in this study has been studied by local herpetologists since 2001, but no moribund or dead specimens have been recorded to date. Moreover, the individuals on which infection was detected had been engaged in reproductive activities.

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Low Prevalence of *Batrachochytrium dendrobatidis* in Two Plethodontid Salamanders from North Carolina, USA

Although the pathogenic fungus *Batrachochytrium dendrobatidis* (*Bd*) was first isolated from anuran amphibians, subsequent research has clearly shown that it also infects many species of caudate amphibians. Opportunistic sampling surveys have shown that at least 56 species of salamanders from the families Ambystomatidae, Amphiumidae, Salamandridae, Crytobranchidae, and Plethodontidae in the United States harbor *Bd* (reviewed in Bryne et al. 2008; Olson 2010). The effect of *Bd* on salamander demography, however, is less understood than its impact on anuran populations. Laboratory challenge experiments have shown that salamanders can be infected by *Bd* and show mortality from chytridiomycosis (Chinnadurai et al. 2009; Vazquez et al. 2009; Weinstein 2009), but more sampling and monitoring of salamanders will help elucidate potential ecological and/or climatic variables that may influence the susceptibility of salamanders in the wild. Here, we contribute information on the prevalence and distribution of *Bd* in salamander populations by testing 166 individuals from two localities in North Carolina, USA. Our results expand upon previous reports of *Bd* infection in amphibian populations in North Carolina (e.g., Bryne et al. 2009; Keitzer et al. 2011; Rothermel et al. 2008).

We opportunistically sampled two plethodontid salamander species at two collection sites on 8–12 August 2010 (Fig. 1). At Deep Gap, we collected salamanders by turning over rocks and logs that were located up to 15 m from a stream. The collecting site at Wayah Bald was a grassy area near the forest edge. We swabbed each salamander 30 times using sterile swabs (Medical wire No. 113) in the manner of Boyle et al. (2004) and Kriger et al. (2006). Each animal was handled with a clean pair of latex gloves. No animals showed any outward signs of disease. After swabbing, animals were retained for additional studies under permits issued by the North Carolina Wildlife Resources Commission and the U.S. Forest Service to LDH. Swabs were stored in 100% ethanol and transported to Cornell University, where molecular testing was performed by Kiemnec-Tyburczy.

Genomic DNA was extracted from the swabs using Prepman Ultra following the protocol of Boyle et al. (2004). The level of *Bd* zoospore load was assessed using the method of Boyle et al. (2004). Briefly, this method used Taqman quantitative PCR to determine the total number of *Bd* zoospore genome equivalents in each unknown sample, based on known standards that were run simultaneously. To maximize cost efficiency but retain individual information, PCRs were run in singlicates at 1:10

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dilutions. Studies have shown that there is no statistical difference in sensitivity or specificity between the singlicate and triplicate assays (Kriger et al. 2006). Every swab sample was run with (1) two negative controls, (2) an internal positive control (ABI Cat. No. 4308323) to test for potential inhibition and contamination, and (3) a range of *Bd* standards corresponding to 0.1, 1, 10, and 100 and 1000 zoospore DNA equivalents in duplicate (Hyatt et al. 2007). Samples that were positive for *Bd* in the first round of qPCR were re-run to confirm loads using the same template dilution. We categorized an individual as *Bd*-positive if its swab sample had ≥ 1 zoospore equivalent in both runs (Boyle et al. 2004). We calculated a mean prevalence (and 95% confidence interval) for each site using Clopper-Pearson binomial confidence intervals (Clopper and Pearson 1934).

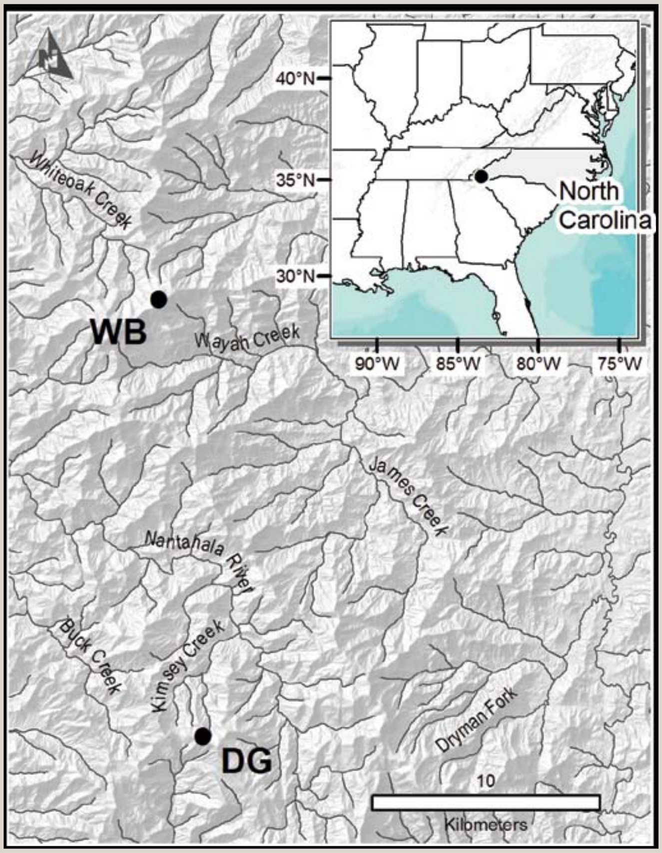

Fig 1. Specific location and topography of two sites in North Carolina, USA (inset; shaded state), where salamanders were tested for the presence of *Batrachochytrium dendrobatidis* (*Bd*). DG = Deep Gap, WB = Wayah Bald.

Table 1. *Batrachochytrium dendrobatidis* (*Bd*) prevalence (number of *Bd*-positive animals/total sampled) in plethodontid salamanders in North Carolina, USA.

		Prevalence			
Locality	Species	♀	♂	Juvenile	Total
Deep Gap (35.0389°N, 83.5431°W)	*Desmognathus ocoee*	1/23	1/31	2/16	4/70
	Plethodon shermani	1/11	0/6	0/13	1/30
Wayah Bald (35.1803°N, 83.5606°W)	*Desmognathus ocoee*	0/1	0/0	0/0	0/1
	Plethodon shermani	1/26	2/14	1/25	4/65

We found that 9 of 166 (5.4%) animals tested positive for *Bd*. Both species—*Desmognathus ocoee* and *Plethodon shermani*—had *Bd*-positive individuals (Table 1). *Plethodon shermani* is a direct-developing species that is commonly found under leaf litter, logs, and rocks. In contrast, *D. ocoee* has an aquatic larval stage and often is associated with seepages and streams (and thus may be more likely to come in contact with *Bd* zoospores). Despite these differences in life histories, both species had similar *Bd* prevalence levels. To our knowledge, this is the first published report of *Bd* infecting these two species, although Keitzer et al. (2011) tested one *P. shermani* and 53 *D. ocoee* at Coweeta Hydrologic Laboratory (Macon Co., North Carolina) but did not detect *Bd* on any individuals. We note, however, that our sampling occurred slightly later in the year and may have occurred at higher elevations. The elevation of our two localities, Deep Gap and Wayah Bald—approximately 1300 m and 1630 m, respectively—are in the upper end of the elevation range of the Coweeta area that was sampled (675–1592 m), and thus our localities may have been cooler and perhaps more suitable for *Bd*.

The prevalence of *Bd* at Deep Gap was 0.050 (95% CI: 0.016–0.11), whereas the prevalence at Wayah Bald was slightly higher at 0.061 (95% CI: 0.017–0.15). All of the zoospore loads we quantified were very low. The highest load we calculated was 57 zoospores, and most of the positive samples contained 3–4 zoospores (range 1–57 zoospores). We did not observe any trend towards particular life stages or sexes being infected within the two species (Table 1), although the animal with the highest load was a juvenile *P. shermani* from Wayah Bald. The low levels of prevalence, combined the lack of clinical signs of disease, suggests that *Bd* exists primarily as a subclinical infection in *D. ocoee* at Deep Gap and in *P. shermani* at Wayah Bald, at least during the summer months.

Our data are consistent with other studies of plethodontid populations that have shown that *Bd* prevalence in some populations is relatively low, but that *Bd* is present in North Carolina (e.g., Keitzer et al. 2011; Rothermel et al. 2008). *Bd* also has been found in other species of *Plethodon* and *Desmognathus* in other areas of the USA. Prevalence in *P. glutinosus* and *P. yonahlossee* in Watauga County, North Carolina was 1/40 and 1/41, respectively (Chinnadurai et al. 2009). *Desmognathus conanti* (Timpe et al. 2008) and *D. fuscus* (Grant et al. 2008) have also tested positive for *Bd*. In fact, *Bd* has been found on plethodontid species as diverse as *Pseudotriton ruber* (Montanucci 2009), *Batrachoseps attenuatus* (Weinstein 2009), *Bolitoglossa dofleini* (Pasmans et al. 2004) and *Plethodon neomexicanus* (Cummer et al. 2005). In other salamander families, population surveys have reported varying estimates of prevalence. A survey of *Notophthalmus viridescens* found 16 of 63 individuals infected in localities in Georgia, North Carolina, and Virginia (Rothermel et al. 2008), whereas another found prevalence in *N. viridescens* varied between 0–100% across multiple ponds in Pennsylvania (Groner and Relyea 2010). Prevalence in ambystomatid salamanders also varies widely; Ouellet et al. (2005) found 4/139 *Ambystoma maculatum* infected across Canada while Padgett-Flohr and Longcore (2005) found 2/11 *A. californiense* infected in two ponds. These studies highlight the need for further work investigating how disease-related mortality has impacted natural populations historically. Further testing across multiple seasons and years is necessary to better understand *Bd* infection dynamics in salamanders.

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Detection of *Batrachochytrium dendrobatidis* in Amphibian Populations of Northeast Ohio

The first North American occurrence of *Batrachochytrium dendrobatidis* (*Bd*) was documented in Quebec in 1961 (Ouellet et al. 2005). As of 2009, *Bd* had been detected in five Canadian provinces and at least 38 US states (for example, Hossack et al. 2010; Sadinski et al. 2010; Fisher et al. 2009; Slough 2009; Muths et al. 2008; Rothermel et al. 2008; Adams et al. 2007; Longcore et al. 2007; Steiner and Lehtinen 2007; Ouellet et al. 2005, and many others, see www.Bd-maps.net). In Ohio, *Bd* has been detected via PCR analysis in wild Northern Leopard Frogs (*Lithobates pipiens*), American Toads (*Anaxyrus americanus*) (Scott and Sheafor, unpubl.), and Blanchard's Cricket Frogs (*Acris blanchardi*) (Steiner and Lehtinen 2008). In addition, Fowler's Toads (*Anaxyrus fowleri*) and cricket frogs captured in Ohio and held at the Toledo Zoo were later found to be infected with *Bd* (G. Lipps, pers. comm.). It is uncertain, however, whether these animals were infected prior to arriving at the zoo, or if they contracted it from other infected species already present at the zoo. Histological surveys of Fowler's Toad museum specimens originally collected from Ashtabula County, Ohio in 1977 determined that the samples were *Bd*-positive (Scott and Sheafor, unpubl.), indicating that *Bd* has been in the northeastern Ohio region for at least three decades. Because *Bd* has been detected in field-collected amphibians from northeast Ohio, the possibility exists that the

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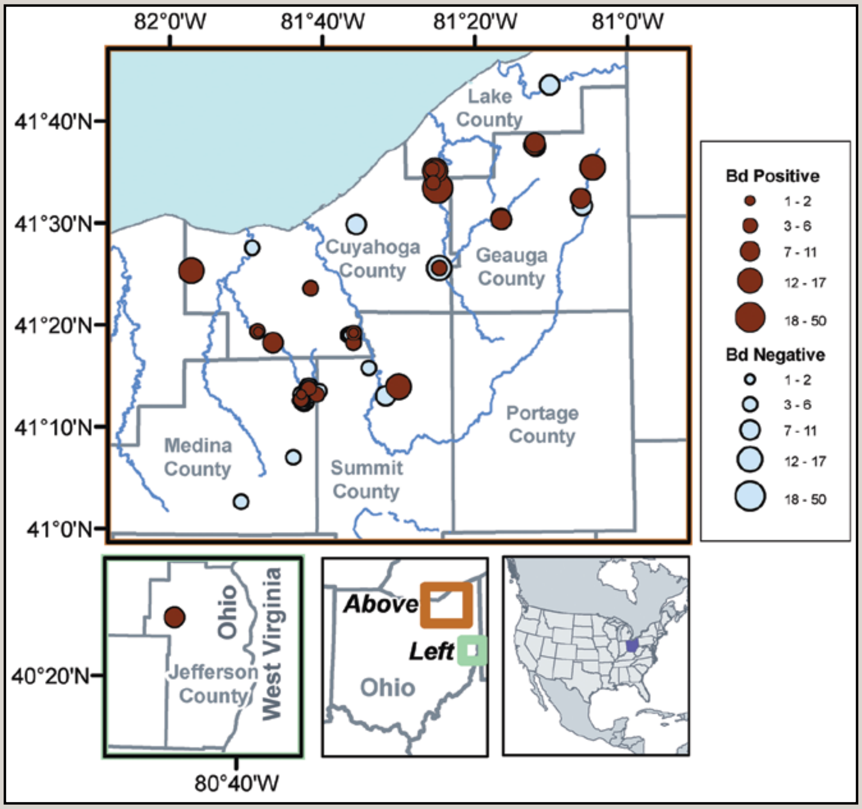

Fig. 1. *Batrachochytrium dendrobatidis* (*Bd*) sampling locations in Northeastern Ohio with both positive and negative sites in the five counties sampled. Circle size indicates sample size.

Table 1. Amphibian species sampled for *Batrachochytrium dendrobatidis* (*Bd*) in northeast Ohio, USA.

Species	No. Sampled	No. Positive (%)
Ambystoma jeffersonianum	32	12 (37.5)
Ambystoma maculatum	31	9 (29)
Ambystoma opacum	5	0
Anaxyrus americanus	24	5 (20.8)
Desmognathus fuscus	31	1 (3.2)
Desmognathus ochrophaeus	22	3 (13.6)
Eurycea bislineata	59	4 (6.8)
Eurycea longicauda	5	0
Pseudacris crucifer	15	4 (26.7)
Notophthalmus viridescens	16	8 (50)
Plethodon cinereus	61	10 (16.4)
Plethodon glutinosus	8	0
Pseudotriton ruber	16	3 (18.7)
Lithobates catesbeianus	8	4 (50)
Lithobates clamitans	54	5 (9.2)
Lithobates pipiens	1	0
Lithobates palustris	5	3 (60)
Lithobates sylvaticus	38	16 (41)
Total	431	87 (20.2)

current amphibian population may be descended from survivors of a previous, unrecorded population decline that occurred sometime after initial introduction of *Bd* to the area (Daszak et al. 1999). The purpose of our survey was to determine presence and geographic distribution of *Bd* in a portion of northeastern Ohio.

Sampling occurred in 2007 and 2008, from mid-March to October at a total of 68 sites in six Ohio counties (Cuyahoga, Geauga, Jefferson, Lake, Medina, and Summit). Volunteers, students, and staff from Cleveland State University, John Carroll University, Cleveland Metroparks, Geauga Park District, and Medina County Park District participated in the project. Most (56/72) sites were classified as forested (> 60% canopy cover), with 12 woodland (< 60% canopy cover), and four open sites. Streams were visited most frequently with 33 perennial and six intermittent streams sampled during the year. Fourteen vernal pools and eight permanent or temporary lakes and ponds were sampled across the region. Wet forests, marshes, and unclassified forests made up the remainder of the sites. Medina County streams were sampled heavily (23 streams) because one team is engaged in a headwater stream assessment project in Cleveland Metroparks Hinckley Reservation.

Two-person (minimum) crews followed an established swab-sampling protocol for collection and preservation of samples (Brem et al. 2007; Livo 2004). Extensive sampling occurred from March to May in forested vernal pools and semi-permanent ponds in woodlands and open areas across northeast Ohio. From mid-May through October, several sites were re-sampled, and additional sampling occurred in stream and riparian areas in Cuyahoga Valley National Park and Hinckley Reservation of Cleveland Metroparks. Amphibians were captured by hand, or with dip nets or minnow traps. When multiple individuals were captured in minnow traps no more than 5 individuals of each species was sampled to decrease pseudo-replication and limit the total number of samples obtained. All equipment and personal gear was disinfected with 10% bleach solution between sites. For each amphibian captured, a clean dip net was used, which was disinfected after use.

All swab samples were placed into individual, labeled microcentrifuge vials containing 70% ethanol. The vials were deposited at the University of Mount Union, Alliance, Ohio for qPCR assay. Microcentrifuge vials containing swabs in 70% ethanol were vortexed for 45 sec and then centrifuged for 3 min at 16,000 × g in an Eppendorf model 5415 microcentrifuge (Eppendorf North America, Hauppauge, New York). After removing the swab, each vial was centrifuged again and the supernatant was carefully removed by aspiration. Prepman Ultra™ (Applied Biosystems, Carlsbad, California) (50 µL) was added and the vial was vortexed for 20 sec to mix the contents. Samples were incubated for 10 min on a boiling water bath, cooled to room temperature, and then centrifuged as above. An aliquot of the supernatant from each sample was diluted 10× with distilled water and used for qPCR.

Quantitative PCR was performed on an MJ Mini thermocycler with a Mini Opticon Real-Time PCR system (Bio-Rad Laboratories, Inc., Hercules, California), according to the method employed by Kirshtein et al. (2007). The 25-µL reaction mixture consisted of 12.5 µL iQ™ SYBR Green Supermix (Bio Rad), 1.2 µM each of primers ITS1-3Chytr and 5.8Schytr, and 5 µL of DNA sample. After one 15 min Taq activation step at 94°C, 40 cycles of 95°C for 30 sec, 57°C, for 30 sec, and 70°C for 30 sec were performed. Melting curves were conducted at the end of each reaction to check for the appearance of primer dimers. Periodic verification of the 146 bp amplified fragment was carried out by electrophoresis on 1.5% agarose gels. Zoospore extracts were prepared from a *Bd* strain isolated from the skin of an infected Northern Leopard Frog found in the Oak Openings Metropark near Toledo, Ohio and maintained on 1% tryptone in our laboratory since 2006. A standard curve, expressed as genome equivalents (*ge*), was prepared from a dilution series of zoospore extracts of known concentration. Positive results were indicated when greater than 0.1 genome equivalent was detected in the qPCR sample.

In total, 431 amphibians were sampled, representing 18 species (8 anuran and 10 caudate) (Table 1). Green Frogs (*Lithobates clamitans*), Red-backed Salamanders (*Plethodon cinereus*), and Northern Two-lined Salamanders (*Eurycea bislineata*) comprised nearly 40% of the samples. Species frequency at any particular site was primarily a function of where field crews were operating and not necessarily an indication of species abundance. Eighty-seven (87) animals tested positive for *Bd* (20.2%), including 14 of 18 species sampled. Wood Frogs (*Lithobates sylvaticus*), Red-backed Salamanders, and Jefferson Salamanders (*Ambystoma jeffersonianum* complex) exhibited the three highest numbers of positive results; however, Pickerel Frogs (*Lithobates palustris*), American Bullfrogs (*Lithobates catesbeianus*), and Northern Spring Peepers (*Pseudacris crucifer*) comprised at least 50% of individuals testing positive for *Bd*; however for those four species testing negative, sample size was very small (N < 8).

Detection of *Bd* was geographically widespread and present in all six counties sampled (Fig. 1), with 37.5% (27/72) of sites containing at least one individual testing positive. Those sites testing negative may be a result of low sample size at a given site (min N = 1, max N = 16).

Our survey represents the largest known effort to document the presence of *Bd* in Ohio. The results confirm the presence of *Bd* in 14 amphibian species (6 anuran and 8 caudate), and *Bd* appears to be geographically widespread, with the lack of detection likely resulting from a low sample size or effort in a given location. With the majority of sampling conducted during March through May, we expected to document *Bd* in explosive-breeding species concentrated in vernal pools where infection can be easily transmitted. We did not expect to document such a large number of positive results in the more terrestrial Red-back Salamanders. These results support the possibility that the amphibian community in Ohio is composed of post-*Bd*-infection populations. Long-term effects of the documented widespread *Bd* infections are still unknown.

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Occurrence of the Fungal Pathogen *Batrachochytrium dendrobatidis* among Eastern Hellbender Populations (*Cryptobranchus a. alleganiensis*) within the Allegheny-Ohio and Susquehanna River Drainages, Pennsylvania, USA

In North America, *Batrachochytrium dendrobatidis* (*Bd*) has been detected among numerous anuran and salamander species in the northwest (Pearl et al. 2007), west (Muths et al. 2003), southeast (Grant et al. 2008; Rothermel et al 2008), northeast (Longcore et al. 2007), and Canada (Ouellet et al. 2005) (see also www.Bd-maps.net). Efforts to describe the taxonomic and geographic extent of *Bd* occurrence are comparatively limited in Pennsylvania. Three studies, examining two ranid, two hylid, two plethodontid, and one salamandrid species, detected the presence of *Bd* on two species, the Red-spotted Newt (*Notophthalmus viridescens*) in central and northwestern Pennsylvania and the Green Frog (*Lithobates clamitans*) in the northwestern region of the state (Glenney et al. 2010; Groner and Relyea 2010; Raffel et al. 2010). Representatives of families Bufonidae, Pelobatidae, Ambystomatidae, Proteidae, and Cryptobranchidae have not been tested for *Bd* in Pennsylvania.

The Hellbender Salamander (*Cryptobranchus alleganiensis*) is a cryptic, stream-dwelling cryptobranchid that has received considerable attention with regard to its population status and conservation needs (Briggler et al. 2007). During the past five decades, numerous researchers have noted changes in the distribution and size of hellbender populations throughout its range in the mid-western and eastern United States (Philips and Humphries 2005). Quantitative evidence of population declines has been reported for the Ozark Hellbender (*Cryptobranchus a. bishopi*) and Eastern Hellbender (*Cryptobranchus a. alleganiensis*) in Arkansas and Missouri (Trauth et al. 1992; Wheeler et al. 2003) and for *C. a. alleganiensis* in the upper Allegheny drainage of New York (Foster et al. 2009). Factors associated with declines include habitat modification and loss, introduced species, and exploitation by humans (Briggler et al. 2007). The disease ecology of hellbenders is poorly studied, although *Bd* has been detected in multiple populations of *C. a. bishopi* and *C. a. alleganiensis* in Missouri and Arkansas and among individual *C. a. alleganiensis* in one Georgia stream (Briggler et al. 2008; Gonynor et al. 2011). Our goal was to assess the occurrence of *Bd* among multiple populations of *C. a. alleganiensis* within the two largest river drainages in Pennsylvania.

During June–August 2009–2010, we assessed *Bd* occurrence among populations of hellbenders associated with four streams within the north-central region of the Susquehanna River drainage and four streams within the Allegheny-Ohio River drainage (Fig. 1). Hellbenders were typically located and captured under large flat rocks and then placed in a plastic tote or mesh laundry bag during processing to obtain *Bd* samples. To minimize cross-contamination, disease sampling was performed while wearing new latex or nitrile gloves for each hellbender. Using a sterile cotton-tipped applicator cut to 2.5 cm length, we swabbed the ventral surface of the feet (fives times each), dorsolateral folds (five times each), and cloaca (five times) of each salamander. We used the cut end of the applicator to gently scrape dorsolateral folds (five times each) of each salamander and then immediately placed the swab in a labeled, 2 mL screw-cap vial containing 1 mL of 70% ethanol. For all hellbenders captured and swabbed, we measured individual total length (cm) and mass (g), qualitatively assessed each salamander for evidence of morbidity, and then released each salamander where it had been captured. Hellbenders ranging from 13–30 cm TL were assigned to the juvenile age class unless secondary sexual characteristics were evident. To minimize potential transfer of *Bd* among sites, all field equipment was treated with a 10% bleach solution, washed with warm water, and then allowed to dry for 24 h before reuse (Johnson et al. 2003). Storage totes and mesh bags were used to hold only a single hellbender on any given field day and then treated as described for other field equipment.

With the exception of hellbenders at one stream, our study populations had not been assessed for *Bd* so we chose to pool swabs for site-level assays of *Bd* occurrence. We split individual swabs into lengthwise halves in sterile laboratory conditions, saved one half-swab in the original screw-cap vial, and pooled the other half-swab with similarly prepared swabs collected from the same population. During pooling, half-swabs were placed in 15 mL screw-cap vials containing 70% ethanol (4–8 half-swabs = 1 pooled sample). In 2008, one hellbender from Loyalsock Creek was confirmed as *Bd*-infected so swabs collected from salamanders at this site were individually assayed. Pooled and individual samples were assayed for the presence of the *Bd* ribosomal RNA Intervening Transcribed Sequence (ITS) region by 45 cycle single-round PCR amplification. All *Bd* assays were performed by Pisces Molecular LLC, Boulder, Colorado.

We swabbed 59 juvenile and adult hellbenders collected from six streams during 2009 (Tubmill/Hendricks Creek, Little Mahoning Creek, Loyalsock Creek, Lycoming Creek, Little Pine Creek, and Kettle Creek) and 19 juvenile and adult hellbenders from two additional streams during our 2010 field season (Oil

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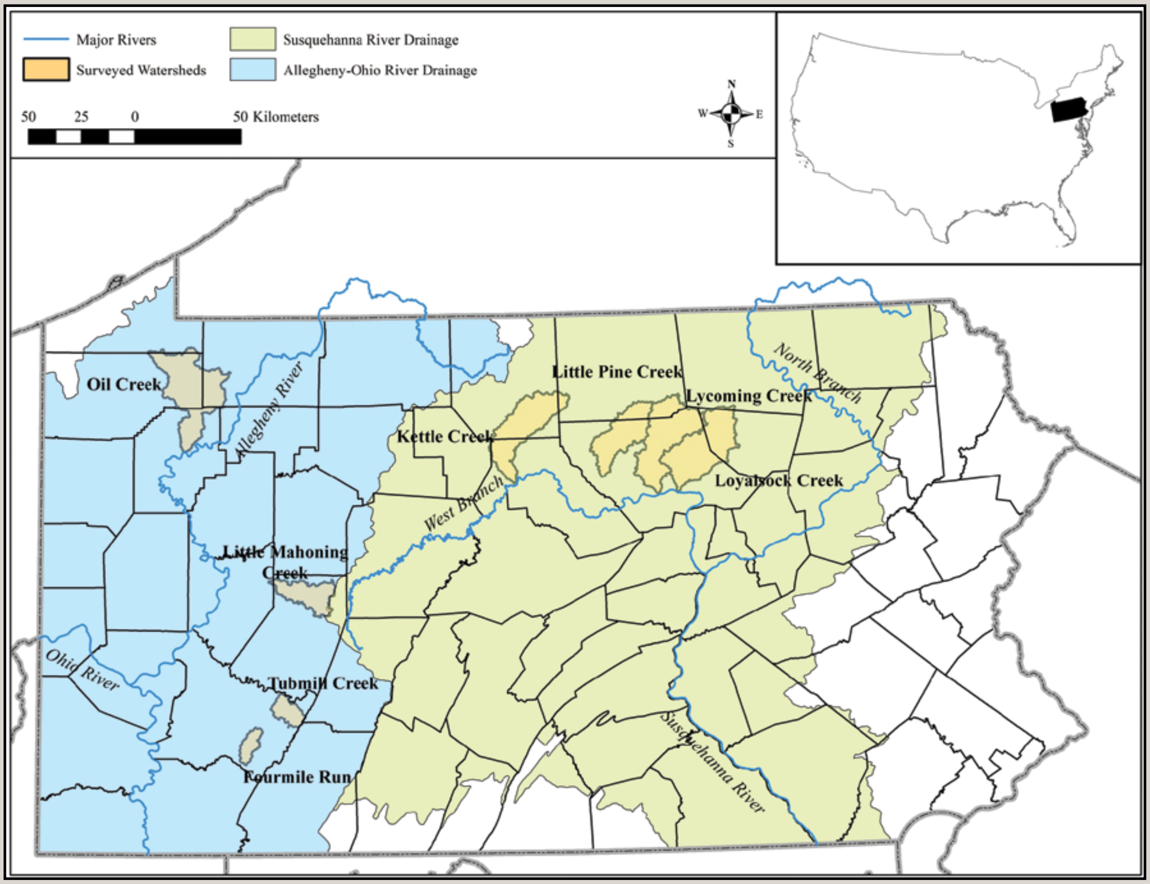

Fig. 1. Distribution of study sites associated with the Allegheny-Ohio River and Susquehanna River drainages, Pennsylvania, USA. Eastern Hellbenders (*Cryptobranchus alleganiensis alleganiensis*) were captured in four watersheds within the Appalachian Plateaus province and four watersheds within the north-central Ridge and Valleys province, and then tested for the fungal pathogen *Batrachochytrium dendrobatidis*. Exact sampling sites are not provided but general locations are indicated as surveyed watersheds.

Creek and Four Mile Run). In total, we assayed 12 pooled samples representing four populations associated with the Allegheny-Ohio River drainage and nine pooled samples representing four populations associated with the Susquehanna River drainage. Forty-three percent of pooled samples assayed provided positive test results for the presence of *Bd*, indicating the occurrence of *Bd*-infected hellbenders in four of the five counties that we examined (Table 1). We detected *Bd* among hellbender populations in two watersheds associated with the Allegheny-Ohio River drainage and two watersheds associated with the Susquehanna drainage. *Bd* was not detected on any swabs collected from hellbenders at Loyalsock Creek that were individually assayed. During the study period, we did not encounter any hellbenders with indications of morbidity or other obvious symptoms of poor health.

We found widespread occurrence of *Bd*, the amphibian chytrid pathogen, among *C. a. alleganiensis* in both major river drainages supporting breeding populations of hellbenders in Pennsylvania (Chapman, Petokas, and Regester, unpubl. data). These results represent the first systematic study of *Bd* occurrence on *C. a. alleganiensis* in Pennsylvania and the first documentation of *Bd* infection among stream-breeding salamanders in the state. Our findings, with those of Briggler et al. (2008) and Gonynor et al. (2011), confirm the occurrence of *Bd*-infected populations from widespread geographic regions within the hellbender's range and show that rates of *Bd* prevalence can be high (48%: Cooper Creek, Georgia) compared to other species of stream-breeding salamanders in the United States and Canada (0–22%: *Desmognathus* spp., *Dicamptodon aterrimus*, *Eurycea* spp., *Gyrinophilus porphyriticus*, *Pseudotriton ruber*: Byrne et al. 2008; Chatfield et al. 2009; Grant et al. 2008; Hossack et al. 2010; Ouellet et al. 2005; Rothermel et al. 2008; Timpe et al. 2008). Our results can be viewed as conservative with regard to the occurrence of *Bd* in Pennsylvania. The total number of hellbenders tested from four sites (Four Mile Run, Little Pine Creek, Loyalsock Creek, Oil Creek) was lower than the minimum sample size required to detect *Bd* in amphibian populations with relatively low rates of prevalence (Skerratt et al. 2008); hence, low sample size may have contributed to our lack of *Bd* detection in those watersheds.

Our study underscores the need for several areas of research. First, studies examining ecological predictors of *Bd* occurrence and testing for interactions between *Bd* prevalence and existing stressors are important for identifying high risk populations of hellbenders. In addition to the emerging pathogen *Bd*, hellbender populations in our region are subject to numerous threats to habitat quality (e.g., acid mine drainage, acid rain, increased sedimentation, and recent expansion of gas well drilling) that may potentially interact with *Bd* pathogenicity. In addition to continued long-term monitoring of hellbender population sizes, quantifying changes in *Bd* prevalence within and among populations and changes in *Bd*-status, condition, and survivorship among

Table 1. Distribution of the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) among Eastern Hellbender (*Cryptobranchus a. alleganiensis*) populations by river drainage, county, and stream watershed in Pennsylvania, USA. Mean total length and mass (± 1SE, range) are provided for hellbenders tested for *Bd*. Swabs collected from salamanders in Loyalsock Creek were individually assayed.

River drainage	County	Stream watershed	Total length (cm)	Mass (g)	N	Pooled samples tested	Pooled samples *Bd*-positive
Allegheny-Ohio	Indiana	Little Mahoning Creek	51.4 ± 1.8 (24.0–64.0)	868.8 ± 64.3 (70.0–1520.0)	32	5	4
	Venango	Oil Creek	44.7 ± 4.4 (16.0–57.0)	771.8 ± 137.2 (25.0–1220.0)	11	2	0
	Westmoreland	Four Mile Run	47.4 ± 2.4 (37.7–54.3)	647.5 ± 73.9 (400.0–930.0)	8	1	0
	Westmoreland	Tubmill/Hendricks Creek	48.3 ± 1.7 (26.0–60.0)	719.8 ± 61.3 (100.0–1260.0)	25	4	2
Susquehanna	Clinton	Kettle Creek	39.1 ± 1.2 (32.9–44.8)	310.8 ± 27.4 (216.0–463.0)	10	2	1
	Lycoming	Little Pine Creek	35.3 ± 0.9 (32.2–40.0)	248.4 ± 16.4 (170.0–356.0)	10	2	0
	Lycoming	Loyalsock Creek	39.3 ± 2.8 (25.5–52.3)	337.5 ± 57.7 (93.0–663.0)	8	0	0
	Lycoming	Lycoming Creek	41.5 ± 1.3 (29.4–51.5)	412.1 ± 33.6 (149.0–725.0)	31	5	2
Total					78	21	9

hellbender individuals and life stages, will provide insights into the disease ecology of this species and help prioritize conservation efforts. Finally, we identify a need for a coordinated, systematic approach to *Bd*-sampling in Pennsylvania, in collaboration with federal and state agencies, academic institutions, and nongovernmental organizations. Collaborative studies can efficiently increase our knowledge of chytridiomycosis in Pennsylvania by using standardized sampling regimes designed to encompass the taxonomic breadth of the state's amphibian fauna and promoting geographically widespread sampling efforts.

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First Record of *Batrachochytrium dendrobatidis* in Paraná, Brazil

Batrachochytrium dendrobatidis (*Bd*) has been reported in seven of twenty-seven federative states of Brazil, including Minas Gerais, Mato Grosso do Sul, Pernambuco, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, and São Paulo (Toledo et al. 2006). Despite its apparent widespread occurrence in Brazil, there are many distributional gaps in our knowledge that are yet to be filled. Understanding the distribution of *Bd* is urgently needed for the development and implementation of amphibian conservation action plans (Verdade et al. 2012). Herein, we provide the first report *Bd* in the state of Paraná, Brazil.

Samples were collected on 26 March 2011 at the municipality of Morretes, within the Atlantic Forest (Fig. 1). Nine tadpoles of two species [*Hylodes cardosoi* (Hylodidae; N = 8) and *Hypsiboas faber* (Hylidae; N = 1)] were collected at the Estrada da Graciosa (PR-410, 25.351297°S, 48.882148°W, 470 m elev.) and examined in the laboratory for *Bd*. Two methods of chytrid diagnosis were applied: cytology (direct observation under the microscope without stains); and isolation of fungus strains in cultures (Longcore et al. 1999).

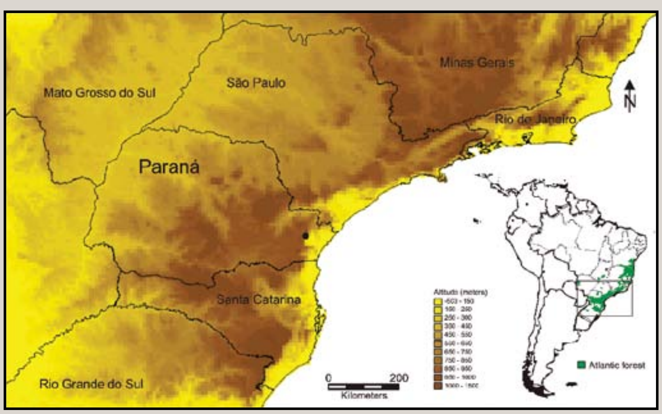

Fig. 1. Location of *Batrachochytrium dendrobatidis* sampling in the city of Morretes, state of Paraná, southern Brazil. SP = São Paulo, PR = Paraná, SC = Santa Catarina.

We detected *Bd* in 7 of 9 individuals we examined: 6 of 8 *Hylodes cardosoi* and 1 of 1 *Hypsiboas faber* were *Bd*-positive. Diagnosis was confirmed by the lack of keratin in mouthparts of the infected tadpoles, and the presence of *Bd* zoosporangia in the still keratinized regions of the mouth; some zoosporangia presented a medium septum (Berger et al. 2000) (Fig. 2). Following microscopic analysis, we isolated the *Bd* fungus (strain CLFT 024) in solid growth medium cultures of 1% tryptone agar (Fig. 2).

Our detection of *Bd* from Morretes fills a 200 km knowledge gap in the distribution of *Bd* in Brazil. The site is approximately 100 km north of São Bento do Sul, Santa Catarina, and 100 km

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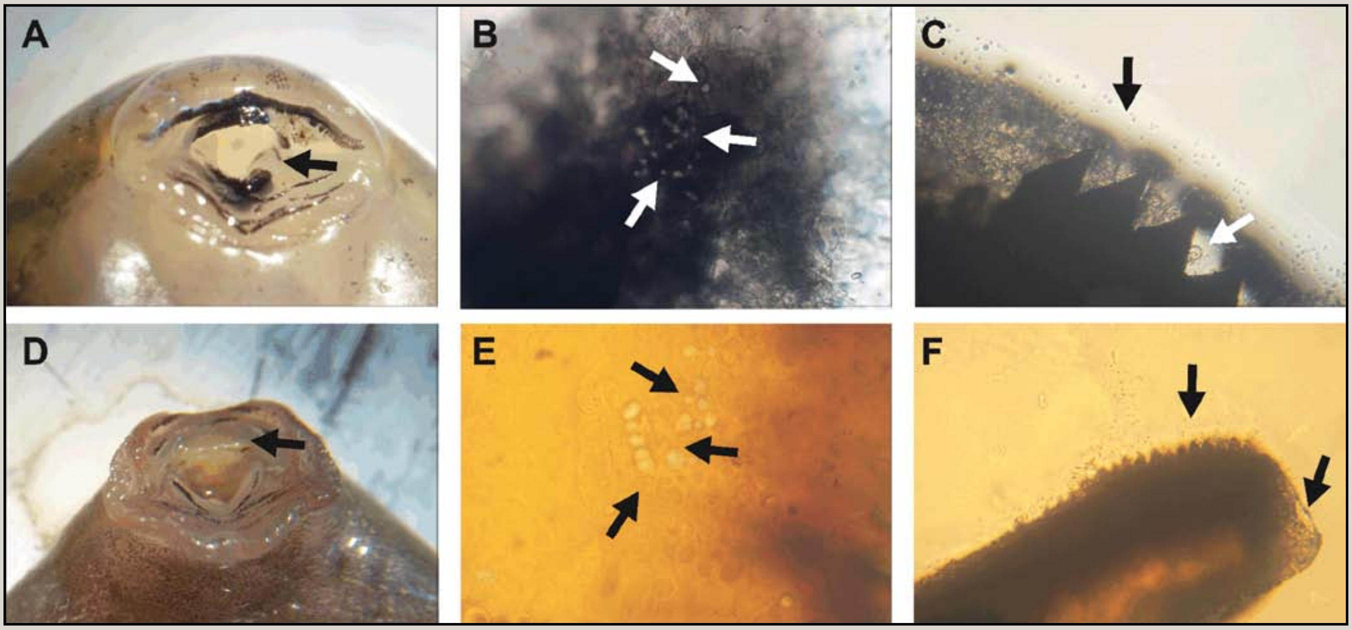

Fig. 2. *Batrachochytrium dendrobatidis* diagnosis by visual examination (A and D: lack of keratin in the tadpole mouthparts indicated by an arrow); cytology (B and E: optical microscope at 400× amplification, arrows indicating zoosporangia), and isolation (C and F: mTGh culture medium, with the arrows indicating zoospores and zoosporangia) methods. Top row of images A–C were taken from *Hylodes cardosoi*; bottom row images D–F were taken from *Hypsiboas faber*, as labeled.

south of Apiaí, São Paulo, which were the nearest sites last reported (Carnaval et al. 2006; Toledo et al. 2006). Also, this site is the type and only known locality of *Cycloramphus rhyakonastes* (Cycloramphidae; Heyer 1983), which is listed as endangered for the state (Mikich and Bérnils 2004). As the tadpoles of both species (*H. cardosoi* and *H. faber*) may live for one year or more in the water bodies, they may be serving as reservoirs of the fungus and infecting other species in the area. Hence, further *Bd* monitoring at this site is warranted to assess the potential threat of chytridiomycosis to these populations.

Other *Bd* distributional gaps exist in Brazil. For example, the occurrence of the fungus has not been studied between the states of Rio de Janeiro and Pernambuco, indicating a lack of sampling across the Atlantic Forest.

Three *Bd* strains have been previously isolated from Brazil; two (CLFT 001/10 and CLFT 021/01) from Serra do Japi, Jundiaí and Cabreúva, São Paulo, and one (CLFT 023/01) in Monte Verde, Camanducaia, Minas Gerais (unpublished data). We report the isolation of a fourth strain (CLFT 024) from the Brazilian Atlantic Forest. The isolation of strains is important because it provides the basis for studies of fungal molecular biology, virology, biogeography, physiology, morphology, and amphibian conservation. In particular, amphibian host-specific virulence patterns of different *Bd* strains are not well known, which could have direct relevance to amphibian conservation efforts.

Acknowledgments.—We thank Diogo Henrique Moraes for help with laboratory work and Mirtis M. G. Ferraz for support and enthusiasm in microbiology. FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo) provided a grant (08/50325-5) and scholarships (08/52847-9 and 2010/15259-1).

Resumo.—Reportamos aqui pela primeira vez a ocorrência do fungo quitrídio (*Batrachochytrium dendrobatidis*) no estado brasileiro do Paraná. A descoberta é preocupante, pois espécies endêmicas e ameaçadas de extinção vivem nos mesmos corpos d'água onde foi encontrado o fungo, organismo que pode ser letal para anfíbios.

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GEOGRAPHIC DISTRIBUTION

Herpetological Review publishes brief notices of new geographic distribution records in order to make them available to the herpetological community in published form. Geographic distribution records are important to biologists in that they allow for a more precise determination of a species' range, and thereby permit a more significant interpretation of its biology.

These geographic distribution records will be accepted in a **standard format** only, and all authors *must* adhere to that format, as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Crother [ed.] 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*. SSAR Herpetol. Circ. 37:1–84, gratis PDF available (http://www.ssarherps.org/pages/HerpCommNames.php); for Mexico as it appears in Liner and Casas-Andreu 2008, *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico*. Herpetol. Circ. 38:1–162), LOCALITY (use metric for distances and give precise locality data, including lat/long coordinates in **decimal degrees** and cite the map datum used), DATE (day-month-year), COLLECTOR, VERIFIED BY (*cannot* be verified by an author; curator at an institutional collection is preferred), PLACE OF DEPOSITION (where applicable, use standardized collection designations as they appear in Leviton et al. 1985, *Standard Symbolic Codes for Institutional Resource Collections in Herpetology and Ichthyology*, Copeia 1985[3]:802–832) and CATALOG NUMBER (required), COMMENTS (brief), CITATIONS (brief and must adhere to format used in this section; these should provide a geographic context for the new record), SUBMITTED BY (give name and address in full—spell out state or province names—no abbreviations). Please include distance from nearest previously known record (provide a citation or refer to existing vouchered material to substantiate your report). If publishing specific locality information for a rare or endangered species has the potential to jeopardize that population, please consult with the Section Editor at time of record submission. If field work and/or specimen collection occurred where permits were required, please include permit number(s) and authorizing agency in the text of the note.

Some further comments. The role of the "Standard Names" lists (noted above) is to standardize English names and comment on the current scientific names. Scientific names are hypotheses (or at least represent them) and as such their usage should not be dictated by a list, society, or journal.

If the locality reported is clearly outside of the natural range of the species, a statement to that effect should be included in the note, along with relevant citation(s). Additionally, if an "introduced" species has become established at the new locality, please include supporting observations, as well as information concerning means of introduction and source population, if known.

Additionally, this geographic distribution section does not publish "observation" records. Records submitted should be based on preserved specimens that have been placed in a university or museum collection (private collection depository records are discouraged; institutional collection records will receive precedence in case of conflict). A good quality photograph (print, slide, or digital file) may substitute for a preserved specimen *only* when the live specimen could not be collected for the following reasons: it was a protected species, it was found in a protected area, or the logistics of preservation were prohibitive (such as large turtles or crocodilians). Photographic vouchers *must* be deposited in a university or museum collection along with complete locality data, and the photographic catalog number(s) must be included in the same manner as a preserved record. Before you submit a manuscript to us, check Censky (1988, *Index to Geographic Distribution Records in Herpetological Review: 1967–1986*; available from the SSAR Publications Secretary), subsequent issues of *Herpetological Review*, and other sources to make sure you are not duplicating a previously published record. The responsibility for checking literature for previously documented range extensions lies with authors. **Do not submit range extensions unless a thorough literature review has been completed.**

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Recommended citation for new distribution records appearing in this section is: Schmitz, A., and T. Ziegler. 2003. Geographic distribution: *Sphenomorphus rufocaudatus*. Herpetol. Rev. 34:385.

CAUDATA — SALAMANDERS

***AMBYSTOMA MACULATUM* (Spotted Salamander)**. USA: GEORGIA: Gwinnett Co.: Mill Creek Nature Center (34.06076°N, 83.98080°W, WGS 84; elev. ~312 m). 7 October 2011. Cyndi Moore and Robert L. Hill. Verified by John Jensen. UTADC 6979. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.); has been previously observed in Gwinnett Co. though this report represents the first vouchered specimen. This species has also been documented in neighboring Fulton, Dekalb, Rockdale, and Walton counties. An adult specimen (~100 mm SVL) was discovered under a log ~3 m S of the hiking path and ~0.25 km from preserve entrance at Mall of Georgia Boulevard. It was photographed and returned.

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***DESMOGNATHUS FUSCUS* (Northern Dusky Salamander)**. CANADA: NEW BRUNSWICK: Victoria Co.: Unnamed stream in Hillandover (46.71965°N, 67.7371°W; WGS 84). 20 July 2011. Gregor F. M. Jongsma, Wendy Wolman, Luke DeCicco, and Andi Emrich. New Brunswick Museum (NBM 009237–009238). New county record. Gorham (1970. The Amphibians and Reptiles of New Brunswick. New Brunswick Museum, Saint John) notes that along the New Brunswick-Maine border region *D. fuscus* occurs only as far north as southern Carleton Co. (south of Victoria Co.) and more recently, McAlpine (2010. *In* D. F. McAlpine and I. M. Smith [eds.], Assessment of Species Diversity in

Atlantic Maritime Ecozone, pp. 613–631. NRC Research Press, Ottawa) listed the species as hypothetical for the ecoregion that includes Victoria Co. Extends the known range of this species 60 km N from the nearest documented locality, near Woodstock (46.15814°N, 67.63716°W, WGS 84; NBM 009096). York Co.: Unnamed stream 4.6 ESE of Stanley (46.2695°N, 66.67605°W, WGS 84). 18 August 2010. Gregor F. M. Jongsma. NBM 009077. The individual, collected near Stanley, extends the range of *D. fuscus* 29 km N from the nearest documented locality, Killarney Park, Fredericton, York Co. (46.01793°N, 66.62197°W WGS 84; NBM 009075). All specimens were verified by Donald F. McAlpine.

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***EURYCEA CIRRIGERA* (Southern Two-lined Salamander)**. USA: TENNESSEE: Weakley Co.: Beech Ridge Unit of the Obion Wildlife Management Area (36.228594°N, 88.942949°W; WGS 84). 12 November 2011. Tom Blanchard. Verified by A. Floyd Scott. Austin Peay State University (APSU 19185). New county record (Redmond and Scott 1996. [updated 29 November 2011] Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. Center for Field Biology, Austin Peay State University. Clarksville, Tennessee. 94 pp. Internet version available at http://www.apsu.edu/amatlas; updated 29 Nov 2011, accessed 15 Nov 2011). Adult male found under log in dry bed of periodically flooded, forested wetland.

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***EURYCEA QUADRIDIGITATA* (Dwarf Salamander)**. USA: ARKANSAS: Jefferson Co.: 6.6 km NW of White Hall (34.329828°N, 92.124281°W; WGS 84). 20 April 2001. H. W. Robison. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetological Collection (ASUMZ 31901). New county record; partially fills a hiatus among Cleveland (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.) and Grant (McAllister and Robison 2012. Herpetol. Rev. 43[*in press*]) counties. This records helps extend the range of *E. quadridigitata* further to the northeast in the state.

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***EURYCEA QUADRIDIGITATA* (Dwarf Salamander)**. USA: LOUISIANA: Acadia Parish: Bayou Plaquemine Brule area (30.1990°N, 92.5337°W; WGS 84). 28 October 2005. Glen Maglalang. Verified by Jeff Boundy. Louisiana State University Eunice Vertebrate Collection (LSUE 2262). New parish record (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana St. Univ. Press, Baton Rouge. 300 pp.). This record fills the gap between Jefferson Davis and Lafayette parishes.

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***NECTURUS MACULOSUS* (Mudpuppy)**. USA: TENNESSEE: Cannon Co.: Brawleys Fork of East Fork Stones River, tributary to Stones River. Accessed from the junction of Tennessee Hwy 64 (Bradyville Road) and Barker Road (35.801944°N, 86.150833°W; NAD 27). 18 March 2011. Matthew D. Wagner and Shawn P. Settle. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19118 color photo). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. [Hard copy and Internet versions, the latter of which includes links to information on Tennessee amphibians having appeared since 1996, http://www.apsu.edu/amatlas/, accessed 3 August 2011]). One adult caught via electrofishing on the downstream side of a bridge pylon.

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***NOTOPHTHALMUS VIRIDESCENS LOUISIANENSIS* (Central Newt)**. USA: ARKANSAS: Jefferson Co.: Tar Camp Creek at US 65/I-530 (34.431264°N, 92.193714°W; WGS 84). 12 May 2003. B. Deeds. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetological Collection (ASUMZ 31902). New county record filling a distributional gap among Arkansas (McAllister and Robison 2009. Herpetol. Rev. 40:245), Lincoln (Robison and McAllister 2008. Herpetol. Rev. 39:104) and Lonoke (Plummer and McKenzie 2008. Herpetol. Rev. 39:104) counties.

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***PSEUDOTRITON RUBER RUBER* (Northern Red Salamander)**. USA: SOUTH CAROLINA: Darlington Co.: Lauther's Lake, about 0.5 km N boat ramp, 13.3 km ENE of Darlington (34.32899°N, 79.72456°W; WGS 84). 29 March 2006. Jeffrey D. Camper. Verified by D. A. Beamer. Photographic voucher deposited in the Clemson University Vertebrate Collections (CUSC 1152). New county record. Extends the range of the species from the fall line sand hills southeast to the upper coastal plain. First record on the coastal plain in northern South Carolina (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. xvi + 587 pp.). Two specimens collected under logs in a seep during early afternoon.

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***STEREOCHILUS MARGINATUS* (Many-lined Salamander)**. USA: GEORGIA: Telfair Co.: 3.3 km ENE Jacksonville, State Hwy 117 at Lampkin Branch (31.816883°N, 82.944207°W; NAD 83). 22 July 2010. K. Stohlgren and D. Stevenson. Verified by Lance D. McBrayer. GSU 11917. First record for county (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.) Extends the species range ca. 62 km N of the nearest record (Satilla River drainage, Atkinson Co., Georgia). Additionally, this record extends the known range in the Altamaha River drainage ca. 83 km to the west of the nearest record (Tattnall Co., Georgia; Williamson and Moulis 1994. Distribution of Amphibians and Reptiles in Georgia. Savannah Sci. Mus. Spec. Publ. No. 3, Savannah, Georgia). Adult found in mucky seepage area within blackwater creek swamp.

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ANURA — FROGS

***DENDROPSOPHUS SANBORNI* (Sanborn's Treefrog)**. BRAZIL: MATO GROSSO DO SUL: Municipality of Três Lagoas: Fazenda Santa Marina (20.3636°S, 52.5815°W; SAD 69). 10 October 2010. F. L. Souza, P. Landgref-Filho, and M. N. Godoi. Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul, Campo Grande, MS, Brazil (ZUFMS-AMP 2156–2158), Museu Nacional, Rio de Janeiro, RJ, Brazil (MNRJ 73486–73488). Verified by U. Caramaschi. This species was previously known in western Rio Grande de Sul, Santa Catarina, Paraná, São Paulo, and Mato Grosso (Brazil), northern Argentina, Uruguay, and Oriental region of Paraguay (Ribeiro et al. 2005. Biota Neotrop. 5[2]:1–15). We present the first record of this species from Mato Grosso do Sul State, filling a distributional gap of 915 km across central Brazil, between the closest published localities, 330 km W from records in São Paulo (Vasconcelos and Rossa-Ferres 2008. Phyllomedusa 7[2]:127–142) and 624 km NW from records in Mato Grosso (Ribeiro et al., *op. cit.*). Individuals were associated with veredas (palm swamp) in a typical Cerrado vegetation.

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***HYLA CINEREA* (Green Treefrog)**. USA: MISSOURI: Jasper Co.: Oronogo, ca.14 air km NNE of Joplin (37.201074°N, 94.463260°W, WGS84; elev. 283 m). 04 September 2010. Nathan A. Mitchell. Verified by Richard Daniel. University of Missouri Columbia (UMC 1841P; digital image). New county record (Daniel and Edmond 2010. Atlas of Missouri Amphibians and Reptiles for 2009. <http://atlas.moherp.org/pubs/atlas09.pdf>). Abundant male calls recorded at wetland ca. 0.70 air km SSW of specimen collection point on 12 June 2011.

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***HYLA CINEREA* (Green Treefrog)**. USA: NEW JERSEY: Salem Co.: 75.542538°N, 39.617964°W (WGS 1984). 02 June 2011. Karena DiLeo. Verified by David Golden. ANSP 36840. New state record. (Aresco 1996. Am. Midl. Nat. 135[2]:293–298). Nearest previously known record in Delaware (Hammerson and Hedges 2004. *In* IUCN 2011. IUCN Red List of Threatened Species. version 2011.2; <www.iucnredlist.org>. Downloaded 07 November 2011).

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***HYLA SQUIRELLA* (Squirrel Treefrog)**. USA: GEORGIA: Baldwin Co.: City of Milledgeville (33.094111°N, 83.247077°W; WGS84). 27 September 2010. Sergio Patitucci Saieh and Dennis Parmley. Verified by John Jensen. GCH 5240. First county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Single adult collected at apartment complex during heavy rain.

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***KALOULA TAPROBANICA* (Sri Lankan Bull Frog)**. BANGLADESH: DHAKA DIVISION: Bangladesh Agricultural University Campus (24.7196°N, 90.4267°E, > 18 m elev.). 11 June 2008. Mahmudul Hasan. Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh, Bangladesh. Specimen deposited at Institute for Amphibian Biology, Hiroshima University, Japan (IABHU F5013). Verified by Mitsuru Kuramoto. First locality record for Mymensingh District, Bangladesh. Nearest population reported from Madhupur National Park, Tangail District (ca. 38 km to W; Reza and Mahony 2007. Herptol. Rev. 38:348). Other records from Assam, India, > 200 km to NE and Kolkata, West Bengal, India > 300 km to SW of this locality (Dutta 1997. Amphibians of India and Sri Lanka [Checklist and Bibliography]. Odyssey Publishing House, Bhubaneswar. xiii + 343 + xxii pp.). Supported by Grant-in-Aids for Scientific Research (C) (Nos. 17570082 and 20510216) to M. Sumida from Ministry of Education, Culture, Sports, Science and Technology, Japan.

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***LEPTODACTYLUS POECILOCHILUS* (Turbo White-lipped Frog)**. COSTA RICA: HEREDIA: San Ramón de Sarapiquí: Braulio Carrillo National Park, Estación El Ceibo (ca. 10.327363°N, 84.078677°W; WGS 84), 525 m elev. 10 January 2005. S. Mohammadi and J. W. Streicher. Verified by W. Ronald Heyer. USNM 561433; UTADC 526. First record for Heredia and one of only a few records from the Atlantic versant of Costa Rica (Savage 2002. Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press. xx + 934 pp.). The frog was caught at 2005 h during a light rain in a pasture bordering a forested portion of Braulia Carrillo National Park. It was secured under MINAE permit #0098520004 (License #38312) issued to both of us.

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***LITHOBATES CATESBEIANUS* (American Bullfrog)**. USA: KANSAS: Kiowa Co.: Greensburg (37.613774°N, 99.300071°W; elev. 679 m). 7 May 2011. Brian Hubbs. Verified by Neftali Camacho. Natural History Museum of Los Angeles County photo voucher LACM PC 1556. New county record (Collins 2010. Amphibians, Reptiles, and Turtles in Kansas. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas. 312 pp.).

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***LITHOBATES* [= *RANA*] *CATESBEIANUS* (American Bullfrog)**. USA: NEW MEXICO: Taos Co.: Rio Grande, ca. 3.2 km N (upriver) of Pilar (36.29367°N, 105.77918°W, WGS 84; elev. 1830 m). 26 September 2009. J. N. Stuart. One juvenile photographed; many present. Digital Archives, Division of Herpetology, Biodiversity Institute, University of Kansas (KUDA 012246).

Los Alamos Co.: Pajarito Spring, on W side of White Rock Canyon above the Rio Grande (35.80396°N, 106.19689°W, WGS84; elev. 1707 m). 4 April 2010. M. Bjorklund. Adult male (KUDA 012251). Tadpoles were also found at Pajarito Spring, 16 April

2010 (KUDA 012252). All verified by Charles W. Painter from photographs. New county records (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. xix + 431 pp.).

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***LITHOBATES HECKSCHERI* (River Frog)**. USA: ALABAMA: Bullock Co.: The Wehle Tract (32.03151°N, 85.47390°W; WGS 84). 19 September 2011. Brian Folt. Verified by Craig Guyer. Auburn University Herpetological collection (photo voucher AHAP-D 326a,b). First county record and the first voucher for this species in Alabama since 1975 (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn University Agricultural Experiment Station, Auburn, Alabama. vii +347 pp.).

Found under log along shoreline of impoundment pond; captured by hand. Previously, *L. heckscheri* had been verified in only three localities in Alabama: one each in Mobile, Baldwin, and Escambia counties (Mount 1975, *op. cit.)*. Whereas the historic Alabama localities are exclusively within the Lower Coastal Plains, this new record is farther north (171 km ENE from the nearest known location in Alabama), situated within the transitional zone between the Red Hills and Black Belt regions. Because this species is thought to be restricted to the Coastal Plains (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.), this record is novel and suggests that other habitats might be suitable.

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***MELANOPHRYNISCUS KLAPPENBACHI* (Klappenbach's Red-bellied Toad)**. BRAZIL, MATO GROSSO DO SUL, Municipality of Porto Murtinho, Fazenda Santo Antônio (21.527163°S, 57.832186°W, SAD 69); Fazenda Carandá (21.554553°S, 57.781036°W, SAD 69). 30 May 2011. I. B. Amaral, P. Landgref-Filho, and D. I. Ferreira. Coleção Herpetológica do Museu de Ciências e Tecnologia PUCRS, Porto alegre, RS, Brazil (MCP/PUC/RS 11944-11946, 11949-11969). Fazenda Patolá (21.686749°S, 57.719681°W, WGS 1984). 27 October 2008. F. L. Souza, M. Uetanabaro, and P. Landgref-Filho. Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul, Campo Grande, MS, Brazil (ZUFMS AMP 1046). Verified by T. Grant. This species was previously known for Paraguay (southern Alto Paraguay, Presidente Hayes, and Ñeembucú Department: Brusquetti and Lavilla 2006. Cuad. Herpetol. 20[2]:1–79) and Argentina (Chaco, Formosa, and Northern Santa Fe and Santiago del Estero provinces: Baldo 2001. Cuad. Herpetol. 15[2]:141–142). First country record. The study site is located in the southern Pantanal, at the left bank of Paraguay River, the only Brazilian region encompassed by the Chaco biome. New localities extends know distribution 90 km N of Alto Paraguay, Paraguay, in Municipality of Porto Murtinho, Brazil.

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***PHLYCTIMANTIS LEONARDI* (Olive Striped Frog)**. CAMEROON: EAST PROVINCE: Ngoum-Bandi (aka PK27), S border of Lobéké National Park (02.13881°N, 15.65567°E; WGS 84; 620 m elev.). 28 May 2010. Václav Gvodík and Oldich Kopecký. National Museum, Prague, Czech Republic. NMP6V 74437/1–5. Verified by Jean-Louis Amiet and Mark-Oliver Rödel. Previously recorded in Gabon, Equatorial Guinea (mainland), Republic of Congo, and western Democratic Republic of Congo (Schiøtz et al. 2004. *In* IUCN 2011. IUCN Red List of Threatened Species, ver. 2011.1. <www.iucnredlist.org>). Four adult males (SVL 47.9–51.0 mm) and one adult female (SVL 54.8 mm) collected from small shallow pond at edge of primary forest. Males calling from grassy inundated banks and low bushes from dusk until ca. 2400 h. Pairs in amplexus and numerous tadpoles also observed. New record extends known range by ca. 50 km N from nearest localities in Republic of Congo. First species record for Cameroon and first record of genus from Cameroonian Congo Basin (cf. Amiet 2007. Rev. Suisse Zool. 114:87–126).

VÁCLAV GVOŽDÍK, Institute of Animal Physiology and Genetics, Academy of Sciences of the Czech Republic, Rumburska 89, CZ 277 21 Libechov & National Museum, Department of Zoology, Cirkusova 1740, CZ 193 00 Prague, Czech Republic (e-mail: vgvozdik@email.cz); **OLDŘICH KOPECKÝ,** Department of Zoology and Fisheries, Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Sciences Prague, Kamycka 957, CZ 165 21 Prague, Czech Republic (e-mail: kopeckyo@af.czu.cz).

***PSEUDACRIS CLARKII* (Spotted Chorus Frog)**. USA: NEW MEXICO: Quay Co.: Playa lake located on the south side of NM Hwy 231, 2.0 km W of intersection of NM Hwy 469 and NM Hwy 23; ca. 2.7 air km SW of Wheatland (34.89232°N, 103.37679°W, NAD1983; elev. 1440 m). 05 August 2011. Jessica A. Kissner. Verified by Toby Hibbitts. University of Kansas (KUDA digital images 012215–012218, and 012219 audio). First state record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico). Nearest previous record was at Muleshoe National Wildlife Refuge in Muleshoe, Texas, ca. 117 km airline SE from the new locality. At 2144 h, two adult males were heard and seen calling from the base of emergent vegetation after a 0.5 mm rainfall. Air temperature was 20.9°C and humidity was 83%, with cloudy skies and an average wind speed of 5.6 mph.

Field work was conducted under permit number 3318 issued by New Mexico Department of Game and Fish.

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***PSEUDACRIS MACULATA* (Boreal Chorus Frog)**. USA: NEBRASKA: Harlan Co.: Republican City (40.089455°N, 99.213149°W; elev. 612 m). 22 May 2011. Brian Hubbs. Verified by Dan Fogell. Natural History Museum of Los Angeles County photo voucher LACM PC 1563. New county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. The Amphibians and Reptiles of Nebraska. University of Nebraska Press, Lincoln, Nebraska. 158 pp.). Frog found in flooded roadside ditch.

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***RAORCHESTES PARVULUS* (Karin Bubble-nest Frog)**. BANGLADESH: SYLHET DIVISION: Sylhet District: Khadimnagar National Park (24.940556°N, 91.93889°E; WGS 84; 46 m elev.). 29 April

2011. Animesh Ghose and Abdur Rakib Bhuiyan. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 1.36a–1.36b). Verified by Guin Wogan, California Academy of Sciences. A new country record for Bangladesh (Kabir et al. 2009. Encyclopedia of Flora and Fauna of Bangladesh, Vol. 25. Amphibians and Reptiles. Asiatic Society of Bangladesh, Dhaka. 204 pp.), and previously known from Myanmar, northeastern and southeastern Thailand, Cambodia, Lao People's Democratic Republic, northern Vietnam and northern Peninsular Malaysia (Inger 1999. *In* W. E. Duellman [ed.], Patterns of Distribution of Amphibians: A Global Perspective, pp. 445–482. John Hopkins University Press, Baltimore and London; Sukumaran 2003. Hamadryad 27:1–10).

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RHINELLA MARGARITIFERA. BRAZIL: PERNAMBUCO: Municipality of Tamandaré: Reserva Biológica de Saltinho – REBIO de Saltinho (8.710°S, 35.200°W; WGS 84). 23 August 2008. E. B. Ferreira Lisboa. Herpetological and Paleoherpetological Collection of the Universidade Federal Rural de Pernambuco – UFRPE, Recife, Brazil (CHPUFRPE 677, LHC 43.33 mm. Instituto Chico Mendes de Conservação da Biodiversidade permission number 19115-3). Verified by E. Maranhão dos Santos. *Rhinella margaritifera* is known from Bolivia, Colombia, Ecuador, Guyana, Peru, Venezuela, and Brazil. In Brazil it occurs in the states of Amazônia, Bahia, Ceará, Mato Grosso do Sul, and Rondônia (Bernarde and Macedo 2008. Série Zoológica 98[4]:454–459; Caramaschi and Pombal Jr. 2006. Pap. Avul. Zool. 46:251–259; Freitas and Silva 2004. Anfíbios na Bahia: um Guia de Identificação. Editora Politeno, Camaçari. 60 pp.; Freitas and Silva 2005. A Herpetofauna da Mata Atlântica Nordestina. Editora USEB, Pelotas. 161 pp.; Frost 2011. Amphibian Species of the World: An Online Reference, ver. 5.4 [8 April 2010]. Electronic database accessible at http://research.amnh.org/herpetology/amphibia.index.html; Lima et al. 2006. Guia de Sapos da Reserva Adolpho Ducke, Amazônia Central. Áttema Design Editorial, Manaus, 168 pp.; Santos and Silva 2009. *In* Congresso Interno de Iniciação Científica 2009. Barra do Bugres – MT. 2º Jornada Científica da UNEMAT, 2009. vol. 1, p. 1). New state record, partially filling the gap of 546 km between the states of Ceará and Bahia; this is 423 km NW from the nearest location in Ceará and 542 km SW from the nearest location in Bahia.

ELIZARDO BATISTA FERREIRA LISBOA, JORGE MÁRIO DE FIGUEIRÊDO JUNIOR, IRIS VIRGINIA CYPRIANO DE MELO, EDSON VICTOR EUCLIDES DE ANDRADE, and **GERALDO JORGE BARBOSA DE MOURA,** Universidade Federal Rural de Pernambuco, Paleoherpetological and Herpetological Laboratory, UFRPE, 52171-900, Recife, Brazil.

***XENOPUS LAEVIS* (African Clawed Frog)**. MÉXICO: BAJA CALIFORNIA: Municipality of Rosarito: Bocana Cantamar (32.22969°N, 116.92132°W, WGS 84), 2 m elev. 27 March 2011. G. Ruiz-Campos and A. Andreu-Soler. Verified by Clark R. Mahrdt. UABC 2029. First vouchered record for México and Baja California, and a 40 km WSW range extension from an undocumented observational record from Río las Palmas, Cañon el Alamo, NE El Testerazo (Mahrdt et al. 2003. Herpetol. Rev. 34:256–257). Even though *X. laevis* has also been reported by others to occur in México, most likely in northern Baja California (e.g., Álvarez-Romero et al. 2008. Animales Exóticos en México: Una Amenaza para la Biodiversidad. CONABIO, Instituto de Ecología, UNAM, SEMARNAT, México, D.F. 518 pp.; Liner 2007. Occas. Pap. Mus. Nat. Sci., Louisiana State Univ. 80:1–59; Tinsley and McCoid 1996. *In* R. C. Tinsley [ed.], The Biology of *Xenopus*. Symposia of the Zoological Society of London, No. 68, pp. 81–94. Clarendon Press, Oxford, England), no vouchered specimens are available. The adult frog was captured by a minnow trap in a stream lined primarily by California Tule (*Scirpus californicus*).

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***XENOPUS PYGMAEUS* (Bouchia Clawed Frog)**. GABON: HAUT OGOOÉ PROVINCE: Batéké Plateau National Park, Camp Ntsa (1.9816°S, 14.0011°E). 30 May 2011. B. M. Zimkus and J. G. Larson. Museum of Comparative Zoology (MCZ A-147875). Verified by José Rosado. Verification supported by mitochondrial data from 16S ribosomal DNA (Genbank Accession JQ302191). Species ranges from Bagandou, Etoi and Bouchia in southern Central African Republic, east to northeastern Democratic Republic Congo and Semliki in western Uganda. First confirmed country record in Gabon, extending range > 750 km SW from type locality in Bouchia, Central African Republic. Presence in Batéké Plateau National Park, southwestern Gabon suggests a distribution across border in Republic of Congo, for which there are currently no records.

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TESTUDINES – TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: NEBRASKA: Sherman Co.: DOR on State Hwy 10 (41.066924°N, 99.082586°W; elev. 648 m.). 23 May 2011. Brian Hubbs. Verified by Neftali Camacho. Natural History Museum of Los Angeles County photo voucher LACM PC 1557. New county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. The Amphibians and Reptiles of Nebraska. University of Nebraska Press, Lincoln, Nebraska. 158 pp.).

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***CHRYSEMYS DORSALIS* (Southern Painted Turtle)**. USA: TENNESSEE: Chester Co.: Henderson, Freed-Hardeman University (35.437317°N, 88.634083°W; WGS84). 31 August 2011. Sarah McReynolds. Verified by A. F. Scott. Austin Peay State University (APSU 19169 photographic voucher). New county record (Scott and Redmond 2008 [latest update: 8 June 2011]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 9 November 2011). Adult male captured in a baited hoop net.

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CHRYSEMYS PICTA BELLI **(Western Painted Turtle)**. USA: NEBRASKA: Phelps Co.: Approx. 3/4 mi. SSW Holdrege (40.429085°N, 99.379989°W; elev. 704 m). 23 May 2011. Brian Hubbs. Verified by Neftali Camacho. Natural History Museum of Los Angeles County photo voucher LACM PC 1523. New county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. The Amphibians and Reptiles of Nebraska. University of Nebraska Press, Lincoln, Nebraska. 158 pp.).

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GRAPTEMYS PSEUDOGEOGRAPHICA PSEUDOGEOGRAPHICA **(False Map Turtle)**. USA: KANSAS: Lincoln Co.: Lincoln (39.85907°N, 93.60844°W; elev. 412 m). 11 May 2011. Brian Hubbs. Verified by Curtis Schmidt. Natural History Museum of Los Angeles County photo voucher LACM PC 1558. New county record. This record fills a gap in the range (Collins 2010. Amphibians, Reptiles, and Turtles in Kansas. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas. 312 pp.).

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GRAPTEMYS PSEUDOGEOGRAPHICA PSEUDOGEOGRAPHICA **(False Map Turtle)**. USA: NEW MEXICO: Sierra Co.: Elephant Butte Reservoir, ca. 9.6 air mi upstream of Elephant Butte Dam, (107.147408°N, 33.289049°W; NAD 83). 30 Sept 2011. Charles W. Painter and Levi T. Cole. Adult female (233 mm SCL; 1486 g) preserved at time of capture. Verified by Kurt Buhlmann. University of New Mexico Division of Herpetology (MSB 79133). New state record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. xix + 431 pp.; Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins Univ. Press, Baltimore, Maryland. xii + 827 pp.).

A male was previously captured 0.6 miles upstream on 15 June 2011 by Levi T. Cole and Luke D. Walker. That animal was photographed and released at capture site.

There is no indication these individuals represent a breeding population in New Mexico.

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STERNOTHERUS ODORATUS **(Eastern Musk Turtle)**. USA: OHIO: Meigs Co.: Sutton Township, 2.5 km E of Syracuse on State Hwy 124 (38.99570°N, 81.94090°W; WGS 84). 23 May 2010. B. Folt. Verified by Scott Moody. Cincinnati Museum Center, Geier Collections and Research Center (CMC HP 7075, photo voucher). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10, Columbus. iv + 81 pp.). Collected DOR.

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TRACHEMYS SCRIPTA ELEGANS **(Red-eared Slider)**. USA: Texas: Goliad Co.: Naval Auxiliary Landing Field Goliad near a shallow pond (28.6112°N, 97.6124°W; WGS 84). Carapace collected on 19 October 2011. F. Weaver, C. Giggleman, and N. Mitton. Verified by Travis J. Laduc. Texas Natural History Collections (TNHC 85064). New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M Univ. Press. College Station. 421 pp.). One juvenile specimen was seined at ca. 1 m depth at the same location, 19 April 2011 by C. Giggleman, A. Miller, P. Clements, and N. Mitton .

FRANKLIN J. WEAVER (e-mail: frank_weaver@fws.gov) and **CRAIG GIGGLEMAN**, U.S. Fish and Wildlife Service, Corpus Christi Ecological Services Field Office, 6300 Ocean Drive, Classroom West, Corpus Christi, Texas 78412-5837, USA.

TRACHEMYS SCRIPTA ELEGANS **(Red-eared Slider)**. USA: WISCONSIN: Kenosha Co.: unnamed tributary of Des Plaines River on west side of Interstate 94 and north side of County Hwy C (93rd St.), T1N R21E Section 13 SE1/4 (42.545747°N, 87.955437°W; WGS84). 18 June 2009. Gary S. Casper, Thomas G. Anton. Verified by Alan Resetar. FMNH 281241. First reproductive record for the state (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 87 pp.). A gravid adult female trapped in a baited hoop net.

Red-eared Sliders are occasionally reported from urban ponds and nature centers in Madison and Milwaukee, disjunct from the known natural range, and are presumed to be released pets (Bob Hay, Wisconsin DNR, pers. comm.). This gravid female represents the first Wisconsin record from a stream system within the natural range (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Man. 8, Champaign, Illinois. 282 pp.), and is considered a natural occurrence in an industrial corridor without public access (as is typical of release sites). Recent (post-1985) records are available from the Des Plains River watershed in Cook (FMNH 267587, INHS 16868), DuPage (INHS 10775), and Will (FMNH 251323) counties, Illinois. A specimen was also collected in 1876 from Lake County, Illinois (FLMNH 51108). The eventual establishment of sliders in Wisconsin has been predicted, possibly abetted by ongoing climate warming (Casper 2008. Bull. Chicago Herpetol. Soc. 43[5]:73–79). Regardless of origin, sliders are now breeding in Kenosha Co., and should be added to the state herpetofaunal list.

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SQUAMATA — LIZARDS

AGAMA GRACILIMEMBRIS **(Little Ground Agama)**. BURKINA FASO: HAUTS-BASSINS REGION: ca. 4 km W Koumi (11.125°N, 04.479°W; WGS 84; 445 m elev.). 2 March 2004. J.-F. Trape. Institut de Recherche pour le Développement at Dakar (IRD TR.473). Verified by Laurent Chirio. First record for Burkina Faso (Grandison 1968. Bull. Brit. Mus. Nat. Hist. 17:67–90; Uetz and Hošek 2011. The Reptile Database. http://www.reptile-database.org/. Accessed December 2011). Previously unreported west of Benin, the type locality.

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AGAMA GRACILIMEMBRIS **(Little Ground Agama)**. MALI: SIKASSO REGION: ca. 3 km W Zambouroula (11.605°N, 07.576°W; WGS 84; 358 m elev.). 8 January 2004. J.-F. Trape. Institut de Recherche pour le Développement at Dakar (IRD TR.262). Verified by Laurent Chirio. First record for Mali and new westernmost locality in Africa (Grandison 1968. Bull. Brit. Mus. Nat. Hist. 17:67–90; Joger and Lambert 1996. J. Afr. Zool. 110:21–51; Uetz and Hošek 2011. The Reptile Database. http://www.reptile-database.org/. Accessed December 2011).

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ANOLIS ORTONII. BRAZIL: PERNAMBUCO: Municipality of Abreu e Lima: CIMNC (Centro de Instrução Marechal Newton Cavalcanti) (7.82°S, 35.101°W; WGS 84, elev. 116 m, Google Earth). 18 October 2009. M. Miranda d'Assunção. Herpetological Collection of the Paleoherpetological and Herpetological Laboratory of the Universidade Federal Rural de Pernambuco UFRPE, Recife, Brazil (CHPUFRPE 567; adult male, LHC 34 mm and total length 86 mm).Verified by M. Trefault Urbano Rodrigues. Species known from Bolivia, Perú, Ecuador, Colombia, Venezuela, Guiana, Suriname, French Guiana, Guatemala, and Brazil (Barrio-Amorós and Duellman 2009. Boletín RAP de Evaluación Ecológica, 55:137–155; Duellman 1978. Misc. Publ. Univ. Kans. Mus. Nat. His. 65:1–352; Alonso et al. 2001. SI/MAB Series 7, Smithsonian Institution; Dirksen and Riva 1999. Graellsia 55:199–215; Peters and Donoso-Barros 1970. U.S. Natl. Mus. Bull. 293, viii+297 pp.; Stuart 1955. Misc. Publ. Mus. Zool. Univ. Michigan 91:1–31). In Brazil the species occurs in Rondônia, Roraima, Amazonas, Pará, Amapá, Tocantins, Paraíba, Alagoas, and Sergipe, with a gap of nearly 300 km between the states of Paraíba and Alagoas (Vanzolini 1992. Estudos Avulsos 6[15]:41–65; Avila-Pires et al. 2009. Bol. Mus. Para. Emílio Goeldi. Cienc. Nat. 4:99–118; Silva 2008. Diversidade de espécies e ecologia da comunidade de lagartos de um fragmento de Mata Atlântica no nordeste do Brasil. Dissertação apresentada ao Programa de Pós-graduação em Ciência Biológicas do Centro de Biociências, Universidade Federal do Rio Grande do Norte. 90 pp.; Souza 2008. Filogeografia em lagartos [Reptilia: Squamata] no baixo Tocantins, Ilha do Marajó e sul do Amapá, Brasil. Dissertação apresenta do Programa de Pós-graduação em Zoologia, Museu Paraense Emílio Goeldi e Universidade Federal do Pará, 53 pp.; Ribeiro-Júnior 2006. S. Am. J. Herpetol. 1[2]:131–137; Macedo et al. 2008. Biota Neotrop. 8[1]:133–139; Freire 1996. Rev. Bras. Zool. 13[4]:903–921; Moraes 2008. Diversidade beta em comunidades de lagartos em duas ecorregiões distintas na Amazônia. Dissertação apresentada ao Programa de Pós-graduação em Biologia Tropical e Recursos Naturais, 40 pp.). First state record, partially filling the gap between Paraíba and Alagoas states; the locality is 100 km S from Cabedelo, Paraíba, and 160 km N from Ibateguara, Alagoas.

MARIANA MIRANDA D'ASSUNÇÃO, DANILO SÁ BARRETO BARROS FILHO, ARMANDO DOS SANTOS ARAÚJO, and **GERALDO JORGE BARBOSA DE MOURA**, Universidade Federal Rural de Pernambuco, Paleoherpetological and Herpetological Laboratory, UFRPE, Rua Dom Manoel de Medeiros, Dois Irmãos - CEP: 52171-900, Recife, PE, Brazil.

***ANOLIS SAGREI* (Brown Anole)**. USA: GEORGIA: McIntosh Co.: Darien, GA Hwy 251, 0.6 km NW of I-95 (31.399967°N, 81.453167°W; WGS 84). 07 May 2009. Georgia Museum of Natural History (GMNH) 50126. First county record. Adult male collected from hotel landscaping and several dozen adults observed on hotel grounds and the edges of adjacent wooded areas. Hotel manager stated that *A. sagrei* were present throughout his two-year tenure. Adult female (GMNH 50127) collected during a subsequent visit on 08 June 2009, at which time several individuals were also observed in the parking lot landscaping of a nearby outlet mall.

Liberty Co.: near Midway, US-84, 0.5 km NW of I-95 (31.781033°N, 81.383250°W; WGS 84). 08 June 2009. GMNH 50128. First county record. Adult female collected from vegetation bordering a parking lot; three additional adult females observed in overgrown vegetation along the parking lot edge.

Brian Co.: Richmond Hill, US-17, 0.2 km E I-95 (31.928017°N, 81.327933°W). 08 June 2009. GMNH 50129. First county record. Adult male collected from fencerow vegetation aside a motel parking lot. Three additional adult males and two adult females observed in a 15-minute search of the motel grounds.

Chatham Co.: Port Wentworth, GA Hwy 21, 0.6 km NW I-95 (32.197267°N, 81.195617°W). 08 June 2009. GMNH 50130. First county record. Adult male collected and two adult females observed in hotel landscaping. Several additional lizards, likely *A. sagrei*, heard moving within dense shrubs. All specimens collected by N. W. Turnbough and verified by A. C. Echternacht.

These records fill a distributional gap between Glynn Co. in southeast Georgia (Campbell 1996. Herpetol. Rev. 27:155–157) and Jasper Co., South Carolina (Turnbough 2006. Herpetol. Rev. 37:361). They resulted from an attempt by the author to assess *A. sagrei* dispersal into the region via vehicular rafting (Godley et al. 1981. Herpetol. Rev. 12:84-86; Campbell 1996, *op. cit.*). An I-95 exit was selected for each county and a suitable site for searching was identified upon exiting—hotels/motels or truck stops with adequate landscaping or surrounding vegetation. *Anolis sagrei* were discovered with a single attempt for each county except Chatham, where the second attempt was successful. Such ease in finding *A. sagrei* suggests that the species was likely widespread throughout the I-95 corridor in Georgia, at least in exit areas, prior to the particularly severe winters of 2009/10 and 2010/11. Vehicular rafting appears to be the most parsimonious explanation for *A. sagrei* dispersal to all of the above sites, though transport in nursery plants may be a possibility for the hotel/motel sites.

South Carolina: Concurrent with or prior to the above collection efforts, the establishment of *A. sagrei* in previously reported South Carolina rest area localities (Turnbough 2006, *op. cit.*) was investigated. The Jasper Co. site was visited every year from 2006–2009, and in those years an established *A. sagrei* population spread throughout the site and became increasingly abundant. The Colleton Co. and Orangeburg Co. sites were each searched for approximately 15 minutes on 08 June 2009: three adult males and one adult female were observed in vegetation surrounding the Colleton Co. rest area facilities, and seven adult males and one adult female were observed around the Orangeburg Co. facilities. Because overwinter survival is probably the limiting factor for *A. sagrei* establishment in South Carolina, the increased abundance of *A. sagrei* at these two localities likely signified population establishment rather than higher rates of post-winter vehicular disembarkation. All of the reported South Carolina populations may have been extirpated by the unusually cold winter of 2010/11, however, as *A. sagrei* were not found in four searches of the sites by up to three observers in summer 2011 (L. Rubio-Rocha, pers. comm.). Notably, *A. carolinensis*, which was present at the Jasper Co. site and abundant at the other two sites in 2009, was still present at all three sites in summer 2011.

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***CHALCIDES DELISLEI* (de l'Isle Three-fingered Skink)**. SENEGAL: FLEUVE REGION: Bala (16.419°N, 14.926°W; WGS 84; 20 m elev.). 1 October 2003. J.-F. Trape. Institut de Recherche pour le Développement at Dakar (IRD TR.2108). Verified by Laurent Chirio. First record for Senegal (Cisse and Karns 1978. Bull. IFAN 40A:144–211; Böhme 1978. Bonn. Zool. Beiträge. 29:360–417; Uetz and Hošek 2011. The Reptile Database. http://www.reptile-database.org/. Accessed December 2011).

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***CHALCIDES OCELLATUS* (Ocellated Skink)**. GREECE: Kyklades Pref.: NAXOS ISLAND: Plaka (37.053372°N, 25.388175°E; WGS 84; 25.3 m elev.). 25 May 2011. A. Belasen, B. Li, and J. Foufopoulos. Verified by P. Pafilis. University of Michigan Museum of Zoology, Division of Reptiles and Amphibians (Digital Image Collection Numbers 968–971, photographic vouchers, one individual). New record for island of Naxos, species has relatively wide distribution on mainland Greece (Valakos et al. 2008. The Amphibians and Reptiles of Greece. Edition Chimaira, Frankfurt, Germany, 480 pp.). Also first record from Cyclades archipelago, which has been isolated from the Greek mainland for >200,000 yrs. Several adults and juveniles observed on dry stone walls separating small fields at this south-facing site, a low elevation area characterized by sparse thermo-Mediterranean vegetation growing on granite substrate and loose sandy soils.

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***DRYADOSAURA NORDESTINA* (Briba Cabeçuda)**. BRAZIL: BAHIA: Município de Wenceslau Guimarães: Estação Ecológica Estadual Wenceslau Guimarães (13.600000°S, 39.716667°W, WGS 84; 800 m elev.). 16 January 2011. M. S. C. Delfino. Museu de Zoologia da Universidade Federal de Bahia, Salvador, Bahia, Brazil (UFBA 2974, 2975). Collected with pitfall traps in a well preserved Atlantic Forest fragment. Município de Salvador: Jardim Botânico (12.930000°S, 38.434722°W; WGS 84). 15 and 20 July 2010. M. S. Soeiro. (UFBA 2715, 2714). Collected with pitfall traps in a 17 ha fragment within the city of Salvador. Both verified by M. T. Rodrigues. Species previously known from Paraíba, Pernambuco, Alagoas, Rio Grande do Norte, Sergipe states, and north of Bahia, Brazil (Camacho and Rodrigues 2007. Herpetol. Rev. 38:218–219; Noronha et al. 2010. Herpetol. Rev. 41:512; Rodrigues et al. 2005. Zool. J. Linn. Soc. 144:543–557). This record extends the distribution almost 200 km SW from the closest record (Mata de São João, Bahia; Camacho and Rodrigues, *op. cit.*).

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***HELODERMA HORRIDUM* (Mexican Beaded Lizard)**. MÉXICO: OAXACA. Municipality of San Pedro Mixtepec, Jardín Botánico de la Universidad del Mar, km 239 on road to Sola de Vega-Puerto Escondido, ca. 6 km N of Puerto Escondido (15.916663°N, 97.076748°W; WGS84), 91 m elev. 17 June 2009. Guillermo Sanchez-de la Vega. Verified by Jerry D. Johnson. Laboratory for Environmental Biology, Centennial Museum, The University of Texas at El Paso photographic voucher (G 2011.2). First municipality record that fills a gap between the closest reported localities ca. 89 km WNW in Jamiltepec and ca. 193 km ENE in Cerro Guiengola on the Isthmus of Tehuantepec (Bogert and Martin del Campo 1956. Bull. Amer. Mus. Nat. Hist. 109:1-238). The individual was found trapped in a man-made depression in a tropical deciduous forest.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: ALABAMA: Wilcox Co.: 208 Caldwell Street, Camden, Alabama (31.992030°N, 87.292539°W; WGS84/NAD83). 3 September 2011. J. Diamond. Verified by Craig Guyer. AUM 39743. New county record (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. xi + 347 pp.). *H. turcicus* has been documented in many of the larger cities in Alabama but records and voucher specimens are lacking for many other portions of the state.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: GEORGIA: Dekalb Co.: 33.776392°N, 84.290554°W (WGS 84), elev. 309 m. 7 September 2011. Valerie Van Sweden. Verified by John Jensen. UTADC 6974. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.). Has been documented in neighboring Clayton and Fulton counties. Different age class specimens of this introduced species have been observed at this private residence in downtown Decatur since May 2011. A juvenile specimen was found under a blown down tarp on the porch of a private residence.

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***LYGODACTYLUS GUTTURALIS* (Chevron-throated Dwarf Gecko)**. GUINEA: UPPER GUINEA REGION: Kalan-Kalan (10.107°N, 08.886° W; WGS 84; 602 m elev.). 18 April 2008. J.-F. Trape. Eight specimens. Institut de Recherche pour le Développement at Dakar (IRD TR.2449-2456). Verified by Laurent Chirio. GUINEA: FOUTA DJALON REGION: Poré (11.706°N, 12.274° W, 405 m elev.). 18 March 2009. J.-F. Trape. Institut de Recherche pour le Développement at Dakar (IRD TR.2541). Verified by Laurent Chirio. First records for Guinea (Böhme et al. 2009. Bonn Zool. Bull. 60:35–61).

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***LYGODACTYLUS GUTTURALIS* (Chevron-throated Dwarf Gecko)**. MALI: SIKASSO REGION: ca Laminina (11.220°N, 07.782°W; WGS 84; 370 m elev.). 15 June 2004. J.-F. Trape and I. Ineich. Institut de Recherche pour le Développement at Dakar

(IRD TR.690). Verified by Laurent Chirio. Niakoni (11.187°N, 07.803°W, 378 m elev.). 16 June 2004. J.-F. Trape and I. Ineich. Institut de Recherche pour le Développement at Dakar (IRD TR.938). Verified by Laurent Chirio. First records for Mali (Joger and Lambert 1996. J. Afr. Zool. 110:21–51; Uetz and Hošek 2011. The Reptile Database. http://www.reptile-database.org/. Accessed December 2011).

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***MABUYA UNIMARGINATA* (Central America Mabuya)**. MÉXICO: ESTADO DE MÉXICO: Municipality of Tonatico: La Puerta de Santiago, 5 km SE of Ixtapan de la Sal (18.751111°N, 99.626389°W; NAD 27), 1456 m elev. 25 June 2005. Rodrigo Macip-Ríos, Gabriel Barrios-Quiroz, and Victor Sustaita-Rodríguez. Verified by Luis Canseco Márquez. CNAR 21655–21656. First record for Estado de México (Casas-Andreu and Aguilar-Miguel 2007. *In* X. Aguilar-Miguel [ed.], Vertebrados del Estado de México, pp. 47–81. Ciencias Naturales y Exactas, Ciencias Biológicas, Universidad Autónoma del Estado de México, México) and a range extension of 35 km NW from the closest known locality in Puente de Ixtla, Morelos (Castro-Franco and Bustos-Zagal 2003. Acta Zool. Mex. [n.s.] 88:123–142). The lizards were collected by hand while they were basking on an abandoned stone wall.

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***MESALINA PASTEURI* (Pasteur's Desert Racer)**. MALI: MENAKA DISTRICT: ca 60 km NW Tidermene (17.0213°N, 02.1039°E; WGS 84; 340 m elev.). 10 February 2004. J.-F. Trape. Institut de Recherche pour le Développement at Dakar (IRD TR.395). Verified by Laurent Chirio. Second record for Mali, extends known range ca 250 km SW of Tin Amzi valley where frontiers of Mali, Algeria and Niger meet (Joger and Lambert 1996. J. Afr. Zool. 110:21–51; Sindaco and Jeremcenko 2008. The Reptiles of the Western Palearctic. Edizioni Belvedere, Latina. 579 pp.; Uetz and Hošek 2011. The Reptile Database. http://www.reptile-database.org/. Accessed December 2011).

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NOROPS CARPENTERI. HONDURAS: GRACIAS A DIOS: Bachi Kiamp (15.133333°N, 84.40°W; WGS84), 40 m elev. 16 July 2009. James R. McCranie. SMF 91746. Verified by Sebastian Lotzkat. First record for Honduras, extending range ca. 120 km NE from the closest known locality in Parque Nacional Saslaya, Atlántico Norte, Nicaragua (Sunyer and Köhler 2007. Salamandra 43:57–62). The lizard was active during the afternoon in secondary vegetation on a riverbank.

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***PANASPIS TOGOENSIS* (Togo Lidless Skink)**. MALI: SIKASSO REGION: ca Doussoudiana (11.1240°N, 07.7725°W; WGS 84; 341 m elev.). 15 June 2004. J.-F. Trape and I. Ineich. Four specimens. Institut de Recherche pour le Développement at Dakar (IRD TR.671-674). Verified by Laurent Chirio. First records for Mali (Joger and Lambert 1996. J. Afr. Zool. 110:21–51; Uetz and Hošek 2011. The Reptile Database. http://www.reptile-database.org/. Accessed December 2011).

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***PHRYNOSOMA MODESTUM* (Round-tailed Horned Lizard)**. USA: OKLAHOMA: Le Flore Co. 1940. W. C. Hobgood. Verified by Alan Resetar. FMNH 40808 (accessed through the HerpNet2 Portal, www.herpnet2.org, 26 Sep. 2011). This specimen was originally identified as *P. cornutum*, and was only recently corrected. The record represents a geographic range extension of approximately 550 km from the nearest confirmed county record of *P. modestum* in Hall Co., Texas (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 500 pp.), excluding an unconfirmed Baylor Co. account that was considered erroneous (Axtell 1988. Interpretive Atlas of Texas Lizards [6]:1–18 + map. Southern Illinois University, Edwardsville).

The closest confirmed location of *P. modestum* in Oklahoma is approximately 790 km distant, in Cimarron Co. (Clarke 1983. Bull. Oklahoma Herpetol. Soc. 12:16). Museum records indicate that FMNH 40808 was collected in Le Flore Co., Oklahoma near Rich Mountain, Arkansas; we suggest this means the specimen was taken in Le Flore Co., Oklahoma very close to the Arkansas border adjacent to Rich Mountain, Arkansas. No additional locality information is available. There is apparently a peripheral population of *Crotalus atrox* in the Ouachita Mountains, another species with a more southwestern U.S. primary distribution (Sievert and Sievert 2011. A Field Guide to Oklahoma's Amphibians and Reptiles. Oklahoma Dept. Wildlife Conservation, Oklahoma City. 211 pp.). Future surveys for *P. modestum* in the area should be conducted to determine if the species persists in eastern Oklahoma.

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***PLESTIODON LATICEPS* (Broad-headed Skink)**. USA: OHIO: Lawrence Co.: Symmes Township, Wayne National Forest (38.76625°N, 82.53390°W; WGS 84). 5 June 2010. B. Folt and C. Brune. Verified by Scott Moody. Photo voucher in Cincinnati Museum Center, Geier Collections and Research Center (CMC HP 6543). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10, Columbus. iv + 81 pp.).

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***POLYCHRUS MARMORATUS* (Green Lizard)**. BRAZIL: ALAGOAS: Municipality of Maceió: Serra da Saudinha (09.366°S, 35.750°W; SAD69). November 2005. U. Gonçalves and S.

Torquato. Setor de Zoologia, Coleção Herpetológica do Museu de História Natural, Universidade Federal de Alagoas, Brazil (MUFAL 3542; collecting license IBAMA/RAN 184/05). Verified by G. Skuk. Municipality of Campo Alegre: Fazenda Pindoba (09.758889°S, 36.235833°W; SAD69; elev. 121 m). 17 April 2007. I. C. S. Tiburcio and others. Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 98144; collecting license IBAMA/RAN 204/06). Verified by H. Zaher. The species was previously recorded from rainforests of Guiana Francesa, Suriname, Guiana, Venezuela, Colômbia, Equador, Peru, and Brazil (Ávila-Pires 1995. Zool. Verh. 1–706). In Brazil the species was mentioned from Amazonas, Amapá, Maranhão, Pará, Roraima, Rondônia, Mato Grosso Ceará, Paraíba, Pernambuco, Bahia, Espírito Santo, and São Paulo (Vanzolini 1974. Pap. Avul. Zool. 18[4]:61–90; Vanzolini 1983. *In* Rhodin and Miyata [eds.], Advances in Herpetology and Evolutionary Biology: Essays in Honor of Ernest E. Williams, pp. 118–131. Museum of Comparative Zoology, Cambridge, Massachusetts; Ávila-Pires 1995, *op. cit.*; Kawashita-Ribeiro and Ávila 2008. Check List 4[3]:362–365; Santana et al. 2008. Biotemas 21[1]:75–84; Turci and Bernarde 2008. Bioikos 22[2]:101–108; Silva-Soares et al. 2011. Check List 7[3]:290–298). First state records, the localities (Serra da Saudinha and Fazenda Pindoba) are about 214 km and 268 km south of nearest occurrences, respectively (municipality of Timbaúba, state of Pernambuco).

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***SCELOPORUS TRISTICHUS* (Plateau Fence Lizard)**. USA: WYOMING: Natrona Co.: near Muddy Mountain Educational Center, on the southern slope of Casper Mountain in a small canyon north of County Road 505 (42.707490°N, 106.396642°W; WGS 84). 29 June 2011. K. J. Weber and K. P. Leuenberger. Verified by Adam Leache. INHS 2011o. New county record (Baxter and Stone 1985. Amphibians and Reptiles of Wyoming. 2nd ed. Wyoming Game and Fish Department, Cheyenne. 137 pp.).

One individual (male) was observed at this site. Subsequently an adult female was captured and observed (42.65369°N, 106.35277°W) on 27 July 2011. Four more individuals were captured near Casper, 20 km E (42.699509°N, 106.142660°W) on 30 June 2011. *S. tristichus* is known to occur in Albany, Laramie, Platte, and Converse counties where it exclusively inhabits rocky outcrops and crevices (Baxter and Stone, *op. cit.*). These observations extend the range of *S. tristichus* approximately 30 km.

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***TARENTOLA PARVICARINATA* (White-spotted Wall Gecko)**. MOROCCO: WESTERN SAHARA: Ca. 10 km NW Galtat Zemmour (25.218°N, 12.445°W; WGS 84; 465 m elev.). 1 October 2006. J.-F. Trape. Institut de Recherche pour le Développement at Dakar (IRD TR.1804). Verified by Philippe Geniez. First record for Morocco (Western Sahara), extends known range ca 400 km N of Adrar mountains in Mauritania (Geniez et al. 2006. The Amphibians and Reptiles of the Western Sahara. Edition Chimaira, Frankfurt an Main, 228 pp.; Padial 2006. Graellsia 62:159–178).

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***TROPIOCOLOTES TRIPOLITANUS* (Tripoli Pigmy Gecko)**. CHAD: KANEM REGION: Ca. 4 km W of Méchiméré (13.832°N, 15.769°E; WGS 84; 285 m elev.). Two specimens collected at night on sandy area near roots of *Acacia* trees. 16 January 2003. J.-F. Trape. Institut de Recherche pour le Développement at Dakar (IRD TR.02 and TR.04). Verified by Laurent Chirio. First records for Chad (Sindaco and Jeremcenko 2008. The Reptiles of the Western Palearctic. Edizioni Belvedere, Latina. 579 pp.; Uetz and Hošek 2011. The Reptile Database. http://www.reptile-database.org/. Accessed December 2011).

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***VARANUS DUMERILII* (Dumeril's Monitor)**. INDONESIA: SUMATERA SELATAN PROVINCE: Musi Banyuasin District: eastern lowlands of Sumatra, along border with Jambi Province (1.8186°S, 104.1206°E, Google Earth; 35 m elev.). 12 October 1995. Mark R. Bezuijen. Verified by Mark Auliya. Photographic voucher deposited in the Zoological Reference Collection of the Raffles Museum of Biodiversity Research, National University of Singapore (ZRC[IMG] 2.159). Adult, observed at 1100 h, motionless among sedges, *Pandanus* and felled timber on swampy ground, in large tract of selectively logged lowland dipterocarp forest with numerous small creeks (tree genera including *Shorea*, *Anisopthera*, *Gonostylus*; understory 5–10 m, canopy 25–30 m). Identified on basis of dark brown-black dorsum with dull yellow transverse bands; large nuchal scales, not arranged in longitudinal rows; large, oval and keeled dorsal scales; and tail laterally compressed with strong double keel (de Rooij 1915. The Reptiles of the Indo-Australian Archipelago. I. Lacertilia, Chelonia, Emydosauria. E. J. Brill Ltd, Leiden. xiv + 384 pp.). Widely distributed in Southeast Asia, but with few published locality records; some specimens mistaken for *V. rudicollis* (Bennett and Lim 1995. Malayan Nat. J. 49:113–116; Böhme 2003. Zool. Verh. 341:3–43; Bennett 2004. *In* Pianka et al. [eds.]. Varanoid Lizards of the World, pp. 172–175. Indiana University Press, Bloomington; Cota et al. 2008. Biawak 2:152–158). Previously recorded from eastern Sumatra (de Rooij 1915, *op. cit.*), although the provenance of some records is unclear.

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SERPENTES — SNAKES

***AGKISTRODON PISCIVORUS LEUCOSTOMA* (Western Cottonmouth)**. USA: TENNESSEE: Weakley Co.: N of Etheridge Levee Rd and White Clay Rd intersection on Obion River WMA (36.20054°N, 88.86903°W; NAD 83). 10 August 2011. Jeremy Dennison. Austin Peay State University Museum of Zoology (APSU 19160). New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 14 April 2011; accessed 13 October 2011]).

Crockett Co.: 2.5 km NE of Hwy 152 on Horns Bluff Refuge. (35.851333°N, 89.091167°W; NAD 83). 23 June 2011. Robert Colvin and Jeremy Dennison. APSU 19137. New county record (Scott and Redmond 2008, *op. cit.* [updated 8 November 2011; accessed 9 November 2011]).

Specimen verifications were made by A. Floyd Scott. Voucher specimens collected under the authority of the Tennessee

Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

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***BOIGA OCHRACEA* (Tawny Cat Snake)**. BANGLADESH: SYLHET DIVISION: Moulovibazaar District: Lawachara National Park (24.330963°N, 91.801120°E; WGS 84; ca. 50 m elev.). Road killed individual found on former Dhaka-Sylhet highway, dissecting Lawachara National Park. 13 July 2011. Verified by Gernot Vogel. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.156). First confirmed record for Sylhet Division. First Bangladesh record from Chittagong Hill Tracts (Khan 1982. Wildlife of Bangladesh—A Checklist. Dhaka University Press, Dhaka. 173 pp.). Nearest record from Chittagong University Campus (ca. 200 km S; Ahsan & Parvin 2004. Asiatic Herpetol. Res. 10:235).

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***BOIGA SIAMENSIS* (Siamese Cat Snake)**. BANGLADESH: SYLHET DIVISION: Moulovibazaar District: Lawachara National Park (24.330963°N, 91.801120°E; WGS 84; ca. 50 m elev.). Two individuals found during day, on tea bushes (*Camellia* sp.) in Fulbari Tea Estate, adjacent to Lawachara National Park. 16 June 2011 and 17 June 2011. Verified by Gernot Vogel. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.155). First confirmed locality record from Bangladesh. Kabir et al. (2009. Encyclopedia of Flora and Fauna of Bangladesh, Vol. 25. Amphibians and Reptiles. Asiatic Society of Bangladesh, Dhaka. 204 pp.) listed Sylhet and Chittagong Division, without locality information, voucher specimen or photographs. Nearest records from Gibbon Wildlife Sanctuary, Assam (ca. 349 km NE), Garo Hills, Meghalaya (ca. 201 km NW) and Sikkim (ca. 483 km NW) by Das et al. (2010. Russian J. Herpetol. 17:161–178), in India.

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***COLUBER* (= *MASTICOPHIS*) *FLAGELLUM* (Coachwhip)**. USA: KANSAS: Lincoln Co.: State Highway 232, 1.36 rd. km S jct. Hill Creek Bridge Rd. (38.911341°N, 98.475550°W; WGS 84). 11 August 2011. Verified by C. J. Schmidt. FHSM-H 15931. New county record (Kansas Herpetofaunal Atlas. http://webcat.fhsu.edu/ksfauna/herps/index.asp, accessed 6 September 2011). Adult DOR; extends the known range one county to the northeast.

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***CONOPSIS LINEATA* (Lined Tolucan Ground Snake)**. MÉXICO: ZACATECAS: Municipality Of Pinos: 2.64 km NE Pinos (22.311961°N, 101.554510°W; WGS84), 2884 m elev. 1 August 2010. Rubén Alonso Carbajal Márquez, Zaira Yaneth González Saucedo, Jason Jones, and Luis Gallegos Román. Verified by L. Lee Grismer. La Sierra University Digital Photo Collection (LSUDPC 6051). First record for the state, extending the known distributional range of the species ca. 69 km NW from Sierra de San Miguelito, Villa de Reyes, San Luis Potosí (USNM 46427; Goyenechea and Flores-Villela 2006. Zootaxa 1271:1–27). The snake was found under a rock in an oak savanna.

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***CROTALUS CULMINATUS* (Northwestern Middle American Rattlesnake)**. MÉXICO: OAXACA: Municipality of San Pedro Mixtepec: Jardín Botánico Puerto Escondido de la Universidad del Mar (JBPE UMAR), km 239 on Sola de Vega-Puerto Escondido Road, ca. 6 km N of Puerto Escondido (15.916947°N, 97.076694°W; WGS 84), 88 m elev. 28 January 2008. Guillermo Sanchez-de la Vega. Verified by Jerry D. Johnson. Laboratorio de Colecciones Biológicas, Universidad del Mar, Campus Puerto Escondido (Rep-42). First municipality record that fills a gap between the nearest confirmed localities, ca. 216 km WNW in Copala, Guerrero (Armstrong and Murphy 1979. Spec. Publ. Mus. Nat. Hist., Univ. Kansas [5]:i–vii, 1–88) and ca. 175 km ENE between Salina Cruz and Tequisistlán on the Isthmus of Tehuantepec (Gadow 1908. Through Southern México. Whitherby and Co., London. xvi + 257 pp.). Gloyd (1940. Spec. Publ. Chicago Acad. Sci. [4]:i–viii, 1–270) shows a map depicting a locality further west (possibly near Puerto Angel?) to the one reported by Gadow (1940, *op. cit.*), but he failed to include it in the localities he listed for Oaxaca. The same locality was seemingly mapped by Campbell and Lamar (2004. The Venomous Reptiles of the Western Hemisphere, Vol. II. Comstock Publ. Assoc., Ithaca, New York. xiv + 477–870 pp.). The adult female was DOR near the main entrance to JBPE UMAR. The vegetation in the area is represented primarily by tropical deciduous forest.

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***DIADOPHIS PUNCTATUS ARNYI* (Prairie Ring-necked Snake)**. USA: NEBRASKA: Harlan Co.: approx. 1.5 mi. NNE Alma (39.85907°N, 93.60844°W; elev. 624 m). 23 May 2011. Brian Hubbs. Verified by Dan Fogell. Natural History Museum of Los Angeles County photo voucher LACM PC 1562. New county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. The

Amphibians and Reptiles of Nebraska. University of Nebraska Press, Lincoln, Nebraska. 158 pp.).

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***HETERODON PLATIRHINOS* (Eastern Hognose Snake)**. USA: TENNESSEE: McNairy Co.: Finger, 294 Sherry Lynn Drive (35.357800°N, 88.635583°W; WGS84). 4 October 2011. Brian P. Butterfield. Verified by A. F. Scott. Austin Peay State University (APSU 19168 photographic voucher). New county record (Scott and Redmond 2008 [latest update: 8 November 2011]. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 9 November 2011). Juvenile male found in a residential garage located in a rural subdivision within an oak-hickory forest.

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***HYPSIGLENA CHLOROPHAEA DESERTICOLA* (Northern Desert Nightsnake)**. USA: UTAH: Cache Co.: River Trail at Stokes Nature Center, south side, Logan Canyon (41.741938°N, 111.768623°W; WGS 84). 13 August 2011. A. M. Durso, K. P. Durso, N. M. Kiriazis, L. A. Neuman-Lee. Verified by Jack W. Sites, Jr. BYU 49957. Found crossing a dirt path at 2139 h. A second specimen (BYU 49958) was found in Logan Canyon.

These two records confirm the presence of *H. chlorophaea* in Cache Co. (Cox and Tanner 1995. Snakes of Utah. Bean Life Science Museum, Provo, Utah. 92 pp.), where it had not been recorded until recently (Mulcahy 2008. Mol. Phylog. Evol. 46:1095–1115), and expands the range of known localities within the county (B. Sutter, Utah Natural Heritage Database, pers. comm.). In October 2005, a single voucher specimen (CAS 235907) was collected in River Heights by a grade school student. Anecdotal reports exist for additional River Heights records (J. A. MacMahon, pers. comm.). Together, these three specimens fill a gap between the nearest records, from ca. 67 mi (airline) S at Fort Douglas, Salt Lake Co., Utah (CAS 30925, 30926) and ca. 81 mi (airline) NE at ~ 1 mi SE of Pocatello, Bannock Co., Idaho (Linder and Fichter 1977. Amphibians and Reptiles of Idaho. Idaho State Univ. Press, Pocatello. 78 pp.).

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***LAMPROPELTIS ALTERNA* (Gray-banded Kingsnake)**. MEXICO: NUEVO LEON: Municipality of Mina: 58.7 air km SW of Sabinas Hidalgo along Mex. Hwy 53 (26.24959°N, 100.69002°W; WGS84), 785 m elev. 7 October 2007. Michael S. Price, Christopher R. Harrison, and David Lazcano. Verified by Robert W. Bryson. UANL 6986. New municipality record that fills in a distributional gap between Monclova, Coahuila (Lemos-Espinal and Smith 2007. Anfibios y Reptiles del Estado de Coahuila, México. UNAM, Tlalnepantla, Estado de México and CONABIO, México, D.F. xii + 550 pp.) and Monterrey, Nuevo Leon (Lazcano-Villarreal et al. 2010. Serpientes de Nuevo Leon. UANL, Monterrey, Nuevo Leon, México. 502 pp.). The snake was found in the Sierra Pedernales at the entrance of a large crevice in an east-facing rock outcrop surrounded by typical xeric Chihuahuan Desert scrub vegetation.

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***LAMPROPELTIS TRIANGULUM* (Milksnake)**. MÉXICO: GUANAJUATO: Municipality of Tarimoro: 3.5 km NNW of La Moncada (20.316241°N, 100.811616°W; WGS84), 1763 m elev. 20 August 2011. José Carlos Arenas Monroy. Verified by Robert Hansen. UTA-DC 6973. First record for the municipality, third record for the State of Guanajuato, and it bridges about a 153 km (airline) gap SSW between the northern population, ca. 153 km (airline) SSW from 12.5 km SE Mineral El Realito, Victoria, Guanajuato (Campos-Rodríguez et al. 2010. Rev. Mex. Biodiv. 81:203–204), and southern populations, ca. 33 km (airline) NNW from Acámbaro, Guanajuato (Williams 1988. Systematics and Natural History of the American Milk Snake, *Lampropeltis triangulum.* 2nd ed., revised. Milwaukee Publ. Mus., Milwaukee, Wisconsin. x + 176 pp.) The specimen was found under a plastic pool cover near a pond in an agriculture field.

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***MICRURUS DISTANS* (West Mexican Coral Snake)**. MEXICO: ZACATECAS: Municipality of Mezquital Del Oro: 8 km E Mezquital del Oro by road Malacate-Moyahua (21.267383°N, 103.313492°W; WGS 84), 1525 m elev. 3 October 2010. Octavio Vázquez-Huizar and Iván T. Ahumada-Carrillo. Verified by Jacobo Reyes- Velasco. UTADC 6967–6968. First state record, extending the range ca. 55 km (airline) N from Río Grande de Santiago drainage, Jalisco (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere, Vol. I. Comstock Publ. Assoc., Cornell Univ. Press, Ithaca, New York. 476 pp.). The snake was found AOR in tropical deciduous forest.

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***NERODIA ERYTHROGASTER FLAVIGASTER* (Yellow-bellied Watersnake)**. USA: TENNESSEE: Crockett Co.: 2.7 km NE of Hwy 152 on Horns Bluff Refuge (35.8575°N, 89.08777°W; NAD 83). 23 June 2011. Robert Colvin and Jeremy Dennison. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19138). New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 8 November 2011; accessed 9 November 2011]).

Voucher specimen collected under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

ROBERT COLVIN (e-mail: Rob.Colvin@tn.gov) and **JEREMY DENNISON** Tennessee Wildlife Resources Agency, Region I, 200 Lowell Thomas Drive, Jackson, Tennessee 38301, USA (e-mail: Jeremy.Dennison@tn.gov).

***NERODIA SIPEDON SIPEDON* (Common Watersnake)**. USA: KANSAS: Lincoln Co.: Lincoln (39.02889°N, 98.151527°W; elev. 412 m). 11 May 2011. Brian Hubbs. Verified by Curtis Schmidt. Natural History Museum of Los Angeles County photo voucher (LACM PC 1559). New county record fills a gap in the range (Collins 2010. Amphibians, Reptiles, and Turtles in Kansas. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas. 312 pp.). Snake observed dead, caught in fishing net on log.

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***OLIGODON CYCLURUS* (Cantor's Kukri Snake)**. BANGLADESH: SYLHET DIVISION: Moulovibazaar District: Lawachara National Park (24.331524°N, 91.818104°E; WGS 84; ca. 32 m elev.). One live individual found at ca. 0700 h in Fulbari village, outside Lawachara National Park. Another individual, a road kill, found on former Dhaka-Sylhet highway, dissecting the Park. 22 July 2011 and 24 October 2011. Verified by Gernot Vogel. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.158). First confirmed record for Sylhet Division. Nearest populations in Bangladesh from Lalmonirhat District (ca. 338 km to NW; David et al. 2011. Zootaxa 2799:1–14), and unconfirmed sightings from Sherpur District (ca. 182 km to NW; M. Khan, pers. comm.).

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***OPHEODRYS AESTIVUS* (Rough Green Snake)**. USA: TENNESSEE: Wilson Co.: Cedars of Lebanon State Forest on Cedar Forest Rd. approximately 1.45 km E of McCrary Rd. (36.08027°N, 86.404722°W; WGS 84). 30 September 2011. Tom Blanchard. Verified by A. Floyd Scott. Austin Peay State University (APSUMZ 19163). Found dead on gravel road in cedar-predominated forest. New county record (Scott and Redmond 2008 [latest update: 08 November 2011]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 30 September 2011).

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***RHABDOPHIS HIMALAYANUS* (Himalayan Keelback)**. BANGLADESH: SYLHET DIVISION: Moulovibazaar District: Lawachara National Park (24.330963°N, 91.801120°E; WGS 84; ca. 50 m asl.). Three roadkilled individuals were also found on former Dhaka-Sylhet highway, dissecting Lawachara National Park. 8 July 2011. Verified by Gernot Vogel. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.154). First confirmed locality record from Bangladesh. Khan (2008. Protected Areas of Bangladesh- A Guide to Wildlife. Nishorgo Program, Bangladesh Forest Department, Dhaka, Bangladesh. 304 pp.) mentioned of a record in northwest Bangladesh, but without locality information, voucher specimen or photographs. Nearest populations recorded from Assam, Meghalaya, northern Bengal and Sikkim, in India (Ahmed at al. 2009. Amphibians and Reptiles of Northeast India. A Photographic Guide. Aaranyak, Guwhati. 168 pp.) Four live individuals found in mixed plantation forest.

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***RHADINAEA FLAVILATA* (Pine Woods Littersnake)**. USA: GEORGIA: Camden Co.: Cumberland Island (30.8153°N, 81.46956°W; WGS 84) 31 May 2011. C. Ruckdeschel. Verified by C. K. Dodd and K. Krysko. Florida Museum of Natural History (photo voucher UF 165513). New island record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.). Single adult in damp area.

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***RHADINAEA LAUREATA* (Crowned Graceful Brownsnake)**. MÉXICO: CHIHUAHUA: Municipio de Bocoyna: near km 86 on Hwy 25 N of Creel (27.789694°N, 107.651972°W; NAD27), 2355 m elev. 12 July 2008. Robert W. Bryson, Jr. and Mike Torocco. UAZ 57331-PSV. Municipio de Guadalupe y Calvo, approximately 1 km N of Baborigame (26.425975°N, 107.268522°W; NAD27), 1800 m elev. 10 October 2008. Ricardo Ramírez-Chaparro and Jesús Enrique-Fuentes. UAZ 57321-PSV. Both specimens verified by Irene Goyenechea and Charles W. Myers. The two localities are separated by ca. 154 km and are the first records for Chihuahua, representing range extensions of 360 km northwest and 312 km northwest, respectively, from the closest recognized records at Laguna del Progresso, Durango (UMMZ 113625–113627; Myers 1974. Bull. Am. Mus. Nat. Hist. 153:1–262); UAZ 57331-PSV is also the northernmost record for this species in Mexico. Both snakes were found in pine-oak woodlands on the Sierra Madre Occidental.

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***SINOMICRURUS MACCLELLANDI* (MacClelland's Coral Snake)**. BANGLADESH: SYLHET DIVISION: Moulovibazaar District: Lawachara National Park (24.333016°N, 91.800096°E; WGS 84; ca. 43 m elev.). Two road-killed individuals found on former Dhaka-Sylhet highway, dissecting Lawachara National Park. 17 October 2011 and 26 October 2011. Verified by Gernot Vogel. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.157). First confirmed locality record from Bangladesh. Kabir et al. (2009. Encyclopedia of Flora and Fauna of Bangladesh, Vol. 25. Amphibians and Reptiles. Asiatic Society of Bangladesh, Dhaka. 204 pp.) mentioned its presence in forested areas of Sylhet and Chittagong Division, but with no locality information, voucher specimens, or photographs. Nearest populations recorded from Assam, India (Ahmed at al. 2009. Amphibians and Reptiles of Northeast India. A Photographic Guide. Aaranyak, Guwahati. 168 pp.).

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***STORERIA DEKAYI* (Brownsnake)**. USA: GEORGIA: Telfair Co.: 14.5 km SW Lumber City, Orianne Indigo Snake Preserve

(31.844090°N, 82.796237°W; NAD 83) October 2011. J. Parker, T. Warfel, and M. Ishimatsu. Verified by Kenneth L. Krysko. UF 165899. New county record (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Adult under debris in Ocmulgee River floodplain.

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***STORERIA DEKAYI DEKAYI* (Northern Brownsnake)**. USA. OHIO: Hamilton Co.: Delhi Township: (39.113290°N, 84.695231°W; WGS 84). 12 October 2011. Paul J. Krusling. Verified by Jeffrey G. Davis. Cincinnati Museum Center Herpetology Collection (CMC 12330). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contrib. No. 10, Columbus).

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***STORERIA DEKAYI WRIGHTORUM* (Midland Brownsnake)**. USA: ARKANSAS: Searcy Co.: vic. Mull, off AR St. Hwy. 14, ca. 2 km S on Ramblewood Trail by private residence (36.056722°N, 92.604324°W; WGS 84). 4 November 2011. M. B. Connior. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31892). First county record filling a distributional gap among surrounding Stone, Marion, and Newton counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

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***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. USA: ARKANSAS: Baxter Co.: On Baxter Co. Rd. 36, at a point 2.4 km W St. Hwy 201 (36.48333°N, 92.35334°W; WGS 84). 3 November 2011. S. E. Trauth. Verified by Benjamin A. Wheeler. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31893). DOR. First county record filling a distributional gap among surrounding Marion, Izard, and Fulton counties (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

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***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. USA: INDIANA: Washington Co.: Jackson-Washington State Forest: 38.70164°N, 86.01019°W (NAD 83). 7 June 2011. Sarabeth Klueh and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2011p). New county record. (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.).

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***THAMNOPHIS PROXIMUS PROXIMUS* (Orange-striped Ribbonsnake)**. USA: KANSAS: Ness Co.: approximately 3 mi. S of Ness City (38.40628°N, 99.89524°W; elev. 676 m) 1 May 2010. Brian Hubbs. Verified by Chad Whitney. Natural History Museum of Los Angeles County photo voucher (LACM PC 1561). New county record (Collins 2010. Amphibians, Reptiles, and Turtles in Kansas. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas. 312 pp.).

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***THAMNOPHIS SAURITUS SAURITUS* (Common Ribbonsnake)**. USA: ALABAMA: Sumter Co.: Near a wet seep on a Selma Chalk exposure (32.98652°N, 88.21576°W; WGS84/NAD83). 18 October 2011. R. Birkhead. Verified by Craig Guyer. AUM 39703. New county record. *T. s. sauritus* is assumed to occur statewide, however verified records are lacking for some counties (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press, Tuscaloosa. xi + 347 pp.).

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***TROPIDOCLONION LINEATUM* (Lined Snake)**. USA: WISCONSIN: Iowa Co.: specific locality information withheld due to the sensitive nature of the site. C. Raimond and J. M. Lorch. Verified by Joshua Kapfer and Rori Paloski. Illinois Natural History Survey (INHS 2011m photo voucher). New state record. Extends the known range of this species by approximately 95 km (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, 668 pp.; INHS 21335 from Jo Daviess Co., Illinois). Two adults were observed on a dry prairie remnant on 4 September 2011; an additional adult (based on differences in belly pattern) was located on 10 September 2011. The site lies within an historic prairie complex (Curtis 1959. The Vegetation of Wisconsin: An Ordination of Plant Communities. University of Wisconsin Press, Madison. 640 pp.) that is now a mixture of pastureland, active agricultural fields, and scattered prairie remnants. The main range of *Tropidoclonion lineatum* extends from southeastern South Dakota south to the Gulf Coast of Texas, but there are isolated populations in northern and central Illinois, southeastern Iowa, east-central Missouri, eastern Colorado, and New Mexico (Ernst and Ernst 2003, *op. cit.*). The nearest known population to the Wisconsin site occurs in southern Jo Daviess Co., Illinois (Bowen 2004. Herpetol. Rev. 35:413). It is unclear whether the Wisconsin animals represent a population disjunct from that of northwest Illinois or whether the secretive habits of this semi-fossorial snake are responsible for the paucity of records. Habitat similar to that found at the newly discovered site is present throughout large portions of Grant, Green, Lafayette, and Iowa counties, Wisconsin, and the species might be more widely distributed in the state than this one record indicates.

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***VIRGINIA STRIATULA* (Rough Earthsnake)**. USA: ARKANSAS: Sevier Co.: 5.1 km E of King off Co. Rd. 342 (34.144665°N, 94.238405°W; WGS 84). H. W. Robison. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetological Museum (ASUMZ 31903). New county record filling a distributional hiatus in extreme southwestern Arkansas near previous record in Miller Co. (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

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***VIRGINIA VALERIAE* (Smooth Earthsnake)**. USA: OHIO: Gallia Co.: Greenfield Township, Dry Ridge Road (Township Hwy 596) in the Wayne National Forest (38.78122°N, 82.54766°W; WGS 84). 5 June 2010. B. Folt and C. Brune. Verified by Scott Moody. Cincinnati Museum Center, Geier Collections and Research Center (CMC HP 6550 photo voucher). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10, Columbus. iv + 81 pp.).

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New Distributional Records from the Lesser Sundas, Indonesia

The Lesser Sunda islands stretch from 114.43° to 127.37°E and lie between latitudes of 8 and 10°S. The islands are primarily volcanic in origin, and currently experience a tropical seasonally wet-dry climate which in general becomes increasingly xeric towards the east, and correspondingly, supports vegetation communities ranging from rainforest to grasslands. The associated herpetofauna is also greatly influenced by altitude and isolation, in addition to being an area of integration between faunas of Asian and Australopapuan origins, the much-discussed zone of Wallacea. Consideration of this zone, and biodiversity of the Lesser Sundas otherwise, has been intrinsically hampered by incomplete zoogeographical knowledge. Of the islands, the two best known are Komodo and Bali, with studies of 17 months (Auffenberg 1980) and nine months (McKay 2006), respectively. Both studies increased the known faunal content considerably, 25% in the case of Bali. Information for the rest of the archipelago is comparatively thinner, despite the efforts of various researchers over the course of the last one hundred years. Recent publications, de Lang's (2011) synthesis of the snakes and the results of the Western Australian Museum/Museum Zoologicum Bogoriense expeditions conducted during 1987–1993 (e.g., How et al. 1996a, 1996b; 1998; How and Kitchener 1997), provide the most modern overview of the herpetofauna, and supported by Merten's works during early to mid-1900s (e.g., Mertens 1927a; 1927b; 1928; 1957), other species-specific or taxonomic snippets (e.g., Das 1993; Iskandar et al.1996; Wüster 1996), and the baseline data of seminal publications, such as de Rooij (1915; 1917), Boulenger (1897) and van Kampen (1923), this forms the body of our herpeto-zoogeographical knowledge for the Lesser Sundas.

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From 2007 to 2011, we visited the Lesser Sundas, one of us was resident on Bali (RL), and in combination spent approximately 50 months on Bali, four months on Lombok, one month on Sumbawa, and one month on Flores. For islands other than Bali, field work was conducted mainly between October and March, the hottest and wettest time, employing searches on foot or from vehicle, and at a few locations (e.g., Sape, Sumbawa) the aid of local snake handlers. Locations were recorded with GPS in the datum WGS84; digital photographs as vouchers were lodged in the collection of the Museum of the Northern Territory, Australia (NTM). Here, we present the resulting new distributional records, again clearly demonstrating that the herpetofaunal composition of these islands remains incomplete, even those as well known as Bali. The use of traps, which in this case was not available to us, would undoubtedly yield further interesting results. In terms of conservation, viewing these islands as more biodiverse than we realize evinces the value of utilizing widespread societal change (i.e., changing attitudes and practices towards preserving natural ecosystems, vegetation or organisms), as equal in importance to the scattering of formally protected areas in Indonesia.

ANURA — FROGS

***DUTTAPHRYNUS MELANOSTICTUS* (Asian Eyebrow-ridge Toad)**. SUMBAWA: Sekongkang (8.9653°S, 116.7526°E). 10 Feb 2010. Dompu (8.5356°S, 118.4671°E).13 Feb 2010. NTM 05113Dmel. Sape (8.5744°S, 119.0082°E). 14 Feb 2011. Common and often breeding. In the Lesser Sundas, known from Bali, Lombok and Timor (McKay 2007). Notably, not yet recorded from Komodo or Flores.

SQUAMATA — LIZARDS

***CYRTODACTYLUS DARMANDVILLEI* (D'Armandville's Forest Gecko)**. LOMBOK: Kuta (8.9069°S, 116.3067°E). 14 Oct 2007. NTM 1007CrytoSpX. Common in rock outcrops. Previously known from Sumbawa and islands further east (Mertens 1930). First record for Lombok.

Fig. 1. *Lepidodactylus intermedius*, Flores, Lesser Sunda islands. First published photograph of a living example.

PHOTO BY J. L. MCKAY

Fig. 2. *Typhlops schmutzi*, Sumbawa, Lesser Sunda islands. First published photograph of a living specimen.

***HEMIDACTYLUS GARNOTII* (Fox Gecko)**. FLORES: Ruteng (8.6160°S, 120.4640°E). 18 Jan 2011. NTM 04343Hgar. Common on unlit walls in town. A widespread species, known from Lombok (Mertens 1927b), but apparently the first record from the eastern Lesser Sundas.

***LEPIDODACTYLUS INTERMEDIUS* (Komodo Mourning Gecko)**. FLORES: Reo (8.3071°S, 120.4997°E). 20 Jan 2011. NTM 04493Lint. One adult on mango tree in suburban situation (Fig. 1). Ota et al. (2000) distinguish preserved specimens of this species from preserved *L. lombocensis* by the extent of interdigital webbing and dorsal pattern. Examination of the dorsum of live specimens of both species (see also below) shows them to be highly similar. First record from the Flores mainland, otherwise known from the smaller islands of Komodo and Rinca (Auffenberg 1980).

***LEPIDODACTYLUS LOMBOCENSIS* (Lombok Mourning Gecko)**. BALI: Ubud (8.5096°S, 115.2619°E). 10 June 2010. NTM 02089Llom. One adult found climbing a divider outside a hotel room. Previously known from Lombok (Ota et al. 2000).

***CRYPTOBLEPHARUS RENSCHI* (Blue-tailed Snake-eyed Skink)**. FLORES: Labuan Bajo (8.4861°S, 119.8789°E). 10 Jan 2011. NTM 04175Cren. Pulau Seraya Kecil (8.4129°S, 119.8698°E). 3 March 2011. A common arboreal lizard. Auffenberg (1980) believed this taxon to exist on Flores on the basis of a personal sighting, although no specimens or records existed, and here, we confirm its presence on Flores. The species has a disjunct distribution occurring in the Kangean islands north of Java, parts of Bali, Komodo, Rinca, Longo, and Sumba.

***EMOIA ATROCOSTATA ATROCOSTATA* (Mangrove Skink)**. BALI: Gilimanuk (8.1757°S, 114.4408°E). 16 Nov 2007. NTM 1107EatroA. One adult in mangrove dominated by *Rhizophora* sp. LOMBOK: Gili Sulat (8.3230°S, 116.7107°E). 26 Jan 2010. One adult in mangrove dominated by *Rhizophora* sp. Kuta (8.9069°S, 116.3067°E). 3 Feb 2010. One adult on a beach with conglomerate boulders. SUMBAWA: Karumbu (8.7041°S, 118.8090°E). 16 Feb 2011. Three adults inhabiting small rocks on mudflat. Although ranging widely in Indonesia (Brown 1991), occurrence of populations is patchy, and these are the first specific records for these islands.

***EMOIA KITCHENERI* (Kitchener's Emoia)**. FLORES: Aimere (8.8380°S, 120.8531°E). 26 Jan 2011. NTM 04462Ekit. One adult climbing low on a banana plant in riparian situation. First record for Flores, previously only the type series from the vicinity of Ngallu, Sumba were known (How et al. 1998).

***EMOIA SIMILIS* (Dunn's Emoia)**. FLORES: Labuan Bajo (8.4861°S, 119.8789°E). 9 Jan 2011. NTM 04148Esim. One adult in savannah. How et al. (1998) mention *Emoia similis* from the opposite end of Flores (Larantuka) have colouration sufficiently different from the type to warrant taxonomic investigation. Brown (1991) includes Flores in the species' distribution without further details. Here, we confirm its presence on western Flores, from a specimen which agreed closely in appearance with the typical form known from neighboring Komodo and Rinca (Auffenberg 1980).

***LAMPROLEPIS SMARAGDINA* (Emerald Tree Skink)**. SUMBAWA: Pantai Lakey (8.8039°S, 118.3836°E). 28 Feb 2011. NTM 05102Lsma. Common in monsoon forest and on coconut palms of foreshore. Known previously from Lombok and Flores (Mertens 1930); notably, still unknown from Komodo (Auffenberg 1980).

***LYGOSOMA BOWRINGII* (Bowring's Supple Skink)**. FLORES: Labuan Bajo (8.4861°S, 119.8789°E). 9 Jan 2011. NTM 04167Lbow. Reo (8.3071°S, 120.4997°E). 21 Jan 2011. Adults taken in monsoon forest. First records for Flores. Previously known from Lombok (Mertens 1927b), Nusa Penida (McKay 2006), and areas further west.

***SPHENOMORPHUS SCHLEGELI* (Schlegel's Forest Skink)**. FLORES: Labuan Bajo (8.4861°S, 119.8789°E). 12 Jan 2011. NTM 04245Ssc. Near Reo (8.3071°S, 120.4997°E). 23 Jan 2011. Adults taken in monsoon forest. First records for Flores, previously considered endemic to Komodo and Rinca (Auffenberg 1980).

SQUAMATA — SNAKES

***TYPHLOPS SCHMUTZI* (Reverend Schmutz's Blind Snake)**. SUMBAWA: Sumi (8.6035°S, 119.0155°E). 15 Feb 2011. NTM 04931Tsch. One adult taken in a deep leaf litter bed at the base of a limestone outcrop in closely vegetated situation (Fig. 2). Previously known from Komodo and Flores (Auffenberg 1980), this is the first record for Sumbawa.

***BOIGA DENDROPHILA DENDROPHILA* (Mangrove Snake)**. BALI: Silakarang (8.5944°S, 115.2564°E). 18 Sep 2010 and 20 Sep 2010. NTM 3RL. One dead animal found floating in a stream, and two adults photographed sitting together in a coconut palm, ca. 20 m above ground. Previously known from Java, and further west.

***CALLIOPHIS INTESTINALIS INTESTINALIS* (Asian Coral Snake)**. BALI: Mas (8.5428°S, 115.2761°E). 23 Jan 2011. NTM 1 RL/NTM 4 RL. One specimen discovered during excavation work for a pool. Previously known from Java and further west.

***DABOIA SIAMENSIS* (Eastern Russell's Viper)**. SUMBAWA: Sumi (8.6035°S, 119.0155°E). 18 Feb 2011. NTM 04958Dsi. One adult in savannah. Ca. 15 km N of Bima (8.4145°S, 118.7730°E). 21 Feb 2011. Roadkill adult from highly transformed open shrubland. Sape (8.5744°S, 119.0082°E), without exact locality. Two adults collected in the vicinity by local snake handler. First records from Sumbawa; other Lesser Sunda populations occur sporadically eastwards to Lomblen (de Lang 2011).

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New Distributional Records for Reptiles from Tennessee, USA

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The geographic distribution of amphibians and reptiles in Tennessee has been well documented by Scott and Redmond (2002), and is regularly updated via online atlas (Scott and Redmond 2008). However, the southeastern region of Tennessee has not received the necessary attention or sampling effort to adequately document the presence of many common species. The following records will assist in filling these data gaps. All turtles were collected during a survey of riverine turtle populations in Marion and Hamilton counties, Tennessee. Other specimens were collected during biological field surveys in the aforementioned counties. Identification and distribution of species followed Powell et al. (1998) and Conant and Collins (1998), respectively. All specimens represent new county records. GPS datum is WGS 84. All county records were supported by Scott and Redmond (2008). All specimens were deposited in the University of

Tennessee at Chattanooga Natural History Museum Reptile Collection (UTC-R). Nomenclature follows Crother (2008). All specimens were independently verified by Timothy Gaudin (UTC) and Rico Walder (formerly of the Tennessee Aquarium).

TESTUDINES – TURTLES

***APALONE SPINIFERA* (Spiny Softshell)**. Marion Co.: Tennessee River Gorge, near Pryor Island (35.0714944°N, 85.5278806°W). Specimen captured in a 3-ft diameter hoop net trap baited with sardines and soybean oil. 14 August 2004. Thomas P. Wilson, Christopher B. Manis, Stefan L. Moss, Robert M. Minton. UTC-R Digital Collection 4658.

***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)**. Marion Co.: Tennessee River Gorge, in a 3 x 5-ft basking-style trap (35.0899833°N, 85.401125°W). 14 July 2000. Christopher B. Manis. UTC-R Digital Collection 4659.

***STERNOTHERUS MINOR PELTIFER* (Stripe-necked Musk Turtle)**. Marion Co.: Tennessee River Gorge, in a 3-ft diameter hoop net-style trap (35.0900889°N, 85.3967583°W). 12 July 2000. Christopher B. Manis. UTC-R 4660.

***STERNOTHERUS ODORATUS* (Eastern Stinkpot)**. Marion Co.: Tennessee River Gorge, in a 3-ft diameter hoop net-style trap (35.0883278°N, 85.391°W). 13 June 2000. Christopher B. Manis. UTC-R 4569.

SQUAMATA – LIZARDS

***OPHISAURUS ATTENUATUS* (Slender Glass Lizard)**. Hamilton Co.: Walden Ridge (35.1999639°N, 85.3282083°W). Adult specimen found dead in an open meadow. September 2008. Evan Collins. UTC-R 4662.

***PLESTIODON FASCIATUS* (Common Five-lined Skink)**. Hamilton Co.: 0.3 miles S of Morrison Springs and Mountain Creek Road intersection. Specimen found in garden of residence (35.1223583°N, 85.3130611°W). 06 June 2009. Thomas P. Wilson and Tabitha M. Wilson. UTC-R 4663. Marion Co.: 2.6 mi. W on US-41 from the Marion Co. line (35.0196444°N, 85.4585722°W). 22 July 1997. UTC-R 40. Timothy Gaudin.

SQUAMATA – SNAKES

***CROTALUS HORRIDUS* (Timber Rattlesnake)**. Marion Co.: Tennessee River Gorge, crossing the Tennessee River, near Pot Point (35.0891417°N, 85.3899667°W). First county record. 2 August 2007. Thomas P. Wilson, Christopher B. Manis, Stefan L. Moss, Robert M. Minton. UTC-R Digital Collection 4664.

***LAMPROPELTIS GETULA* (Common Kingsnake)**. Hamilton Co.: Stuart Heights neighborhood at 3100 Lockwood Drive at intersection (35.1025417°N, 85.2850389°W). First county record. 11 July 1999. UTC-R 45. Timothy Gaudin.

***REGINA SEPTEMVITTATA* (Queensnake)**. Marion Co.: Found dead on road (35.0899639°N, 85.3996833°W). First county record. 01 April 2008. UTC-R 4666. Jennifer Grubb, Jill Harrison-Whitaker, and Thomas P. Wilson.

***STORERIA DEKAYI* (Dekay's Brownsnake)**. Marion Co.: Terrestrial area associated with Mullins Cove (35.0687306°N, 35.0687306°W). 24 November 1971. UTC-R 14. John Shadwick.

***THAMNOPHIS SIRTALIS* (Common Gartersnake)**. Hamilton Co.: Found dead on Mountain Creek Road (35.148325°N, 85.297925°W). 24 April 2010. UTC-R 4665. Thomas P. Wilson and Tabitha M. Wilson. Marion Co.: Terrestrial area associated with Mullins Cove (35.0664389°N, 85.4762°W). 04 September 1971. UTC-R 35. Kent Tapper, Georgia Tapper, and Carrol Tapper.

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Amphibian and Reptile Distribution Records for Louisiana – II

The following distributional records for Louisiana amphibians and reptiles have accumulated since an earlier list of records (Boundy 2004), and are based on Dundee and Rossman (1989) and subsequent sources. Many of the new records are the result of specimens collected for the Natural Science Museum at Louisiana State University (Baton Rouge, LSUMZ), whereas others were detected in a survey of the collection of the Louisiana State University at Shreveport Natural Science Museum (LSUS). Identifications of specimens at LSUS were verified by Laurence Hardy and/or Amanda Lewis. Specimens at LSUMZ were verified by Eric Rittmeier or Douglas Rossman. All specimens represent parish records unless otherwise noted. Geographic coordinates are based on NAD83 datum.

CAUDATA — SALAMANDERS

***AMBYSTOMA TALPOIDEUM* (Mole Salamander)**. Webster Parish: 3.4 km E, 0.8 km of N Doyline (32.5392°N, 93.3691°W). 3 February 1994. Laurence M. Hardy. LSUS 8597–8600. A second specimen, LSUS 8601, was collected in this parish. Winn Parish: Kisatchie National Forest, Winn Ranger District, compartment 22 (approximately 32.10°N, 92.87°W). 30 April 2005. E. S. Walsh. LSUS 8977.

***AMPHIUMA TRIDACTYLUM* (Three-toed Amphiuma)**. Claiborne Parish: Corney Lake (approximately 32.91°N, 92.74°W). 1 April 1989. K. Lutsch and D. Wyrick. LSUS 7587–7588.

***DESMOGNATHUS CONANTI* (Spotted Dusky Salamander)**. DeSoto Parish: 18.4 km SE of Mansfield, Sec 7 at Cane Branch (31.9479°N, 93.6319°W). 28 February 1981. Joe Hollenberg. LSUS 7956.

ANURA — FROGS

***ANAXYRUS (= BUFO) TERRESTRIS* (Southern Toad).** East Feliciana Parish: Gilead Road, 10.9–12.2 km S of LA 10 (approximately 30.81°N, 90.86°W). 14 May 2004. Jeff Boundy. LSUMZ 87975. A second specimen, LSUMZ 87977, was collected in this parish.

***ELEUTHERODACTYLUS CYSTIGNATHOIDES* (Rio Grande Chirping Frog)**. East Baton Rouge Parish: Hawthorne Drive at Buttercup Drive, Baton Rouge (30.3796°N, 91.0723°W). 16 July 2007. John D. McVay. LSUMZ 90427. Castle Kirk Drive, Baton Rouge (30.3752°N, 91.1217°W). 27 September 2007. Patti Faulkner. LSUMZ 90640. This exotic species has been established at the latter site for at least three years (P. Faulkner, pers. comm.).

***GASTROPHRYNE CAROLINENSIS* (Eastern Narrow-mouthed Toad)**. West Carroll Parish: Big Colewa Wildlife Management Area, Bearskin Unit (32.42°N, 91.38°W). 28 April 2010. Jeff Boundy and Beau Gregory. LSUMZ 93800.

***HYLA CINEREA* (Green Treefrog)**. La Salle Parish: N end of Dewey Wills Wildlife Management Area (31.5124°N, 92.0372°W). 9 May 2007. Jeff Boundy. LSUMZ 90290.

***LITHOBATES (= RANA) CATESBEIANUS* (American Bullfrog).** Red River Parish: Bayou Pierre, East side of Bayou Pierre Bridge (32.1921°N, 93.5545°W). 22 September 2004. Malcolm McCallum and E. S. Walsh. LSUS 8863.

***LITHOBATES (= RANA) CLAMITANS* (Green Frog)**. West Carroll Parish: Big Colewa Wildlife Management Area, Bearskin Unit (32.42°N, 91.38°W). 28 April 2010. Jeff Boundy and Beau Gregory. LSUMZ 93798, 93799.

TESTUDINES — TURTLES

***DEIROCHELYS RETICULARIA* (Chicken Turtle)**. DeSoto Parish: 0.4 km S, 5.6 km E of Longstreet (32.0932°N, 93.8904°W). 14 April 1972. Marilyn Brumley. LSUS 8146.

***MACROCHELYS TEMMINCKII* (Alligator Snapping Turtle)**. DeSoto Parish: Toledo Bend, near Ace's Camp outside Logansport (approximately 31.91°N, 93.91°W). No date or collector. LSUS 8425. Livingston Parish: right descending bank of Natalbany River at LA 1048 (30.4820°N, 90.5568°W). 29 October 2004. Jeff Boundy. LSUMZ 88083.

***STERNOTHERUS CARINATUS* (Razor-backed Musk Turtle)**. Bossier Parish: 0.4 km S, 0.8 km W of Magenta (32.3719°N, 93.5966°W). 7 February 1994. C. Cormier. LSUS 6224–6227. A more recent specimen, LSUS 8799, was collected in this parish. East Feliciana Parish: lake just E of LA 63, 0.8 km N of LA 37 (30.7360°N, 90.8547°W). 13 August 2005. Jeff Boundy. LSUMZ 88909–88912.

***TRACHEMYS SCRIPTA* (Pond Slider)**. Winn Parish: LA 501, 2.4 km S of Brewton's Mill (32.0992°N, 92.8408°W). 10 June 1999. Laurence M. Hardy. LSUS 8427.

SQUAMATA — LIZARDS

***ANOLIS CAROLINENSIS* (Green Anole)**. Cameron Parish: Peveto Beach, Johnsons Bayou (29.7490°N, 93.6583°W). 15 November 2003. Steven W. Cardiff and Donna L. Dittman. LSUMZ 87671–87674.

***ANOLIS SAGREI* (Brown Anole)**. St. Tammany Parish: US 190 in town of Covington (approximately 30.46°N, 90.09°W). September 1998. Tom Lorenz. LSUMZ 80085.

***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. Livingston Parish: Jordan Drive, Denham Springs (30.5027°N, 90.9326°W). 8 July 2007. Beau Gregory. LSUMZ 90415. Plaquemines Parish: Headquarters of Pass A Loutre Wildlife Management Area (29.1259°N, 89.2069°W). 23 October 2007. Beau Gregory. LSUMZ 90684.

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Extends range to structure at mouth of the Mississippi River. Sabine Parish: 600 m N of intersection of LA 6 and Marthaville Rd, Many (31.5781°N, 93.4768°W). 5 September 2009. Beau Gregory. LSUMZ 93442. Saint John the Baptist Parish: 1.1 km N of jct of US 61 and LA 54, Garyville (30.0900°N, 90.6258°W). 18 March 2009. Jeff Boundy. LSUMZ 92793. One of two found between boards at hunters' camp in swamp.

***PLESTIODON ANTHRACINUS* (Coal Skink)**. Bienville Parish: 4.5 km W, 9.3 km N of Lucky (32.3401°N, 93.0276°W). 30 May 2007. Beau Gregory. LSUMZ 90391. 3.2 km W, 1.0 km S of Lucky (32.2488°N, 93.0383°W). 18 April 2008. Beau Gregory. LSUMZ 90968.

***PLESTIODON FASCIATUS* (Common Five-lined Skink)**. West Carroll Parish: Big Colewa Wildlife Management Area, Bearskin Unit (32.42°N, 91.38°W). 28 April 2010. Jeff Boundy and Beau Gregory. LSUMZ 93801.

***PLESTIODON LATICEPS* (Broad-headed Skink)**. Ascension Parish: Bluff Swamp, directly E of Bayou Braud (30.2996°N, 91.0180°W). 17 March 1999. Jeff Boundy. LSUMZ 80891. Bienville Parish: 4.5 km W, 9.3 km N of Lucky (32.3401°N, 93.0276°W). 1 August 2007. Jeff Boundy. LSUMZ 90439. A more recent specimen, LSUMZ 90982, was collected at this location. La Salle Parish: Nature Trail area, N end of Dewey Wills Wildlife Management Area (31.5089°N, 92.0365°W). 30 March 2007. Jeff Boundy. LSUMZ 90022.

***PLESTIODON SEPTENTRIONALIS* (Prairie Skink)**. Lincoln Parish: 0.8 km W of Hico (32.7436°N, 92.7261°W). 15 September 1950. L. W. Herren. LSUMZ 24334.

SQUAMATA — SNAKES

***CROTALUS ADAMANTEUS* (Eastern Diamond-backed Rattlesnake)**. Tangipahoa Parish: no further data. 24 March 1982. G. Slade. LSUMZ 80833.

***CROTALUS HORRIDUS* (Timber Rattlesnake)**. Lincoln Parish: Choudrant (32.352°N, 92.507°W). 5 June 1973. A. Brad McPherson. LSUS 8793.

***DIADOPHIS PUNCTATUS* (Ring-necked Snake)**. Sabine Parish: 8.0 km SW of Negreet near Toledo Bend Lake (31.3950°N, 93.6154°W). 22 March 1969. Don J. Arceneaux. LSUMZ 82459.

***FARANCIA ABACURA* (Red-bellied Mudsnake)**. Winn Parish: LA 126, 1.9 km W of Brewton's Mill (32.1214°N, 92.8507°W). 30 June 1999. Laurence M. Hardy. LSUS 7333, 7399.

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. Red River Parish: 6.4 km E of Coushatta (32.0055°N, 93.2859°W). 30 April 1973. Len Barker. LSUMZ 88331.

***LAMPROPELTIS HOLBROOKI* (Speckled Kingsnake)**. Red River Parish: Bayou Pierre Wildlife Management Area around silos (32.1964°N, 93.5555°W). 20 May 2004. E. S. Walsh. LSUS 8796. West Carroll Parish: Big Colewa Wildlife Management Area, Bearskin Unit (32.42°N, 91.38°W). 28 April 2010. Jeff Boundy and Beau Gregory. LSUMZ 93803.

***MICRURUS TENER* (Texas Coralsnake)**. Claiborne Parish: Athens: R7W, T19N, Sec. 3 (32.647°N, 93.026°W). 20 September 1992. Aaron Callaway. LSUS 8044. Vermilion Parish: Vermilion River at Abbeville (29.980°N, 92.133°W). November 1973. C. Gremillion. LSUMZ 82116.

***NERODIA FASCIATA* (Southern Watersnake)**. Winn Parish: junction of PR-506 and LA 1233, section 3 between compartments 25 and 26 (32.1271°N, 92.8945°W). 20 May 1999. Laurence M. Hardy. LSUS 7351, 7382.

***PANTHEROPHIS OBSOLETUS* (Texas Ratsnake)**. Claiborne Parish: LA 519 just N of I-20 (32.5913°N, 92.9236°W). 26 May 1994. Michael L. Matthews. LSUS 8054.

***PANTHEROPHIS SPILOIDES* (Gray Ratsnake)**. Iberville Parish: Pecan Drive, 5.6 km airline N of St. Gabriel (30.3089°N, 91.1014°W). 7 May 1993. Jeff Boundy. LSUMZ 56499. A more recent specimen, LSUMZ 89189, was collected in this parish.

***SISTRURUS MILIARIUS* (Pygmy Rattlesnake)**. Bossier Parish: 9.6 km E via LA 2, 1.4 km S of Plain Dealing (32.8964°N, 93.6021°W). 8 September 1973. Laurence M. Hardy. LSUS 2446.

***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. Pointe Coupee Parish: Little Alabama Bayou at LA 975 (30.5120°N, 91.7185°W). 19 February 2009. Jeff Boundy. LSUMZ 92229.

***THAMNOPHIS PROXIMUS* (Western Ribbonsnake)**. Bienville Parish: 1.9 km by air E of Kepler Lake bridge (32.3353°N, 93.1125°W). 8 October 2007. Beau Gregory. LSUMZ 90645. Jackson Bienville Wildlife Management Area (approximately 32.4°N, 92.8°W). 6 November 2004. E. S. Walsh and Victor Bogosian. LSUS 8888. Webster Parish: Bayou Dorcheat, 16 km N of Minden (approximately 32.72°N, 93.35°W). November 1985. A. Brad McPherson. LSUS 6897.

***VIRGINIA STRIATULA* (Rough Earthsnake)**. SABINE PARISH: 4.8 km E of Fisher on East Fisher Road (31.5006°N, 93.4121°W). 22 March 1973. Larry Cox. LSUMZ 88416.

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New County Records for the Rolling Plains of North Texas

The rolling plains region of north-central Texas is part of the Kansan biotic province (Blair 1949; Werler and Dixon 2000). This region has been poorly sampled for reptiles and amphibians (Dixon 2000; Werler and Dixon 2000). Here, new records are reported from surveys of this region. County records were determined by examination of Dixon (2000) and issues of Herpetological Review published since Dixon (2000). All voucher specimens and photographs are deposited at the Texas Natural History Collections (TNHC), Texas Memorial Museum. Travis J. LaDuc verified all specimens. Lat/long data were obtained via a handheld GPS using the WGS84 datum. All collections were made under Scientific Collecting Permit SPR-0305-036, issued by Texas Parks and Wildlife.

ANURA — FROGS

***BUFO DEBILIS* (Green Toad).** Motley Co.: Double Helix Ranch, ca. 6.4 air km NW of Dumont (33.85157°N, 100.55209°W). 22 June 2007. Collected by D. M. Hillis and G. B. Pauly. TNHC 67360. This specimen fills a gap in the distribution.

***GASTROPHRYNE OLIVACEA* (Western Narrow-mouthed Toad).** Motley Co.: Double Helix Ranch, ca. 5.8 air km NW of Dumont (33.84026°N, 100.53489°W). 21 June 2007. Collected by D. M. Hillis and G. B. Pauly. TNHC 67402. Previously reported from Floyd and Cottle counties, which are to the west and east of Motley Co., respectively.

***PSEUDACRIS CLARKII* (Spotted Chorus Frog).** King Co.: Roadside ditch along U.S. Rt. 83, 0.8 km N of FM 193 (34.78110°N, 100.33865°W). 30 May 2007. Collected by G. B. Pauly. TNHC 67421–67423). These males were observed calling in a chorus of numerous *Gastrophryne olivacea* and one *Anaxyrus debilis*. Previously reported from Stonewall and Knox counties, which are to the south and east of King Co., respectively.

SQUAMATA — LIZARDS

***PHRYNOSOMA CORNUTUM* (Texas Horned Lizard).** Foard Co.: Co. Rd. 361, 9.6 km SW of FM 263 (33.84260°N, 99.90765°W). 22 June 2007. Observed by D. M. Hillis and G. B. Pauly. TNHC 84400 (photo voucher). This specimen fills a gap in the distribution.

SQUAMATA — SNAKES

***ARIZONA ELEGANS* (Glossy Snake).** Cottle Co.: DOR, U.S. Rt. 83, 0.5 km N of FM 3256 (34.12302°N, 100.29845°W). 29 May 2007. Collected by G. B. Pauly. TNHC 67574. This specimen fills a gap in the distribution.

***COLUBER CONSTRICTOR* (North American Racer).** Foard Co.: DOR, U.S. Hwy 70, 3.5 km E of Cottle/Foard Co. line (34.07560°N, 100.01220°W). 22 June 2007. Collected by D. M. Hillis and G. B. Pauly. TNHC 67575. This specimen fills a gap in the distribution.

***LAMPROPELTIS GETULA* (Common Kingsnake).** Foard Co.: DOR, U.S. Hwy 70, 3.2 km W of Crowell (33.98934°N, 99.76497°W). 22 June 2007. Collected by D. M. Hillis and G. B. Pauly. TNHC 67578. This specimen fills a gap in the distribution.

***LAMPROPELTIS TRIANGULUM* (Milksnake).** Motley Co.: Double Helix Ranch, ca. 5.8 air km NW Dumont (33.84026°N, 100.53489°W). 21 June 2007. Observed by D. M. Hillis and G. B. Pauly. TNHC 84401 (photo voucher). This species is largely unrecorded from the rolling plains region of north Texas.

***PANTHEROPHIS EMORYI* (Great Plains Ratsnake).** Dickens Co.: FM 193, 4.2 km W of Dickens/King Co. line (33.78112°N, 100.56343°W). 29 May 2007. Collected by G. B. Pauly. TNHC 67563. This specimen fills a gap in the distribution.

***SONORA SEMIANNULATA* (Western Groundsnake).** Motley Co.: Double Helix Ranch, ca. 6.4 air km NW Dumont (33.85157°N, 100.55209°W). 29 May 2007. Collected by G. B. Pauly. TNHC 67583. This specimen fills a gap in the distribution.

***THAMNOPHIS PROXIMUS* (Western Ribbonsnake).** Stonewall Co.: DOR, U.S. Rt. 83, 13.1 km N of U.S. Rt. 380 (33.29410°N, 100.24737°W). 23 June 2007. Collected by D. M. Hillis and G. B. Pauly. TNHC 67587. Previously reported from Fisher, Jones, and Haskell counties, which are to the south and east of Stonewall Co.

Acknowledgments.—I am grateful to D. M. Hillis and J. J. Bull for access to the Double Helix Ranch, to D. M. Hillis for field assistance, and to T. J. LaDuc for verifying all specimens.

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NATURAL HISTORY NOTES

The Natural History Notes section is analogous to Geographic Distribution. Preferred notes should 1) focus on observations in the field, with little human intrusion; 2) represent more than the isolated documentation of developmental aberrations; and 3) possess a natural history perspective. Individual notes should, with few exceptions, concern only one species, and authors are requested to choose a keyword or short phrase which best describes the nature of their note (e.g., Reproduction, Morphology, Habitat, etc.). Use of figures to illustrate any data is encouraged, but should replace words rather than embellish them. The section's intent is to convey information rather than demonstrate prose. Articles submitted to this section will be reviewed and edited prior to acceptance. Notes concerning captive animals should be directed to Herpetological Husbandry (see inside front cover for section editor contact information).

Electronic submission of manuscripts is requested (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments). Color figures can be submitted electronically as JPG files, although higher resolution TIFF or PDF files will be requested for publication. Please DO NOT send graphic files as imbedded figures within a text file. Additional information concerning preparation and submission of graphics files is available on the SSAR web site at: http://www.ssarherps.org/HRinfo.html. Manuscripts should be sent to the appropriate section editor: **Jackson Shedd** (crocodilians, lizards, and *Sphenodon*; jackson.shedd@gmail.com); **Charles Painter** (amphibians; charles.painter@state.nm.us); **J. D. Willson** (snakes; hr.snake.nhn@gmail.com); and **James Harding** (turtles; hardingj@msu.edu).

Standard format for this section is as follows: SCIENTIFIC NAME, COMMON NAME (for the United States and Canada as it appears in Crother [ed.] 2008. *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico.* SSAR Herpetol. Circ. 37:1–84, available from SSAR Publications Secretary, ssar@herplit.com; for Mexico as it appears in Liner and Casas-Andreu 2008, *Standard Spanish, English and Scientific Names of the Amphibians and Reptiles of Mexico.* Herpetol. Circ. 38:1–162), KEYWORD. DATA on the animal. Place of deposition or intended deposition of specimen(s), and catalog number(s), if relevant to your report. Then skip a line and close with SUBMITTED BY (give name and address in full—spell out state names—no abbreviations). (NCN) should be used for common name where none is recognized. References may be briefly cited in text (refer to this issue for citation format).

Recommended citation for notes appearing in this section is: Medina, P., and R. L. Joglar. 2008. *Eleutherodactylus richmondi*: reproduction. Herpetol. Rev. 39:460.

CAUDATA — SALAMANDERS

***GYRINOPHILUS PORPHYRITICUS* (Spring Salamander). ALBINISM.** *Gyrinophilus porphyriticus* is a rather large, stout-bodied plethodontid with a salmon to pinkish orange ground color overlain with black streaks or spots that ranges from southern Quebec and southern Maine to central Alabama. In more mountainous regions of western North Carolina, Spring Salamanders can be found in or near springs, seepages, small streams, and wet roadside ditches (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.). Herein we report on the observation of a wild albino specimen of *G. porphyriticus.*

At ca. 2140 h on 18 June 2011, we observed a sub-adult *G. porphyriticus* that appeared to lack black pigmentation. This *G. porphyriticus* was found on a wet rock wall above a ditch along the eastern edge of FR 70 (Tate City Road) in the Nantahala National Forest of Clay Co., North Carolina, USA, ca. 0.4 km N of the Georgia state line (34.99586°N, 83.55569°W, WGS 84; elev. 781 m). It still appeared to exhibit red and yellow pigmentation, giving it an overall light orange hue (Fig. 1A). The

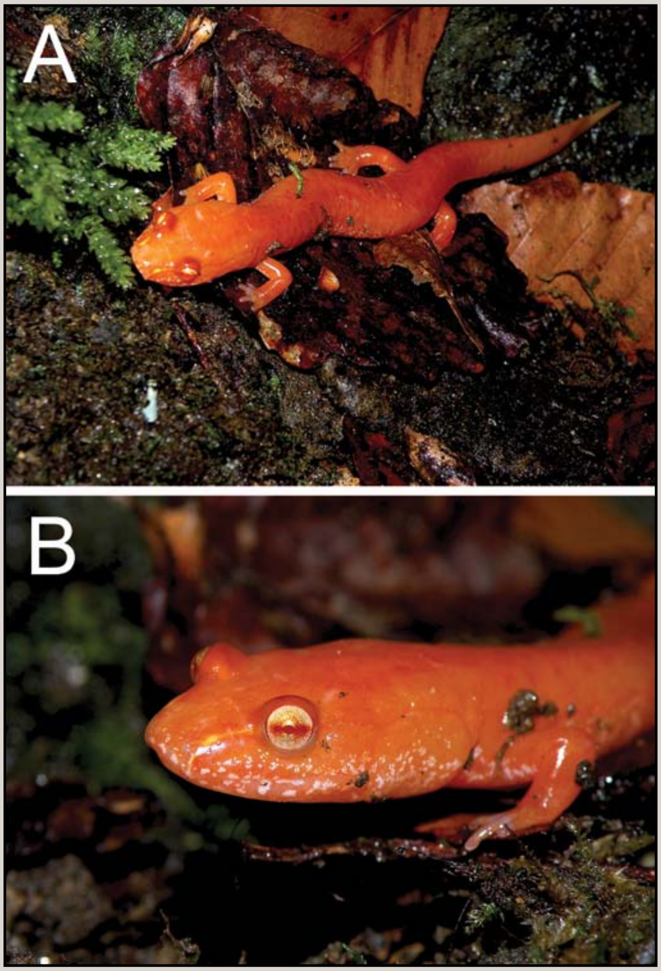

PHOTO BY ROBERT L. HILL

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

Fig. 1. A) Albino *Gyrinophilus porphyriticus* observed in Clay Co., North Carolina, USA. B) Close-up of the head.

canthus rostralis on this specimen was evident, although the typical dark border was absent. The eyes were pale yellow with a red horizontal line through the center and the pupils were red instead of black (Fig. 1B). The specimen was photographed and left *in situ*.

Albinism has been reported for larval *G. porphyriticus* (Brandon and Rutherford 1967. Am. Midl. Nat. 78[2]:537–540), however, to our knowledge this is the first documentation of albinism in a post-metamorphic specimen.

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ANURA — FROGS

***ACRIS CREPITANS* (Northern Cricket Frog). FIRE ANT ENVENOMATION.** Red Imported Fire Ants (*Solenopsis invicta*) are an aggressive invasive species that have spread throughout much of the southeastern United States after being accidentally introduced into the port of Mobile, Alabama in the 1930s (Wojcik et al. 2001. Am. Entomol. 47:16–23). A growing number of studies have reported both direct and indirect negative effects of *S. invicta* on native amphibians and reptiles (Allen et al. 1997. J. Herpetol. 31:318–321; Diffie et al. 2010. J. Herpetol. 44:294–296; Todd et al. 2008. Biol. Invasions 10:539–546). However, it is not known how frequently or to what extent *S. invicta* actively prey upon native herpetofauna, highlighting the importance of reporting anecdotal observations. Here I describe a natural agonistic encounter between a fire ant and a Northern Cricket Frog.

At ca. 0915 h on 9 June 2011,100 m S of Rome Pond, 150 m N of U.S. Hwy. 29, Covington Co., Alabama, USA (31.142559°N, 86.673418°W; WGS 84), I observed a Red Imported Fire Ant stinging an adult *Acris crepitans*. The ant had pierced the skin of the frog's right forelimb with its mandibles and was seen inserting its stinger repeatedly. This attack was observed more than 5 m away from the closest fire ant mound, in an open grassy area. I removed the ant to examine the frog for species identification. Upon identification, the frog was released at its point of capture. To the best of my knowledge, this is the first account of a *S. invicta* envenomating *A. crepitans*.

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***ANAXYRUS AMERICANUS CHARLESMITHI* (Dwarf American Toad). NEMATODE PARASITE.** Several parasites have been reported from the Dwarf American Toad. Herein we report a new host record for a nematode parasite of *Anaxyrus* (=*Bufo*) *americanus charlesmithi*.

A single *A. a. charlesmithi* was collected on 29 May 1994 from 3.2 km SW Shannon Hills, Saline Co., Arkansas (34.608622°N, 92.433261°W) and examined for helminths. It was killed with a dilute chloretone solution and a midventral incision was made to expose the entire length of the digestive tract. Two nematodes were removed from the rectum and cleared on glass slides with undiluted glycerol. These were identified as a male and female *Cosmocercoides variabilis* (Harwood 1930) Travassos, 1931. Voucher specimens were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as USNPC 84402. A host voucher is deposited in the Arkansas State University Herpetological Collection (ASUMZ), State University, Arkansas as ASUMZ 19701.

Previous bufonid hosts of *C. variabilis* include *A. americanus americanus* (Vanderburgh and Anderson 1987. Can. J. Zool. 65:1666–1667), *A. boreas* (Goldberg et al. 1999. Bull. S. California Acad. Sci. 98:39–44), *A. debilis debilis* (McAllister et al. 1989. Proc. Helminthol. Soc. Washington 56:162–167), *A. hemiophrys* (Bursey and Goldberg 1998. J. Parasitol. 84:617–618.), *A. quercicus* (Goldberg and Bursey 1996. Alytes 14:122–126); *A. terrestris* (Harwood 1932. Proc. U.S. Nat. Mus. 81:1–71), and *A. woodhousii woodhousii* (McAllister et al., *op. cit.*).

This nematode has an extensive range and has been reported previously from Arizona, Arkansas, California, Florida, Idaho, Illinois, Iowa, Louisiana, Massachusetts, Michigan, Nebraska, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, South Dakota, Texas, Utah, Virginia, Washington, West Virginia, Wisconsin, Alberta, British Columbia, New Brunswick and Quebec, Canada , Baja California Norte, Mexico, Costa Rica, and Panama (Bursey et al. 2007. Comp. Parasitol. 74:108–140).

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***BUFO* (= *ANAXYRUS*) *HOUSTONENSIS* (Houston Toad). HEAD-START JUVENILE DISPERSAL.** The Houston Toad is a federally endangered amphibian endemic to east-central Texas. A head-starting program was initiated in 2007 as a population recovery strategy for *Bufo houstonensis*. As part of the program, wild laid eggs are collected, reared at the Houston Zoo and post-metamorphosed juveniles are released to their natal pond. A genetic mark-recapture technique was developed to monitor the success of the head-starting program. Microsatellite markers were used to reconstruct family relationships based on the probability of individuals sharing alleles identical by descent. A small sample of tadpoles per egg strand (between 8 and 80) was sacrificed to obtain a genotypic "fingerprint" for 29 head-started egg strands. This mark-recapture technique accurately assigned 94–97% of all family members to their appropriate egg cohort (Vandewege 2011. Unpubl. MS. thesis, Texas State Univ. San Marcos, Texas. 84 pp.). A tissue sample was collected from any adult or juvenile captured after the release of head-starts to assess the frequency of captive-reared *B. houstonensis* on the landscape.

During a *B. houstonensis* reproduction survey conducted on 18 April 2010, an egg strand was harvested from a temporary pond on the Griffith League Ranch, Bastrop County, Texas, USA. Post-metamorphosed juveniles from this egg strand (N = 1908) with a mean weight of 0.09 g were released at their natal pond on 21 May 2010. On 23 June 2010 a juvenile *B. houstonensis* weighing 3.8 g was collected from a pitfall trap 1.34 km from the release point. This juvenile had a DNA genotype 100% consistent with the head-started individuals released five weeks prior. This is the longest confirmed distance a juvenile *B. houstonensis* has moved. Prior to this record, *B. houstonensis* had been monitored up to 50 m (Greuter 2004. Unpubl. MS. thesis, Texas State Univ. San Marcos, Texas 80 pp.) and 100 m (Hillis et al. 1984. J. Herpetol. 18:56–72) from their natal pond. A previous technique using fluorescent pigment proved successful for tracking daily movement patterns (Swannack et al. 2006. Herpetol. Rev. 37[2]:199–200), whereas this new technique allowed juvenile

B. houstonensis to be monitored over long distances and time periods. This record illustrates that juvenile *B. houstonensis* are capable of moving long distances in a short period of time. Although it remains unclear how far *B. houstonensis* typically disperse between metamorphosis and adulthood, this observation highlights the importance of increasing habitat connectivity in a highly fragmented environment for the conservation and recovery of this endangered species.

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***GASTROPHRYNE CAROLINENSIS* (Eastern Narrow-mouthed Toad). PREDATION.** A series of strong scattered thunderstorms passed through the Central Savannah River Area (CSRA) in Georgia and South Carolina, USA on 28 June 2011 from ca. 1400–2100 h and filled a few patchily-distributed depression wetlands with a few centimeters of standing water. One small (ca. 20 m × 10 m) wetland (Risher Pond Sloughs, Barnwell Co., South Carolina) hosted an anuran breeding assemblage of ca. 30 *Hyla femoralis*, 20 *H. squirella*, 20 *Gastrophryne carolinensis*, 6 *Pseudacris ocularis*, and 10 *H. chrysoscelis* by 2138 h. At 0016 h, an adult (499 mm SVL; 32.6 g) female *Thamnophis s. sauritus* was found ca. 1.7 m above the surface of the water in a stand of dead *Panicum hemitomon*. The *T. s. sauritus* was in the process of swallowing a gravid female *G. carolinensis* (32 mm SVL; 2.25 g) and moved slowly around in the *Panicum* with the front of the toad hanging out of the right side of its mouth. After observing the snake for four minutes, we captured it and removed the *G. carolinensis* from its mouth. Both animals were returned to the lab for measurements. The *G. carolinensis* was dead by 0800 h the next morning and the *T. s. sauritus* was released unharmed post-processing without any noticeable ill effects from exposure to the *G. carolinensis*. *Gastrophryne carolinensis* are toxic to many predators, which will often refuse to eat them (Garton and Mushinsky 1979. Can. J. Zool. 57:1965–1973), and few firsthand accounts of *G. carolinensis* predation exist, possibly because of this toxicity. *Thamnophis s. sauritus* is a generalist amphibian predator that is known to consume a wide variety of prey (Brown 1979. Brimleyana 1:113–124; Carpenter 1952. Ecol. Monogr. 4:235–258). Only one account of a *T. sauritus* eating a *G. carolinensis* exists as a personal communication from R. W. Gaul Jr. in North Carolina (Palmer and Braswell 1995. Reptiles of North Carolina. Univ. North Carolina Press, Chapel Hill, North Carolina), but to our knowledge, this is the first confirmed firsthand observation of a *T. s. sauritus* depredating a *G. carolinensis*.

Animals were captured under scientific research permit G-11-03 from the South Carolina Department of Natural Resources. Funding for this research was provided by the National Science Foundation (Awards DEB-0242874 and DBI-0139572) and the Savannah River Ecology Laboratory under Financial Assistance Award DE-FC09-96SR18-546 between the University of Georgia and the U.S. Department of Energy.

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***HYALINOBATRACHIUM ORIENTALE* (Oriental Glass Frog). MALE PARENTAL CARE.** One clade of glass frogs, the Hyalinobatrachinae, is distributed in tropical Central America, the tropical Andes, the coastal ranges of Venezuela, the island of Tobago, the upper Amazon Basin, and the Guiana Shield. Males of all species of *Hyalinobatrachium* call from the underside of leaves and females deposit their eggs on the underside of leaves; at least seven species have been reported to have males guard the eggs, a behavior that is considered a primary homology of the genus (Guayasamin et al. 2009. Zootaxa 2100:1–97; Kubicki 2007. Ranas de Vidrio de Costa Rica /Glass Frogs of Costa Rica. Editorial INBio, Santo Domingo de Heredia). Here we report the first observations of male *Hyalinobatrachium orientale* attending eggs. On the evenings of 4 and 5 June 2011 we detected the calls of male *H. orientale* along several of the streams that drain Tobago's Main Ridge, and on the evening of 5 June we observed and photographed males next to egg masses (Fig. 1), males covering egg masses with their bodies (Fig. 2), and guardian males calling. Calling males were 1–10 m above the stream and minimally separated by 2–3 m; usually the separation distance was greater.

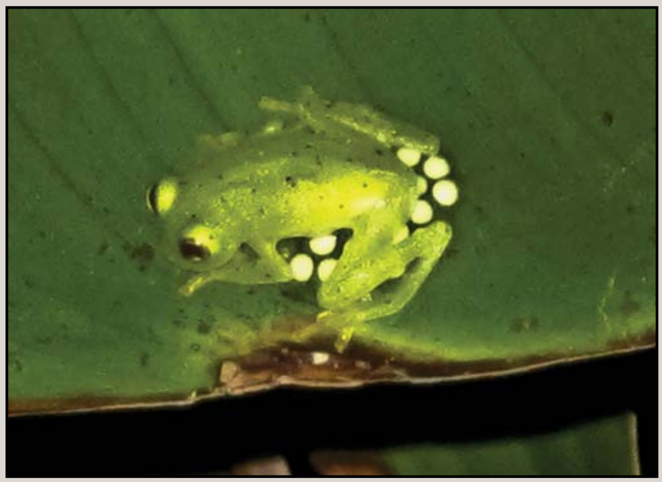

FIG 1. A male *Hyalinobatrachium orientale* covering an egg mass with its body, behavior that may reduce desiccation or deter predators. The leaf was about 4 m above the stream.

FIG 2. A male *Hyalinobatrachium orientale* calling from the underside of a leaf.

The male frogs were often on the undersides of *Heliconia* leaves, a position that may offer protection from desiccation, falling rain drops, and predators. Also, the leaves supporting the frogs and egg masses were frequently covered by a second leaf that would likely provide additional protection from wind and sun. Crabs were observed on the same plants that contained frogs and they may be a primary factor in the frogs of this genus selecting the undersides of leaves for calling stations and egg laying.

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***HYLA ARBOREA* (European Tree Frog). POTENTIAL CANNIBALISM.** Cannibalism is widespread in a variety of animals, including amphibians (Elgar and Crespi 1992. Cannibalism: Ecology and Evolution Among Diverse Taxa. Oxford University Press, Oxford, New York. 376 pp.). Cannibalism may occur during food shortages, desiccation of the habitat, or because of a high concentration of individuals (Crump 1983. Am. Nat. 121[2]:281–289; Pfennig and Frankino 1997. Evolution 51:1993–1999; Summers 1999. Oecologia 119:557–564; Michimae and Wakahara 2001. Behav. Ecol. Sociobiol. 50:339–345.). Studies show that cannibalistic individuals have a higher growth rate, a larger size at metamorphosis, a greater likelihood of survival, and better reproductive parameters (Fox 1975. Annu. Rev. Ecol. Evol. Syst. 6:87–106; Polis 1981. Annu. Rev. Ecol. Evol. Syst. 12:225–251; Crump 1990. Copeia 1990[2]:560–564; Babbit and Meshaka 2000. Copeia 2000[2]:469–474). Cannibalism in tadpoles of *Hyla intermedia* as a result of drying habitat was described by Grant and Halliday (2011. Herpetol. Rev. 42[1]:86).

FIG. 1. *Hyla arborea* tadpoles with damaged caudal fins.

On 20 July 2007 on the Krk island in Croatia (45.03°N, 14.55°E, 54 m elev.), we observed different stages of *Hyla arborea* tadpoles that exhibited noticeable signs of damage to the caudal fin, especially the smaller individuals (Fig. 1). No dead specimens were observed, and potential natural predators (e.g., *Dytiscus* sp., *Pelophylax ridibundus*, *Natrix natrix*) were not found associated with the tadpoles. The habitat was completely unnatural, a small enamel livestock tank with drying aquatic habitat and dense larval aggregations. The tank was about 100 × 40 × 50 cm, with water ca. 30 cm deep. We estimated ca. 150–200 tadpoles ranging in size from 1–2.5 cm. Although direct cannibalism was not observed, the size differentiation and high density of individuals may of lead to the wounds observed.

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***HYLA AVIVOCA* (Bird-Voiced Treefrog). CONSTRUCTED WETLAND COLONIZATION.** At the northern end of its range, *Hyla avivoca* populations have been extirpated or reduced in size due to drainage of Bald Cypress (*Taxodium distichum*) and Tupelo Gum (*Nyssa aquatica*) swamps (Redmer et al. 1999a. Illinois Nat. Hist. Surv. Bull. 36:37–66). Many remaining *H. avivoca* populations are isolated from each other by extensive deforested areas such as agricultural fields.

In the Cache River drainage of southern Illinois, USA, government agencies and private conservation groups are acquiring and reforesting cropland, and constructing wetlands. The Nature Conservancy's Grassy Slough Preserve (GSP) is an 1123-ha former vegetable farm bisected by a channelized portion of the Cache River in Johnson Co., Illinois. Fifteen shallow (< 2 m) wetlands (0.9–47.9 ha in area) were constructed or restored on GSP in 1999 and 2000, and seedling oaks (*Quercus* spp.) and hickories (*Carya* spp.) were planted on intervening uplands from 1999–2002. I studied herpetofaunal colonization of constructed wetlands from 2001–2004, when upland vegetation was dominated by pioneering herbaceous vegetation that over-topped the planted trees, and wetlands were vegetated principally by algae, Cocklebur (*Xanthium commune*), and Water Primrose (*Jussiaea repens*). Although I heard *H. avivoca* vocalizing from forested wetlands north and south of the former agricultural fields in 2000, *H. avivoca* was not among the 35 herpetofaunal species encountered at newly-constructed wetlands (Palis 2007. Trans. Illinois State Acad. Sci. 100:177–189).

On 15 June 2011, I heard choruses of *H. avivoca* in one restored and two constructed wetlands on GSP. Wetlands 3 and 1 are 65 m east and 485 m south, of a forest-bordered former channel of the Cache River where I heard *H. avivoca* calling in 2000 and 2008 (see Figure 1 in Palis 2007, *op. cit.*; available at www.il-acad-sci-org/publications). Wetland 3 (37.331222°N, 88.919189°W; geocoordinates derived from Google Earth), the restored wetland, is bordered on the west by a dense stand of young (≤ 7.5-m tall) trees including Sweetgum (*Liquidambar styraciflua*), Box Elder (*Acer negundo*), Red Maple (*Acer rubrum*), American Sycamore (*Platanus occidentalis*), Green Ash (*Fraxinus pennsylvanica*), oak, and River Birch (*Betula nigra*), as well as Buttonbush (*Cephalanthus* *occidentalis*). The dense stand of young trees forms a continuous canopy from the wetland to the mature oak-hickory forest bordering the old river channel. With the exception of the forested edge, the wetland is treeless and vegetated principally with American Lotus (*Nelumbo lutea*), sedges (*Carex* spp.), rush (*Juncus* sp.), arrowhead (*Sagittaria* sp.), and widely-scattered buttonbush and Rose Mallow (*Hibiscus lasiocarpus*). An estimated 100± *H. avivoca* called from shrubs and trees along an ca. 500 m length of the western wetland edge examined from 2025–2150 h; air temp = 19°C). I also observed one amplectant pair. Wetland 1 (37.3269°N, 88.919061°W) is also dominated by herbaceous vegetation; ca. 90% of the surface is covered with Water Primrose. A continuous canopy of young trees occurs between Wetland 1 and Wetland 3 to the north. Approximately 10–15 *H. avivoca* called from a stand of Black Willow (*Salix nigra*) on the northern edge of the wetland (2155–2205 h). Wetland 10 (37.306528°N, 88.957806°W) is about 445 m north of a swamp where I heard *H. avivoca* in 2000. Dominant herbaceous and woody vegetation in Wetland 10 includes Water Primrose and Sweetgum, and a continuous canopy of young trees lies between Wetland 10 and the swamp. I heard approximately 10 *H. avivoca* vocalizing from the western end of Wetland 10 from 2247–2250 h.

Unlike 2001–2004, the uplands between constructed/restored wetlands and remnant forested wetlands support young forest in 2011. The tree canopy may provide an avenue for *H. avivoca* dispersal. Diet studies (Jamieson et al. 1993. Texas J. Sci. 45:45–49; Redmer et al. 1999b. Trans. Illinois State Acad. Sci. 92:271–275) suggest that *H. avivoca* is more arboreal than sympatric congeners (*H. chrysoscelis* and *H. cinerea*); therefore a continuous canopy may facilitate dispersal. Long-distance movements by *H. avivoca* away from breeding sites have also been observed in forested corridors (Palis 2010. Herpetol. Rev. 41:63–64).

At the northern end of its range, *H. avivoca* is thought to breed only in remnant Bald Cypress and/or Tupelo Gum swamps (Barbour 1971. Amphibians and Reptiles of Kentucky. Univ. Press of Kentucky, Lexington; Redmer et al. 1999a, *op. cit.*). My observations, however, indicate that newly-constructed/restored (11–12 years), herbaceous-dominated wetlands flanked by a rank growth of pioneering tree species can also serve as breeding habitat for *H. avivoca*. Thus, in Illinois, reforested agricultural fields and constructed/restored wetlands may provide habitat and movement corridors for *H. avivoca* which may, in turn, serve to expand and connect disparate populations of this state threatened species.

These observations would not have been possible without the kindness of E. Palmer; her assistance and companionship in the field is greatly appreciated.

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***HYLA CHRYSOSCELIS* (Cope's Gray Treefrog). CALLING/MATE CHOICE.** On 10 May 2011, at the Anita C. Leight Estuary Center (Abingdon, Maryland, USA; 39.45119°N, 76.26831°W), several *Hyla chrysoscelis* were observed using an unusual call to attract a female. Eight frogs were calling from four tanks of submerged aquatic vegetation. In two of the tanks, two males were positioned together on the inside of a corner with each frog on an adjoining wall (Fig. 1). The other four males were scattered around the tanks.

The frogs used the normal trilling call of *H. chrysoscelis*, but occasionally would use a chirping call that consisted of 3–5 rapid chirps rather than trills (Fig. 2). Chirping often was immediately followed by trilling. Only the four males in the corners used the chirping call, but when one of them used it, the male that shared its corner almost always began chirping, and the two males in the corner of the other tank usually began chirping. The males also tended to discontinue chirping as soon as the other males stopped.

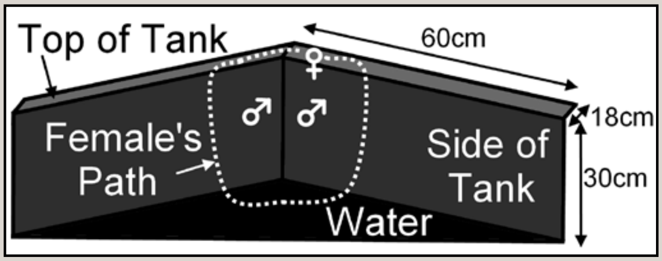

Fig. 1. An inside view of the corner of the tank from where the males called. Each male was on a separate wall and the female circled around them.

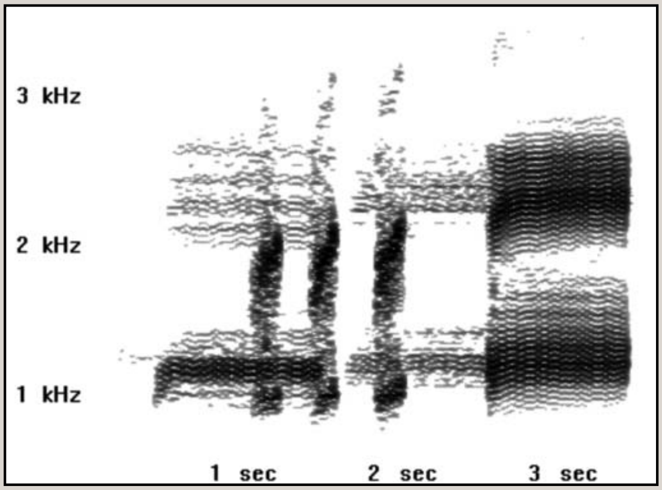

Fig. 2. A spectogram of a male *Hyla chrysoscelis* calling. Each of the three pulses between 1.25–2.25 seconds is a chirp, and the call from 2.5 seconds to the end is a normal trill. Everything else is background noise.

The frogs were easily disturbed while chirping. While trilling, they did not seem disturbed by observers, and would continue trilling even if a light was shone on them. While chirping, however, they almost always either stopped calling or switched to trilling the instant a light was shone on them.

As the frogs called, a female approached the corner where two of the males were calling. She began making loops around the males starting at the top, going down one side, through the water, up the other side, and back across the top (Fig. 1). She repeated this loop several times, sometimes switching directions part way through. The males seemed to use the chirping call in relation to her proximity. While going up or down the sides of the tank, the male that she was passing nearly always began rapidly and repeatedly chirping (usually stimulating the other male to chirp), and the chirping stopped once she reached the water or the top of the tank. Then, as she ascended or descended the other side, the other male would begin chirping (usually stimulating the original male to chirp). After making several loops, the female stopped at the top of the tank, and one of the males approached her. He walked up behind her, rubbed the side of her stomach with his front foot, and then mounted her. They both hopped into the water, and the female began laying eggs. It was unclear how or if the female signaled her acceptance of that male over the other, but only one male moved, and the female showed no resistance when he approached.

It is interesting that the males used this short chirping call when the female was near because multiple studies have shown that female Gray Treefrogs (*Hyla versicolor*) prefer long calls to short ones (Fellers 1979. Copeia 1979:286–290; Schwartz et al. 2001. Behav. Ecol. Sociobiol. 49:443–455; Schwartz et al. 2004. Anim. Behav. 68:533–540). Perhaps, the handicap principal is at play. Chirping may be more noticeable to predators, thus putting the caller at a higher risk of predation, while simultaneously being highly attractive to females because it acts as a mechanism for judging male fitness. This makes sense in light of the observation that males were easily disturbed while chirping, and only the males that were in close proximity to another male chirped (the other males did not have as much direct competition and therefore did not need the more attractive but more dangerous call).

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HYPSIBOAS CREPITANS **(Rattle-voiced Treefrog). PREDATION.** Snakes are major predators of anurans and depending on preference, abundance, and habitat, they can exert the greatest predation pressure on a frog community. It is not uncommon in Neotropical regions to find Dipsadidae snakes preying on adult anurans in the breeding season near ponds (Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 1148 pp.). *Leptodeira annulata* is a nocturnal arboreal snake that inhabits primary and secondary forests (Vitt 1996. Herpetol. Nat. Hist. 4:69–76). On 09 March 2010 at 2145 h we observed an individual *L. annulata* (TL = 760 mm, JZ 1521) preying on an adult male *Hypsiboas crepitans*, that by the time of our observation was almost completely ingested (Fig. 1). The tree frog was in calling activity on the grass at the edge of a semi temporary water body. The predation event occurred in a transition area between patches of Caatinga and Atlantic Rain Forest at Serra do Brejo Novo (13.94472°S, 40.10942°W; 700 m elev.), municipality of Jequié, state of Bahia, Brazil. *Hypsiboas crepitans* has a long breeding season associated with temporary or permanent ponds (Arzabe 1999. Rev. Brasil. Zool. 16[3]:851–864). As typical prolonged breeders, males spend consecutive nights calling at the same site, which increases their exposure to predators (Wells 2007, *op. cit.*). Predation accounts like the current one, although anectodal, help form a theoretical basis for larger studies about the importance of these events on the structure of anuran communities (Toledo 2005. Herpetol. Rev. 36[4]:395–400).

Fig. 1. Predation of an adult *Hypsiboas crepitans* by an individual of *Leptodeira annulata* (TL = 760 mm).

Voucher specimens are deposited in Juliana Zina's personal collection pending installation of the Natural History Museum of Jequié, at the Universidade Estadual do Sudoeste da Bahia, UESB, Jequié, Bahia, Brazil.

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KASSINA SENEGALENSIS **(Senegal Kassina). UNILATERAL HINDLIMB MICROMELY.** The discovery of frog populations with a large number of malformed individuals generated the need to list and better identify the causes of these malformations, a particularly relevant subject for the conservation of this highly endangered group (Lannoo 2008. Malformed Frogs. Univ. California Press, Berkeley, California. xvi + 270 pp.). Most of the documentation concerns metamorphosed individuals as the malformations are more conspicuous than in tadpoles. Furthermore, malformations in tadpoles can appear late in development, as in the cases involving limbs. A case of hindlimb developmental asymmetry was observed in a tadpole of *Kassina senegalensis* collected in an isolated lagoon with connections, Banhine National Park, Gaza Province, Mozambique (22.52917°S, 32.64583°E; WGS 84), 5 June 2005 and housed at the South African Institute for Aquatic Biodiversity, Grahamstown, South Africa under the collection number SAIAB 88010. The left hindlimb was in stage 40 (Fig. 1A) whereas the right hindlimb was in stage 32/33 (Fig. 1B) (Gosner 1960. Herpetologica 16:183–190). The right hindlimb presents a larger base than usually observed in other tadpoles as well as a strong indentation between the foot paddle and the proximal segment of the limb. However, the base of this hindlimb was still much less wide than in the stage 40 hindlimb. The cause of this developmental asymmetry is unknown. Frequency of this anomaly within the population is unknown as only this tadpole was collected at this locality. The malformations in amphibians are known to arise from pollution (radioactive pollution; agricultural or industrial chemicals), disease (infection by the fungus *Batrachochytrium dendrobatidis*) or parasitism, or may be of genetic origin (see Lannoo 2008, *op. cit.* for review). If the less developed hindlimb would stay shorter at the adult stage, this would be a case of unilateral hindlimb micromely. Another hypothesis could be a regenerating limb after failed predation. However, this limb and the surrounding tissue did not show the presence of any scars.

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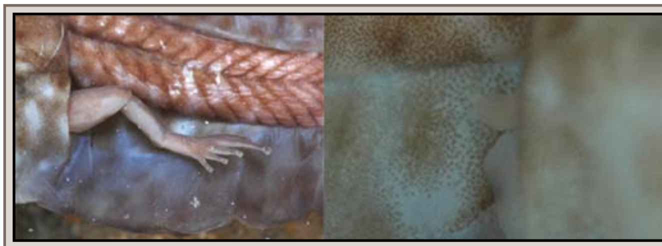

Fig 1. The left hindlimb in Gosner Stage 40 (left) and the right hindlimb in Gosner Stage 32/33 (right). Note that the two pictures are not at the same scale.

***LEPTOBRACHIUM ABBOTTI* (Lowland Litter Frog). MAXIMUM ELEVATION.** *Leptobrachium abbotti* is a stocky and large anuran (to 95 mm SVL) with a broad head and truncate but non-protruding snout, bulging dark eyes characterized by small bluish arcs, visible tympanums and supratympanic folds, rather smooth blackish top of the head and body, slightly granular venter distinctively mottled in black and white, slender and short limbs, rounded tips of digits, as well as toes webbed at bases (Inger 2005. The Systematics and Zoogeography of the Amphibia of Borneo. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 402 pp.; Malkmus et al. 2002. Amphibians and Reptiles of Mount Kinabalu [North Borneo]. A.R.G. Gantner Verlag K.G. Ruggell. 424 pp.). *Leptobrachium abbotti* occurs in Indonesia (West Sumatra, and Riau), and throughout Borneo (Sabah and Sarawak of Malaysia, Brunei Darussalam, and Kalimantan of Indonesia) (Das 2007. A Pocket Guide: Amphibians and Reptiles of Brunei. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. viii + 200 pp.; Inger et al. 2004. *Leptobrachium abbotti*. *In* IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>. Accessed on 20 April 2011). The species inhabits the leaf litter of primary and old secondary forests with small to medium slow-moving streams with rocky bottoms for breeding, up to the maximum elevation of 1000 m (AmphibiaWeb: Information on amphibian biology and conservation. [web application] 2011. Berkeley, California: AmphibiaWeb. http://amphibiaweb.org/. Accessed on 20 April 2011; Haas and Das 2010. Frogs of Borneo. Frogs and Tadpoles of East Malaysia. Website: http://frogofborneo.org/. Accessed on 20 April 2011; Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo. 2nd ed. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. viii + 201 pp.). Herein we report a new altitudinal limit for *L. abbotti*.

On 8 Dec 2010 at 2050 h, an adult *L. abbotti* (51 mm SVL, 8.6 g) was found on a trail adjacent to Sungai Mayampak (5.9818°N, 116.5329°E; 1138 m elev.), Bundu Tuhan, Ranau District, West Coast Division, Sabah, Bornean Malaysia. Air temperature was 19.2°C, and relative humidity was 91%. The individual was found on the ground with minimal leaf litter as the trail is commonly used by local people. Due to the proximity to human settlement and forest, both groups of human commensal species (*Fejervarya limnocharis*) and forest-related species, such as *Ansonia longidigita*, *Leptolalax pictus*, *Megophrys nasuta,* and *Chaperina fusca*, occur along the trail. The finding suggests an extension of habitat for *L. abbotti*. As another *L. abbotti* has been found above 1000 m elev. (at 1081 m elev.) at Sungai Lidan (5.9844°N 116.5258°E), Bundu Tuhan, the new altitudinal limit finding holds taxonomic significance for *L. abbotti* to help avoid misidentification of the species at higher elevations. The specimens (Sungai Mayampak: HEP01824, and Sungai Lidan: HEP00536) were deposited in BORNEENSIS, the Bornean reference collection of the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah.

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***LEPTODACTYLUS* AFF. *HYLAEDACTYLUS*. DEFENSIVE BEHAVIOR.** It is well known that frogs are included in the diet of many predators, although they have evolved several defense mechanisms to survive (Duellman and Trueb 1994. Biology of Amphibians. MacGraw-Hill Book Co., New York. 670 pp.). Different species of amphibians, when touched and in danger, inflate their bodies with arms outstretched and legs close to the body and remain motionless (Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 1400 pp.). This defensive behavior is known as thanatosis. Observations reported herein occurred during January to March 2011 in the municipality of São Gonçalo do Amarante, west coast of Ceará State, Brazil (3.51525°S, 38.9188°W). We captured about 20 individual *Leptodactylus* aff. *hylaedactylus* that, when handled in the field for measurements and photographs, exhibited thanatosis. They inflated their bodies and turned arms and legs upward with the arms outstretched and the legs close to the body, maintaining a belly-up position in the hand of an observer (Fig. 1). The animals remained motionless for about 2 minutes and then slowly returned to normal position. Soon after righting themselves, they attempted escape by leaping away. This behavior was photographed and filmed with a Sony HX1 digital camera. This behavior has been reported for other *Leptodactylus* and other anurans (Azevedo-Ramos 1995. Rev. Bras. Biol. 55[1]:45–47; Hartmann et al. 2003. Herpetol. Rev. 34:50; Zamprogno et al. 1998. Herpetol. Rev. 29:96–97) but this is the first report of this behavior in *Leptodactylus* aff. *hylaedactylus*.

FIG. 1. Adult *Leptodactylus* aff. *hylaedactylus* exhibiting death-feigning behavior following handling.

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***LEPTODACTYLUS MELANONOTUS* (Sabinal Frog). PREY.** *Leptodactylus melanonotus* is known to prey mainly on Coleoptera and Lepidoptera (Greding and Hellebuyck 1980. Carib. J. Sci. 16[1–4]:23–31), but it has also been reported to scavenge on ranid tadpoles (Lewis et al. 2008. Herpetol. Rev. 39[1]:79).

On 6 Oct 2009, an adult *Leptodactylus melanonotus* (sex unknown) was found biting the back leg of an adult *Tlalocohyla*

PHOTO BY OSCAR AVILA-LÓPES

Fig. 1. Predation on *Tlalocohyla smithi* by an adult *Leptodactylus melanonotus*, Colima, México.

smithi, in a drying pond about 0.8 km NE of Paticajo, municipality of Minatitlán, Colima, México (19.3061°N, 104.148°W, WGS 84; 483 m elev.). The *L. melanonotus* slowly started ingesting the *T. smithi*, hind legs first, and about 25 minutes later the entire *T. smithi* was ingested. The frogs were not captured, but several photographs were taken during the process and are deposited in the Digital Collection of the University of Texas at Arlington (UTADC 6255, 6656).

To our knowledge, this is the first report of a *Leptodactylus melanonotus* feeding on an adult anuran.

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***LITORIA SERRATA* (Green-eyed Treefrog)** and ***LITORIA INFRAFRENATA* (White-lipped Treefrog). REPRODUCTIVE BEHAVIOR.** *Litoria serrata* and *L. infrafrenata* are tropical, arboreal frog species that inhabit rainforest and adjacent habitats of the Wet Tropics region of northeast Queensland, Australia. *Litoria serrata* is a relatively small species (SVL 37–80 mm) that is closely associated with streams and creeks where it breeds. *Litoria infrafrenata* is a considerably larger species (SVL 65–140 mm) that breeds in permanent or temporary ponds (Hoskin and Hero 2008. Rainforest Frogs of the Wet Tropics North-east Australia. Griffith Univ., Gold Coast, Australia. 96 pp.; Hero and Fickling 1994. A Guide to the Stream-dwelling Frogs of the Wet Tropics Rainforests. Dept. Zoology, James Cook University. Townsville, Qld. 27 pp.) Although examples of interspecific amplexus among frogs are relatively common (Grogan and Grogan 2011. Herpetol. Rev. 42: 89–90; Manzano and Corzas 2011. Herpetol. Rev. 42:84), Streicher et al. (2010. Herpetol. Rev. 41:208) commented on the lack of examples pertaining to tropical hylids. Herein I report one such example of amplexus between *L. serrata* and *L. infrafrenata*, despite differences in size and preferred breeding habitat.

At 1055 h on 11 Oct 1998, I observed a male *L. serrata* in amplexus with a small adult (sex unknown) *L. infrafrenata*. Conditions were overcast (shade temperature 24°C) and there had been rain the previous evening. The pair was encountered sitting stationary on a wet semi-secluded stone within the spray-zone of a small cascade of Polly Creek in the Seymour Range (60 m elev.) near the township of Innisfail (146.02917°E, 17.499444°S). The male *L. serrata* had a firm grasp around the chest of the *L. infrafrenata*. The eyes of the *L. serrata* were partially retracted into their sockets (which is typical for the genus when at rest) while those of the *L. infrafrenata* were not and the transparent eye-coverings were half-open. The pair was observed at close range for a period of ca. 15 min. during which time there was no

Fig. 1. Male *Litoria serrata* in amplexus with a small adult *Litoria infrafrenata*.

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movement and they were flash photographed (Fig. 1). Although the pair was briefly manipulated, they remained in amplexus and both frogs were quite unresponsive. The pair was observed ca. two hours later in the same position. As both species are nocturnal, it seems likely that amplexus was initiated the previous evening when both were presumably active. The timing of this observation coincided with the start of the breeding season of *L. serrata* in the local area.

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***PHYSALAEMUS BILIGONIGERUS*. BURROW USE.** Burrows provide an amenable environment for anurans; they have cooler temperatures and higher moisture as compared to surface conditions (Franz 1986. *In* Jackson and Bryant [eds.], The Gopher Tortoise and its Community. Proceedings of the 5th Annual Meeting of the Gopher Tortoise Council, pp. 16–20. Florida State Museum, Gainesville). Cei (1980. Monitore Zool. Ital. Monogr. 2:74–75) reported that the anurans of the Gran Chaco often seek shelter in burrows of the Vizcacha (*Lagostomus maximus*; Rodentia: Chincillidae) but only listed Oven Frogs (*Leptodactylus bufonius*) and Coralline Frogs (*L. laticeps*) as occupants.

On 9 Feb 2011 at 2100 h, I observed a frog emerging from an entrance of a *L. maximus* burrow in the Isoceño community of Kuaridenda (19.17°S, 62.53°W; WGS 84), Cordillera Province, Department of Santa Cruz, Bolivia. I captured the frog and confirmed it to be a female *Physalaemus biligonigerus*. When the frog was released, it re-entered the burrow, emerging again ca. 10 min. later. The frog was not disturbed when it emerged the second time and proceeded to hop in the direction of a temporary pond that was ca. 30 m away. I also observed multiple *L. bufonius* utilizing these same sets of burrows. This observation confirms an additional anuran species as an occupant of *L. maximus* burrows.

Anurans of the Gran Chaco possess many strategies to limit water loss. Examples include coating their skin with waxy lipids (e.g., *Phyllomedusa sauvagii*; Shoemaker et al. 1972. Science 175:1018–1020) or forming a cocoon for aestivation (*Lepidobatrachus llaenis*; McClanahan et al. 1976. Copeia 1976:179–185). Those anurans, like *P. biligonigerus*, lack extreme physiological adaptations to limit water loss and may utilize these burrows as refuge from the environmental stress of desiccation. A more intensive survey of these burrows may yield a more complete list of anuran burrow occupants.

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***PHYSALAEMUS BILIGONIGERUS*. PREDATION.** *Physalaemus biligonigerus* is probably a complex of more than one species, and is known from northern and central-western Argentina, adjacent Bolivia, Paraguay, Uruguay, and southern and central Brazil. It is common throughout its range and occurs from sea level to 1400 m elev. It occupies grasslands near temporary and permanent lentic water where it breeds. Males call from the edge or from within the water, and the eggs are deposited in spherical foam nests that float on top of the water. It is able to adapt to anthropogenic disturbance, and is not generally considered threatened. However, the species is threatened in Argentina by the destruction of Chaco habitat for agriculture and wood extraction, and land and water pollution caused by agrochemical runoff. Taxonomic studies are needed to resolve the status of different populations that might represent different species (Kwet et al. 2004. *In* IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>).

This observation occurred near Fazenda Pinhal (30.2199°S, 50.2814°W), near the town of Palmares do Sul (Rio Grande do Sul, Brazil). This area is adjacent to the town of Pinhal and is coastal plain habitat. The region is largely urbanized and agricultural. During the night of 17 Jan 2010 we witnessed predation of *P. biligonigerus* by a young Wolf Fish, *Hoplias* sp., ca. 10 cm long. The frog was attacked on the bank of a slow moving, artificial stream. The Wolf Fish grabbed the frog by the back, and the frog instantly inflated its body; this caused the Wolf Fish difficulty in swallowing the frog as the inflated body of the frog made it difficult for the Wolf Fish to immerse underwater. However after ca. 10 minutes the Wolf Fish succeeded in swallowing the frog and swam away.

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***PHYSALAEMUS PUSTULOSUS* (Tungara Frog). DIET.** *Physalaemus pustulosus* occurs in northern South America and throughout much of the lowland tropical forests of Middle America (Ryan 2010. *In* M. Breed and J. Moore [eds.], Encyclopedia of Animal Behavior, pp. 453–461. Academic Press, Oxford). Ryan (1985. The Túngara Frog: A Study in Sexual Selection and Communication. Univ. Chicago Press, Chicago, Illinois. 246 pp.) reported that *P. pustulosus* eats primarily termites, in addition to ants, mites, dipterans, and snails; although no detailed information exists on the food habits of this species. Herein we provide data on the diet of *P. pustulosus* from Reserva Rio Manso (5.666°N, 74.77416°W; ca. 220 m elev.), municipality of Norcasia, departament of Caldas, Colombia.

We examined the diet of *P. pustulosus* by stomach-flushing 78 individuals, sampled by GGD and SEL from 12–20 May 2010, between 1900 and 2200 h, around ponds in pasture lands. We identified each prey item to order or family, and measured the length and width of each item using manual calipers (to nearest 0.1 mm). We estimated prey volume using the formula for a prolate spheroid.

Table 1. Types of prey in the diet of *Physalaemus pustulosus* from Reserva Rio Manso, Norcasia, Caldas, Colombia. Volume in mm^3.

Prey	Number (%)	Volume (%)	Frequency of occurrence
Arachnida			
Acari	102 (9.6)	13.2 (0.52)	15
Insecta			
Coleoptera			
Chrysomelidae	1 (0.1)	0.5 (0.02)	1
Melolonthidae	1 (0.1)	0.3 (0.01)	1
Mycetophagydae	2 (0.2)	7.0 (0.28)	2
Nitidulidae	1 (0.1)	0.1 (0.00)	1
Silvanidae	2 (0.2)	0.9 (0.03)	2
Staphylinidae	5 (0.5)	1.5 (0.06)	5
Trogossitidae	1 (0.1)		1
Diptera			
Chironomidae	1 (0.1)	0.1 (0.00)	1
Drosophilidae	6 (0.6)	6.4 (0.25)	4
Micropezidae	4 (0.4)	2.2 (0.09)	1
Psychodidae	11 (1.0)	2.7 (0.11)	11
Sphaeroceridae	64 (6.0)	3.6 (0.14)	3
Hemiptera			
Cicadellidae	1 (0.1)	0.4 (0.01)	1
Fulgoridae	2 (0.2)	0.4 (0.01)	2
Hymenoptera			
Diapriidae	1 (0.1)	0.1 (0.00)	1
Figitidae	1 (0.1)	0.1 (0.01)	1
Formicidae	199 (18.8)	38.7 (1.54)	34
Isoptera			
Termitidae	630 (59.4)	2432.1 (96.50)	22
Protura			
Dycirtomidae	16 (1.5)	0.6 (0.02)	6
Thysanoptera			
Thripidae	1 (0.1)	0.3 (0.01)	1
Larvae	3 (0.3)	0.7 (0.03)	2
Diplopoda	1 (0.1)	0.1 (0.00)	1
Chilopoda	4 (0.4)	2.9 (0.11)	2
Mollusca	1 (0.1)	5.6 (0.22)	1
TOTAL	1061	2520.3	

Of 78 individuals examined, 46 (58.9%) contained prey. These individuals ranged from 17.9–33.5 mm SVL (mean 26.01 ± 3.2). The diet consisted mainly of arthropods although mollusks were also present (Table 1). Insects (seven orders and 19 families, and larvae) and mites were the most important prey. Termites were dominant in the diet, representing 59.4% of the total number and 96.5% of the volume. Ants were also important, but consumed in less proportion (18.8% and 1.54%, respectively). Other prey groups were not as evident, with values below 9.6% total number and below 0.52% volume).

Duellman (1978. Univ. Kansas Mus. Nat. Hist. Misc. Pub. 65:1–352), Parmelee (1999. Sci. Pap. Nat. Hist. Mus. Univ. Kansas 11:1–59), and Menéndez-Guerrero (2001. Ecología Trófica de la Comunidad de Anuros del Parque Nacional Yasuní en la Amazonía Ecuatoriana. Pont. Univ. Catol. Ecuador. 173 pp.) reported that other *Physalaemus* species, e.g., *P. freibergi* and *P. petersi*, consume a lot of termites, up to 99% both numerically and volumetrically, and very small quantities of other prey such as Coleoptera, Hymenoptera, Dermaptera, Hemiptera, and Arachnida.

Frogs in the genus *Physalaemus* has been reported as active foragers, usually feeding on small and aggregated prey (Rodrigues et al. 2004. Rev. Esp. Herpetol.18:19–28), and proposed as a termite specialist (Duellman 1978, *op. cit.*; Vitt and Caldwell 1994. J. Zool. [Lond.] 234:463–476). Because of the large quantities of termites found in this work, we suggest that *P. pustulosus* in this region could be considered a termite specialist, and that the low values exhibited for other prey items might be due to accidental ingestions (Rodrigues et al. 2004, *op. cit.*).

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***RAORCHESTES MENGLAENSIS* (Mengla Small Treefrog). COLORATION.** *Raorchestes menglaensis* is a data deficient species. All information for the species is based on 10 individuals that were collected at one site in Zhushihe, Mengla county, Xishuangbanna prefecture, Yunnan province, China at 900 m elev. (Kou 1990. *In* Zhao, E.-M. [ed.], From Water onto Land. China Forestry Press, Beijing). During breeding surveys on 26 June 2009, we encountered a single individual in the Xishuangbanna Tropical Botanic Garden. The frog was found at night during a light rain, calling on a leaf ca. 0.4 m above ground. There was no standing water or streams anywhere nearby, further suggesting this species may breed via direct development. The individual was collected and held overnight for photographing. At night, the frog was largely tan in color with irregular darkened areas and faint banding visible on the hind limbs. The following morning the frog was dark brown to nearly black with light gray specks (Fig. 1).

During three months of weekly breeding surveys, we only saw *R. menglaensis* once. However, other individuals were heard calling on several occasions. This is likely a rare species in need of conservation attention given that its habitat is experiencing significant land use change (Li et al. 2007. Biodiversity and Conservation 16:1731–1745).

Photo vouchers documenting the coloration were deposited in the University of Wisconsin Zoology Museum (light coloration: UWZM V.20187, dark coloration UWZM V.20188). We thank Xishuangbanna Tropical Botanic Garden for access to breeding areas. Funding was provided by NSF DGE-0549369 and Fulbright.

Fig. 1. On left, *Raorchestes menglaensis* at night; on right *R. menglaensis* during the day. The same individual is depicted in both photos.

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***RHINELLA MARINA* (Cane Toad). PREDATION.** *Rhinella marina* is a widely distributed toad; in Mexico it is found in the southern region, and along the Atlantic and Pacific versants (Oliver-López et al. 2009. La Familia Bufonidae en México. UNAM, CONABIO, México. 139 pp.). Here we report on the first case of predation of a Cane Toad by the Barn Owl (*Tyto alba*), in the green areas of Instituto Tecnológico del Valle de Oaxaca, in the locality of Nazareno, municipality of Santa Cruz Xoxocotlán, Oaxaca, Mexico (17.0207°N, 96.7673°W; 1565 m elev.). The area is surrounded by remnants of tropical dry forest and arid tropical scrub, which have been replaced extensively by corn crops. Individuals of *T. alba* were observed while they were perching on palm trees, where the pellets of this species were collected. In one of these, we found a partly digested *R. marina* (ca. 132 mm SVL; Fig. 1). This was not in the typical pellet form; however, we were able to confirm ingestion by the owl by the presence of three rodent lower jaws that were associated with the partly digested *R. marina.* This partial digestion may be due to the parotoid glands of *R. marina*, which secrete toxins that are utilized for defense, forcing it to be regurgitated, along with other prey.

Predation on amphibians by *T. alba* has been documented elsewhere (Hernández-Muñoz and Mancina 2011. Rev. Mex. Biodiv. 82:217–226; Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 1148 pp.), but the only two papers we found that mentioned a toad in the diet of *T. alba* are those of Arredondo and Chirino (2002. El Pitirre 15:16–24) who cited the species *Peltaphryne empusa* in Cuba, and Morales-Hernández (1997. Análisis de los Hábitos Alimenticios de la Lechuza *Tyto alba* en la Población de Chichicasco, Estado de México. Unpubl. BS thesis. BUAP, Puebla, México), who found an unidentified toad in the cave of Agustín Lorenzo in San Pedro Chichicasco, State of Mexico, Mexico. However, this is the first report of *R. marina* in the diet of *T. alba.*

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Fig. 1. Partly digested *Rhinella marina*, found in a pellet of the Barn Owl (*Tyto alba*), in Santa Cruz Xoxocotlán, Oaxaca, Mexico.

***RULYRANA OREJUELA* (Orejuela Glass Frog). PREDATION.** Spiders commonly prey on amphibians. Menin et al. (2005. Phyllomedusa 4[1]:39–47) provided an extensive review of spiders preying on amphibians in the Neotropics. Predators belong to several species of spiders, especially within the families Ctenidae, Lycosidae, Pisauridae, Sparissidae, and Theraphosidae. Hayes (1983. Biotropica 15:74–76) reported predation by spiders *Cupiennius* sp. (Ctenidae) on two species of glass frogs: *Hyalinobatrachium fleischmanni* and *Espadarana prosoblepon*. Herein, we report predation of *Rulyrana orejuela* by a spider of the family Clubionidae. This event was observed in an area at the southern border of Reserva Ecológica Cotacachi Cayapas, Provincia de Imbabura, northwestern Ecuador (0.33101°N, 78.93152°W; 670 m). The general locality includes a mixture of secondary and primary forests in the Low Montane Evergreen Forest. We observed a female *Clubiona* sp. preying on *Rulyrana orejuela* on 31 Oct 2009 at 2325 h on the Aguas Verdes stream. At the site, we observed at least three additional juveniles and two adult *R. orejuela*. The genus *Clubiona* was recorded only recently from Ecuador (Yánez-Muñoz and Cisneros-Heredia 2008. Check List 4[1]:50–54). The predation occurred on a dark night with cloudy sky and air temperature averaging 24°C. The spider (cephalothorax and abdomen length CAL = 14.5 mm) and the *R. orejuela* (SVL = 13.9 mm) were located over a leaf of *Selaginella* sp. at about 150 cm above the water surface of the stream, near a rock (1.5 m diam) in midstream. This large rock divided the stream into two parts and formed a small island with herbaceous vegetation, branches, and trunks. The stream had a depth of 25 cm and a width of 7 m. When first sighted the spider was about 10 cm from a dead juvenile *R. orejuela*. After about 5 minutes the spider was seen over the frog with its chelicerae embedded in the frog's body. About 80 cm away we found a nest of the spider with the male inside (CAL = 10.9 mm). The cone-shaped nest was built with a leaf of plant belonging to the Araceae. The nest had a depth of 81.4 mm (inner maximum diameter of nest entrance = 13.1 mm.)

PHOTOS BY L. A. COLOMA

Fig. 1. Female *Clubiona* sp. preying on a juvenile *Rulyrana orejuela*.

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Fig. 2. Lateral (left) and dorsal (right) views of the nest of *Clubiona* sp. The male spider is visible at right photo.

Spiders of the genus *Clubiona* are small and are characterized by building their nests on the soil with dry leaves, though sometimes their nests are built with live green leaves. In general, they are hunters and specialize in hunting insects around their nests. Austin (1984. S. Austr. J. Arachnol. 1-2:87–104) reported the main prey of *C. robusta* were Hymenoptera, Coleoptera, and Heteroptera. The prey of *C. cycladata* mostly comprised the groups; Heteroptera, Hymenoptera, Araneae, and Coleoptera. Pollard (1984. J. Arachnol. 11:323–326), discussed oophagy in *C cambriggei*. However, this is the first report of a female *Clubiona* sp. eating a *R. orejuela*.

Voucher specimens were deposited at Museo de Zoología of Pontificia Universidad Católica del Ecuador (QCAZ 48616 *R. orejuela* and QCAZ uncatalogued spider).

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TESTUDINES — TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle). GROWTH RATES.** Standard carapace length (SCL) growth rates of adult *Chelydra serpentina* have been reported for Iowa, USA (Christiansen and Burken 1979. Herpetologica 35:261–266), and Ontario, Canada (Brown et al. 1994. J. Herpetol. 28:405–410). In Iowa, Christiansen and Burken (*op. cit.*) reported 4.4% growth for one *C. serpentina* re-captured after 11 months. Brown et al. (*op. cit.*) reported mean annual growth of 1.12% (N = 53) and 0.26% (N = 40) for adult female *C. serpentina* at two separate sites in Ontario, Canada.

On 25 May 2011 and 06 July 2011, within the Blood River and Panther Creek, Calloway Co., Kentucky, USA, we re-captured two *C. serpentina* initially marked with metal cattle tags on 14 May 2004 and 28 May 2004. Initial SCL measurements were 240 mm and 231 mm, and final SCL measurements were 315 mm and 277 mm respectively. Percent SCL growth for these two turtles was 3.4% and 2.4% annually, over a 7-year period. Two previous studies detail regionally specific age estimates for *C. serpentina* based on carapace length (Christiansen and Burken, *op. cit.*; Galbraith et al. 1989. Copeia 1989:896–904). Based on these studies, the two Kentucky *C. serpentina* were captured at approximately 15–16 years of age (based on Ontario data) or between 11–12 years of age (Iowa); however, these may be over-estimates considering Kentucky's warmer climate and longer growing season compared with Iowa and Ontario.

Growth rates for periods exceeding five years have rarely been reported for *C. serpentina*. The 3.4% and 2.4% annual growth rates for two *C. serpentina* in Kentucky fall within the upper end of the range of previously reported annual growth rates for *C. serpentina* (0.26%–4.4%). These data are consistent with previous studies (Ligon and Lovern 2009. Chelon. Cons. Biol. 8:74–83; Parmenter 1980. Copeia 1980[3]:503–514) demonstrating a relationship between warmer water temperatures and increased annual growth rates of turtles.

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***GOPHERUS AGASSIZII* (Desert Tortoise). COHABITATION WITH AMERICAN BADGER.** American Badgers (*Taxidea taxus*) are known predators of juvenile and adult Desert Tortoises as well as their nests (Berry and Duck 2010. Answering Questions About Desert Tortoises: a Guide for People Who Work with the Public. Desert Tortoise Council, Ridgecrest, California. Available online at <http://www.deserttortoise.org/answeringquestions/index.html>). Despite this fact, on 8 August 2011, we observed a badger sharing a caliche cave retreat with an adult male Desert Tortoise in southern Nevada. The badger was seen peering out of the cave before retreating, upon which time some "shuffling" was heard and the tortoise appeared at the cave entrance, apparently unharmed, and proceeded to sit just inside the mouth of the cave. As the tortoise was part of a radio-tracking study, we relocated it a week later and it remained alive and healthy. Though badgers will occasionally kill Desert Tortoises, this observation suggests that they may, at least temporarily, share desert retreat sites with tortoises without antagonistic or predatory behavior.

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***KINOSTERNON BAURII* (Striped Mud Turtle). HABITAT AND AERIAL BASKING.** Reported Striped Mud Turtle habitats include lentic bodies of water such as canals, Carolina bays, ponds, swamps, slow-moving streams, and sloughs (Ernst and Lovich 2009. Turtles of the United States and Canada. Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.). Observations of this species in riverine systems are rare. Norman (1989. Catesbeiana 9:9–14; M. Norman, pers. comm.) noted this species' (originally reported as *K. subrubrum*, see Mitchell 1994. The Reptiles of Virginia. Smithsonian Inst. Press, Washington, DC. 352 pp.) occurrence in the Blackwater River in southeastern Virginia but did not elaborate on whether captures were in the mainstem or in associated streams and swamps. Only 4 of 2552 turtles captured by Huestis and Meylan (2004. Southeast. Nat. 3:595–612) in the Rainbow River, Marion Co., Florida, were *K. baurii*. Johnston et al. (2011. Florida Sci. 74:126–133) reported two *K. baurii* in the Santa Fe River (Alachua and Columbia counties, Florida) but speculated that those turtles had immigrated to the river from surrounding floodplain swamps which had dried due to prevailing drought conditions.

During May 2007–July 2011, we captured by hand and with baited hoop traps 105 *K. baurii* in the mainstem and associated springs and spring runs of the Santa Fe River. Of these, 9 were caught in the mainstem and 96 were caught in springs and their associated outflow runs adjacent to the river. All river captures were in areas with submerged, emergent, or floating aquatic vegetation (Tapegrass [*Vallisneria americana*], Indian Swampweed [*Hygrophila polysperma*], Hydrilla [*Hydrilla verticillata*], Water Hyacinth [*Eichhornia crassipes*]), or snags. All individuals in the mainstem were adults. Our observations confirm the occurrence of a *K. baurii* population associated with the Santa Fe River mainstem and strengthen the known association between *K. baurii* and lotic habitats.

In addition, we observed five instances of daytime aerial basking by *K. baurii* along the banks of the Santa Fe River and associated spring runs. One juvenile was basking on a leaf overhanging the water and two adult males were on tree limbs (< 10 cm above water) in Blue Spring run, Gilchrist Co. (29.831041°N, 82.681915°W) on 10 August 2009 and 27 March and 4 April 2011, respectively. One adult (unknown sex) was basking on exposed roots along the margin of the mainstem at Rum Island Park, Columbia Co. (29.833143°N, 82.678346°W) on 16 March 2011. One adult male was basking on a small (14 cm diam) piece of limestone 0.28 km downstream from the Hwy. 441 bridge in High Springs, Alachua Co. (29.851967°N, 82.611310°W) on 23 March 2011. All observations were between 1100 and 1700 h. Most observations of these bottom-walkers occur when they are in shallow water or as they walk across the landscape (Ernst and Lovich 2009, *op. cit.*, Wilson et al. 2006. *In* P. A. Meylan [ed.], Biology and Conservation of Florida Turtles, pp. 180–188. Chelon. Res. Monogr. 3). Although aerial basking has been reported for other species of kinosternids, e.g., *K. subrubrum* (Ernst and Lovich 2009, *op. cit.*), *Sternotherus carinatus* (Lindeman 1996. Herpetol. Nat. Hist. 4:23–34), *S. minor* (Carr 1952. Handbook of Turtles. The Turtles of the United States, Canada, and Baja California. Cornell University Press, Ithaca, New York. 542 pp.)), and *S. odoratus* (Ernst 1986. J. Herpetol. 20:341–352), there appears to have been no published documentation of this behavior in *K. baurii* (Wilson et al. 2006. *op. cit.*; D. Wilson, pers. comm.). Basking behavior by *K. baurii* in the Santa Fe River population may have a thermoregulatory function, as we recorded air temperatures 1.7–3.1°C greater than water temperatures. Basking may also be related to ectoparasite removal, as suggested by a statistically significant difference in leech (*Placobdella* sp.) load between basking adult males (mean = 37.3 leeches/turtle, SD = 45.6, range = 10–90, N = 3) and non-basking adult males (mean = 1.9 leeches/turtle, SD = 3.0, range = 1–12, N = 43) (Mann-Whitney Rank Sum Test, U = 2.500, p = 0.004). These suggested causes of aerial basking in riverine environments need to be tested with other observations of basking *K. baurii* in lotic as well as lentic habitats.

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***STERNOTHERUS CARINATUS* (Razor-backed Musk Turtle). ECTOPARASITES.** To our knowledge, there have been no previous published reports of leeches infesting *Sternotherus carinatus.* Herein we report a new host record for a leech species found on this turtle.

Three adult *S. carinatus* were collected by dipnet on 5 June 2001 from the Caddo River off St. Hwy. 7, Clark Co., Arkansas, USA (34.176523°N, 93.07121°W). Turtles were returned to the laboratory and (because vouchers were required for parasitological surveys) they were killed with an overdose of sodium pentobarbital (Nembutal®), and examined for leeches and gastrointestinal helminth parasites. No helminths were found but one (33%) was infested with 15 leeches attached in the corners of its limbs. They were removed and placed in a vial containing 70% ethanol. These were subsequently identified as juveniles of *Placobdella multilineata* Moore, 1953. Voucher specimens of leeches were deposited in the Invertebrate Zoology Collection of the Department of Invertebrate Zoology, National Museum of Natural History (USNM), Smithsonian Institution, Washington, D.C. as USNM 2057950. Host vouchers were deposited in the Texas A&M University-Texarkana Herpetological Collection (TAMUT), Texarkana, Texas as TAMUT 1005–1006.

This leech is a relatively common blood-feeding species on amphibians and reptiles. Previously reported turtle hosts include the Eastern Snapping Turtle, *Chelydra serpentina* (Sawyer and Shelley 1976. J. Nat. Hist. 10:65–97; Stone 1976. Southwest. Nat. 20:575–576), Alligator Snapping Turtle, *Macroclemys temminckii* (Saumure and Carter 1998. Herpetol. Rev. 29:98), Yellow-bellied Slider, *Trachemys scripta scripta* (Sawyer and Shelley 1976. J. Nat. Hist. 10:65–97), and Bog Turtle, *Clemmys muhlenbergii* (Saumure and Beane 2001. Herpetol. Rev. 32:38; Saumure and Carter 1998. Herpetol. Rev. 29:98).

This leech has an extensive range in the southern United States, extending northward through the Mississippi River Valley and eastward to the Atlantic coast, including Alabama, Arkansas, Florida, Georgia, Kansas, Illinois, Iowa, Louisiana, Nebraska, North Carolina, Oklahoma, South Carolina, Tennessee, and Texas (Klemm 1982. Leeches (Annelida: Hirudinea) of North America. Environmental Monitoring and Support Laboratory, USEPA-600/3-82-025. Cincinnati, Ohio. 177 pp.). Moser et al. (2006. J. Arkansas Acad. Sci. 60:84–95) reported free-living specimens of *P. multilineata* from Arkansas for the first time in Conway, Jackson, Perry, Randolph, and Van Buren counties, all located north of the Arkansas River Valley; our site reported herein is south of the valley in the Ouachita Mountains.

We thank the Arkansas Game and Fish Commission for a Scientific Collecting Permit issued to CTM and Renn Tumlison for assistance in collecting.

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***STERNOTHERUS MINOR MINOR* (Loggerhead Musk Turtle). PREDATION.** A large number of likely mammalian, avian, and reptilian predators have been listed for the eggs and juveniles of *Sternotherus m. minor* (Ernst and Lovich 2009. Turtles of the United States and Canada. Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.), but invertebrate predators have apparently not been noted, and few predators have been documented for adults of this species. These include Alligator Snapping Turtles (*Macrochelys temminckii*), American Alligators (*Alligator mississippiensis*), and humans (Pritchard 1989. The Alligator Snapping Turtle: Biology and Conservation. Milwaukee Public Mus., Milwaukee, Wisconsin. 104 pp.; Zappalorti and Iverson 2006. *In* P. A. Meylan [ed.], Biology and Conservation of Florida Turtles. Chelonian Res. Monogr. No. 3:197–206). In this note, we describe successful predation on adult *S. minor* by River Otters (*Lutra canadensis*), and attempted predation of a juvenile by an invertebrate.

In two separate observations on 10 and 11 January 2011, we observed an adult River Otter in the process of biting off the head and forelimbs of an adult *S. minor* in the Santa Fe River, 1.15 km downstream from Deer Spring (Gilchrist Co., Florida; 29.84757°N, 82.71074°W, WGS 84). In each instance, the otter set the turtle on a log near shore after eating it; the turtle's rear limbs were still moving a minute later, though most of the internal organs had been consumed. Together with *M. temminckii* and *Alligator mississipiensis* that also occur in the Santa Fe River (G. R. Johnston, pers. obs.), River Otters may be significant predators of *S. minor* and play a role in the population ecology of these turtles in this river system.

On 13 February 2011, we observed a female Giant Water Bug, *Lethocerus americanus* (Belostomatidae), manipulating a prey object as it was anchored on *Hydrilla* stems at the confluence of the Ginnie Spring outflow run with the Santa Fe River in Gilchrist County, Florida (29.83655°N, 82.69942°W, WGS 84). She was gripping a juvenile *S. minor* (34 mm carapace length, 22 mm plastron length, 5.5 g) at a depth of about 3 cm, holding the turtle by its anterior carapace and probing the shell with her proboscis. She had not yet penetrated soft tissue when discovered but would likely have killed and eaten the turtle had we not intervened. The turtle was marked and released. This is the first report of attempted predation of *Sternotherus minor* by an invertebrate and apparently the first such attempt reported for the genus.

Matthew Kail aided in the field observation.

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***TRACHEMYS ORNATA* (Ornate Slider). HATCHLINGS.** *Trachemys ornata* is a middle-sized emydid turtle that ranges from northern Sinaloa and Nayarit to isolated populations in Guerrero and Oaxaca on the Pacific coast of Mexico (Ernst and Barbour 1989. Turtles of the World. Smithsonian Institution Press. Washington, D.C. 313 pp.). There is little published information about the life history and reproduction of this species, other than anecdotal data on clutch size (12–20 eggs) and age of first reproduction (4–8 years) (Moll and Moll 1990. *In* J. W. Gibbons [ed.], Life History of the Slider Turtle, pp. 152–161. Smithsonian Institution Press, Washington, DC).

On 24 May 2005 we recorded hatchling emergence from one nest of 13 eggs located just a few meters away from a road in Playa Linda (17.681028°N, 101.644139°W), a beach resort in the tourist-oriented corridor Ixtapa-Zihuatanejo, in Guerrero, México. The nest had been deposited 25 m away from a small marsh and approximately 70 m from the sea coastline. After the last hatchling emerged, we excavated the nest and found one unhatched (decayed) egg. We measured the surviving hatchlings (N = 12) with a dial caliper (± 0.02 mm). The shell measurements (in mm) are given as: average (± SD, range). Carapace length 37.96 (± 2.58, 34.16–41.81), carapace width 34.72 (± 3.33, 28.77–39.04), carapace height 18.25 (± 1.20, 16.91–20.71), plastron length 34.74 (± 2.29, 31.72–37.61), and plastron width 24.88 (± 1.23, 22.94–26.54). After measurement, the hatchlings were released at the marsh shore. This clutch size for *T. ornata* was similar to that reported for *T. venusta* (N = 12, 5–22 eggs); however, average hatchling carapace length was larger in *T. ornata* than reported for *T. venusta* (mean = 31.8, 25.0–37.8 mm) (Vogt 1990. *In* Gibbons, *op. cit.*, pp. 162–168).

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SQUAMATA — LIZARDS

***AMEIVA AMEIVA* (Giant Ameiva). BIFURCATION.** *Ameiva ameiva* is one of the most widely distributed Neotropical lizards, occurring from the Caribbean Islands and Costa Rica to southern Brazil, northern Argentina and the eastern Andes in South America (Vitt and Colli 1994. Can. J. Zool. 72:1986–2008). All teiid lizards are capable of caudal autotomy as a means of predation evasion. Occasionally an additional lateral tail can be produced if the original is broken, but not entirely lost.

On 26 March 2009 during the rescue activities of wildlife from the Project of Integration of São Francisco River (PISF) within the basins of Northeastern Setentrional, we collected an adult *A. ameiva* in the municipality of Sertânia, state of Pernambuco, Brazil (8.086°S, 37.384°W, datum: WGS84; elev. 558 m). The tail of the lizard was bifurcated in the medial region (ca. 35 mm posterior from the cloaca), and one of the regenerated tails was much shorter than the other (Fig. 1). Records of bifurcated tail regeneration have been published for many lizard species (see Kumbar and Ghadage 2011. Herpetol. Rev. 42:94; Mata-Silva 2010. Herpetol. Rev. 41:352–353, and citations therein), and some of these cases show that the bifid or multiple regeneration of tails involve damage to a vertebra. This is presumably what the *A. ameiva* incurred in this report.

The *A. ameiva* (LC 0969) was deposited in the scientific collection of the Centro de Conservação e Manejo de Fauna da Caatinga (CEMAFAUNA-Caatinga/UNIVASF), Petrolina, Pernambuco, Brazil. We thank the Ministério da Integração Nacional for financial support, and the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes) for the research scholarship granted to ML; IBAMA provided the collecting permits (# 042/2007 and 125.r/2010 Process n° 02001.003112/2007-12).

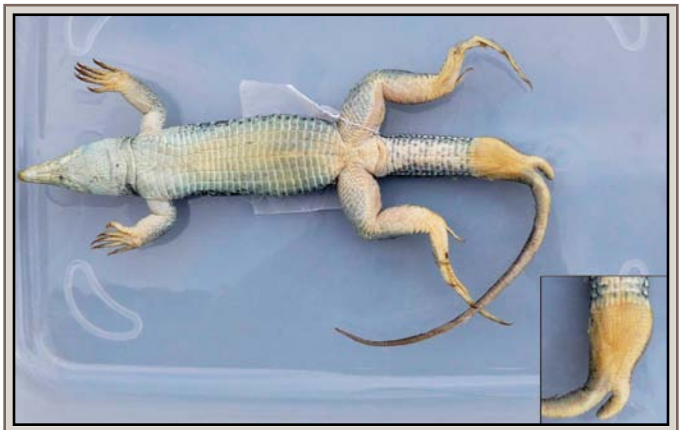

Fig 1. *Ameiva ameiva* (135 mm SVL) with bifurcated tail in the medial region (inset); length of broken tail: 35 mm; length of regenerated tails: 120 mm and 15 mm.

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***ANOLIS CAPITO* (Pug-nosed Anole). DIET.** Although some lizards are dietary specialists, most species consume a wide variety of arthropods (Magnusson and Da Silva 1996. J. Herpetol. 27:380–385). Some detailed dietary studies on small lizards in neotropical areas showed relatively few vertebrate prey (e.g., Garnier et al. 1994. J. Herpetol. 28:187–192; Vitt 1991. Can. J. Zool. 69:504–511; Vitt and de Carvalho 1992. Can. J. Zool. 70:1995–2006; Vitt et al. 1993. Can. J. Zool. 71:2391–2400; Vitt et al. 1998. Can. J. Zool. 76:1681–1688; Vitt et al. 1997. Can. J. Zool. 75:1876–1882; Vitt et al. 2001. Copeia 2001:401–412). However, *Neusticurus ecpleopus* (Gymnophthalmidae) includes frog larvae in its diet at an Amazon locality (Vitt et al. 1998. Can. J. Zool. 76:1671–1680) and *Kentropyx striatus* (Teiidae) has been found to have a high proportion of vertebrates, especially frogs, in its diet (Magnuson and Da Silva 1996, *op. cit.*; Vitt and de Carvalho 1992, *op. cit.*). Some other teiids such as *Tupinambis* also are known to consume frogs (Pianka and Vitt 2003. Lizards: Windows to the Evolution of Diversity. Univ. California Press, Los Angeles, California. 333 pp.), but these are large bodied animals. Frogs are consumed by *Anolis* lizards, especially relatively large-bodied species such as *Anolis punctatus* in Brazil (Vitt et al. 2003. J. Herpetol. 37:276–285). Here we provide the first report of frog predation by *Anolis capito*, a small species (SVL = 83–96 mm, females; 78–90 mm, males) (Savage 2002. Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 1056 pp.).

In Costa Rica, *Anolis capito* is found along the Caribbean slope and in the southwestern lowlands, in deeply shaded forest interiors (Leenders 2001. A Guide to Amphibians and Reptiles of Costa Rica. Zona Tropical, Miami, Florida. 305 pp.). It is most frequently observed on the ground or perched low on a trunk 0.25–2 m above the ground (Savage 2002, *op. cit.*). It feeds mainly on spiders, orthopterans, and caterpillars, and often also takes slugs (Savage 2002, *op. cit.*). It also takes small vertebrates such as other anoles (Leenders 2001, *op. cit.*). At 0950 h on 20 October 2001 in Golfito National Wildlife Refuge, Puntarenas Province, SW Costa Rica (8.638611°N, 83.167778°W), we found an adult male (85 mm SVL) *A. capito* eating a Pigmy Rain Frog (*Pristimantis ridens*) (18 mm long). Neither animal was collected. *Pristimantis ridens* is a very common nocturnal forager in low vegetation that often hides in the leaf litter during the day (Savage 2002, *op. cit.*). The two species have overlapping distributions along the Pacific and Atlantic slopes of Costa Rica. We do not know the frequency of predation or the importance of *P. ridens* in the diet of *A. capito*. This is one of relatively few observations of *Anolis* consuming a frog and is the first report of lizard predation on *Pristimantis ridens*.

Observations were made during a field trip of the "Reptiles" course of the School of Biology, University of Costa Rica (UCR).

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***BRACHYMELES BOULENGERI* (Philippine Slender Skink). DIET.** *Brachymeles boulengeri* is a pentadactyl, semi-fossorial lizard known from Luzon, Polillo, and Marinduque islands in the northern Philippines. Considered a model system for studying the evolution of limb reduction and loss in squamate reptiles, the genus *Brachymeles* possesses species with a full spectrum of body forms, including pentadactyl, non-pentadactyl, and limbless species (Siler and Brown 2011. Evolution doi:10.1111/j.1558-5646.2011.01315.x; Siler et al. 2011. Mol. Phylogen. Evol. 59:53–65). All species are known to burrow in loose soil and rotting logs, making it difficult to observe dietary preferences (Siler and Brown 2010. Herpetol. Monogr. 24:1–54). As a result of their secretive nature, no studies have reported on observed dietary preferences for any species within this unique genus, and it has long been presumed that the diet consists of small invertebrate species. This is the first record of saurophagy for the genus *Brachymeles*.

While conducting fieldwork in the Philippines, we observed a male *Brachymeles boulengeri* (total length = 178 mm; 17.9 g) consume an adult *B. bonitae* head-first. Adult specimens of both species were collected on 7 May 2011, and placed in the same specimen bag during the return trip to base camp Malaboo, Mt. Makiling Forest Reserve, Barangay Bagong Silang, Municipality of Los Baños, Laguna Province, Luzon Island, Philippines (14.13356°N, 121.20447°E, datum: WGS84; elev. 665 m). Between the time of collection and arrival in camp, the individual of *B. boulengeri* consumed the individual of *B. bonitae*. An autotomized tail fragment of the *B. bonitae* specimen was not consumed, and was preserved in 95% EtOH as a tissue voucher. Examination of the stomach contents of the *B. boulengeri* specimen confirmed the ingestion of the smaller species *B. bonitae* (Fig. 1). The *B. boulengeri* specimen, with intact stomach content, and the tail sample of the consumed individual of *B. bonitae*, were preserved and deposited at the Biodiversity Institute, University of Kansas (CDS 5626: *Brachymeles boulengeri*; CDS 5612 [Genetic Sample]: *Brachymeles bonitae*).

Fig. 1. An adult *Brachymeles boulengeri* (above) with dissected stomach contents showing an ingested adult *Brachymeles bonitae* (below) on Mt. Makiling, Luzon Island, Philippines.

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***CERCOSAURA SCHREIBERSII*. DIET.** *Cercosaura schreibersii* is a gymnophthalmid lizard with wide geographical distribution in South America that occurs in southeastern Peru, Bolivia, Paraguay, Argentina, Uruguay and southern Brazil (Lema 1994. Comun. Mus. Ciênc. PUCRS, Sér. Zool. 7:41–150). Information concerning the biology of the species is scarce and here we present basic information on diet of this lizard. Data were obtained from analysis of 28 adult individuals of *C. schreibersii* (10 males and 18 females; mean SVL 358 mm ± 32 mm) collected in coastal sand dune environments in Rio Grande, Rio Grande do Sul (32.1654°S, 52.1523°W, sea level), southern Brazil. The contents from stomachs and intestines were analyzed and each prey item was identified to order under a stereomicroscope. The results are presented in Table 1. Aranae were a predominant item in the diet, present in 67.9% of lizard contents and representing 46.3% of total items consumed. The second most important prey were Isopoda, present in 17.9% of lizards and representing 12.2% of the items consumed. Only 10.7% of lizards had no contents in the digestive tract. Our data support preliminary assessments concerning dietary specialization in *C. schreibersii* (Achaval 1984. Bol. Soc. Zool. Uruguay Seg. Epoc. 2:59–62). The consumption of spiders is known for some species of lizards but not as a predominant dietary item (e.g., *Anolis*, *Tropidurus*, and *Ophiodes*; Ávila-Pires 1995. Zool. Verh. Leiden. 1995:3–706; Vitt

Table 1. Prey items present in the digestive tracts of 28 adult individuals of *Cercosaura schreibersii* captured in sand dune habitats of southern Brazil.

Items	Frequency of occurrence (%)	% of total registered items
Arachnida		
Acari	3.6	2.4
Aranae	67.9	46.3
Scorpiones	3.6	2.4
Crustacea		
Isopoda	17.9	12.2
Unidentified	3.6	2.4
Insecta		
Coleoptera	10.7	7.3
Diptera	7.1	4.9
Hemiptera	3.6	2.4
Heteroptera	3.6	2.4
Hymenoptera	3.6	2.4
Homoptera	3.6	2.4
Larvae	7.1	4.9
Orthoptera	3.6	2.4
Trichoptera	3.6	2.4
Unidentified	3.6	2.4
Empty	10.7	—
Unidentified	14.3	—

and Caldwell 1993. J. Herpetol. 27:46–52). Dietary specialization suggests particular adaptation processes highlighting its potential for studying the evolution of foraging habits on lizards. The *C. schreibersii* vouchers (RGRM: 05, 06, 16, 17, 19–37, and 40–45) were deposited in the Coleção Herpetológica Laboratório de Ecologia de Vertebrados Terrestres of Instituto de Ciencias Biológicas, Universidade Federal do Rio Grande. We thank CNPq and Fapergs for financial support and ICMBio by collecting permits.

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CROTAPHYTUS BICINCTORES **(Mojave Black-collared Lizard). ENDOPARASITES.** *Crotaphytus bicinctores* occurs in xeric rocky habitats in southeastern and northeastern California, parts of Arizona, Oregon, Idaho, Utah, and much of Nevada (McGuire 1996. Bull. Carnegie Mus. Nat. Hist. 32:1–143.). To our knowledge, there are no reports of helminths for this species. The purpose of this note is to establish the initial helminth list for *C. bicinctores.*

One nematode was found in the body cavity of one female *C. bicinctores* (SVL = 88 mm) collected October 1962 at Pisagh Crater, San Bernardino Co., California, USA (34.746378°N, 116.37557°W, WGS84; elev. 753 m) and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA as LACM 21651. The nematode was cleared in a drop of glycerol on a glass slide, cover-slipped, and identified as an adult female *Thubunaea iguanae.* It was deposited in the United States National Parasite Collection, Beltsville, Maryland as USNPC 104864.

Thubunaea iguanae is a common stomach parasite of lizards from the southwestern United States and Mexico (McAllister et al. 2008. Comp. Parasitol. 75:241–254) and has been found in the congeners *C. collaris* (McAllister et al., *op. cit.*) and *C. vestigium* (Goldberg and Bursey 2010. Herpetol. Rev. 41:353). It also occurs in colubrid snakes (Goldberg and Bursey 2001. Bull. So. California Acad. Sci. 100:109–116). It is in the family Physalopteridae, species of which utilize insect intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission, 2nd ed. CABI Publishing, Oxfordshire, UK. 650 pp.). *Crotaphytus bicinctores* is a new host record for *Thubunaea iguanae.*

We thank Christine Thacker (LACM) for permission to examine *C. bicinctores.*

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CTENOSAURA SIMILIS **(Gray's Spiny-tailed Iguana) and** ***IGUANA IGUANA*** **(Green Iguana). CARRION FEEDING.** Adult *Ctenosaura similis* and *Iguana iguana* are primarily herbivorous (Hirth 1963. Ecology 44:613–615; Krysko et al. 2008. Florida Sci. 72:48–58; Montanucci 1968. Herpetologica 24:305–315; Rand et al. 1990. J. Herpetol. 24:211–214). However, *C. similis* will opportunistically prey upon small vertebrates (summarized by Krysko et al., *op. cit.*), and an adult female ate a piece of meat from a discarded roast beef sandwich (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 155 pp.). In Panama, *Iguana iguana* purportedly will eat human excrement (Swanson 1950. Herpetologica 6:187–193), and two adults were observed feeding upon the carcass of a putrefying opossum (probably *Didelphis marsupialis*) along with two Turkey Vultures (*Cathartes aura*) (Loftin and Tyson 1965. Copeia 1965:515).

Fig 1. An adult female *Iguana iguana* (foreground) and adult male *Ctenosaura similis* (background) feeding on the carcass of an *Odocoileus virginianus clavium* along with *Cathartes aura* on Big Pine Key, Monroe Co., Florida, USA.

In pine rockland habitat on Big Pine Key, Monroe Co., Florida, USA, a Wildgame© passive infrared camera was positioned near carcasses of three Key Deer (*Odocoileus virginianus clavium*) from 16–20 May 2011. As many as three iguanas were caught in a single image, and at least four different iguanas were recorded. The camera was set to 30-sec intervals and recorded 59 images of *I. iguana* and 20 images of *C. similis* between 0928 h and 1738 h. The longest feeding period recorded was >5 min (N = 2), and the shortest was <30 sec. *Cathartes aura*, *C. similis*, and *I. iguana* were recorded feeding together in multiple images (Fig. 1). Some images seemed to indicate that a large male *C. similis* was able to take possession of the carcass from *C. aura* for short periods. Biologists have noted high numbers of *I. iguana* at the deer carcass disposal site since at least 2009 but had not previously witnessed carrion feeding.

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DIPSOSAURUS CATALINENSIS **(Santa Catalina Island Desert Iguana). PREDATION.** Little information has been reported about the natural history of Santa Catalina Island Desert Iguana (Grismer 2002. Amphibians and Reptiles of Baja California, Including its Pacific Islands and the Islands in the Sea of Cortes. University of California Press, Berkeley and Los Angeles. 399 pp.). The rattlesnake *Crotalus catalinensis* has been reported as a predator of *D. catalinensis* (Avila-Villegas et al. 2007. Copeia 2007[1]:80–84), but to date, reports of avian predation have not been documented for this species. We report here evidence of bird predation on *Dipsosaurus catalinensis* by the Loggerhead Shrike (*Lanius ludovicianus*), which preys on a wide variety of vertebrates including reptiles (mainly lizards) (Lefranc 1997. Shrikes: A Guide to the Shrikes of the World. Yale University Press, New Haven and London. 192 pp.).

On 3 April 2011 at 1450 h, we saw a shrike fly past us with a lizard in its bill. It perched on an Adam's Tree (*Fouquieria diguetii*) at 1.55 m off the ground, on Santa Catalina Island, Gulf of California, Mexico (25.60536944°N, 110.7747917°W, datum WGS 84; elev. 13 m). As the bird settled, it pierced the iguana's dorsal skin with a thorn, leaving it hanging on the branch and still alive. As we approached, the shrike moved to another branch and then flew away. We removed the iguana and measured it after taking some photographs. The juvenile *D. catalinensis* measured 87 mm SVL and weighed 13 g. After the measurement the iguana was returned to the same branch as first positioned by the shrike. After we moved away several minutes later, the shrike came back and took the iguana elsewhere to continue consumption.

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GEKKO MONARCHUS **(Warty House Gecko). BIFURCATION.** *Gekko monarchus* is a large house gecko from Southeast Asia found primarily in southern Thailand, the Philippines, the Malay Peninsula, Borneo, Java, Sumatra, and Indonesia. It occupies forest edges as well as human habitations and has been known to nest communally, with over 50 eggs discovered in a single area (Das 2010. A Field Guide to the Reptiles of South-east Asia. New Holland Publishers, London. 376 pp.). Near an electric light on 1 August 2011 at 2330 h, we observed a small (~60 cm SVL) individual *G. monarchus* with a bifid tail on an interior support beam of a wooden longhouse structure near Batang Ai National Park in Sarawak, Borneo (1.159064°N, 111.925263°E). The tail was bifurcated for roughly 2 cm at the posterior end, with one tail tip roughly 0.5 cm longer than the other. Although we observed neither predation nor intraspecific agonistic interactions, many of the other individuals found on this and nearby structures were missing limbs or had regenerated or damaged tails.

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HELODERMA SUSPECTUM **(Gila Monster). INJURY FROM NON-NATIVE SEED.** The deserts of the southwestern U.S. have been invaded by a multitude of non-native species of grasses and noxious weeds. Their establishment has had significant ecological effects on the landscape, including increased fire regime, competition with native flora for water and growing space, as well as injurious effects on wildlife. Among these invasive species, Red Brome (*Bromus madritensis* ssp. *rubens*) has established itself throughout much of the Sonoran Desert. In Arizona, Red Brome typically occurs in soils of low to mid-elevation regions (300–2843 m) in arid and semi-arid desert scrub. It has several modes of seed dispersal, including wind, caching by ants and rodents, and attaching to mobile organisms with the sharp, pointed florets that develop when it senesces (Esque and Schwalbe 2002. *In* B. Tellman [ed.], Invasive Exotic Species in the Sonoran Region, pp. 165–194. University of Arizona Press, Tucson, Arizona). The latter trait has been known to injure herbivorous animals that feed on it and predatory animals that forage in stands of it (McCrary and Bloom 1984. J. Wildl. Manag. 48:1005–1008; Medica and Eckert 2007. Herpetol. Rev. 38:446–448). Here I present an observation of Red Brome having attached to a Gila Monster (*Heloderma suspectum suspectum*) in central Arizona, with obvious deleterious effects.

On 22 April 2011, at 1825 h, I (and another observer) encountered an adult *H. suspectum* as it walked in the open on a public trail in a canyon adjacent to Roosevelt Lake in Gila Co., Arizona, USA (33.69575°N, 111.18861°W, WGS 84). The trail was at the north end of the canyon at the base of an east-facing slope. Associated vegetation included Brittlebush (*Encelia farinosa*), Ocotillo (*Fouquieria splendens*), Jojoba (*Simmondsia chinensis*), Flat-top Buckwheat (*Eriogonum fasciculation*), palo verde (*Parkinsonia* sp.), Saguaro Cactus (*Cereus giganteus*), and Red Brome. As I approached the animal it became alert and assumed a defensive position. I observed a grass seed caught in the left eye, and upon capturing the animal for further examination, found that the grass seed was Red Brome. The sharp end of the floret was wedged in the anterior portion of the left eye and had caused severe inflammation, fluid drainage in the form of pus, and the eye partially swelling closed. I proceeded to remove the seed from its eye and released the lizard, after which it quickly retreated under a nearby Jojoba plant.

This incident demonstrates the potential injurious effects of Red Brome on native reptiles. Whether injury caused by Red Brome is a common occurrence in *H. suspectum* is unknown. However, similar instances have been documented in other large desert reptiles such as the (Mojave) Desert Tortoise (Medica and Eckert, *op. cit.*).

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HELODERMA SUSPECTUM **(Gila Monster). DIET.** *Heloderma suspectum* is a predatory lizard of the southwestern U.S. and adjacent northwestern Mexico that specializes in raiding the nests of lagomorphs, rodents, and ground-dwelling birds (reviewed by Beck 2005. Biology of Gila Monsters and Beaded Lizards. Univ. California Press, Los Angeles and Berkeley. 224 pp.). Though other reptiles have been recorded as prey items (Ortenburger and Ortenburger 1926. Proc. Oklahoma Acad. Sci. 6:101–121), predation on non-egg life stages is a somewhat uncommon occurrence in the literature. Additionally, hatchling birds and adult rodents are rarely seen in the dietary spectra of *H. suspectum* (Beck, *op. cit.*).

From 2004 to 2008 we conducted radio-telemetry on sympatric *H. suspectum*, *Crotalus cerberus*, *C. atrox*, and *C. molossus* at Tonto National Monument, Gila Co., Arizona, USA. The site is characterized by steep rocky slopes, bajadas, and dry washes with upland Sonoran desertscrub, with elevations ranging from 695–1230 m. We documented prey use through blunt dissection of scats opportunistically collected when an animal defecated (Quick et al. 2005. J. Herpetol. 39:304–307), as well as regurgitated meals.

Prey use was documented for three *H. suspectum* (two adults, one subadult) by scat analysis. Two scats were collected from two of the adults (one male, one female, both telemetered) and one scat was collected from the subadult (female, not telemetered). One occasion when the subadult female was recaptured, hairs were removed from her mouth and saved for analysis. Scat dissection/hair analysis revealed five types of prey consumed by the three individuals. The adult male had consumed *Peromyscus eremicus* (Cactus Mouse) and *Callipepla gambellii* (egg fragments and feathers); the adult female consumed *Sylvilagus audubonii* (Desert Cottontail) and an *Aspidoscelis* sp. (whiptail lizard); and the subadult female consumed *Eutamias dorsalis* (Cliff Chipmunk) (represented at separate times by both scat and the hairs in her mouth). In addition to the scat observations, two other feeding observations were made. The subadult female was observed feeding on cottontail pups in a burrow (number unknown) and a third adult (male, telemetered) regurgitated two cottontail pups during surgery while in captivity.

Because *H. suspectum* may consume several individual prey items in a single meal, especially when raiding nests, the number of individual prey items taken in a particular, single feeding event is unknown. Based on size and length of the chipmunk hairs analyzed, they were presumed to be adult hairs; however, because hairs were often damaged after gut passage, ontogenetic characteristics of some hairs may have been distorted. Given the typical nest raiding habits of this predator, the presence of adult mammal hair and feathers in the *H. suspectum* scats may be parental hairs and feathers associated with neonates in the nest. The presence of the *Aspidoscelis* sp. in the scat is unusual but has been previously documented once before (Ortenburger and Ortenburger, *op. cit.*). Based on previous inventories conducted at the Monument, the possible species of *Aspidoscelis* at the site are *A. tigris* (Tiger Whiptail), *A. sonorae* (Sonora Spotted Whiptail), and *A. flagellicauda* (Gila Spotted Whiptail; Albrecht et al. 2007. Vascular Plant and Vertebrate Inventory of Tonto National Monument. OFR 2007-1295. USGS, Southwest Biological Science Center, Sonoran Desert Research Station, Univ. Ariz., Tucson). A possibility for this prey item is opportunistic predation of a whiptail lizard cornered in a burrow (perhaps while it was sleeping) or the *Heloderma* scavenging a dead whiptail lizard.

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***HEMIDACTYLUS FRENATUS* (House Gecko). PREDATION.** On 28 April 2011 at 2015 h, we observed a Great-tailed Grackle (*Quiscalus mexicanus*) feeding on an adult *Hemidactylus frenatus* on the edge of a window of a house in Sanchez Magallanes, Tabasco, México (18.2888694°N, 93.8716167°W). The next day we made a second observation of a *Q. mexicanus* feeding on another *H. frenatus* at the same location at 0745 h.

This interaction is notable, given that *H. frenatus* is an invasive species native to Asia and the Indo-Pacific that has displaced native species in some regions (Case et al. 1999. Ecology 72:464–477; Cole et al. 2005. Biol. Conserv. 125:467–474). In México, this gecko typically inhabits tropical and subtropical regions, usually associated with urban areas. Knowledge regarding ecological interactions between *H. frenatus* and other species in this region is poor (Álvarez-Romero et al. 2005. *In* Vertebrados Superiores Exóticos en México: Diversidad, Distribución y Efectos Potenciales, pp. 1–5. Instituto de Ecología, Universidad Nacional Autónoma de México. Bases de datos SNIB-CONABIO. Proyecto U020. México. D.F.). This report contributes to the knowledge of ecological interactions of this invasive species and also serves as the first report of predation on *H. frenatus* by *Q. mexicanus*, an opportunistic feeder that is known to prey on lizards (Gurrola-Hidalgo et al. 2009. Acta Zool. Mex. [n.s.] 25:427–430).

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***HEMIDACTYLUS MABOUIA* (Tropical House Gecko). PREDATION.** This non-native lizard is broadly distributed throughout Brazil, occupying natural habitats despite commonly being associated with human settlements. Although relatively abundant in most regions, there is a considerable lack of information regarding its interactions with sympatric native species (Rocha and Anjos 2007. Braz. J. Biol. 67:485–491). Here we report predation on *Hemidactylus mabouia* (SVL = 133.9 mm) by a spider of the family Ctenidae (SVL = 20 mm).

At 1126 h on 20 October 2010, in the Museu de Biologia Mello Leitão, Santa Teresa municipality, Espírito Santo state, southeastern Brazil (19.5609°S, 40.3559°W; elev. 655 m), one of us (FAL) observed a ctenid spider on the wall of the Zoological Collection attached to and feeding on an adult of *H. mabouia*. The lizard was no longer alive. After minutes of observing the predation, FAL collected both specimens and transferred them to a small plastic container, where the spider remained attached to the lizards for two days.

Generally due to predation, non-native species have been considered the second most influential factor threatening biodiversity (McNeely et al. 2001. A Global Strategy on Invasive Alien Species. IUCN Gland. Switzerland and Cambridge UK. 50 pp.). This report adds to the literature that non-native species also play a role as prey for native species.

Fig. 1. Ctenid spider feeding on a *Hemidactylus mabouia*, in Santa Teresa, Espírito Santo, southeastern Brazil.

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***IGUANA DELICATISSIMA* (Lesser Antillean Iguana). ECTOPARASITISM.** *Iguana delicatissima* is a large, long-lived (up to 25 yrs) herbivorous generalist inhabiting less than 10 main islands in the Lesser Antilles from Anguilla to Martinique. *Iguana delicatissima* is primarily arboreal except on extreme xeric islands with limited tree diversity. Its historic range has been reduced dramatically because of habitat loss, non-native predators and competitors, hunting, road mortality, and genetic introgression with *I. iguana*. Consequently, *I. delicatissima* is listed as Endangered by the IUCN – the World Conservation Union (IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>. 13 June 2011).

Here we provide the first report of parasitism on *I. delicatissima* by the scale mite, *Hirstiella stamii* (Acariformes: Pterygosomatidae). To our knowledge, this is only the second ectoparasite (Kohls 1969. J. Med. Entomol. 6:439–442) reported for the species. From April to September 2009, and from April to June 2010, we captured and recorded body measurements from 906 subadult and adult *I. delicatissima* inhabiting the island of Dominica, West Indies. We also documented the presence of white, scale-like patches on the heads and dewlaps of 170 (18.8%) iguanas. Parasitized iguanas ranged in SVL from 16.3–36.3 cm (mean = 27.4, SD = 4.1), and body mass from 150–2050 g (mean = 928.3, SD = 347.5). Patches ranged in diameter from 2–10 mm and were located typically on the subocular, postocular, temporal, nasal, and/or canthal scales (Fig. 1). Patches also were located dorsally on the head in the region of the frontal, parietal, and/or interparietal scales. In five occurrences, patches were recorded on the dewlap. Voucher mite specimens are housed at the Museum of Biological Diversity, The Ohio State University with accession numbers OSAL0102567–70 (females), OSAL0102571 (male), and OSAL0102572–74 (larvae).

This is the first report of *I. delicatissima* parasitized by *H. stamii*. The mite was recorded previously from captive *I. iguana* at the Amsterdam Zoological Gardens in the Netherlands (Jack 1961. Ann. Mag. Nat. Hist. 13:305–314) and from non-native, wild-caught *I. iguana* in Florida, United States (Corn et al. 2011. J. Med. Entomol. 48:94–100).

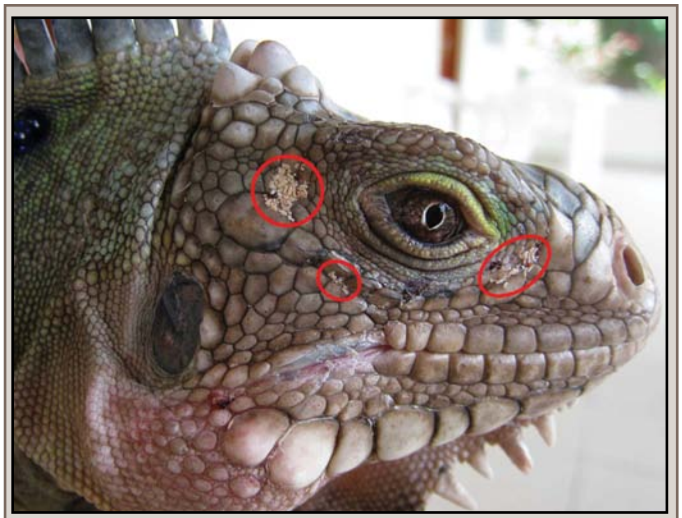

Fig. 1. Example of site attachment by the scale mite, *Hirstiella stamii*, on the head of *Iguana delicatissima* inhabiting the island of Dominica, West Indies. Patches circled in red.

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***IGUANA IGUANA* (Green Iguana). PREDATION.** Double-toothed Kites (*Harpagus bidentatus*) are known to eat lizards, including juvenile *Iguana iguana* (Greene et al. 1978. J. Herpetol. 12:169–176). Double-Toothed Kites often forage by following monkeys (Egler 1991. Wilson Bull. 103:510–512; Fontaine 1980. Auk 97:94–98), capturing prey that the monkeys have flushed out of the brush by their movements. We did not find any reports of these kites taking prey directly from primates.

On 13 June 2011 at 1110 h, we captured two hatchling iguanas on the south edge of Bohio Reach, Panama Canal, Barro Colorado Natural Monument, Panamá (9.191111°N, 79.846111°W). Hatchlings were <0.25 m off the ground and 0.5 m apart in a patch of Canal Grass (*Saccharum spontaneum*) ca. 0.5 m from the water's edge. Each of us held one hatchling as we processed them in our boat (ca. 3 m from site of capture). During processing, we observed a Double-toothed Kite swoop from a tree ca. 4 m from us, appearing to watch our activity. The kite was initially perched ca. 6 m in a tree and swooped to a branch 2 m off the ground, loudly rustling the leaves. Upon attempting to release the first iguana (72 mm SVL, 11.4 g) onto a rock 3 m from the grass, it ran back into the lap of BAW. Thereafter, BAW walked the iguana to the grass to release it, during which time the kite flew toward his hand, hitting his hand with its wing, and directly snatching the iguana with its talons in a quick motion. The kite flew into nearby trees and out of sight with the iguana in its talons.

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***LANKASCINCUS FALLAX* (Peters' Litter Skink). REPRODUCTION.** *Lankascincus fallax* is a subfossorial skink endemic to Sri Lanka (Somaweera and Somaweera 2009. Lizards of Sri Lanka, A Colour Guide with Field Keys. Edition Chimaira, Frankfurt am Main. 303 pp.). The purpose of this note is to present information on the reproductive biology of *L. fallax*.

Thirty-one *L. fallax* (15 males, mean SVL = 39.3 mm ± 2.2 SD, range = 36–45 mm; 16 females, mean SVL = 39.1 mm ± 2.4 SD, range = 35–43 mm) were examined from the following localities: Central Province (7.2631°N, 80.6028°E), CCA (= Christopher C. Austin, field number) 1745, 2361, 2362, 2368, 2383, 2407–2411, 2413, 2416–2418, 2422–2424, 2448, 2453; North Central Province (8.3500°N, 80.3833°E), CCA 2375–2377, 2386, 2387, 2391, 2392; North Western Province (7.7500°N, 80.1667°E), CCA 2425, 2426; Sabaragamuwa Province (6.7500°N, 80.5000°E), CCA 2445; Southern Province (7.9500°N, 80.7500°E), CCA 2452; Western Province (7.1807°N, 79.8841°E), CCA 2359. *Lankascincus fallax* were collected in August 1999 and November 2002 and were deposited in the herpetology collection of the National Museum of Sri Lanka, Colombo, Sri Lanka.

For histological examination, the left gonad was removed to check for yolk deposition in females and spermiogenesis (sperm formation) in males. Counts were made of enlarged ovarian follicles (3 mm diameter) or oviductal eggs. Tissues were embedded in paraffin, sectioned at 5 µm using a rotary microtome and stained with hematoxylin followed by eosin counterstain.

All males of *L. fallax* were from November and were undergoing spermiogenesis. The smallest spermiogenic male measured 36 mm SVL (CCA 2413). Fifteen females of *L. fallax* were from November, one was from August. All were reproductively active, with 13 containing oviductal eggs and two containing enlarged follicles (> 4 mm). Mean clutch size for fifteen females was 1.8 ± 0.44, range: 1–2. Three females with two oviductal eggs, each (CCA 2383, 2387, 2391) were undergoing concomitant yolk deposition for a subsequent clutch indicating *L. fallax* produces multiple clutches annually. The smallest reproductively active female *L. fallax* measured 35 mm SVL (two oviductal eggs, CCA 2453).

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***LEPIDODACTYLUS LUGUBRIS* (Mourning Gecko). FORAGING MOVEMENT.** *Lepidodactylus lugubris* is a small (45 mm) gecko native to Indo-Australia. The species has been widely introduced in tropical areas throughout the world, including the Bocas del Toro islands of the Republic of Panama. This species is predominantly a nocturnal insectivore. However, individuals are known to supplement their diet with nectar and ripe fruit, and have been observed to forego insects when feeding on nectar (Perry and Ritter 1999. Herpetol. Rev. 30:166–167). They have also been documented to change their typical behavior to gain access to sugar sources (McCoid and Hensley 1993. Herpetol. Rev. 22:8–9). Thus, sugar and nectar may serve as a behaviorally influential dietary resource for this species.

A small population of *L. lugubris* located on Isla Coln at the Bocas Del Toro Biological Station in the Republic of Panama was noted to undergo mass concerted movements at dusk from their daytime retreat within a building to a nearby *Morinda citrifolia* tree. Within the tree, individuals were observed consuming excretions from the pores of the fruit, as well as nectar from the flowers. After initial observation, I removed all vegetation in contact with the building that was originating from, or in the vicinity of, the *M. citrifolia* tree. In place of the vegetation, I constructed a series of four rope bridges (diameter: 3.2 mm) that served to ensure access to the tree was limited to crossing the rope bridge. One rope bridge connected a building beam to the shortened *M. citrifolia* branch at their previous point of tree entry. The other three bridges were connected to nearby vegetation lacking fruit or flowers to ensure movement was non-random. The same building beam was connected to a mango tree (*Mangifera indica*) and to two independent, unidentified woody shrubs. After the first two nights it became apparent that geckos were only using the bridge connected to *M. citrifolia*, so additional bridges were not monitored on subsequent nights. Due to the diameter of the rope, individuals were only able to cross single-file, simplifying quantification. I recorded their movements across the *M. citrifolia* rope bridge at dusk for six days from the period of 30 June to 7 July 2005 (1830–2030 h) and from 0530–0630 h on 8 July 2005. Crossing individuals were marked on their back with a water-based, non-toxic permanent paint marker, similar to DECOCOLOR® paint markers. The number of marked and unmarked individuals was recorded each night.

The majority of movement occurred during or immediately after dusk. Movements after that period were less frequent and greatly interspersed. Over a standardized period of two hours following dusk, a mean of 39 (range: 35–54) geckos were observed to cross to the *M. citrifolia* each night. With the exception of the first night when all individuals were new to the altered pathway, approximately half of the individuals recorded crossing each night were unmarked. This suggests that individuals readily adapt behavior to gain access to foraging resources, and do not forage in the tree every night. On the morning of 8 July 2005, 69 individuals returned. I also observed marked individuals up to 12.49 m straight line distance from the crossing point, feeding under building lights in concert with *Hemidactylus frenatus* (House Gecko; native to southeastern Asia, widely introduced elsewhere). No *H. frenatus* individuals were observed to cross into the *M. citrifolia* tree.

The distance I observed marked individuals from the *M. citrifolia* crossing point suggests geckos were willing to move over a considerable distance of open space to gain access to nectar, and that nectar is an important food source for this population. Petren and Case (1998. Proc. Natl. Acad. Sci. 95:11739–11744) found that increasing topographic complexity of foraging areas drastically reduced competition between *L. lugubris* and *H. frenatus*. The presence of *H. frenatus* at the structurally simple insect feeding stations used by *L. lugubris* and their absence at the structurally complex *M. citrifolia* may indicate the observed phenomenon is one strategy used by *L. lugubris* to reduce interspecific competitive interactions.

I am grateful to Dr. Tom Jones and the owners of the Bocas Del Toro Biological Station restaurant for their contributions to this study.

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***LIOLAEMUS ESPINOZAI*. PREDATION.** *Liolaemus espinozai* has only been recently described and little is known about its natural history. It is found southeast of the Nevados del Aconquija in Catamarca province, Argentina, 2200–2800 m elev. (Abdala 2005.

Fig. 1. *Philodryas psammophidea* seizing a *Liolaemus espinozai* just below the neck.

Rev. Esp. Herpetol. 19:5–17). It is a medium-sized lizard (approx. 60 mm SVL). The colubrid *Philodryas psammophidea* occurs within the distribution of *L. espinozai* and is known to feed on lizards (Scrocchi et al. 2006. Serpientes del Noroeste Argentino. Miscelanea, Fundación Miguel Lillo. 174 pp.). Here we report on an occurrence of predation by this snake on *L. espinozai*.

On 18 February 2005, at ca. 1700 h, in Campo el Arenal, Catamarca (27.21°S, 66.23°W, datum WGS84; 2858 m elev.), an adult female *L. espinozai* was seen moving towards a shrub, perhaps responding to the presence of the observers. A *Philodryas psammophidea* happened to be in the aforementioned shrub. It immediately attacked the lizard, grasping it by the side of the body (Fig. 1). The lizard bit the snake on the side of its neck, a defensive response that might sometimes be effective as an antipredator mechanism (e.g., Leal and Rodríguez-Robles 1995. Copeia 1995:155–161). The snake slightly constricted the lizard, a technique many colubrids use to overcome larger prey (Zug 1993. Herpetology: An Introductory Biology of Amphibians and Reptiles. Academic Press, San Diego, California. 527 pp.). Later the snake located the lizard's head and ingested it headfirst.

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***MESALINA GUTTULATA* (Desert Lacerta). ENDOPARASITES.** *Mesalina guttulata* occurs in North Africa from Western Sahara to Egypt, Sinai, Israel, Jordan, Syria, Iraq, Saudi Arabia, W Yemen, Niger, and Eritrea (Sindaco and Jeremcenko 2008. The Reptiles of the Western Palearctic. Monografie della Societas Herpetologica Italica – I, Latina, Italy. 579 pp.). To our knowledge there are no records of helminths from *M. guttulata* and this note's purpose is to establish the initial helminth list for *M. guttulata*.

A sample of 78 *M. guttulata* (mean SVL = 42.9 mm ± 5.2 SD, range = 30–54 mm) collected 1949 to 2007 from Israel was borrowed from the Natural History Collections, Tel-Aviv University, (TAUM) Tel-Aviv, Israel for coelomic helminth examination. The body cavity was opened and examined for helminths. Four *M. guttulata* (TAUM 2979, 4004, 8468, 13172) collected in the Southern District, Israel, contained macroscopically visible, oblong, whitish bodies, of ca. 1 mm in length. They were regressively stained in hematoxylin, cleared in xylol, mounted in balsam on a glass slide, coverslipped, examined under a compound microscope and identified as larval cestodes, tetrathyridea of *Mesocestoides* sp. Prevalence (number infected/number examined × 100) was 5.1%. Mean intensity (mean number helminths per infected lizard ± 1 SD) was 32.8 ± 19.1 SD, range = 10–56. Vouchers were deposited in the United States National Parasite Museum (USNPC), Beltsville, Maryland as USNPC (104866, 104867).

Mesocestoides is a cosmopolitan genus with a unique larval form, the tetrathyridium; reptiles are common intermediate hosts in what is thought to be a three-host life cycle (Padgett and Boyce 2005. J. Helminthol. 79:67–73). A list of amphibian and reptile hosts for *Mesocestoides* spp. is in Goldberg et al. (2004. Comp. Parasitol. 71:49–60). *Mesalina guttulata* represents a new host record for tetrathyridea of *Mesocestoides* sp.

We thank Shai Meiri (TAUM*)* for permission to examine *M. guttulata* and Erez Maza (TAUM) for processing the loan.

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***PHELSUMA GRANDIS* (Madagascar Day Gecko). PREY.** *Phelsuma grandis* is native to northern Madagascar (Henkel and Schmidt 2000. Amphibians and Reptiles of Madagascar and the Mascarene, Seychelles, and the Comoro Islands. Krieger Publ. Co., Malabar, Florida. 319 pp.), and has been introduced to at least nine islands in the Florida Keys (Krysko and Hooper 2007. Gekko 5:33–38; Krysko and Sheehy 2005. Carib. J. Sci.

Fig. 1. Nonindigenous *Phelsuma grandis* preying upon a nonindigenous Bark Anole (*Anolis distichus*) on Ramrod Key, Monroe County, Florida.

41:169–172). *Phelsuma grandis* is known to consume mostly nectar, pollen, and arthropods (Demeter 1976. Internat. Zoo Yearbk. 16:130–133; Krysko and Hooper, *op. cit.*; Tytle 1992. Vivarium 2:15–19), but has also been documented consuming lizards such as neonate *P. grandis* (Krysko et al. 2003. Florida Sci. 66:222–225). In this note, we report *P. grandis* preying upon a nonindigenous Bark Anole (*Anolis distichus*) in Florida.

On 5 July 2011 at 1930 h, we observed an adult female *Phelsuma grandis* near the junction of West Indies Drive and Cayman Lane, Ramrod Key, Monroe Co., Florida, USA (24.65154°N, 81.40447°W, WGS84; elev. <1 m). This gecko was about 1.8 m above ground on a nonindigenous Umbrella Tree (*Schefflera actinophylla*) and had an adult female *Anolis distichus* in its mouth. We quickly took photographs with an 8 MP camera phone (Florida Museum of Natural History, photographic voucher UF 165521; Fig. 1), but after returning about 3 min later with other photographic equipment both lizards were gone. This is the first known record of this nonindigenous gecko preying upon a nonindigenous anole in Florida.

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PHOLIDOBOLUS MONTIUM **(Lagartija Minadora). PREDATION.** *Pholidobolus montium* is a gymnopthalmid lizard known from interandean basins and valleys in northern and central Ecuador (Provincias Imbabura, Pichincha, Cotopaxi) and southern Colombia at elevations between 2000–3190 m (Montanucci 1973. Misc. Publ. Univ. Kansas Mus. Nat. Hist. 59:1–52; Reeder 1996. Herpetologica 52:282–289). Here we provide the first report on natural predators of this species.

On 10 April 2009, FAV collected a subadult female *Liophis epinephelus albiventris* (SVL = 221.0 mm, TL = 64.0 mm; QCAZ 8044) in Ecuador, Pichincha Province, Tababela (0.11362°S, 78.36331°W, 2374 m elev.), which had recently eaten. A few minutes after capture, the snake regurgitated two prey items: a full specimen of *Pholidobolus montium* (SVL = 47.5 mm; QCAZ 10064) and a hindlimb of the marsupial frog *Gastrotheca riobambae*. On 16 May 2009 at 1100 h in Tababela (0.0986395°S, 78.36936°W, 2346 m elev.), FAV observed a predation event in which a juvenile male specimen of the snake *Mastigodryas* *pulchriceps* (SVL = 218.0 mm, TL = 80.0 mm; QCAZ 8045) was found ingesting a specimen of *P. montium* (QCAZ 8046, SVL = mm). First, the snake grasped the lizard with its mouth (Fig. 1). Then the snake ingested the lizard starting at the posterior region of the body. The same predatory behavior has been reported for *Mastigodryas melanolomus* (Dehling 2009. Herpetol. Rev. 40:357). This is the first record of predation of *Pholidobolus montium* by *L. e. albiventris* and *M. pulchriceps*. The snakes and the lizards are deposited in the herpetological Collection of Museo de Zoología QCAZ, Pontificia Universidad Católica del Ecuador.

Fig. 1. Predation of *Pholidobolus montium* by *Mastigodryas pulchriceps.*

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PHRYNOSOMA MODESTUM **(Round-tailed Horned Lizard). PREDATION.** *Phrynosoma modestum* occurs from extreme southeastern Colorado and western Oklahoma to western Texas, southern New Mexico (USA), and then south through Chihuahua, Coahuila, Zacatecas, and San Luis Potosi (Mexico) (Espinal and Smith 2007. Amphibians and Reptiles of the State of Coahuila, Mexico. Universidad Nacional Autónoma de México and Comisión Nacional Para El Conocimiento y Uso de la Biodiversidad. 550 pp.; Hodges 2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest, pp. 186–189. Rio Nuevo Publ., Tucson, Arizona; Sherbrooke 2003. Introduction to the Horned Lizards of North America. University of California Press, Berkeley, California. 178 pp.). Tarantulas of the genus *Aphonopelma* (consisting of approximately 87 species that inhabit North America) are documented predators. Along with other genera of the subfamily Theraphosinae, the majority of the species are found in North America. Fifty-one species have been reported for the United States and 24 or 25 for Mexico (Smith 1995. Tarantula Spiders: Tarantulas of the U.S.A. and Mexico. Fitzgerald Publ., London. 196 pp.). Predation on *P. modestum* has been documented by Sherbrooke (2003, *op. cit.*; 2010 Herpetol. Rev. 41:356) and Hodges (2009, *op. cit.*), who mention that the species is predated by collared lizards (*Crotaphytus* spp.), Greater Roadrunners (*Geococcyx californianus*), Loggerhead Shrikes (*Lanius ludovicianus*), and grasshopper mice (*Onychomys* spp.).

While conducting a survey on 22 July 2011 on the araneofauna of the Bolson of Cuatro Cienegas Region, Coahuila, Mexico,

Fig. 1. A female *Aphonopelma* sp. preying on a female *Phrynosoma modestum*, in the valley of Cuatro Cienegas, Coahuila, Mexico.

near El Mezquite (26.92268°N, 102.43409°W, datum NAD27; 1030 m elev.), we came across a female *Aphonopelma* sp. (55.20 mm TL, 19.64 mm median length of the carapace) at 1745 h that had immobilized a female *Phrynosoma modestum* (SVL = 84.44 mm; TL = 154.53 mm). As we approached the tarantula, after taking a series of photos, it released the horned lizard. Inspecting the lizard carefully, we found no sign of puncture holes on the head or any other part of the body, but it appeared that a great quantity of blood had come from the left eye. After measuring the lizard we released it *in situ*, and it appeared to move with some difficulty, perhaps from the trauma of the event. The tarantula was collected for future behavioral studies (CAFCB-UANL-T500). At present the species has not been identified. This event occurred about 40 cm from a burrow (ca. 11.5 cm diam), which it may have occupied.

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PLESTIODON FASCIATUS **(Five-lined Skink). HIBERNATION.** Few published observations of hibernation or hibernacula are available for *Plestiodon fasciatus* (COSEWIC 2007. COSEWIC Assessment and Update Status Report on the Five-lined Skink *Eumeces fasciatus* (Carolinian Population and Great Lakes/St. Lawrence Population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 50 pp. [www.sararegistry.gc.ca/status/status_e.cfm]). At ca. 1000 h on 7 March 2011 at Point Pelee National Park (41.93148°N, 82.51252°W; WGS 84) in Essex County, Ontario, Canada, a skink was unearthed by a backhoe 34 m ESE of the Visitor Centre in an open area of deciduous forest during an archaeological inspection before septic tank installation. The field crew present (G. Almasi, D. Dawdy, J. Goundry, M. Teal, D. Kipping, S. Hossain, and A. Miller) notified park resources staff. The lone adult male *P. fasciatus* (70 mm SVL, 150 mm TL) was found ca. 23 cm deep in loamy sand soil that was under ca. 10 cm of snow. Ground frost penetration was ca. 8–10 cm in the vicinity but soil appeared unfrozen at the spot where the skink was observed. No stumps, logs, or large roots were present but a cedar stump was about 2.4 m from the skink. There was no sign of obvious tunneling by the skink. Ambient conditions were sunny (temp: -5°C; wind: NE 7 km/h; RH: 79%). The specimen appeared in good condition but was torpid upon capture. Slight movements and partial eyelid opening occurred during handling and photographing the specimen and it remained lethargic for the first two days of holding indoors. The specimen became fully active after about 5 days and was maintained on a cricket diet until being released on 28 April in healthy condition after annual skink activity resumed. Skink hibernacula have not been observed in the park but in several previous years we observed single or small numbers of individuals on the first day of annual activity adjacent to skink-sized holes under woody debris in sandy soils within their home ranges. Similar observations were reported from Kansas (Fitch 1954. Univ. Kansas Publ. Mus. Nat. Hist. 8:1–156). Skinks have also entered the Visitor Centre building during previous winters. Some literature has noted Five-lined Skinks hibernating alone, in pairs, or with small groups of other lizards, in or under logs, stumps, sawdust or debris piles, ground litter, mammal burrows, building foundations, under rocks, or within rock crevices (Conant 1951. Am. Midl. Nat. 20:1–200; Fitch 1954, *op. cit.*; Hamilton 1948. Copeia 1948:211; Harding 1997. Amphibians and Reptiles of the Great Lakes Region. Univ. Michigan Press, p. 231; Linsdale 1927. Copeia 1927:75–81; Neill 1948. Herpetologica 4:107–114) but few details have been published. Tihen (1937. Trans. Kansas Acad. Sci. 40:401–409) reported two *P. fasciatus* hibernating 2.5 m underground in Kansas. Point Pelee is a natural sandspit in Lake Erie so skinks must overwinter below the frost line but above the shallow and fluctuating water table where late winter–early spring flood mortality has occurred in communal snake hibernacula (T. Linke, unpubl. park records). Our note adds to the existing literature and provides the first report of overwintering conditions for the endangered Carolinian population of *P. fasciatus* in southwestern Ontario and for the northern portion of its range.

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PLESTIODON FASCIATUS **(Common Five-lined Skink). BIFURCATION.** *Plestiodon fasciatus* is the only lizard species in Michigan known to occur outside of Tuscola County, and is relatively abundant throughout the Lower Peninsula (Harding 1997. Amphibians and Reptiles of the Great Lakes Region. University of Michigan Press, Ann Arbor. 378 pp.). On 11 July 2011 at 1000 h we observed an adult with a bifurcated (bifid) tail under a pine log in Northern Midland County (43.68073°N, 84.29604°W). The tail was bifurcated somewhat vertically at the posterior end, and appeared to have been lost and regrown at least once prior to the splitting event. The dorsal fork was longer than the ventral fork. A non-lethal tissue sample with accession number FTB2749 was collected under a permit to ADM from the Michigan Department of Natural Resources and Environment and deposited in the Burbrink genetic resources collection at College of Staten Island, Staten Island, New York.

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PLESTIODON LATICEPS **(Broad-headed Skink). HERBIVORY.** *Plestiodon laticeps* is a common and widespread North American skink that, like most members of its genus, is generally regarded as a strict carnivore (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Univ. Agric. Exp. Sta., Auburn, Alabama. 347 pp.; Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. Univ. Georgia Press, Athens. 575 pp.). At 1400 h on 29 May 2011, I observed herbivory by a free-ranging adult male in a partially wooded section of my backyard, which is situated in a large-lot residential subdivision that supports a substantial skink population in Tallahassee, Leon Co., Florida, USA (30.48341°N, 84.18301°W; datum NAD83; elev. 40 m). Observations were made in light shade at an air temperature of 32°C. Five minutes after leaving a ripe strawberry and canned dog food in front of a captive adult female Florida Box Turtle (*Terrapene bauri*: Butler et al. 2011. Biol. J. Linn. Soc. 102:889–901), I returned to see the skink grasping the strawberry, which was at least as large as his head, directly beneath the turtle's mouth. Upon observing me, he carried the berry 1 m to feed on it beneath an azalea bush on the opposite side of a chain link fence, where I observed him for 15 minutes. During feeding, he repeatedly jerked his head and upper body to remove bites of strawberry, which he swallowed. No animal life was present on the berry. When I moved to within 1 m, the skink carried the remaining berry 75 cm to another spot, where he finished swallowing it, including the top rosette of greenery.

Although many other skinks regularly include some plant food in their diets (Cooper and Vitt 2002. J. Zool., Lond. 257:487–517; Sazima et al. 2005. Biota Neotrop. 5:185–192), this may be only the second report of herbivory in the monophyletic clade of East Asian and North American skinks recognized as *Plestiodon* by Brandley et al. (2005. Syst. Biol. 54:373–390). Cooper and Vitt (*op. cit.*) mentioned that *P. laticeps* sometimes eats grapes and berries in the field but offered no supporting data. These observations are perhaps not surprising given the association of large body size with herbivory and omnivory in lizards (Cooper and Vitt, *ibid.*). *P. laticeps* is among the largest members of its clade. Thus, plant matter potentially may form a larger portion of its diet than traditionally realized. Whether it responds to plant chemicals, a trait generally typical of herbivorous but not insectivorous lizards (Cooper et al. 2000. J. Chem. Ecol. 26:1623–1634), would be especially noteworthy.

I am indebted to John Iverson for facilitating a literature review of lizard herbivory.

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***PODARCIS HISPANICA* (Iberian Wall Lizard). CAUDOPHAGY.** On 23 February 2011 at 1320 h, while conducting field sampling in a rocky area close to Nava de Francia (Salamanca, Spain), we observed a male *Podarcis hispanica* eating the tail from a conspecific. We immediately started to video record this behavior for the next 1 min. and 32 sec. The video shows that the tail was extending about 17 mm out of the mouth of the lizard, and that the individual was trying to swallow it by rubbing the tail against the surface of a granite rock. The lizard moved forward ca. 40 cm and performed repeated movements during the whole process, probably to help in swallowing the tail: 1) The lizard rubbed the left side of the head against the rock 17 times and the right side four times. Of the left-side movements, 13 of them had an associated head rotation that made them more abrupt and vigorous; 2) the lizard made what appeared to be swallowing motions (raising the snout and pulling the head back) 23 times; 3) the lizard moved the head up and down on 7 occasions and side-to-side for at least 3 times (see Hews and Dickhaut 1989. Herpetol. Rev. 20:71 for a description of a similar movement); 4) the lizard opened and closed the mouth at least 12 times. The individual continued to bask in open sun, alternating between the described behaviors and returning to its basking position five separate times. The lizard kept its snout in contact with the rock for at least 45 sec., rubbing it on the substrate, and even might have used its right forelimb at least twice to facilitate ingestion of the tail.

We captured the lizard (47 mm SVL; 2 g) at 1342 h and it had swallowed almost the entire tail, with only 7 mm protruding from the mouth, compared with more than 17 mm protrusion detected at the beginning of the process. The lizard had a non-regenerated tail that was 92 mm long. The tail consumed was 48 mm long, likely from an adult. The lizard was released to the field immediately after measurement.

The contents of several stomachs from mainland *Podarcis hispanica* have been analyzed (Pérez-Mellado 1983. Studia Oecologica 4:89–114; Pérez-Mellado 1998. Fauna Ibérica 10:258–272) and conspecific remains were absent. Hence, this is the first record of conspecific caudophagy by *Podarcis hispanica*.

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***QUEDENFELDTIA TRACHYBLEPHARUS* (Atlas Day Gecko). ENDOPARASITES.** *Quedenfeldtia trachyblepharus* is known from the Atlas Mountains of Morocco where it inhabits rock faces and boulders from 0–4000 m (Schleich et al. 1996. Amphibians and Reptiles of North Africa. Koeltz Sci. Publ., Koenigstein, Germany. 630 pp.). To our knowledge there are no helminths known from *Q. trachyblepharus*. The purpose of this note is to establish the initial helminth list for *Q. trachyblepharus*.

A sample of 69 *Q. trachyblepharis* (mean SVL = 38.7 mm ± 3.5 SD, range = 31–46 mm) collected in May 1974 at Igrherm, Taroudant Province, Souss-Massa Draa Region, Morocco (30.06250°N, 8.40833°W, datum WGS 84; elev 1600–1700 m) was borrowed from the herpetology collection of the Field Museum of Natural History (FMNH) for coelomic helminth examination. The body cavity was opened and examined for helminths. Two *Q. trachyblepharus* (FMNH 197642, 197718) contained 22 and 49 macroscopically visible, oblong, whitish bodies ca. 1 mm in length. One (FMNH 197652) contained fragments of a cestode protruding from the broken small intestine. Helminths were regressively stained in hematoxylin, cleared in xylol, mounted on a glass slide, coverslipped, examined under a compound microscope and identified as larval cestodes, tetrathyridea of *Mesocestoides* sp. (FMNH 197642, 197718). Prevalence (number infected/number examined ×100) was 3.0%. Mean intensity (mean number helminths per infected lizard ± 1 SD) was 35.5 ± 19.1). Found in FMNH 197652 were proglottids of an adult cestode consistent with *Oochoristica*. Voucher helminth specimens were deposited in FMNH.

Mesocestoides is a cosmopolitan genus with a unique larval form, the tetrathyridium; reptiles are common intermediate hosts in what is thought to be a three-host life cycle (Padgett and Boyce 2005. J. Helminthol. 79:67–73). A list of amphibian and reptile hosts for *Mesocestoides* spp. is in Goldberg et al. (2004. Comp. Parasitol. 71:49–60). Regarding the *Oochoristica* sp., the scolex was not present so species identification was not possible but ovary morphology was most similar to *O. chabaudi* described from *Chalcides mionecton* from Morocco by Dolfuss (1954. Arch. Inst. Pasteur Maroc. 4:654–714.). *Quedenfeldtia trachyblepharus* represents a new host record for *Mesocestoides* sp. and has not been previously reported for a species of *Oochoristica*.

We thank Alan Resetar (FMNH) for permission to examine *Q. trachyblepharis*.

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SCELOPORUS MARMORATUS **(Northern Rose-bellied Lizard). KYPHOSIS AND SCOLIOSIS.** Kyphosis and scoliosis is occasionally seen in green iguanas and other lizards and these malformations can result from genetic defects, malnutrition or improper environmental conditions during incubation, primarily by temperature levels that are too high or too low for some or all of the incubation clutch (Mader 1996. Reptile Medicine and Surgery. W.B. Saunders Co., Philadelphia, Pennsylvania. 512 pp.). A case with both kyphosis and scoliosis in sceloporine lizards has been recently reported (Mitchell and Georgel 2005. Herpetol. Rev. 36:183–184).

On 15 September 2010, we collected a female *Sceloporus marmoratus* (SVL = 28 mm SVL; tail length = 39 mm; 0.91 g) active on soil litter in submontano scrubland in the federal natural protected area Cerro de La Silla in the municipality of Juarez, Nuevo Leon, Mexico (25.589861°N, 100.168306°W, datum WGS84; 531 m elev.). The lizard exhibited two vertical curvatures of the spine (kyphosis), one behind the head in the pectoral region and one over the pelvic girdle. In addition, the detached tail had four, alternating lateral curves (scoliosis). Apparently, these malformations do not appear to decrease the probability of survival of lizards (Frutos et al. 2006. Herpetol Rev. 37:468–469; Mitchell and Georgel, *op. cit.*; Norval et al. 2010. Herpetol. Rev. 41:224–225). The lizard was deposited in the herpetological collection of the Universidad Autónoma de Nuevo León, Facultad de Ciencias Biológicas (UANL 7250). To our knowledge, this is the first reported occurrence of these conditions in *S. marmoratus* in the wild.

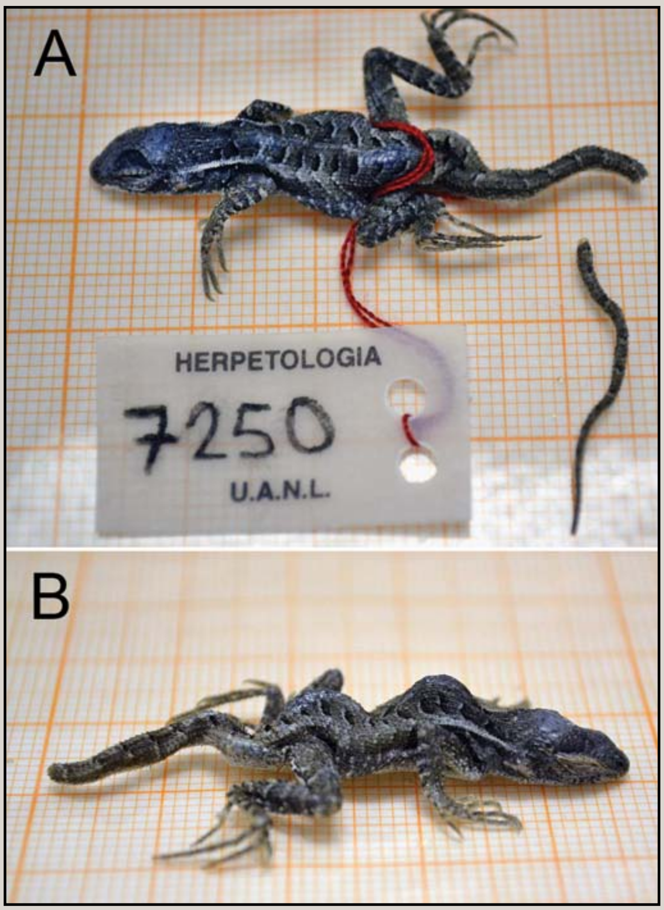

Fig. 1. Juvenile female *Sceloporus marmoratus* illustrating multiple kyphosis and scoliosis. A) Dorsal view with detached tail. B) Lateral view.

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SCELOPORUS SMARAGDINUS **(Bocourt's Emerald Lizard),** ***SCELOPORUS TAENIOCNEMIS*** **(Guatemalan Spiny Lizard). ENDOPARASITES.** Both *Sceloporus smaragdinus* and *S. taeniocnemis* occur in southeastern Mexico (Chiapas) and Guatemala in pine and cloud forests; *S. smaragdinus* at 2000–4000 m elev.; *S. taeniocnemis* at 1200–2500 m elev. (Köhler 2003. Reptiles of Central America. Herpeton, Offenbach, Germany. 367 pp.). The purpose of this note is to establish the initial helminth lists for *S. smaragdinus* and *S. taeniocnemis*.

Specimens of the two species collected in Guatemala were borrowed from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), California, USA, and examined for helminths: one male *Sceloporus smaragdinus* (LACM 39871; SVL = 61.0 mm; Huehuetenango Department, Chemal, April 1968; 15.5500°N, 91.5000°W WGS 84, 3288 m elev.); and three *S. taeniocnemis* (LACM 40285–40287; 2 females, 1 male, mean SVL = 73.7 mm ± 4.2 SD; range = 69–77 mm; Huehuetenango Department, Barillas, April 1968; 15.8036°N, 91.3158°W WGS 84, 1554 m elev.).

The digestive tract was removed and opened. One species of Nematoda was found in the large intestines of all specimens, cleared in a drop of glycerol on a microscope slide, coverslipped, studied under a compound microscope, and identified as *Spauligodon oxkutzcabiensis*. In *S. taeniocnemis*, prevalence (number infected lizards/lizard sample × 100) was 100% (3/3); mean intensity of infection (mean number of helminths per infected lizard ± SD) was 9.3 ± 10.2 SD, range = 2–21. For *S. smaragdinus*; prevalence was 100% (1/1). Selected specimens of *Spauligodon oxkutzcabiensis* were deposited in the United States National Parasite Collection, Beltsville, Maryland, USA as *Sceloporus smaragdinus*: USNPC 104832; *S. taeniocnemis*: USNPC 104833.

Spauligodon oxkutzcabiensis, an oxyurid nematode, does not utilize an intermediate host (Anderson 2000. Nematode Parasites of Vertebrates: their Development and Transmission. CABI Publishing, Oxon, U.K. 650 pp.). Infection likely occurs when lizards ingest eggs from infected soil while feeding. *Spauligodon oxkutzcabiensis* is a common parasite in lizards from Mexico, Central America (Bursey et al. 2007. Comp. Parasitol. 74:108–140), and South America (Goldberg and Bursey 2010. Comp. Parasitol. 77:91–93). *Sceloporus smaragdinus* and *S. taeniocnemis* represent new host records for *Spauligodon oxkutzcabiensis*. Guatemala is a new locality record.

We thank Christine Thacker (LACM) for permission to examine *S. smaragdinus* and *S. taeniocnemis*.

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***SCELOPORUS TRISTICHUS* (Plateau Fence Lizard)** and ***SCELOPORUS MAGISTER* (Desert Spiny Lizard). PREDATION.** On 25 August 2011 at 1838 h along the Virgin River in Zion National Park, Kane Co., Utah (37.205827°N, 112.978917°W, elev. 1211 m), one of us (CG) observed, photographed, and recorded video of an adult male *Sceloporus tristichus* predating a hatchling *S. magister* (*sensu* Leaché and Mulcahy 2007. Mol. Ecol. 16:5216–5233). The hatchling was being consumed tail-end first and being beat against a rock several times while in mouth of the adult *S. tristichus*. These two species commonly co-occur along stream habitats in Utah (Tinkle 1976. Herpetologica 32:1–6). There have been accounts of *S. consobrinus* (as *S. undulatus hyacinthinus*) predating other lizards in captivity (Groves 1971. J. Herpetol. 5:205), and also cannibalism within *S. magister* (Cardwell 1994. Herpetol. Rev. 3:121–122). However, this is the first published account of *S. tristichus* predating *S. magister*.

Digital video of this predation event is available. For those interested please contact the lead author.

Fig. 1. Adult male *Sceloporus tristichus* consuming a hatchling *S. magister* tail-end first.

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***SPHENOMORPHUS INCOGNITUS* (Brown Forest Skink). PARENTAL CARE.** Parental care is common in some terrestrial vertebrates, such as birds and mammals, but is much rarer in reptiles. About 140 reptile species have been reported to exhibit parental care, but many of these records are unconfirmed due to a lack of direct evidence of such behavior (Huang 2006. Anim. Behav. 72:791–795). Crocodilians are the most well-documented group of reptiles that provide parental care (Shine 1988. *In* C. Gans and R. B. Huey [eds.], Biology of the Reptilia, Volume 16, Ecology B: Defense and Life History, pp. 275–329. Alan R. Liss, New York), but relatively few squamate reptiles exhibit such behavior (Huang 2006, *op. cit.*, Huang and Wang 2009. Ethology 115:273–279; O'Connor and Shine 2004. Anim. Behav. 68:1361–1369). Here we describe an observation of nest defense, a form of parental care, by the skink *Sphenomorphus incognitus*.

Sphenomorphus incognitus is a small (ca. 8 cm SVL), surface-dwelling skink distributed from southern China to Taiwan. This oviparous skink produces 3–6 eggs per clutch, and reproduces from spring to summer (Huang 2010. Zool. Stud. 49:779–788). On

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Fig. 1. Brown Forest Skink (*Sphenomorphus incognitus*) biting a Taiwanese Kukri Snake (*Oligodon formosanus*).

28 August 2008 at 1600 h on Orchid Island, Taitung County, Taiwan (22.0333°N, 121.5666°E), we observed a female *S. incognitus* (8.5 cm SVL) defending its nest from predation by a Taiwanese Kukri Snake (*Oligodon formosanus*; 41 cm SVL). *O. formosanus* is a reptile egg specialist, and regularly eats the eggs of other skink species in the area (e.g., *Eutropis longicaudata*; Huang 2006, *op. cit.*). Female *E. longicaudata* commonly protect their eggs from predation by viciously attacking *O. formosanus*, which causes the snake to leave the nest site (Huang 2006, *op. cit.*). In the current observation, we observed the snake attempting to eat a clutch of *S. incognitus* eggs buried in the soil. The female *S. incognitus* bit the snake at mid body several times over a period of a few minutes (Fig. 1), and by doing so was presumably attempting to deter the snake from eating the eggs. However, this attempt was unsuccessful, because after digging up the nest we discovered that the entire clutch had been eaten by the snake. Despite our long-term studies on Orchid Island (2001–2010), this is our first observation of *S. incognitus* defending a nest from predation. Unlike *E. longicaudata* (which reaches a SVL of ca. 12 cm), the smaller *S. incognitus* was unable to protect its eggs from snake predation, possibly because the snake was undeterred by bites from such a small skink. We suspect that this skink had recently laid the eggs, and was still in the area when the snake predated the nest, explaining the absence of other observations of similar behavior. Otherwise, most oviparous squamates bury their eggs, which makes it difficult to document instances of parental care.

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***TROPIDURUS HISPIDUS* (Calango). SAUROPHAGY.** *Tropidurus hispidus* has a wide geographical distribution, mainly in open landscapes of northeastern South America (Rodrigues 1987. Arq. Zool. 31:105–230). *T. hispidus* is considered a generalist predator that preys on several arthropod taxa as well as plant items (Kolodiuk et al. 2010. S. Am. J. Herpetol. 5:35–44; Van Sluys et al. 2004. J. Herpetol. 38:606–611; Vitt 1995. Occ. Pap. Oklahoma Mus. Nat. Hist. 01:01–29; Vitt et al. 1996. J. Trop. Ecol. 12:81–101).

Among tropidurids, saurophagy has been recorded for *T. montanus* (Kiefer and Sazima 2002. Herpetol. Rev. 33:136), *T. torquatus* (Galdino and Van Sluys 2004. Herpetol. Rev. 35:173), and *T. hygomi* (Kohlsdorf et al. 2004. Herpetol. Rev. 35:398). Herein, we report the predation of *Cnemidophorus ocellifer* by *T. hispidus*.

Observations were made during an ecological study on reproduction and diet of *C. ocellifer* in São Gonçalo do Amarante municipality, west coast of Ceará, northeastern Brazil (3.30495°S, 38.55127°W), where specimens of *C. ocellifer* were collected. On 29 July 2010, at ca. 0830 h, one of us (DZ) hit an individual of *C. ocellifer* (ca. 50 mm SVL) of unknown sex using an air gun (the lizard was stunned momentarily and then ran away). During its attempted escape, the *C. ocellifer* was detected by an adult male *T. hispidus* (ca. 100 mm SVL), which attacked the right side of its body, grabbing almost the entire lizard, with only the head and tail protruding from its mouth. Swallowing lasted for ca. 1 min., the resulting ingestion of the prey oriented tail-first.

This report indicates that *T. hispidus* is a potential predator of *C. ocellifer*, contributing to the knowledge of the ecology of both species in a coastal region of northeastern Brazil. Moreover, this record contributes to the notion that lizards are important components of their ecosystems, acting as predators of other vertebrate species (Rocha and Vrcibradic 1998. Ciência e Cultura 50:364–368).

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***TROPIDURUS HISPIDUS* (Peters' Lava Lizard). SLEEP-SITE FIDELITY.** Little attention has been given to the study of sleep, despite its essential role in the lives of lizards. The behavior of species during sleep has important implications in their natural history traits, such as predator avoidance, fitness related with proximity to feeding or basking sites, restorative functions, and partitioning of adequate microhabitats (Singhal et al. 2007. Behavior 144:1033–1052; and references therein). Information on sleep-site fidelity (SSF) is even more scarce, and has been reported in less than a dozen species of lizards (Singhal et al., *op. cit.*). Herein, we report on some observations of SSF in the lizard *Tropidurus hispidus*, a tropidurid distributed from northeastern South America to the northeastern and central-eastern regions of Brazil (Rodrigues 1987. Arq. Zool. 31:105–230).

Observations took place at the authors' house in the city of Fortaleza, State of Ceará, northeastern Brazil. Since we have resided at this house in August 2009, lizard residents (*T. hispidus*; *Hemidactylus mabouia*) have pacifically occupied their space. During this period observations *ad libitum* have been made on their behavior, leaving them undisturbed whenever possible. Measurements (snout–vent length and tail length) were calculated with the program ImageJ (Abramoff et al. 2004. Biophotonics Internacional 11:36–42) based on photographs we have taken. Although no individual was marked, daily contact enabled us to differentiate among individuals. From November 2009 to May 2011 four different individuals of *T. hispidus* were observed to display SSF. Observations were distributed between at least 3 months from one another and individuals' site fidelity ranged from 5 to 20 days, after which they were no longer seen. Size of these four lizards ranged from 54.73–101.89 mm and perch height from 1.6–3 m. Sleeping sites were usually behind objects, usually poorly hidden, although one individual used a conspicuous spool of string as perch. In all observations, individuals would maintain the exactly same site for the duration they used it, occasionally changing only the direction they were facing. On two occasions individuals left the sleep-site upon being disturbed, although in both cases they returned the following day to the same perch. Among tropidurid lizards, SSF has only been reported in *T. albemarlensis* from the Galápagos (Stebbins et al. 1967. Ecology 48:839–851). An important factor when choosing sleep sites is the risk of predation (Lima et al. 2005. Anim. Behav. 70:723–736). The use of exposed and poorly hidden sites in the present report indicates that lizards have become aware of their low risk situation, thus choosing circumstances they would probably avoid in nature. We hope these observations will serve as baseline data, aiding in future studies on the largely unknown study of sleep in lizards.

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***UROSAURUS ORNATUS WRIGHTI* (Northern Tree Lizard). NEMATODE PARASITE.** Examinations of *Urosaurus ornatus* from Arizona, New Mexico, and Texas have recorded three species of nematodes: *Parathelandros texanus*, *Spauligodon giganticus*, and larva of *Physaloptera* sp. (Goldberg et al. 1993. J. Helminthol. Soc. Washington 60:118–121; Specian and Ubelaker 1974. Trans. Amer. Microsc. Soc. 93:413–415). Herein we report a new distributional record for a nematode parasite of *U. ornatus*.

Four adult *U. o. wrighti* (two males, two females, SVL = 41–53 mm) were collected in mid-May 2011 by hand from 9.0 km S of US 191 on St. Hwy 279 at Williams Bottom Campground, Grand Co., Utah, USA (39.08579°N, 109.759167°W). Their feces were examined for coccidian and helminth parasites. Lizards were killed with an overdose of sodium pentobarbital and fecal pellets were removed from their rectum and placed in individual vials of 2.5% (w/v) aqueous potassium dichromate. Feces were concentrated by flotation according to previous methods (McAllister et al. 1991. J. Parasitol. 77:910–913) using Sheather's sugar solution (specific gravity = 1.30). Specimens were examined using a compound microscope.

No coccidian oocysts were found, but a single nematode was recovered from a 52 mm SVL male *U. o. wrighti*, placed in 70% ethanol, and cleared on glass slides with undiluted glycerol. It was subsequently identified as a male *Parathelandros texanus*. A voucher specimen was deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as USNPC 104871. A host voucher is deposited in the Arkansas State University Herpetological Collection (ASUMZ), State University, Arkansas as ASUMZ 31775.

Parathelandros texanus was originally described from the Big Bend Canyon Lizard (*Sceloporus merriami annulatus*) from Brewster County, Texas (Specian and Ubelaker, *op. cit.*). Other hosts (all from Arizona, New Mexico, or Texas) include the Gray-checkered Whiptail (*Aspidoscelis dixoni*), Gila Spotted Whiptail

(*A. flagellicauda*), Texas Spotted Whiptail (*A. gularis gularis*), Trans-Pecos Striped Whiptail (*A. inornata heptagramma*), Plateau Spotted Whiptail (*A. septemvittata septemvittata*), Colorado Checkered Whiptail (*Aspidoscelis tesselata*), Western Marbled Whiptail (*Aspidoscelis tigris marmorata*), Southwestern Earless Lizard (*Cophosaurus texanus scitulus*), Canyon Lizard (*Sceloporus merriami*), and Eastern Fence Lizard (*S. undulatus*, *sensu lato*) as well as previously mentioned *U. ornatus* (Goldberg et al. 1995. J. Helminthol. Soc. Washington 62:188–196; McAllister 1990a. J. Wildl. Dis. 26:139–142; McAllister 1990b. Texas J. Sci. 42:381–388; McAllister et al. 1991. Texas J. Sci. 43:309–314; McAllister 1992. Texas J. Sci. 44:233–239; McAllister et al. 1995. Texas J. Sci. 47:83–88; McAllister et al. 2003. Texas J. Sci. 55:307–314; Specian and Ubelaker, *op. cit.*; Walker and Matthias 1973. Proc. Helminthol. Soc. Washington 40:168–169).

In conclusion, the geographic range of *P. texanus* now includes Arizona, New Mexico, Texas, and Utah (new distributional record) and at least 12 species of lizard hosts within two families (Phrynosomatidae, Teiidae). We expect additional hosts and localities for *P. texanus* will be reported with future surveys of lizards.

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SQUAMATA — SNAKES

ARIZONA ELEGANS ELEGANS* (Kansas Glossy Snake). DIET AND FEEDING BEHAVIOR.** *Arizona elegans elegans* is known to prey upon lizards and small mammals (McKinnney and Ballinger 1966. Southwest. Nat. 11:410–412). *Dipodomys ordii* (Ord's Kangaroo Rat) is a known prey species of *A. elegans* (Rodríguez-Robles 1999. J. Herpetol. 33:87–92). In a literature review of carrion foraging in snakes, Devault and Krochmal (2002. Herpetologica 58:429–236) did not identify *A. elegans* as a scavenger. Herein we report the first observation of *A. elegans* foraging on a road-killed *D. ordii.**

On 12 June 2010, at 2300 h, we observed an *A. elegans* (SVL = 585 mm; total length = 694 mm) consuming a road-killed *D. ordii* (Fig. 1) on Highway 249, Chavez Co., New Mexico, USA (33.0185°N, 103.8723°W, datum: WGS 34; elev. 1320 m). To prevent the snake from being killed by oncoming traffic, we gently moved it to the south shoulder of the highway. Rodrigues-Robles et al. (*op. cit.*) investigated the stomach contents of approximately 700 museum specimens of *A. elegans*. Of the 107 prey items recovered, 43.9% were mammals. However the design of their study did not allow them to determine the disposition of the prey prior to consumption. Devault and Krochmal's (2002, *op. cit.*) literature review suggests that carrion foraging in snakes should not be considered unusual, however it was unclear until this observation if *A. elegans* could be counted among the snakes known to consume carrion in the wild.

Fig. 1. *Arizona elegans elegans* consuming a road killed *Dipodomys ordii.* Note the rodent's viscera, confirming that it was a road kill.

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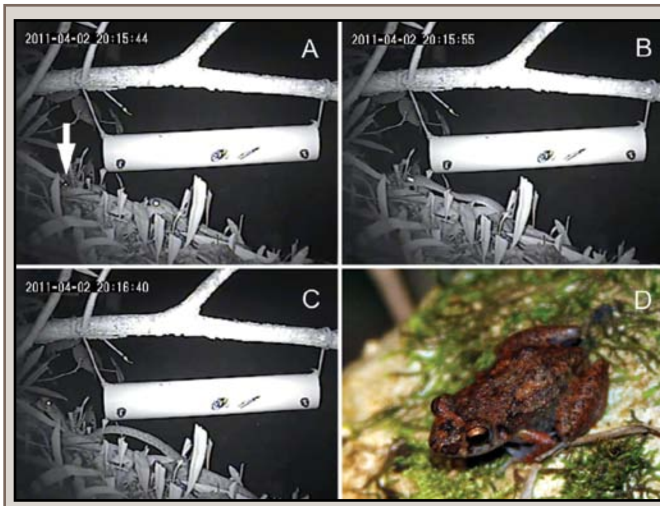
***BOIGA IRREGULARIS* (Brown Treesnake). DIET.** The invasive *Boiga irregularis*, having decimated most of the native species it preyed on in Guam, now preys heavily on other invasive vertebrates. *Eleutherodactylus planirostris* (Greenhouse Frog), which has recently become established on Guam (Christy et al. 2007. Pac. Sci. 61:469–483), may provide the snake with an additional food source because the frogs are active nocturnally and can attain high densities (12,500 frogs ha^{-1} in Hawaii; Olson 2011. Unpubl. dissertation. Utah State University, Logan. 116 pp.). *Boiga irregularis* consume *E. planirostris* in captivity (unpubl. data in Christy et al. 2007. Pac. Sci. 61:469–483), but it is unknown whether they take them in the field. Others have suggested that *B. irregularis* are unlikely to prey upon anurans because of learned avoidance after attempting to take a poisonous species, *Bufo marinus*, which is also introduced and common throughout Guam.

On 2 April 2011, during the course of video recording of nocturnal snake activity in roadside vegetation at U.S. Naval Computer and Telecommunications Station Guam (13.574758°N, 144.834967°E; datum WGS84), we observed two *E. planirostris* moving about on a moss and fern-covered log approximately 1 m above the forest floor. This location is approximately 7.7 km north of the discovery site for this recently-arrived species (Christy et al., *op. cit.*) At 2015 h, a juvenile Brown Treesnake (ca. 600 mm SVL) appeared on the side of the log approximately 10 cm from one of the frogs, which quickly leapt off of the log. The snake



PHOTOS BY TOM MATHIES

Fig. 1. *Boiga irregularis* feeding sequence on an *Eleutherodactylus planirostris*, northern Guam, USA. A. Snake approaches frog (arrow indicates eye-shine of frog); B. Snake lunging toward frog. C. Snake swallowing frog; D. *Eleutherodactylus planirostris* at study site.

rapidly swung around to face the direction of the departed frog, but did not follow. Soon after, the second frog emerged from cover and took a few steps toward the snake (Fig. 1A). The snake then moved toward the frog, paused, and then lunged at the frog (Fig. 1B), catching it in its mouth and consuming it immediately thereafter (Fig. 1C). To verify whether the frogs on our video recording were *E. planirostris*, we returned to the site the following night. A cursory visual search of a 1.5 × 4.5 m strip of forest floor beneath the log revealed approximately 15 small *E. planirostris* (Fig. 1D). If juvenile *B. irregularis* are taking substantial numbers of frogs as prey, the snake may become more difficult to control than at present. Moreover, large populations of *E. planirostris* (both on Guam and elsewhere) may facilitate the establishment of *B. irregularis* in new areas, such as Hawaii or other Pacific Islands.

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***BOTHROPS JARARACUSSU* (Jararacussu). DIET.** The South American pitviper *Bothrops jararacussu* is a large viperid, reaching up to 1.8 m in length, and is known to feed on small mammals, amphibians, and reptiles (Martins et al. 2002. *In* Schuett et al. [eds.] Biology of Vipers, pp. 307–328. Eagle Mountain Publ., Eagle Mountain, Utah). On 1 January 2011, we found a Brazilian squirrel, *Guerlinguetus ingrami* (33 cm; 150 g) in the process of being ingested by a female *B. jararacussu* (total length = 110 cm). The snake was found in the afternoon (1700 h) in the middle of a dirt road, near a secondary forest fragment in the municipality of Cascavel, Paraná, south Brazil. This location is part of Araucarian Forest (Atlantic Forest; Castella and Britez 2004. A Floresta com Araucária no Paraná. MMA Publ., Brasília. 233 pp.) and is in close proximity to a river. When approached the snake regurgitated the squirrel and tried to escape. To our knowledge, this is the first record of *B. jararacussu* preying on a *G. ingrami.* This observation is particularly interesting, given that *B. jararacussu* is terrestrial and primarily feeds on terrestrial prey (Martins et al. 2001. J. Zool. 254:529–538; Martins et al. 2002, *op. cit.*; Hartmann et al. 2009. Pap. Avul. Zool. 49:343–360), whereas *G. ingrami* is primarily arboreal (Bordignon and Monteiro-Filho 1997. Rev. Bras. Zool. 14:707–722; Bordignon and Monteiro-Filho 2000. Can. J. Zool. 78:1732–1739).

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***CHRYSOPELEA PARADISI* (Garden Flying Snake). DIET.** *Chrysopelea paradisi* is a common lowland snake in Southeast Asia (Inger and Stuebing 1999. A Field Guide to the Snakes of Borneo. Natural History Publications, Sdn Bhd, Kota Kinabalu. viii + 254 pp.), and a known predator of gekkonid lizards (Das 2010. A Field Guide to the Reptiles of Southeast Asia. New Holland Publishers Ltd., London. 376 pp.), the agamid *Bronchocela cristatella* (Lim and bin Peral 1959. Malayan Nat. J. 14:33–34), the scincid *Lamprolepis smaragdina philippinica* (Gaulke 1986. Salamandra 22:211–212), and the bamboo bat, *Tylonycteris* sp. (Leong and Foo 2009. Nature in Singapore 2:311–316).

On 30 December 2009, at ca. 1200 h, a *C. paradisi* was observed on a concrete walking path at the Piasau Boat Club (04.436541°N, 113.996485°E, datum: WGS84), Miri, Sarawak, East Malaysia. It was tightly coiled around a small struggling arboreal scincid lizard, *Apterygodon* [*Dasia*] *vittatum*, recognizable by the robust body shape and distinctive stripes along the head. This particular specimen had a truncated tail, presumably lost in a prior (near) predation event.

Over a period of ca. 10–15 min, the snake remained almost stationary, apparently constricting the skink, whose movements gradually became more erratic and less frequent. When the movements had almost ceased altogether, the snake changed position, and maneuvered the skink to begin consuming the skink head-first (Fig. 1). Once consumption started, less than a minute elapsed before the entire skink was swallowed.

Fig. 1. *Chrysopelea paradisi* ingesting an *Apterygodon vittatum* in Sarawak, East Malaysia.

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***CROTALUS CERBERUS* (Arizona Black Rattlesnake). DIET.** *Crotalus cerberus* is a denizen of mesic environments in higher-elevation regions of Arizona and western New Mexico (Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Dept., Phoenix. 150 pp.). Prior to being recognized as a separate species from *C. viridis* [*oreganus*], it was presumed that *C. cerberus* was an opportunistic predator, taking a variety of prey taxa (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque, New Mexico. 433 pp.; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 668 pp.). Since being distinguished from *C. viridis*, its diet has been documented to include lizards, including *Sceloporus* [*undulatus*] *tristichus* (Schuett et al. 2002. Herpetol. Rev. 33:210–211). Here, based on one of the first field studies of free-ranging *C. cerberus*, we present new information on prey use at a low-elevation site in Arizona.

From 2004 to 2008 we conducted radio-telemetry on sympatric *C. cerberus*, *C. atrox*, *C. molossus*, and *Heloderma suspectum* at Tonto National Monument, Gila Co., Arizona, USA. The site is characterized by steep rocky slopes, bajadas, and dry washes with upland Sonoran desertscrub, with elevations ranging from 695–1230 m. We documented prey use through blunt dissection of scats opportunistically collected when an animal defecated (Quick et al. 2005. J. Herpetol. 39:304–307). We also documented prey use from regurgitated prey items and through direct observation of predation.

Prey use was documented for three telemetered adult male *C. cerberus* from six separate feeding events. Through scat dissection, four distinct prey were identified: one unidentified bird (based on feather remains); two rodents (Cactus Mouse, *Peromyscus eremicus*; and Harris' Antelope Squirrel, *Ammospermophilus harrisii*); and one lizard (*Sceloporus* sp., likely *S. magister*). Importantly, four prey types (and therefore feeding events) were found in three scats of our subjects, indicating that a single scat may represent more than one feeding event. One male consumed the bird, the *P. eremicus*, and the *Sceloporus* sp.; of these, the mouse and lizard remains were found in the same scat. Two direct feeding observations were also made. One individual regurgitated a *Neotoma albigula* (White-throated Woodrat) after being captured on 14 July 2003, and was thought to contain a separate meal that was not regurgitated (J. Schofer, pers. obs.). A different adult male was observed consuming an adult Ash-throated Flycatcher (*Myiarchus cinerascens*) during a routine telemetric location on 5 June 2004 (A. Madara-Yagla, photo voucher).

Given the prey taxa documented for *C. cerberus* at this site, the species appears to be an opportunistic predator, supporting previous assessments. An apparent lack of lagomorphs in *C. cerberus* diet compared to other venomous species at the site (Nowak 2009. Unpubl. PhD dissertation. Northern Arizona University, Flagstaff, Arizona.) might reflect habitat partitioning (Beck 1995. J. Herpetol. 29:211–223) with other rattlesnakes, or it may reflect differences in body and gape size among the species (Klauber 1972. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind. Univ. California Press, Los Angeles. 1533 pp.). Nevertheless, the wide variety of prey types consumed by *C. cerberus* suggests that this species may play an important mesopredator role in certain ecosystems (Nowak et al. 2008. Biol. Rev. 83:601–620).

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***CROTALUS MOLOSSUS MOLOSSUS* (Northern Black-tailed Rattlesnake). DIET.** *Crotalus molossus* is a large-bodied rattlesnake whose dietary habits have been fairly well documented (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 433 pp.; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 668 pp.). Small mammals are most frequently consumed; however birds also comprise a portion of its diet (16.7%; Reynolds and Scott 1982. *In* N. J. Scott, Jr. [ed.], Herpetological Communities, pp. 99–118. U.S. Fish and Wildlife Service, Widl. Res. Rep. 13.) Though birds have been documented in the diet, which bird species are actually consumed is largely unknown. From 2004 to 2008 we conducted radio-telemetry studies on sympatric *C. molossus*, *C. atrox*, *C. cerberus*, and *Heloderma suspectum* at Tonto National Monument, Gila Co., Arizona, USA. Based on results from this study, we present a new dietary record for *C. molossus*.

Prey use was documented for a single, telemetered adult male *C. molossus* (SVL = 100 cm; 675 g) using scat dissection (Quick et al. 2005. J. Herpetol. 39:304–307). Two scats were collected from this individual; one on 26 March 2006 and one on 29 March 2006. Both scats contained feathers from a passerine bird, which was later identified as a Black-throated Sparrow (*Amphispiza bilineata*). No other remains were found in either scat. Because both scats were collected within one week of each other, it is likely that the remains in the scats represent the same prey item. To our knowledge, these observations represent the first record of predation by *C. molossus* on *A. bilineata*.

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***CROTALUS MOLOSSUS* (Black-tailed Rattlesnake). RAIN HARVESTING BEHAVIOR.** Opportunistic water gain from rain, sleet, dew, fog, or snow seems to be an adaptive strategy utilized by many reptiles in desert habitats, where accumulation of rain water on ground surfaces is infrequent (Sherbrooke 1990. J. Herpetol. 24:302–308). To date, there is a single documented episode of *C. molossus* drinking rainwater from a rock surface (Greene 1990. Pacific Discovery 43:10–19). Herein, we report the first observation of *C. molossus* consuming water from its own body during a rainstorm in the Chihuahuan Desert of west Texas.

On 26 June 2010, at 1840 h, we radio tracked an adult male *C. molossus* (SVL = 1000 mm; tail length = 80 mm; 820.0 g) as part of an ongoing study of rattlesnake spatial ecology at the Indio Mountains Research Station, Hudspeth Co., Texas, USA (30.770480°N, 105.013491°W, datum: WGS84; elev. 1221 m). The snake was located, prior to a rainfall event, in a coiled position on a rocky slope (10° angle) with its head pointing downward and its snout in contact with the lateral surface of the body. It began to rain and subsequently the snake was able to harvest water flowing off the tilted lateral mid-body section (Fig. 1). The rattlesnake continued consuming water during the entire rainfall episode (ca. 25 min.). Unlike previous reports of rain harvesting behavior by other rattlesnakes (e.g., Aird and Aird 1990. Bull. Chicago Herpetol. Soc. 25:217; Cardwell 2006. Herpetol. Rev. 37:142–144; Glaudas 2009. Southwest. Nat. 54:515–521), the *C. molossus* did not use its tongue to lick water from a dorsally

Fig. 1. An adult male *Crotalus molossus* harvesting water from its body at Indio Mountains Research Station, Hudspeth Co., Texas, USA.

flattened body section. We presume that the rattlesnake did not need to flatten its body to collect water due to constant flow from the ongoing rainstorm. After rainfall ceased, the rattlesnake continued harvesting water from the wet body surface, but in due course stopped and then crawled into a rock crevice.

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ELAPOMORPHUS QUINQUELINEATUS **(Raddi's Lizard-eating Snake). DIET.** The rear-fanged *Elapomorphus quinquelineatus* is known to prey on other burrowing snakes and amphisbaenians (Greene 1997. Snakes: the Evolution of Mystery in Nature. Univ California Press, Berkeley. 351 pp.). On 3 February 2011, at 1800 h, an adult female *E. quinquelineatus* (SVL = 912 mm, tail length = 87 mm; 170 g) was found preying on adult male *Amphisbaena microcephala* (IBSP CRIB 0114; SVL = 440 mm; tail length = 25 mm; 108 g) in a backyard of Núcleo Residencial/Instituto Butantan, close to a remnant of secondary Atlantic Forest in São Paulo City, Brazil (23.34143°S, 46.43031°W, datum WGS84; 730 m elev.). After being collected, the snake voluntarily regurgitated the freshly killed amphisbaenian, which had been ingested head first and displayed spreading hemolytic signs in the gular region (Fig. 1). The prey/predator mass ratio was 0.63. To my knowledge, this is first record of *A. microcephala* in the diet of *E. quinquelineatus*. The snake was kept in captivity at Laboratório de Herpetologia, Instituto Butantan, São Paulo, Brazil.

Fig. 1. *Elapomorphus quinquelineatus* with an *Amphisbaena microcephala* that it had consumed.

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ERYTHROLAMPRUS AESCULAPII **(Southern Mock Coral-snake). DIET AND PREY SIZE.** On 23 June 2008, at 1330 h, an adult female *Erythrolamprus aesculapii* (total length = 711 mm; 56 g after prey regurgitation) was caught next to a lake, in an anthropogenic habitat at The Instituto Cultural Inhotim, Brumadinho municipality, in Minas Gerais State, Brazil (27.125°S and 44.220°W, datum WGS84). While being handled, the snake, which appeared to have fed recently, regurgitated an adult female *Liophis poecilogyrus* that was longer and heavier than itself (total length = 803 mm, 85 g). A study on the diet and feeding behavior of *E. aesculapii* (Marques and Puorto 1994. Rev. Bras. Biol. 54:253–259), did not record *E. aesculapii* consuming snake prey greater than their own body weight. Sazima and Martins (1990. Mem. Inst. Butantan 52:73–79) reported juvenile snakes unsuccessfully attempting to ingest very large prey, a behavior that results in energy waste and increases the risk of injuries and predation. However, the small diameter of an elongated prey item (such as another snake) may alleviate gape limitation, allowing consumption of very large prey. To our knowledge, the relative size of this prey item (152% of predator mass) is the largest reported for *E. aesculapii* and is among the largest reported for snakes in general. Both snakes were deposited in the herpetological collection of the Museu de Ciências Naturais of Pontifícia Universidade Católica de Minas Gerais (MCNR 3751, MCNR 3750), in Belo Horizonte, State of Minas Gerais, Brazil.

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GEOPHIS MUTITORQUES **(Highland Earth Snake). REPRODUCTION.** *Geophis mutitorques* is known from the Sierra Madre Oriental of the northeastern México; recorded from the highlands of San Luis Potosí, Hidalgo, Puebla, and Veracruz (Downs 1967. Misc. Publ. Mus. Zool. Univ. Michigan 131:1–193; Wilson and Townsend 2007. Zootaxa 1395:1–31). The natural history of this species is poorly understood and no data on reproduction are available. On 15 March 2011, three gravid female *G. mutitorques* (CIB 4121–4123) were collected in cloud forest habitat at the community El Xoté, Municipality Tenango de Doria, Hidalgo, México (20.2054°N, 98.160270°W, datum WGS84; elev. 1506 m). One female (CIB 4121) measured 384.7 mm SVL, body mass 30.0 g, with a clutch size of 6 eggs, and a total egg mass of 4.03 g; the second female (CIB 4122) measured 406.6 mm SVL, body mass 35.0 g, with a clutch size of 5 eggs, and a total egg mass of 3.89 g; and the last female (CIB 4123) measured 365.6 mm SVL, body mass 21.0 g, with a clutch size of 3 eggs, and a total egg mass of 1.09 g. This information is the first record of clutch size for *G. mutitorques* from cloud forest habitat.

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***LIOPHIS ALMADENSIS* (Almaden Ground Snake). PREDATION.** Snakes are an important component of the diet of many mammals, birds, anurans, crocodilians, lizards, other snakes, and even invertebrates (Costa et. al. 2009. Rev. Bras. Zool. 11:171–173; Mattison 1995. Cassel Paper. 256). Here we report the successful predation on a young *Liophis almadensis* (SVL = 240 mm) by a *Leptodactylus vastus* (Northeastern Pepper Toad; SVL = 148 mm). The predation event was observed on 10 October 2010, at 2132 h, in the U.C. Wildlife Refuge Mata do Junco (10.291037°S, 36.583701°W; datum: SAD 69), in the city of Capela, Sergipe, Brazil. The toad was found in a "clean field" (pasture), approximately 1 m from the margin of a temporary pond, with the snake in its mouth (Fig. 1). The snake was still moving, indicating that it had been attacked shortly before the viewing, and exhibited small wounds on the posterior regions. The anuran and the snake were both deposited in the Herpetological Collection of the Federal University of Sergipe (CHUFS C 1037 and C 1256).

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FIG. 1. *Leptodactylus vastus* found preying upon a young *Liophis almadensis* in Capela, Sergipe, Brazil.

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***LIOPHIS MILIARIS* (Watersnake). DIET.** *Liophis miliaris* is a semi-aquatic snake that is widely distributed in cisandean South America (Dixon 1989. Smithson. Herpetol. Inf. Serv. 79:1–28). Judging from records in the literature, this snake preys mainly on anurans (Hartmann et al. 2009. Pap. Avul. Zool., São Paulo 49:343–360; Marques and Sazima 2004. *In* Marques and Duleba [eds.], Estação Ecológica Juréia-Itatins. Ambiente Físico, Flora e Fauna, pp. 257–277. Holos, Ribeirão Preto; Michaud and Dixon 1989. Herpetol. Rev. 20:39–41). In spite of having semi-aquatic habits, there are few published records of this species feeding on fishes; to our knowledge, only two species of fishes have been reported as prey of *L. miliaris* in natural conditions: *Bathygobius soporator* (Gobiidae) and *Guavina guavina* (Eleotridae) (Marques and Sazima, *op. cit.;* Marques and Souza 1993. Rev. Brasil. Biol. 53:645–648). Lema et al. (1983. Comun. Mus. Ci. PUC-RS, Porto Alegre 26:41–121) also reported a specimen preying on the fish *Gymnotus carapo* (Gymnotidae) in captivity.

In the present note, we report a new prey item for *L. miliaris* based on the stomach contents of a female specimen from the region of Itaipuaçu, in Niterói municipality, state of Rio de Janeiro, Brazil. The snake (adult female; SVL = 455 mm; tail length = 135 mm) was brought to the first author in 2010, but the exact date of collection was unknown. The snake's head and neck region were badly damaged, suggesting that it had been bludgeoned to death. Upon dissection, the snake was found to contain an armored catfish (*Callichthys callichthys*; Callichthyidae) in the esophagus. The fish, which had been swallowed head-first, measured 68.6 mm in length, but was missing the tail (it was probably torn off during the bludgeoning of the snake). The original standard length of the specimen was estimated to be ca. 121 mm based on its head length of 32.5 mm, according to measurements of Lehmann and Reis (2004. Copeia 2004:336–343). The snake and its prey were deposited at the reptile collection of the Universidade Federal do Estado do Rio de Janeiro (UNIRIO 46).

Like other fishes of the Order Siluriformes, *Callichthys callichthys* has spines on the dorsal and pectoral fins which are equipped with friction locking mechanisms that, when activated, keeps them erect (Schaefer 1984. Copeia 1984:1005–1008). The fish was probably manipulated to be swallowed head-first in order to prevent its fin spines from locking, impairing ingestion (Sturaro and Gomes 2008. Bol. Mus. Para. Emílio Goeldi, Ciências Naturais 3:225–228). Also, *C. callichthys* has a body covered by an "armor" of plate-like scales, unlike the other fishes previously reported as prey for *L. miliaris* which are all "soft-bodied." Armored catfishes of the genus *Callichthys* have been previously reported as prey for the aquatic coral snake *Micrurus surinamensis* (Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150). Lema et al. (*op. cit.*) reported a specimen of another aquatic snake (*Helicops infrataeniatus*), which was found coiled around a *C. callichthys* and trying to swallow it, but the authors did not mention if it succeeded in consuming the fish. Aguiar and Di Bernardo (2004. Stud. Neotrop. Fauna Environ. 39:7–14) recorded another species of Callichthyidae (*Corydoras paleatus*) in the diet of *H. infrataeniatus*. The above observations, together with the present record, indicate that the "armored" body and the fin spines of *C. callichthys* and other callichthyids do not completely deter predation by snakes.

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***LIOPHIS POECILOGYRUS* (Yellow-bellied Liophis). DIET AND FORAGING BEHAVIOR.** *Liophis poecilogyrus* is a colubrid snake widely distributed across South America. The species is often associated with mesic habitats, which is reflected in its diet that primarily consists of anurans and fish (Michaud and Dixon 1989. Herpetol. Rev. 20:39–42; Schalk 2010. Herpetol. Rev. 41:366–367). Although its diet has been well documented, other aspects of its natural history (e.g., behavior) are lacking. Here we report an observation on the foraging behavior of a *L. poecilogyrus* on tadpoles of *Leptodactylus bufonius* (Oven Frog).

On 30 December 2010, at 2300 h, we observed a male *L. poecilogyrus* (SVL = 411 mm; tail length = 81 mm; 32 g) foraging in a flooded ditch (approximately 10 m long and 0.5 m wide) in the Isoceño community of Yapiroa (19.60721°S, 62.57492°W; datum WGS 84), Province Cordillera, Department of Santa Cruz, Bolivia. While swimming in the ditch, the *L. poecilogyrus* had its head submerged and its mouth open as it chased and captured tadpoles of *L. bufonius*. When the snake captured a tadpole, it would push and hold the tadpole against the mud until it was able to move its mouth onto the head of the tadpole, after which it was able to swallow the individual. After approximately 30 sec underwater without a successful capture, the *L. poecilogyrus* would stop and raise its head above water and remain completely still. The snake would then plunge its head back underwater, swimming with its mouth agape in areas of the ditch where we observed a high abundance of swimming tadpoles. The snake continued foraging in this manner for an additional ten minutes before it left the ditch. This observation is consistent with other reports of head-first prey ingestion by *L. poecilogyrus* (De Souza et al. 2009. Biota Neotrop. 9:263–269) and also suggests that *L. poecilogyrus* primarily relies on tactile cues to detect and locate its prey while foraging in water.

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***MICRURUS NIGROCINCTUS* (Central American Coralsnake). DIET.** Much remains to be learned about the natural history of many Central American snakes. *Micrurus nigrocinctus* is a relatively common terrestrial and semi-fossorial snake that ranges from southern Mexico to northern Colombia. The diet has been relatively well studied and is known to include caecilians, many lizards, and snakes of the genera *Anomalepis*, *Helmanthophis*, *Typhlops*, *Coniophanes*, *Geophis*, and *Ninia* (Savage 2002. The Amphibians and Reptiles of Costa Rica: a Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Illinois. 934 pp.) Solórzáno (2004. Snakes of Costa Rica: Distribution, Taxonomy, and Natural History. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica. 791 pp.) reports on hundreds of individuals and adds the snake genera *Boa*, *Conophis*, *Dendrophidion*, *Drymobius*, *Enulius*, *Imantodes*, *Masticodryas*, *Rhadinaea*, *Tantilla*, and *Urotheca*.

On 1 February 2011, at 0755 h, an adult *M. nigrocinctus* (SVL = 46.2 cm; US National Museum Field Series #254130) was collected dead on the entrance road to El Copé, Coclé Province, Republic of Panama, between the communities of Las Tibias and El Copé (8.62343°N, 80.57100°W, datum WGS84). The snake was split open and protruding from the body wall was a small black snake identified as *Liotyphlops albirostris* (US National Museum Field Series #254181). The anterior 14.5 cm of the snake was undigested. This is the first dietary record for *M. nigrocinctus* for the Republic of Panama and the first documentation of *L. albirostris* as a prey item for the species.

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***NERODIA ERYTHROGASTER TRANSVERSA* (Blotched Watersnake). ENDOPARASITES.** Twelve species of trematodes and seven species of nematodes have been reported previously from *Nerodia erythrogaster* (Ernst and Ernst 2006. SSAR Herpetol. Circ. 34:1–86); however, to our knowledge, no pentastomids have been reported from this host. Here we report two new endoparasite records for *N. e. transversa*.

A single adult Blotched Watersnake was obtained from an unknown locale in Harris Co., Texas, USA, and housed at the Houston Zoological Gardens where it remained until it died on 1 June 1992. A midventral incision was made to expose the entire length of the digestive tract. A single larval nematode and four nymphal pentastomids were recovered from dermal cysts and cleared on glass slides with undiluted glycerol. These were subsequently identified as larval *Eustrongylides* sp. (Nematoda) and nymphs of *Porocephalus* sp. (Pentastomida). A voucher specimen of *Eustrongylides* sp. was deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as (USNPC 104634). The *Porocephalus* sp. was retained in our personal collection.

Adults of *Porocephalus crotali* Humboldt (Porocephalida: Porocephalidae) have been reported from various crotalids (Forrester et al. 1970. J. Parasitol. 56:977; Nicoli 1963. Ann. Parasitol. Hum. Comp. 38:483–516; Self 1969. Exp. Parasitol. 24:63–119). The life history of this parasite may be similar to the life history of another pentastomid, *Kiricephalus coarctatus* (Diesing), where ophiophagous snakes are the definitive hosts and other snakes can serve as paratenic hosts (Self, *op. cit.*). However, a mammal could be an alternative host (Layne 1967. Bull. Wildl. Dis. Assoc. 3:105–109; Self 1972. Trans. Amer. Micros. Soc. 91:2–8). *Eustrongylides* sp. Jägerskiöld (Trichuridea: Dioctophymatidae) have been reported previously from the stomach, mesenteries, body wall musculature, coelomic cavity, and subcutaneous tissues of several free-ranging and captive snakes, including *Agkistrodon contortrix*, *Bothrops atrox*, *Coluber constrictor*, *Drymarchon couperi*, *Masticophis flagellum*, *Nerodia sipedon*, *Pituophis catenifer*, *P. melanoleucus*, *Thamnophis eques*, *T. sirtalis*, and an unknown species of python (Bursey 1986. J. Wildl. Dis. 22:527–532; Ernst and Ernst, *op. cit.*). *Nerodia erythrogaster transversa* represents a new host record for nymphs of *Porocephalus* sp. and larva of *Eustrongylides* sp.

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NERODIA RHOMBIFER WERLERI **(Diamond-backed Watersnake). ENDOPARASITES.** *Nerodia rhombifer werleri* is known from Veracruz, south through Tabasco and parts of Campeche and Chiapas, Mexico (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. Univ. Oklahoma Press, Norman. 438 pp.). Parasites of *N. rhombifer* are listed in Gibbons and Dorcas (*op. cit.*) and Ernst and Ernst (2006. Synopsis of Helminths Endoparasitic in Snakes of the United States and Canada. SSAR Herpetol. Circ. 34:1–86). To our knowledge, there are no reports of helminths from *N. r. werleri*. The purpose of this note is to establish the initial helminth list for *N. r. werleri*.

A sample of 38 *N. r. werleri* consisting of 17 females (mean SVL = 600.6 mm ± 114.6 SD, range = 330–740 mm) and 21 males (mean SVL = 614.8 mm ± 93.6 SD, range = 460–758 mm) collected in 1987 by (RDA) near Tlacotalpan (18.6667°N, 95.7500°W, datum WGS84; elev. 10 m), Veracruz, Mexico were examined. Snakes were deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA. The body cavity of each snake was opened and the digestive tract was removed, opened by a longitudinal incision, and examined under a dissecting microscope. Food contents of the stomach were previously removed (Aldridge et al. 2003. Herpetologica 59:43–51). In some cases stomach residuum remained, which was examined. One species of Cestoda, and four species of Nematoda were found. Cestodes were regressively stained in hematoxylin, mounted in Canada balsam. Nematodes were cleared in glycerol. All were mounted on glass slides, cover slipped, studied under a compound microscope and identified: Cestoda *Ophiotaenia perspicua* (small intestine) and Nematoda *Paracapillaria sonsinoi* (large intestine), *Terranova caballeroi* (stomach), *Contracaecum* sp. larvae (body cavity), and *Porrocaecum* sp. larvae (small intestine). Voucher specimens were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as: *Ophiotaenia perspicua* (USNPC 104628); *Paracapillaria sonsinoi* (USNPC 104630); *Terranova caballeroi* (USNPC 104632); *Contracaecum* sp. (USNPC 104629); *Porrocaecum* sp. (USNPC 104631).

Prevalence (number infected snakes/number examined snakes × 100) and mean infection intensity (mean number helminths per infected snake) were: *Ophiotaenia perspicua* (prevalence 92%, cestodes were intertwined and could not be counted); *Paracapillaria sonsinoi*; (prevalence 8%, mean intensity 5.7 ± 5.7 SD, range = 1–12); *Terranova caballeroi*; (prevalence 11%, mean intensity 1.3 ± 0.5 SD, range = 1–2); *Contracaecum* sp. (prevalence 13%, mean intensity 2.4 ± 3.1 SD, range = 1–8); *Porrocaecum* sp. (prevalence 5%, mean intensity 2.0 ± 1.4 SD, range = 1–3).

The ascarid nematode *T. caballeroi* was described from specimens taken from the stomach of *Cubophis cantherigerus* from Cuba (Barus and Coy Otero 1966. Poeyana 23:1–16). The life history is unknown. The definitive hosts of species of *Contracaecum* are piscivorous birds and mammals; larvae hatch in water and are ingested by invertebrate hosts; fish serve as vertebrate intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission, 2nd ed. Publishing, Wallingford, Oxon, U.K. 650 pp.). Species of *Porrocaecum* sp. are parasites of the intestines of birds; earthworms serve as intermediate hosts and small mammals that consume earthwotms may serve as paratenic (= transport) hosts (Anderson, *op. cit*).

Contracaecum sp. and *Porrocaecum* sp. in *N. r. werleri* are new host records. Veracruz, Mexico is a new locality record for all helminths found in *N. r. werleri*.

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NINIA MACULATA **(Banded Coffee Snake). REPRODUCTION.** *Ninia maculata* is a diurnal species distributed from Honduras to Costa Rica from 36 to 1800 m in elevation (Savage 2002. The Amphibians and Reptiles of Costa Rica: a Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). It is considered abundant across its range and inhabits a wide variety of habitats, including urban, semi-urban, and agricultural areas. To date, there has been little data published on the reproduction of this species. Here we report some observations on the nesting and reproductive ecology of *N. maculata* in an urban habitat in the Central Valley of Costa Rica, including an extension of the nesting season and information on an unusually large clutch based on the size of the female.

On 25 September 2003 we observed a female *N. maculata* (SVL = 215 mm; tail length = 70 mm) laying eggs at 2100 h in the leaf litter under closed forest cover in a small forested area at the Instituto Nacional de Biodiversidad Park (INBio Parque), which is located within the urban area of Santa Rosa in Santo Domingo de Heredia, Costa Rica (9.97365°N, 84.09310°W, datum WGS84; elev. 1128 m). The clutch consisted of three eggs measuring 28, 29 and 30 mm by 13, 14 and 15 mm, respectively. The eggs were deposited in a small hole in the leaf litter with high moisture levels, and the hole was entirely within the leaf litter and did not reach the mineral layer of the soil. All three eggs hatched on 15 March 2004, completing an incubation period of 5 months and 20 days, with offspring measuring 76, 80 and 86 mm SVL. The incubation period has not been reported previously for this species. This observation also increases the previously reported period for egg laying; Solórzano (2004. Serpientes de Costa Rica. Instituto Nacional de Biodiversidad. Santo Domingo de Heredia, Costa Rica. 791 pp.) reported that egg laying occurs between October and March and hatching between January and June. Our observation is in agreement with year-round reproduction observed by Fitch (1970. Univ. Kansas, Mus. Nat. Hist., Misc. Publ., 52:1–247). Finally, based on previous work by Goldberg (2004. Tex. J. Sci., 56:81–84), this observation represents an unusually large clutch based on the female's body size.

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***OLIGODON ARNENSIS* (Common Kukri Snake). DIET.** Snakes of the genus *Oligodon* are commonly known as Kukri snakes because of their knife-shaped hind teeth which are curved like a Nepalese knife (Kukri). The interesting morphology of their teeth is very effective for cutting open eggs, upon which this these snakes commonly feed (Green et al. 2010. Asian Herptol. Res. 1:1–21). Here we report an instance of *Oligodon arnensis* preying upon a lizard, the skink *Eutropis multifasciata*. On 27 February 2011, at 2030 h, we observed an *O. arnensis* in the process of subduing an *E. multifasciatus* in the botanical garden of Robertson College (23.16237°N, 79.9700°E, datum WGS 84; elev. 414 m) Jabalpur, Madhya Pradesh, India. The snake took approximately 25 min to completely swallow the skink, after which it retreated into a burrow on an elevated site nearby. To our knowledge, this is the first record of *E. multifasciatus* in the diet of *O. arnensis*.

Fig. 1. *Oligodon arnensis* preying upon a skink, *Eutropis multifasciata*, in Madhya Pradesh, India.

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***OXYBELIS AENEUS* (Mexican Vinesnake). DIET.** *Oxybelis aeneus* is a common colubrid snake inhabiting a variety of habitats throughout Mexico, Central America, and northern South America (Savage 2002. The Amphibians and Reptiles of Costa Rica: a Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). This species is known to consume a wide array of prey, including lizards, amphibians, arboreal mammals, small rodents, small birds and fledglings, insects, and fish (Henderson 1982, Amphibia-Reptilia 3:71–80; Hetherington 2006, Herpetol. Rev. 37:94–95). Studies indicate that lizards, particularly anoles, are important prey for *O. aeneus* (Lee 1996. Amphibians and Reptiles of the Yucatán Peninsula. Cornell Univ. Press, Ithaca, New York. 500 pp.). On 26 May 2010, at 1300 h, on Playa Ventura, Guerrero, México (16.54097°N and 98.90697°W, datum NAD27; elev. ca. 48 m), one of us (AN-A) observed an *O. aeneus* in the process of constricting an adult *Sceloporus squamosus* which later was ingested head first (CAREM 0001 photographic voucher). This observation is the first record of *S. squamosus* in the diet of *O. aeneus*.

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***OXYRHOPUS FORMOSUS* (False Coralsnake). ELEVATION.** *Oxyrhopus formosus* is a rare and poorly studied snake with a disjunct distribution in northwestern South America and in the Atlantic rainforest (Bailey 1986. *In* Peters and Orejas-Miranda [eds.], Catalogue of Neotropical Squamata. Part I. Snakes, pp. 229–235. Bull. U.S. Natl. Mus.). According to Bailey (*op. cit.*), *O. formosus* encompasses a complex of forms. In addition, several records identified as *O. formosus* in northern South America are, in fact, *O. occipitalis*, as pointed out by Lynch (2009. Pap. Avul. Zool. 49:319–337) and MacCulloch et al. (2009. Pap. Avul. Zool. 49:487–495). This taxonomic chaos makes it difficult to define geographic distribution limits of *O. formosus* sensu stricto, including the maximum elevations inhabited by the species. The holotype of *O. formosus* was collected in Mucuri, Bahia, Brazil, in the heart of Atlantic rainforest (Bailey, *op. cit.*). In this biome, the only information on the occurrence of the species in highlands is a photographic record from the Reserva Biológica de Duas Barras at an elevation between 550 and 738 m (Tonini et al. 2010. Biota Neotrop. 10:339–351). Here, we present the first elevational records of *O. formosus* in the mountains of the Atlantic rainforest biome.

In February 2010, an *O. formosus* was killed by farmers in a cocoa plantation on the farm Alto Bela Vista (14.61°S, 39.60°W, datum WGS84), ca. 780 m elev., in the Serra da Palha, municipality of Coaraci (Bahia), Brazil. A second individual was found at night (2200 h) on the edge of a stream in a forest (14.70°S, 39.60°W) at ca. 735 m elev. in the Serra do Corcovado, municipality of Almadina (Bahia) on 18 February 2011. These sites are about 10 km apart in Southern Bahian wet forest habitat. Voucher specimens (MZUESC 8485, 9250) are deposited in the Museu de Zoologia da Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brazil.

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***PANTHEROPHIS GLOYDI* (Eastern Foxsnake). REPRODUCTION-CLUTCH SIZE.** On 1 July 2009 we captured a *P. gloydi* at Shiawassee National Wildlife Refuge in Saginaw Co., Michigan, USA, as part of a radio telemetry joint project conducted by Central Michigan University and the U.S. Fish and Wildlife Service. The snake was a large gravid female (SVL = 1550 mm; total length = 1750 mm; 1654 g). The snake was radiographed after transmitter implant surgery, revealing a clutch of 34 eggs. To our knowledge, this represents a new maximum clutch size (previous maximum = 29 eggs, mean = 14.4 eggs) and near record length (previous maximum total length = 1791 mm; Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin, New York. 640 pp.). Evidence of vigorous reproduction in this species is of particular conservation interest, as this species is now uncommon or rare where it was once abundant (Harding 1997. Amphibians and Reptiles of the Great Lakes Region. Univ. Michigan Press, Ann Arbor, Michigan. 378 pp.).

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***PHILODRYAS OLFERSII*. DIET.** The colubrid snake *Philodryas olfersii* is widely distributed in South America, occurring in Brazil, Peru, Bolivia, Paraguay, Uruguay, and Argentina (Peters and Orejas-Miranda 1970. Bull. U.S. Natl. Mus. 297:1–347). The species is known to have semi-arboreal habits and inhabit forested areas. Studies have documented a variety of diet items, including small mammals, birds, and anurans (Hartmann and Marques 2005. Amphibia-Reptilia 26:25–31; Leite et al. 2009. North-West. J. Zool. 5:53–60; Vitt 1980. Pap. Avul. Zool. 34:87–98).

On 19 December 2010 we collected a female *P. olfersii* (SVL = 890 mm; tail length = 47 mm; mass = 203 g) in restinga habitat (coastal sand dune vegetation habitat of the Atlantic Rainforest domain), municipality of São João da Barra, State of Rio de Janeiro, Brazil (21.7374556°S, 41.0311306°W; datum WGS84). The snake was unresponsive, and when dissected, was found to contain the digested remains of a colubrid snake, probably *Clelia* or *Boiruna*, based on head scales, in its stomach. We also observed a large edema and a perforation at the posterior portion of the stomach and necrosis of adjacent tissues, including rib musculature (Fig. 1.). In that portion of the stomach, we found the decomposed remains of a keeled-scaled viperid snake, likely *Bothropoides neuwiedi*, *B. jararaca*, or *Bothrops jararacussu*. We suspect that the tissue necrosis may have been caused by the venom of the ingested snake, either through a bite, or release of venom into an existing wound in the stomach of the *P. olfersii*.

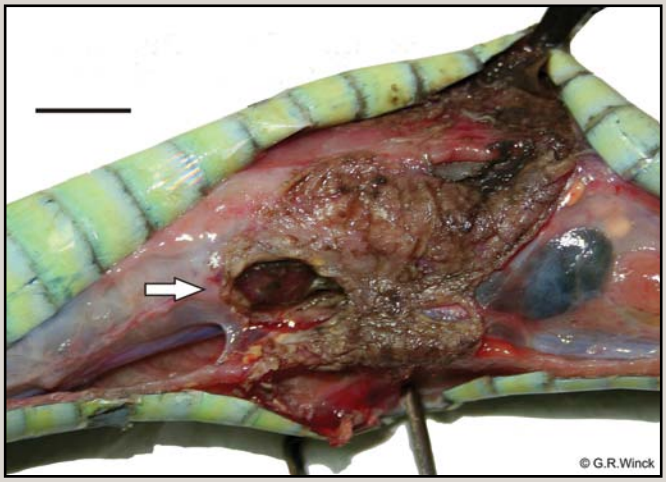

Fig. 1. Internal edema in the stomach of a *Philodryas olfersii* from the municipality of São João da Barra, state of Rio de Janeiro, Brazil. White arrow shows the perforation of the stomach, associated to the ingestion of a venomous snake.

Fig. 2. *Philodryas olfersii* found deceased with a tropidurid lizard, *Tropidurus torquatus*, protruding from its mouth. The specimen was collected at a restinga habitat, municipality of São João da Barra, state of Rio de Janeiro, Brazil.

On 21 December 2010 we collected another female *P. olfersii* (SVL = 434 mm, tail length = 200 mm, 91.1 g) in the same locality. The snake was dead with a partially ingested (head first) *Tropidurus torquatus* (SVL = 94 mm, tail length = 107 mm, 16.9 g; Fig. 2.) protruding from its mouth. Apparently, the snake failed in its attempt to ingest the lizard and was not able to regurgitate the large prey item. The inability of the snake to regurgitate may have been partially due to the lizard's scales, which are imbricated and oriented in posterior-anterior direction. Indeed, another case of a snake (*Bothropoides pradoi*) dying after attempting to ingest a large *T. torquatus* has been reported (Rocha et al. 1997. Herpetol. Rev. 28:153–154). Our observation represents an additional case of the not uncommon situation where a snake dies after being unable to regurgitate a large prey item. Voucher specimens of the snakes and the prey are housed at the Museu Nacional (MN-UFRJ), Rio de Janeiro, RJ, Brazil (the first as MNRJ 20107, and the second as MNRJ 20109).

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***PHILODRYAS TRILINEATA* (Argentine Mousehole Snake). DIET.** *Philodryas trilineata* is a large and robust colubrid snake endemic to Argentina (Leynaud and Bucher 1999. Misc. Publ. Acad. Nac. Sci. Córdoba 98:1–52). The diet of this species is known to include small vertebrates such as lizards, birds, and rodents (Cei 1993. Reptiles del Noroeste, Nordeste y Este de la Argentina. Herpetofauna de Zonas Áridas y Semiáridas. Mus. Reg. Sci. Nat. Torino. Monografie IV. 945 pp.). Here we report an observation of *P. trilineata* feeding upon a novel prey species, *Upucerthia ruficauda* (Stright-billed Earthcreeper) fledglings.

On 14 December 2008, at 1411 h, in Quebrada Vallecito, Andes Mountains, Calingasta Department, San Juan Province, corresponding to pre-Andean limit of the occidental Monte Phytogeographic Region, Argentina (31.2°S, 69.6°W, datum WGS84; elev. 2543 m) we discovered an adult female *P. trilineata* (total length = 1070 mm) lying motionless beneath a shrub (*Larrea coneifolia*). As we approached, we noticed that the snake had a dark prey item in its mouth, pinned to the ground. The prey item was found to be a fledgling *U. ruficauda*. Dissection of the snake revealed another intact *U. ruficauda* fledgling in the stomach. Together, they two prey totaled 50% of the snake's mass.

The snake and prey were deposited in the Colección Herpetológica de la Universidad Nacional de San Juan (CH-UNSJ 3212)

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***PITUOPHIS CATENIFER* (Gophersnake). DIET.** The feeding ecology of *Pituophis catenifer* is one of the best known of any snake species (Rodríguez-Robles 2002. Biol. J. Linn. Soc. 2002:165–183). While 213 (18%) of the more than 2600 specimens reviewed by Rodríguez-Robles (2002, *op. cit.*) contained birds or their eggs, only two contained the remains of owls or their eggs (Imler 1945. J. Wildl. Manage. 9:265–273, Short-eared Owl, *Asio flammeus*; 2 nestlings, Nebraska; McCallum et al. 1995. Wilson Bull. 107:530–537; Flammulated Owl, *Otus flammeolus* eggs, New Mexico).

On 25 May 2005, during routine nest burrow monitoring on Kirtland Air Force Base (KAFB), Bernalillo Co., New Mexico, USA, KCM and OCC discovered and photographed a dead *P. catenifer* (Fig. 1) lying approximately 15 m from an active burrow that was being utilized by a Burrowing Owl (*Athene cunicularia*) to incubate eggs that were expected to hatch around 31 May. The cause of death of the *P. catenifer* was not determined, although it contained an obvious large food bolus. After dissection, the bolus was identified as an adult Burrowing Owl which had been banded during an ongoing study of Burrowing Owls on KAFB.

During studies of Burrowing Owls on KAFB, it was suspected that adults, juveniles, or eggs had been predated by snakes. There were burrows where young chicks were observed one evening, but were missing the following morning with no signs of digging, tracks, or other mammal activity around the burrow, and also no owl feathers or carcass. To our knowledge this is the first verified report of a Burrowing Owl being preyed upon by *P. catenifer*.

PHOTO BY OCTAVO AND KIRSTEN CRUZ

Fig. 1. Dead *Pituophis catenifer* found near an occupied Burrowing Owl (*Athene cunicularia*) nest burrow, Kirtland Air Force Base, Bernalillo County, New Mexico, USA. Dissection revealed that it had consumed an adult Burrowing Owl.

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***STORERIA OCCIPITOMACULATA* (Red-bellied Snake). BEHAVIOR AND REPRODUCTION.** On 7 Sep 2006, at ca. 1530 h, we observed a cluster of four adult *Storeria occipitomaculata* wrapped around a branch about 1 m off the ground in a young Sourwood (*Oxydendrum arboreum)* tree. The area was located below the main sandstone cliff-line in a small ravine in southeastern Powell Co., Kentucky, USA, a rugged area with massive sandstone cliff-lines and extensive limestone outcrops. The snakes were in such a tight mass that we could initially only see two heads but two of them dropped to the ground in response to being disturbed by our group. The remaining pair moved down the tree and escaped. Since the four snakes were all of one species and were of adult size, and the time of observation falls within the known breeding period, it is likely that this was a mating aggregation. Although individual *S. occipitomaculata* have been observed in low vegetation (Barbour 1971. Amphibians and Reptiles of Kentucky. Univ. Press Kentucky, Lexington. 334 pp.; Green and Pauley 1987. Amphibians and Reptiles in West Virginia, Univ. Pittsburgh Press, Pittsburgh. 241 pp.). Our observation of aggregative behavior in these snakes is unique in that the site was open and arboreal rather than in burrows or under objects. This observation also confirms that this species mates in late summer. Previous reports indicate that mating occurs in spring and possibly in late summer and fall (Barbour, *op. cit.*; Martof et al 1980. Amphibians and Reptiles of the Carolinas and Virginia, Univ. North Carolina Press, Chapel Hill. 264 pp.; Green and Pauley, *op. cit.*; Willson and Dorcas 2004. Southeast. Nat. 3:1–12).

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***TANTILLA ARMILLATA* (Black-necked Crowned Snake). REPRODUCTION.** Much remains to be learned about the natural history of Central American snakes, particularly among the various small leaf-litter taxa. Snakes of the genus *Tantilla* are rare to common components of the leaf litter guild. Savage (2002. The Amphibians and Reptiles of Costa Rica: a Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.) makes no mention of any aspect of the reproductive biology of *T. armillata* and Solorzáno (2004. Snakes of Costa Rica: Distribution, Taxonomy, and Natural History. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica. 791 pp.) notes only that this snake is oviparious, but that nothing is known of the reproductive cycle.

On 11 August 2010, at ca. 1130 h, a female *T. armillata* (SVL = 24.5 cm; US National Museum Field Series 254029) was collected from under a small wooden slab in cut-over forest on a hillside adjacent to La Barrigón Elementary School, 4 km N of El Copé, Coclé Province, Republic of Panama (8.6424111°N, 80.5899556°W, datum WGS84). When captured, it was noted that the snake had two eggs clearly visible through the body wall. When dissected, the eggs measured 21.39 mm × 5.28 mm and 21.04 mm × 6.29 mm. To our knowledge this is the first record of reproduction in this taxon. Pending a review of the taxonomy of the *T. melanocephala* group in Panama, we follow Savage (*op. cit.*) in the use of the name *Tantilla armillata.*

We thank K. Knight and M. Pérez for assistance in the field and La MICA Biological Station for logistical support.

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***TANTILLA RETICULATA* (Lined Crowned Snake). DIET.** Although members of the colubrid genus *Tantilla* often are referred to as "centipede snakes," the use of this food source has been confirmed for relatively few of the 60 species currently recognized (Canseco-Márquez et al. 2007. J. Herpetol. 41:220–224), especially the numerous tropical species. *Tantilla reticulata* is found at low to moderate elevations (near sea level to 1430 m) of the Atlantic versant, from southeastern Nicaragua to Panama and both the Atlantic and Pacific versants of northwestern Colombia (Wilson 1985. Cat. Am. Amphib. Rept. 370.1; Solórzano 2004. Serpientes de Costa Rica/Snakes of Costa Rica. INBio, Santo Domingo de Heredia. 791 pp.). To our knowledge, information on the diet of this snake is unavailable, except for the presumption that it feeds on centipedes (Guyer and Donnelly 2005. Amphibians and Reptiles of La Selva, Costa Rica, and the Caribbean Slope. Univ. California Press, Berkeley. 299 pp.). Here we document the consumption of an adult centipede (*Scolopocryptops* sp.) by an adult *T. reticulata* (Fig. 1.). This interaction was observed in primary rainforest on Cerro Frío, Yorkín, Prov. Bocas del Toro, Panama (9.43730°N, 82.84164°W, datum WGS 84; elev. 850 m), on 25 October 2008, at 0840 h. The two animals were found in a crack in a fallen log. The snake and the centipede are deposited in the Museo de Vertebrados de la Universidad de Panamá (MUVP 1988).

Fig. 1. *Tantilla reticulata* found consuming a large centipede (*Scolopocryptops* sp.) at Cerro Frío, Yorkín, Prov. Bocas del Toro, Panama.

We thank Angel Solís, who took the photographs during the Expedición de Proyecto Herramientas Básicas para el Manejo del Parque Internacional Lam Amistad: Costa Rica-Panamá, financed by Iniciativa Darwin del Reino Unido. We also thank Eduardo Boza for providing the collecting information on the specimen.

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***THAMNOPHIS ELEGANS* (Terrestrial Gartersnake). DEFENSIVE BEHAVIOR.** Anti-predatory behavior of gartersnakes (*Thamnophis* spp.) has received considerable attention with respect to behavioral variation associated with either age, temperature or hormonal status of an individual under attack (e.g., Langkilde et al. 2004. Ethology 110:937–947). However, field observations under natural conditions are lacking. Here, we report variation in the anti-predatory behavior of a single *T. elegans*, exposed to mock predation by humans and dogs.

At 1000 h on a sunny day (air temp = 21°C) we captured a *T. elegans* (unsexed; ca. 700 mm total length) near the margin of a pool in an open meadow surrounded by Petran Montane Forest

Fig. 1. Dog approaching *Thamnophis elegans* from the front. Note the elevated tail of the snake.

(34.29931°N; 110.88642°W; datum NAD27; elev. 2300 m) in Coconino Co., central Arizona, USA. The snake was first captured at the pool's edge and was moved ca 10 m away to obtain photographs. As we photographed the snake, it consistently moved in the opposite direction from any person that walked toward the snake. With each approach, it reversed direction, and continued its evasive movements in the opposite direction from the nearest individual. After three minutes of these interactions, we allowed a leashed dog (Cardigan Corgi; Fig. 1) to approach the snake. Though the dog slowly approached the snake from the rear, the snake immediately ceased its forward motion and lifted its tail while simultaneously exuding cloacal contents and musk over the posterior portion of its body. The dog cautiously approached, but appeared irritated by the scent or lack of movement. The snake remained motionless for ca. 30 sec while the dog remained between ca. 30 cm to the rear of the snake. At no time did the snake re-orient to face the dog.

When the dog was removed and a person approached the snake from the rear, it again moved forward, resuming its previous pattern of escape behavior. When the dog was allowed to approach the snake a second time, from in front of the snake, it again stopped moving, elevated its tail and began exuding cloacal contents (Fig. 1). The snake remained motionless, except for tail movement, until the dog was removed, but resumed its straight-line flight behavior when approached by a person a third time. Thus, the snake's response to the approach of a human was flight, whereas it ceased movement and exuded musk and cloacal contents in response to the approach of a dog. It is unclear what proximate cues might play a role in the differential anti-predatory behavior we observed, and which natural predators may have prompted evolution of such behaviors, but our observations add to a growing list of species-specific defensive behavior exhibited by squamates when approached by potential predators. Gibbons and Gibbons (2009. Herpetol. Rev. 40:440) noted differential defensive behavior by *Coluber constrictor* in response to approaches by cats and humans, respectively, and Sherbrooke (pers. comm., 2011) has noted a number of predator-specific defensive behaviors of horned lizards (*Phrynosoma* spp.) in response to attacks by a variety of predators (carnivores, squamates).

Special thanks to Elizabeth Sullivan and Darci, the cautious dog predator.

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THAMNOPHIS SIRTALIS SIRTALIS **(Eastern Gartersnake). COLORATION.** Unique color variations such as amelanism and leucism are not unusual in *T. s. sirtalis* and have been documented multiple times (Cook 1986. Herpetol. Rev. 17:23–24; Shively and Mitchell 1994. Herpetol. Rev. 25:30). *Thamnophis s. parietalis* and *T. elegans vagrans* have shown other color variations including axanthism and melanism (Mason et al. 1991. Herpetol. Rev. 22:61; Peterson and Fabian 1984. Herpetol. Rev. 15:113). Melanistic *T. s. sirtalis* have also been well documented in the Lake Eerie area (Conant and Collins 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin, New York. 640 pp.). *T. s. similis* in northern Florida exhibits a blue coloration, but this is considered normal coloration and not axanthism (Conant and Collins, *op. cit.*). Axanthic individuals, however, have not been documented in *T. s. sirtalis*.

Fig. 1. An axanthic female *T. s. sirtalis* found at Table Rock State Park, Pickens Co., South Carolina.

An axanthic adult female *T. s. sirtalis* (SVL = 69 cm, 245 g) was captured on 25 May 2010 at Table Rock State Park, Pickens Co., South Carolina, USA (Fig. 1). The snake was dark gray and black with blue dorsal and lateral stripes instead of the usual yellow. Its ventral scales were also light blue in color. The snake was gravid at the time of capture and on 22 July 2010 gave birth to 31 live and 1 stillborn normal colored neonates. She later died in captivity and has been added to the Campbell Museum of Natural History at Clemson University.

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UROTHECA EURYZONA **(Halloween Snake). REPRODUCTION.** *Urotheca euryzona* is an uncommon fossorial coral snake mimic distributed within humid forests of lowland and premontane Latin America, from northern Nicaragua south to Ecuador. On 10 March 2011, at 2345 h, we collected a gravid female *U. euryzona* (SVL = 414 mm; tail length = 222 mm, 22.2 g) moving on the ground in a section of *Manicaria* swamp forest at Caño Palma Biological Station, 8 km N of Tortuguero National Park, Limón Province, Costa Rica. One day later the snake died and was dissected, revealing five eggs. The eggs averaged 20.82 mm in length, 9.18 mm in width, and 1.10 g in mass. *Urotheca euryzona* was previously presumed to be oviparous based on the knowledge of oviparity in *U. elapoides* (Greene 1969. J. Herpetol. 3:27–31). Thus, this represents the first published account of oviparity and clutch size for *U. euryzona*. We deposited the specimen along with the eggs in the herpetological collections of the Universidad de Costa Rica. We thank the Ministerio del Ambiente y Energía Sistema Nacional de Áreas de Conservación for granting us research permits.

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BOOK REVIEWS

Herpetological Review, 2012, 43(1), 155–157.

Lizards of Peninsular Malaysia, Singapore and their Adjacent Archipelagos

by L. Lee Grismer. 2011. Edition Chimaira, Frankfurt am Main (www.chimaira.de). 728 pp. Hardcover. 98,00 Euros (approximately US $125.00). ISBN 978-3-89973-484-3.

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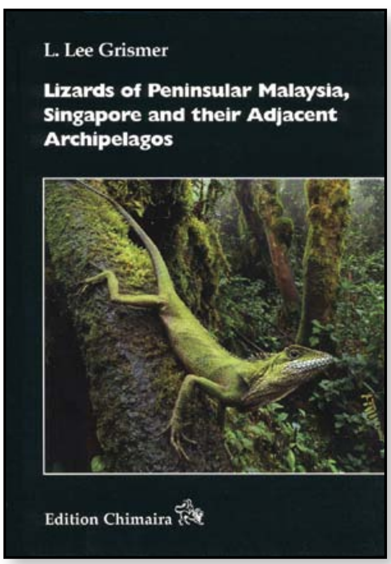

Many books have recently been published on the herpetofauna of Southeast Asia, but this is not just yet another of them. This new opus, a *chef-d'oeuvre* as we are tempted to say, is extremely informative and accurate, amazingly illustrated, and summarizes an impressive amount of knowledge and experience accumulated by the author on the subject treated. With its excellent glossy paper and high binding quality, it sets new, very high standards for herpetological books on the region. The author is already well known for his work on herpetological subjects in both the Old and the New Worlds and for his large number of mostly taxonomic publications on the reptiles of Peninsular Malaysia, including a recent guide on the reptiles and amphibians of the Seribuat Archipelago (Grismer 2011), and the (co-)description of 32 of the 124 Peninsular Malaysian native lizard species—i.e., more than a third!—, among them 14 of the 19 local *Cnemaspis* spp., and 8 of the 16 *Cyrtodactylus* spp.

The main sections of the book are the brief introduction (pp. 14–15), an abundantly illustrated presentation of the physical and natural environments and the climate found in the area covered by the book (pp. 17–80), a general presentation of the local herpetofauna with a history of the herpetological research on the area (pp. 81–96), the species accounts (pp. 97–703) which form the principal part of the book, including identification keys to families, genera, and species, a brief section on two introduced exotic lizard species (the iguanid *Iguana iguana* and the agamid *Physignathus cocincinus*) (p. 704), another brief section on conservation (pp. 705–707), and the bibliographic references (pp. 708–728).

With not a single exception, photographic illustrations in the book are absolutely astonishing. Among the 530 figures in the book, all in color, one is a map of Southeast Asia, two others are maps of Peninsular Malaysia, 96 show habitats (sometimes featuring a snake or an amphibian as well), and all others are lizard photographs, including lizards in their natural habitat and detailed views of body parts (such as heads with extended dewlaps or expanded wings of *Draco* spp.). Each photograph is accompanied by detailed locality data, which adds a lot of information. Actually a few photographs lack locality data (in particular, the *Gekko smithii* on pp. 82–83 was photographed on Pulau Perhentian Besar, Terengganu; the *Cyrtodactylus consobrinus* on p. 290 was in Hutan Lipur Sekayu, Terengganu; the *Eutropis multifasciata* p. 544 was in Bukit Larut, Perak, and the *Varanus salvator* on p. 683 was in Kuala Perlis, Perlis; L. L. Grismer, pers. comm.). Photos of Malaysian lizards were taken by the author in virtually all kinds of environments, from mangroves and highland cloud forests to karst caves, restaurants, and even massage parlors. One of the most extraordinary photographs in the book, on page 101, used to illustrate the introduction to Agamidae, shows a *Gonocephalus robinsonii* in its biotope. We asked Lee Grismer how this remarkable shot was taken: "The wide angle shot took several days to set up. I thought about it for a week before I shot it and I had very specific ideas and images in my head of what I wanted. I wanted a flashy upland endemic known only from a cloud forest and the shot to 'feel' cold and wet. I scouted out a place in Cameron Highlands to shoot the lizard and stayed throughout the day to determine at what time the best light would occur and hopefully get an idea of when the fog would arrive. Then I went to an area to where *Gonocephalus robinsonii* are the most attractive. I caught the lizard and brought it back to the site and set it on the log and got my gear ready. Just as I began shooting, the clouds began to roll in as you can see in the top of the photo" (L. L. Grismer, pers. comm.).

Each species account includes the scientific name of the species and its author(s), a common Malaysian name, a reference to the original description of the species with the type locality, a diagnosis, a morphological description, a coloration description, a distribution section, a natural history section, and a list of the examined museum material with collection numbers and localities. In some species, when appropriate, there is an additional section on geographic variation. In those cases where the species is variable or suspected to be a species complex, the variation is often well illustrated in the several photographs provided, and several potentially undescribed species are illustrated (like the lowland form of *Cnemaspis mcguirei* shown on figures 287–288, which actually represents a distinct, undescribed species — L.L. Grismer pers. comm., as well as several atypically colored *Cyrtodactylus pulchellus*). Each species account is accompanied by a specific dot map, with a detailed caption listing the mapped localities (these maps are not counted among the 530 figures mentioned above). Maps are not provided for only four species: *Hemidactylus frenatus* and *Eutropis multifasciata*, because they are ubiquitous, and the two introduced alien species. About 90% of the photographs were taken by the author himself. Only nine species are not illustrated (*Pseudocalotes dringi*, *Cnemaspis argus*, *Cyrtodactylus stresemanni*, *Lygosoma bampfyldei*, *Sphenomorphus anomalopus*, *S. cophias*, *S. langkawiensis*, *S. malayanus*, and *S. sibuensis*), and just a few species were illustrated only by photographs taken out of Peninsular Malaysia (*Hemidactylus garnotii*, from Myanmar; *Eutropis novemcarinata* from Myanmar; *Lygosoma albopunctatum*, from India; *Lygosoma herberti*, from Thailand; *Sphenomorphus maculatus*, from Cambodia; and *S. stellatus*, from Cambodia and Vietnam). Such a huge proportion of photos taken of individuals native to the area covered by the book is absolutely remarkable. Too many books are illustrated by photos of individuals from populations outside the area covered, and that sometimes later turn out to belong to distinct taxa.

Detailed morphological data on Malaysian lizards were lacking for many species, and dispersed in many journal articles, often old and difficult to find. This new book offers a very complete and homogeneous description of each species, in a level of detail that has not been achieved in any synthetic work on Southeast Asian lizards since Taylor's (1963) opus on Thai lizards. These detailed morphological descriptions make the book an extremely useful tool for identification and for the future work of taxonomists.

The natural history section is based on very thorough field notes taken for 15 years and retrieved from taxonomic indices the author put in his notebooks at the end of each year, a method that was already successfully adopted for the author's book on Baja California (2002). It is by reading these field notes that one fully realizes how much field work actually entered into this book: many remote localities were visited at numerous occasions over a number of years and at different seasons, which allowed, among other useful information, a better understanding of the reproductive cycles of each species. Lee Grismer's *in situ* observations represent a really large proportion of what is presently known on the natural history of the local lizards. These natural history accounts testify to the quasi-obsessional dedication of the author to the improvement of our knowledge on each species. Another sign of this extreme dedication is the large number of Malaysian and American students and researchers Lee Grismer has trained and is still training on Malaysian herpetology through courses and group field trips, as notably reflected by the multi-authorships of many papers listed in the literature section.

The literature cited section includes 480 pertinent references, the most recent of which date from early 2011 (indeed on page 99 it is stated that the acquisition of data for the book terminated on 3 April 2011, a very useful bit of information that we would encourage all book authors to provide).

Negative points about this remarkable book are few, and to find most of them required a very thorough examination of the book. The introduction gives a list of the species with scientific and common names, but the latter are not always those used in the main text of the book. We regret the absence of an index in the book. More importantly, we feel there should be an introductory chapter on scale morphology and morphological characters used in identification keys. The keys are very well conceived, but are usable only by persons who already have a very good knowledge of lizard meristic characters. Drawings showing the various scale types, and a brief definition of each type, would have allowed more people to use the keys without needing recourse to other books describing and illustrating these characters. The key to *Draco* spp. (p. 158) largely uses the number of ribs supporting the patagium, but the variation in rib numbers in the key does not reflect the whole variation as indicated in the species accounts (see accounts for *D. formosus*, *D. sumatranus*, and *D. taeniopterus*), which might lead to some misidentifications. The key to scincid genera (p. 545) misses entries to the genera *Dasia* and *Eutropis*. The key to *Sphenomorphus* spp. (couplet 7) states that *S. langkawiensis* has 60–62 paravertebral 'scales' (actually 'scale rows'), while the species account indicates it has 60–72; this mistake has some consequences for the use of the key. In couplet 11 of the same key, there is an alternative between six and five supraoculars, but it does not take into account the variation within *S. scotophilus* (as given in the species account), which also makes the key to *Sphenomorphus* spp. a bit delicate to use. The type locality for *Lygosoma herberti* was copied and pasted from that of the former species account (*L. bowringii*: Hongkong), but is actually 'Nakhon Si Thammarat Mts., peninsular Thailand' (Taylor 1963). As the author states, the book does not intend to provide a detailed taxonomic history for each species; however, for a number of recently described species, natural history data, summarized in the species accounts' natural history sections, were published before their description, and it would have been useful to know under which name they had then been referred to. A number of references cited in the main text are missing in the literature cited section, and in the latter several references are not in alphabetical order. There are some typographic errors in the book, but these certainly do not occur with a frequency that would distract from the reading and consultation of the book. These few negative points are by no means significant in view of the extremely high general quality of the book.

Lee Grismer has to be congratulated to have restricted himself to a limited and manageable taxonomic group over a limited geographical area, and to have provided detailed and comprehensive information about it, as well as identification keys including all species treated and photographs illustrating nearly all of them. There is indeed a dangerous tendency, maybe motivated by commercial reasons imposed by publishers, for guides to cover too many species over a too large geographical area. This tendency is well examplified by a recent "field guide" that treats about 1000 reptile species and subspecies from eight Southeast Asian countries (Das 2010), including Malaysia and Singapore. This represents so many taxa and so much information to deal with that in the end, to fit in a single book, descriptions had to be extremely brief and not sufficiently diagnostic. Further, no keys were provided, more than a third of the lizards were not illustrated, and much information is missing or erroneous, rendering the guide very superficial and nearly impossible to use in the field for identification purposes (Pauwels and David 2011). Accounts on Malaysian lizards contained so many errors that in the opus discussed here, Grismer had to mention these mistakes in not less than 48 instances throughout the book.

Lee Grismer's latest book is absolutely exceptional by universal standards, and it is without any hesitation that we strongly recommend it to all naturalists, herpetologists, teachers, and conservationists who want to know more about Malaysian lizards and Peninsular Malaysia. The author is currently working on the description of more than 15 new Malaysian lizard species (Gekkonidae and Scincidae), that will be integrated into a next edition of the book; with Malaysian colleagues he is finishing up a book on Malaysian snakes, and he will as well participate in a book on Malaysian amphibians that should appear next year—all books will be of the same style as the one treated here (Grismer, pers. comm., Dec. 2011). Needless to say, we are waiting impatiently.

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Herpetological Review, 2012, 43(1), 157–159.

Amphibians and Reptiles: An Introduction to Their Natural History and Conservation

by Marty Crump. 2011. McDonald & Woodward Publishing Company (www.mwpubco.com). 249 pp. Softcover. US $29.95. ISBN 978-1-935778-20-2.

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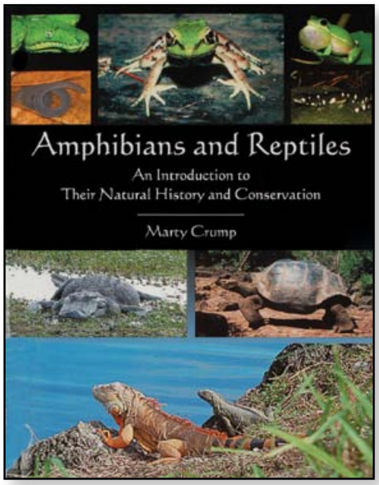

Herpetologists know that amphibians and reptiles are endlessly engaging of the mind and spirit, and deserving of our efforts to protect them and their habitats. We do require people, however, who can transition information from herpetological journals to popular outlets. We especially need those who can reach out to children, because as the author notes in her dedication to this book, children "hold the future of amphibians and reptiles in their hands."

According to information posted on Amazon.com, Marty Crump's latest book is intended for middle-school children and older. It is a revision of the first edition (2002), which became, according to the publisher's website, "the 'Outstanding Trade Book for Students, K-12' in 2004 and 'Selector's Choice,' an award given jointly by the National Science Teachers Association and the Children's Book Council."

Dr. Crump is well-known to readers of this journal for her work in tropical herpetology and behavioral ecology, which led her to author such books as *In Search of the Golden Frog* (2000), *Headless Males Make Great Lovers: And Other Unusual Natural Histories* (2007), *Sexy Orchids Make Lousy Lovers: & Other Unusual Relationships* (2009), and *Extinction in Our Times: Global Amphibian Decline* (2009, coauthored with James P. Collins). The book under review here is the second of her children's books; the other is the recently-published *Mysteries of the Komodo Dragon: The Biggest, Deadliest Lizard Gives Up Its Secrets* (2010). She is also the coauthor of one of the herpetology textbooks, now in its fourth edition (2009).

Since this book is pitched at children in grades 6–8, I ran the first paragraph of the first chapter through a test for readability scores, which provided a mean score of 7.7 grade level for five measures, which is appropriate. The book contains 17 chapters, which have an average length of 13.1 pages. This seems like a comfortable read for the intended 12–14-year-olds, especially as the chapters often are divided into sections and provided with numerous illustrations.

I found two features of the book's chapters especially inviting. One is that the illustrations, both black-and-white (135 of them) and color (eight multi-photo plates), have legends that provide the reader with some interesting information about the creature pictured. For example, the legend for figure 7 on page 9 of the first chapter reads: "Komodo dragons, the largest lizards in the world, get their food in three major ways. They ambush active prey, attack sleeping animals, and eat dead animals such as these fish washed up onto the beach." The photograph, naturally, shows one of these varanids consuming some dead fish.

Among the color photographs is one that is truly "suitable for framing." It shows Dr. Brady Barr hefting a 4-foot 9-inch *Andrias japonicus*. The question posed by the author is how he can manage to hold onto such a slippery creature. Although Brady is smiling (well, maybe grimacing), he is probably hissing "Quick, take the damn photo!" This photo also appears on the AmphibiaWeb site and must be seen to be believed. The information provided there indicates that the animal (the salamander, not Brady) weighed 86 pounds (39 kg).

Another color photo, of the Titicaca Water Frog (*Telmatobius culeus*), taken by Danté Fenolio, is rather eerie. Crump says, "What a face!" I agree. It is a good choice to place in this book, since this species is judged Critically Endangered by the IUCN, having undergone an 80% population decline in the last 15 years (amphibiaweb.org).

The other feature I found inviting is that words that might prove difficult for middle-schoolers are italicized, indicating they are defined in the four-page glossary. Nonetheless, an indication of their meaning often appears in the text, which helps the reading ease and promotes vocabulary expansion.

Dr. Crump's book also features three appendices. Appendix I lists additional resources (books and websites) on amphibians and reptiles, and their conservation (six pages). Appendix II provides names and addresses for 17 conservation organizations, ranging from the big, broad-scale groups like Conservation

International, World Wildlife Fund, and Worldwatch to groups with a narrower focus, such as Save the Frogs. Appendix III offers some “amphibian and reptile place names,” such as Frog Suck, Wyoming, Toad Suck, Arkansas, and Lizard Lick, North Carolina, with an invitation for the reader to find more (the three I mention would be hard to beat). Appendix IV lists the photographic credits. The book concludes with a page and a half listing of the “main sources consulted,” which are, as the author notes, “in addition to more than 100 scientific papers.” An eight-page-plus index also is included, in which the references to illustrations are in boldface type.

The first six chapters are concerned with the natural history of amphibians and reptiles and the remaining 11 with their conservation. The initial chapter is entitled “Too Weird to Be True?” and is intended to pull the reader into the book. It deals with the appearance, defense mechanisms, parental care, and feeding of amphibians and reptiles and uses several unusual creatures as examples. The author notes that as “interesting as these isolated tidbits of information are, they really don’t tell us much about reptiles and amphibians,” so the next four chapters introduce more typical species to the reader. The first of these chapters answers the question “What are Amphibians and Reptiles?” by discussing their similarities and differences. Also, a two-and-a-half-page box introduces scientific classification and another provides four examples by using the seven standard taxonomic levels. Nevertheless, scientific names generally are avoided, although they could have been included in another appendix. The three chapters that follow, one of which deals with amphibians and the other two with reptiles, provide more details. As expected, each of these chapters is subdivided along ordinal lines, with discussions that summarize general information in a pleasant but information-packed narrative.

Chapter 6 describes the key roles amphibians and reptiles play in their ecosystems and sets the stage for the principal purpose of the book—to promote conservation. In doing so, Dr. Crump emphasizes the “conveyor-belt” role these animals play in “transfer[ing] energy from invertebrates to *endothermic* predators higher up the *food chain*.” Thus, she provides a rationale for conserving amphibians and reptiles in their natural habitats by asking the question, “What would happen if Earth lost large numbers of amphibians and reptiles?” This central question is coupled with another, “How much longer will amphibians and reptiles be around to serve as critical components of ecosystems?,” which provides the focus for the remainder of the book.

So, significant emphasis is placed on conservation, inasmuch as more than half of the book (131 of 249 pages) is devoted to this subject (indeed, this is the reason I was interested in reviewing this book). The author’s examination of conservation issues begins with Chapter 7, entitled “Disappearing Acts.” As its name suggests, this chapter deals with examples of decline and disappearance, the IUCN conservation status categories, numbers and percentages of amphibians and reptiles under threat, the six major causes of amphibian and reptile declines, and the features that render certain of these creatures more prone to population decline.

Chapter 8, entitled “Why Should We Care?” presents arguments explaining why amphibians and reptiles should be of concern to humans. Crump notes that we should care because we are responsible for most of the declines, we are still learning about these organisms, we put them to important uses, we recognize their importance in both aquatic and terrestrial ecosystems, and we acknowledge that “every living species has a right to exist.”

The next two chapters explore direct and indirect reasons why amphibians and reptiles are undergoing decline. Chapter 9 considers the direct impacts, including the use of skins for leather and whole animals and parts as souvenirs, the use of flesh as food, the use of live creatures as pets, the use of body parts in folk remedies and modern medicine, and the use of living and preserved animals in research and teaching. Chapter 10 examines the indirect impacts of habitat modification and destruction, the introduction of exotic species, and environmental pollution.

Chapter 11 is entitled “Who Turned Up the Heat?” and obviously discusses global warming. The author indicates that humans have created the problem by burning fossil fuels, and disabled the fundamental solution by cutting down trees and plants, the carbon dioxide absorbers. She also notes that many amphibians and reptiles, including their eggs, might not be able to adapt to the warmer, drier conditions, as well as the predicted increase in UV levels.

The major environmental problem facing amphibians is discussed in Chapter 12, entitled “Attack of the Killer Fungus!” Logically, Dr. Crump begins the story of *Bd* with her personal story of watching *Incilius periglenes* disappear from the elfin forests at the Monteverde Cloud Forest Reserve in northern Costa Rica during the unseasonably warm and dry 1986–1987 period. Jay Savage had described this extraordinary toad only two decades earlier; since then, this anuran has become the “poster child” for amphibian conservation. Although the disappearance of *I. periglenes* has not been linked to *Bd* infection, this disease certainly has been demonstrated to be the causal agent in the decline of other amphibian populations on all continents where they occur. The author uses the El Valle, Panama, example of the “heroic airlift” that removed individuals of 35 species to sanctuary in Atlanta, Georgia, to ask a number of ethical questions about which species should receive our attention and for how long, especially since conservation dollars always are limited. Does it make sense to maintain certain species in captivity in the unconfirmed hope that their natural homes eventually might be able to support them in the indeterminate future? These kinds of questions can be used to set up debates in middle-school classes to teach students how to construct defensible arguments.

The remaining five chapters examine solutions for amphibian and reptile conservation, beginning with a chapter on human attitudes toward these creatures, entitled “Good or Bad? Love or Hate?” The author notes that people will “protect amphibians and reptiles only if they think these animals are worthy of protection.” However, according to the author, only a nickel of every conservation dollar is spent on these animals. Then, the reader is regaled with stories of these organisms as symbols of both good and evil, depending on the nature of the superstitions and legends involved. She concludes the chapter by emphasizing the importance of knowing what people think about these creatures, as a prelude to changing negative attitudes that will increase our appreciation and desire to protect them.

Chapter 14 asks the question “We Can Live Together, Can’t We?” The main point of this chapter is evident in the concept of living together and not apart. That is, conservation biologists must find ways to provide living spaces for amphibians and reptiles in a world that, as I write this sentence on Halloween, 2011, now supports a human population of seven billion. The seventh billion was added in just 12 years, the same length of time it took for the sixth billion to accrue. Dr. Crump emphasizes not only an obvious solution, preservation of land, but also ways in which we can change how we use the environment to promote amphibian and reptile survival, such as building under-road tunnels (I am writing this review in Gainesville, Florida, where just south of town such structures have been installed in the road across the famed Payne's Prairie), digging ponds to facilitate amphibian breeding, and using shrimp nets equipped with turtle excluder devices.

The final three chapters deal with ways to help conserve amphibians and reptiles. Chapter 15 is concerned with "Research and Education." For herpetologists, it is self-evident that "We need more research to understand how we can best protect amphibians and reptiles." Clearly, we know much less about their lives than we have discovered to date, especially as new species continue to be discovered. As new taxa are named, the number and percentage of threatened forms will likely increase, and each new taxon will represent a new biology to explore. Since most species remain poorly-known, biologists are facing an enormous task. So, basic research is essential, as long as the right questions are being asked. Environmental education programs are the link between scientists and the public, and the author notes that such programs can be coupled with tourism to become ecotourism or provide opportunities for non-scientists to participate in scientific research. She also points out the importance of private individuals (read "children") educating themselves to become agents of change to benefit conservation.

Chapter 16, "What Else Can Be Done?," treats of other ways to protect amphibians and reptiles, such as through laws like the Endangered Species Act and the CITES treaty, which work when properly enforced. In addition, populations can be reestablished in their natural habitat, animals can be captive bred for skins, food, and pets, wild populations can be harvested more wisely, and alternatives to classroom specimen dissections can be used, like videotapes, CD-ROMs, and computer-based virtual dissections.

The last chapter is oriented toward the reader and asks, "What Can YOU Do to Help?" Actually, the discussion is divided among things for the reader to do—and not to do. The things not to do are somewhat limited, but the ones to do are more extensive, such as educating oneself about these animals, volunteering time to individuals and organizations, sharing information with others, supporting conservations organizations, being a responsible pet owner, and improving one's backyard to serve as habitat for amphibians and reptiles. The last paragraph of the book presents a simple, but powerful message—"You and I together can make a difference. Please help."

Marty Crump has done herpetologists a tremendous favor in creating this book directed toward middle-schoolers. She transferred our concerns about the fate of amphibians and reptiles expressed in our technical papers and books to the young people who can make a real difference in the years to come, in a way they can understand. She carefully crafted her book using the appropriate language level and engaging information about "our" creatures that can be read on more than one level. The text can be read straight through to provide a strong conservation message, but also can be explored more deeply by pursuing the information in the additional references and various appendices.

Although my elder grandson, at age nine, is still a bit young for this book, I think his burgeoning interest in herpetology will stand him in good stead and I plan to give him my copy. It won't be so long, anyway, before he will be ready to handle all this excellent book has to offer.

I have just a couple of suggestions for improvement, should this book go into a third edition. One is to turn the black-and-white illustrations into color. Amphibians and reptiles are colorful organisms and seeing their color patterns can increase their appeal to young readers. The other is to include ideas about appropriate projects and presentations for the target audience to make in school and other social settings.

Herpetological Review, 2012, 43(1), 159–160.

The Eponym Dictionary of Reptiles

by Bo Beolens, Michael Watkins, and Michael Grayson. 2011. Johns Hopkins University Press, Baltimore, Maryland (http://www.press.jhu.edu). xiii + 296 pp. Hardbound. US $100.00. ISBN 978-1-4214-0135-5.

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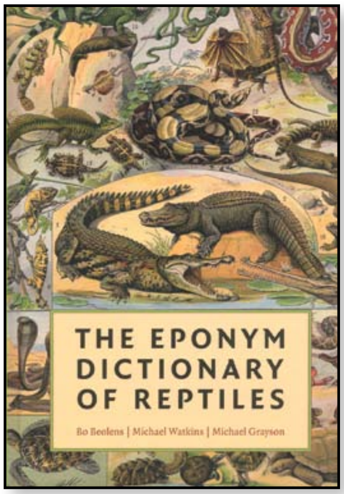

Most reptile aficionados will recognize that *Amphiesma boulengeri* has been named after George Albert Boulenger (1858–1937) or *Plestiodon copei* after Edward Drinker Cope (1840–1897). But who was the Dugand in *Leptotyphlops dugandi* (now *Trilepida dugandi*) or the King in *Anops kingi* (now *Amphisbaena kingii*)? Such questions are answered by the *Eponym Dictionary of Reptiles*, which tracks down the people after whom species have been named. This book is welcome because the issue at stake is not that trivial. For instance, there are quite a few species epithets which appear to be named for people but which originate from place names, such as *Chironius vincenti* named after the island St. Vincent. These cases are covered too. In addition, the dictionary contains those species that have been named after people but may not be obvious, e.g., *Eurydactylodes agricolae*, named after Aaron Bauer, whose last name means "farmer" in German, which is translated to "agricola" in Latin. Finally, some reptile names which may sound like people, such as *Anolis bicaorum*, have been named after organizations, here the Bay Island Conservation Association (BICA). While such cases are also included in the dictionary, they may not have been covered comprehensively as the origin of some names remains mysterious. Many older species descriptions did not explain their etymology, so once their authors have passed away it becomes a detective's job to figure out their history. In addition to the scientific names, Beolens et al. also catalogued those common names derived from people, such as Blanford's Pipe Snake (*Cylindrophis lineatus*), even though the scientific name is of purely Greek and Latin origin. Finally, a surprising number of species (or genera) have been named after mythical characters, be they from Tolkien's Lord of the Rings (*Liolaemus tulkas*) or Burroughs' Tarzan (*Calumma tarzan*), appropriately named after its arboreal lifestyle.

The Eponym Dictionary tracks down the names of a total of 4,130 species and subspecies and is alphabetically organized by eponym, that is, usually the last name of the person (or sometimes place, organization, etc.) after which species have been named. Each entry then lists the species named after that person. Most people have only one or two species named after them, but the superstars such as Boulenger or Cope can claim dozens of species named in their honor. For each person a very short biography is provided, sometimes only a sentence ("Charles Snell donated the holotype of this snake [*Vermicella snelli*] to the Western Australian Museum") but rarely exceeding a quarter of a page, even for the most famous herpetologists. While this heterogeneity is a certain weakness of the book, it may have been a necessary compromise to keep the book's size manageable. Nevertheless, it is one of those dictionaries which you may end up reading just for fun as it is a treasure trove of anecdotes, amusing factoids, and family gossip (many herpetologists named some snake or turtle after their wives [often!], sisters, uncles, mother-in-laws, or other family members and friends). We also learn about less pleasant aspects of being a herpetologist, such as the abrupt ends of Roberto Donoso-Barros (*Liolaemus donosoi* and other species) and Benoit Mys (*Carlia mysi*) in car crashes or Johan August Wahlberg (*Colopus wahlbergii*), who was killed by an elephant, or those scientists who died, perhaps fittingly, from snake bite (e.g., Robert Mertens and Joseph Slowinski).

Besides the heterogeneity of the entries, I have only few complaints: first, the introduction and background information is limited to a mere three pages. Here the authors explain how to use the book and how they dealt with dubious names (such as those common names erected by Frank and Ramus). I would have liked to see a bit more data analysis, e.g., some statistics (where the patrons came from, when they lived, etc.) or a list of epithets that are neither Greek or Latin nor derived from people. It would have been helpful to indicate for which names more extensive biographies or obituaries are available. While some resources are cited (e.g., Adler 1989, 2007; Rieck et al. 2001), there is no information on whose biographies they contain. Furthermore, the whole bibliography is less than two pages so you have to resort to other resources to find the original descriptions of the species listed (e.g., the supplement to Uetz 2010).

Despite its shortcomings, Beolens and co-authors have produced a great book that is fun to read. Notably, they have already published similar books on birds and mammals (Beolens and Watkins 2003; Beolens et al. 2009) and reportedly have a companion volume on amphibians in press. If they live long enough to work through the 30,000 species of fish, a future eponym dictionary of vertebrates may keep saving biologists from buying *People* magazine for years to come.

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Amphibians of Malawi

by Vincenzo Mercurio. 2011. Edition Chimaira, Frankfurt am Main (www.chimaira.de). 393 pp. Hardcover. 49,80 Euros (approximately US $65.00). ISBN 978-3-89973-495-9.

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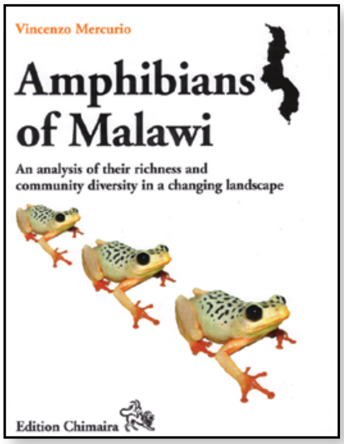

Recent years have seen a welcome proliferation of high quality country and regional field guides to the amphibians and reptiles of various parts of Africa (e.g., Baha El Din 2006; Channing and Howell 2006; du Preez and Carruthers 2009) and a new book by Vincenzo Mercurio on the amphibians of Malawi continues this trend. Malawi is a comparatively small southern African country that is wedged in among Tanzania, Mozambique, and Zambia and extends along the southern part of the East African Rift Valley and Lake Malawi. Although Malawi has an interesting geographical position between the mountains of Southern Africa and those of the Albertine Rift and the Eastern Arc, it lacks the high number of endemic amphibian species found to the south and north. As such, Malawi has received relatively little attention and has usually been considered only peripherally in treatments of the herpetofauna of its more important southern and eastern neighbors. The only notable exception has been Margaret Stewart's (1967) seminal book *Amphibians of Malawi*—the first and only comprehensive guide to the amphibians of Malawi. With his new book, Mercurio presents a complete update of our knowledge of the amphibians of this country.

The book is based on Mercurio's Ph.D. dissertation, which explains the somewhat unconventional (for a field guide) arrangement of the different parts of the books into introduction, material and methods, results, discussion, abstract, German summary, and a bibliography. The first part comprises some 50 pages and contains more or less comprehensive introductions to the geography, geology, climate, and particularly the vegetation, with several subsections devoted to the various predominant vegetation types. Further sections are dedicated to the current state of conservation, list protected areas, and provide an overview of the history of herpetological research in Malawi as well as of studies using amphibians as biological indicators in Africa in general. The second part (Material and Methods) gives details on the survey methods used and on data analyses. Of more interest to most readers in this chapter will most likely be the detailed descriptions of the sites visited for the study. Both introduction and material and methods are amply illustrated with a number of maps (political, geographical, hydrological, protected areas, study sites) and excellent, representative photographs of the different habitat types and study sites visited.

The bulk of the results section contains the systematic accounts, which cover 86 taxa including two possible new species and four subspecies and include keys to all genera and species. All species accounts contain a list of synonyms and list the pertinent literature, a brief diagnostic description of the species, the geographic range, the distribution in Malawi, and habitat. Every account is completed by a distribution map indicating known records from Malawi. Most species accounts further contain a section with remarks and, where applicable, a list of examined material (with museum/field numbers) and a description of the advertisement call complete with accompanying spectrograms and oscillograms. With a few exceptions, every species is illustrated by one, sometimes more, good quality photographs. In addition, some species accounts also include photographs depicting the typical habitat.

The remainder of the results contains a section describing the diversity of reproductive modes of the anurans of Malawi and another section with an analysis of species richness and community diversity. The section on reproductive diversity is largely identical to Mercurio et al. (2009) and contains descriptions of the anuran reproductive modes (following Wells 2007) found in Malawi, as well as a comprehensive table listing every species with its reproductive mode and further reproductive characters such as clutch size, egg deposition site, tadpole habitat, etc. Alas, information on whether the tadpole of a given species has been described or is unknown is missing.

The relatively short discussion mostly summarizes and synthesizes the distribution and abundance data from the results section. The main conclusion is that at the species level there is a "lack of a match between environmental degradation and amphibian diversity." As a reason for this result, the author suggests either considerable ecological plasticity of the Malawian anurans or a change in the amphibian communities in historical times due to progressive human habitat modification, a scenario which overall does not seem to be all that unlikely. As the author furthermore points out, true forest endemics or other habitat specialists are almost completely absent from the sampled species and most of them are habitat generalists, which may also account for the lack of correspondence between habitat degradation and amphibian diversity. These main results are furthermore even less surprising when considering that apparently only species with a good visibility and thus likelihood of detection were selected for the abundance analyses, whereas small ground-dwelling, aquatic, or fossorial species were excluded. Given that the resulting data set contains primarily species known to be tolerant of anthropogenic habitat modifications it is not surprising that the author arrives at his main conclusion.

Overall, as a field guide, the book seems well worth its price. Especially the detailed and well-illustrated introductory chapters and species accounts provide a lot of information; anyone planning on visiting Malawi or interested in the amphibians of the area in general will find plenty of interest here. Unfortunately a list of museum acronyms seems to be lacking. Moreover, some of the acronyms given for the examined material seem to indicate field numbers (VM – Vincenzo Mercurio?), rather than collection numbers, and I could not find any mention in the book into which museum collection these specimens will be accessioned, if they have not been already. What detracts further from the overall positive impression of the book are some entirely unnecessary errors and typos. The figure legends especially contain a disproportionately high number of errors; some examples: fig. 82 shows a specimen of *Leptopelis mossambicus* in "position of minimus traspiration" and refers to figs. 67 and 69, which supposedly illustrate the same specimen but in fact represent the distribution map and a photograph of *Arthroleptis xenodactyloides*. Figure 215 refers to a "*Hyperolius viridiflayassaevus*" instead of *Hyperolius viridiflavus*, fig. 298 to "*Ptychadena* cf. *fuscigula*" instead of *Amietia* cf. *fuscigula*, and fig. 304 to "*Afrana angolensis*" instead of *Amietia angolensis*. In Table 10, the percentages for the Chongoni sample do not add up to 100%. The records for *Phrynobatrachus perpalmatus* are indicated by giant red squares in the distribution map, instead of the small dots used in the other maps. In addition, there are a number of simple typos throughout the text (e.g., "*P. uzugwensis*," "*S. murumontanus*," "embrionic development") as well as grammatical errors. After all the work that went into this book, it is regrettable that neither the author nor the publisher seemed to have found the time for that final round of proof reading.

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Snakes and Reptiles: The Scariest Cold-Blooded Creatures on Earth

by Susan Barraclough. 2008. Sandy Creek Press, 122 Fifth Ave., New York. Hardcover. 192 pp. US $25.95. ISBN 9781435107748.

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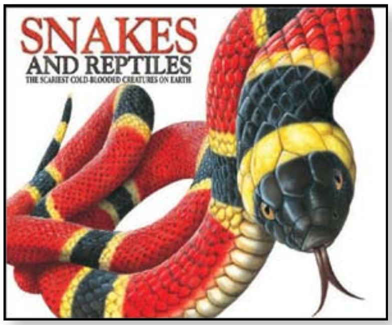


Although one may find a review of a children's book a bit out of the ordinary from typical reviews of scholarly works in herpetology, I believe this one to be no less important. I appeal to my fellow herpetologists, colleagues, and parents who frequent the children's sections of local and national

Fig. 1. Examples of the overdramatized illustrations and accounts presented in this book creating undo fear among children. Examples presented here include a woman collecting timber from a woodpile in her garden who is subsequently bitten by a coral snake (A), a man bitten by a cottonmouth while canoeing in Florida (B), and a Brazilian fisherman bleeding out in his boat after attempting primitive first-aid on the bite wounds (C). Illustrations are copyrighted by Sandy Creek Press with arrangement with Amber Books, Ltd.

bookstores with their sons and daughters. What I found and present here is most offensive to our passionate and professional efforts to create an appreciation and respect for the animals we study. We are all too familiar with how the presentation of misleading and inaccurate information creates misconceptions in herpetology and the "only good snake is a dead snake" mentality. I, as do so many of my colleagues, dedicate countless hours to educating our youth about amphibians and reptiles in an attempt to shape future citizens that are well informed and educated so that they might also share our appreciation and respect for these unique animals and their interesting natural histories. The above author, Susan Barraclough, has now touched the minds of thousands (ca. 18,000 copies sold)[1] and has single-handedly undermined our efforts to properly educate and instill an appreciation and respect for reptiles. Instead, such appreciation is replaced with undue fear, misunderstanding, and a certain propensity for wanton killing.

This book is targeted toward a very impressionable age group of 8 to 10 year-olds and is littered with outrageous images (e.g., Fig. 1) in an attempt to create a true sense of fear rather than wonderment. Even the quote on the inside cover "…reptiles are the real-life monsters of the modern world" and the quotes within the cottonmouth account (e.g., "As dark and sinister as its swampland habitat, this fierce hunter haunts the sluggish waters of southeastern United States" and "After the snake plunges its fangs into a victim, it hangs on until its venom starts to work") are unconscionable statements for someone who is supposedly dedicated to the education of children. The book's jacket states that "Susan Barroclough is a highly experienced author and editor specializing in children's nonfiction and reference books" and "during her career she has written and managed a wide range of teen and children's titles on science and the natural world." It seems that the author has now managed to fit a project of science fiction into her repertoire.

In addition to this "reference book" being clearly overdramatized all for the sake of creating a fear factor, it is also riddled with errors and misconceptions (Table 1). However, my objective here is not to critically review the material presented in this book, but rather to draw attention to the educational "miscue" that has now influenced thousands of impressionable children. As true science educators we understand and share a basic educational philosophy for meeting curiosity with honesty and scientific integrity, especially when touching the minds of children. This book has failed in this basic and essential educational philosophy. In my professional opinion, this publication may be a perfect example of how not to educate our youth about science and natural history. As most of my colleagues will likely concur with my assessment of this book, I assure you that this book is one that I will be keeping off my son's bookshelf.

Table 1. Representative examples of errors and misconceptions presented in the book, *Snakes and Reptiles: The Scariest Cold-Blooded Creatures on Earth.*

Example	Error or Misconception
1	"Snakes and Reptiles" rather than "Snake and other Reptiles" (title page).
2	Perpetuation of the term "cold-blooded" rather than the use of ectothermic (title page).
3	Use of "*species*" rather than species or sp. to indicate a non-specified specific epithet of the genus (throughout book). By italicizing the word species this indicates that "species" is the specific epithet.
4	Species are organized alphabetically by genus (Throughout book). This becomes extremely noticeable and problematic in the "Turtles, Crocodiles, & Alligators" section (p. 147) when turtle species seem to be randomly present between crocodilian species.
5	"Relentlessly tightening its powerful coils, the mighty boa constrictor squeezes the last breath out of its victims, listening for their heartbeat..." (p. 21).
6	Description of a rattlesnake's rattle: "This is a series of horny shells…" (p. 38).
7	Tuatara is listed and classified under lizards (p. 130).
8	Why an amphibian section in a book entitled "Snakes and Reptiles"? (p. 165).

[1]Approximately 18,000 copies were sold estimated from the Amazon Best Sellers Rank (88,039 in Nov. 2011) where this rank is converted to the number of books sold per week using a logarithmic function (fonerbooks.com). This number is then used in a calculation (BeneathTheCover.com) to account for all national sales and years since publication.

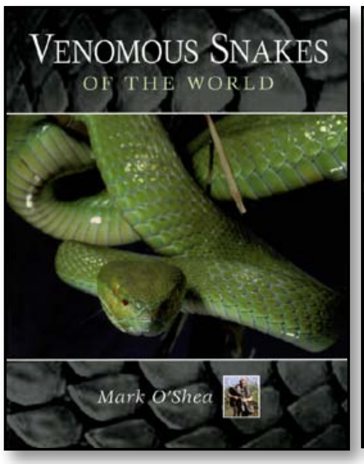
PUBLICATIONS RECEIVED

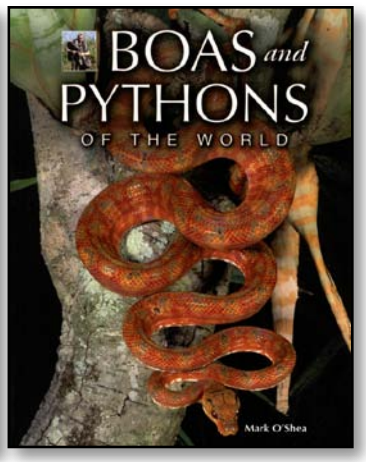
Venomous Snakes of the World

by Mark O'Shea. 2011. Princeton University Press, Princeton, New Jersey (http://press.princeton.edu) and New Holland Publishers, UK. 160 pp. Softcover. US $19.95, £13.95. ISBN 978-0-691-15023-9.

Boas and Pythons of the World

by Mark O'Shea. 2011. Princeton University Press, Princeton, New Jersey (http://press.princeton.edu) and New Holland Publishers, UK. 160 pp. Softcover. US $19.95, £13.95. ISBN 978-0-691-15015-4.





Both of these titles are newly issued softbound versions of books originally published in 2005 and 2007, respectively, with no changes evident. Both are characterized by outstanding color photography (ca. 150 images in each) and attractive graphics.

Venomous Snakes begins with an explanation as to which species are included in a book on "venomous" snakes, given the diversity of colubrid (*sensu lato*) species with some level of toxic secretions. The solution was to include those species whose bites are known or suspected to be dangerous. The book first presents a review of snake anatomy, with particular attention to features relevant for venomous snakes, followed by concise overviews of families of modern snakes containing venomous species, snake venoms and their actions, seasnake adaptations for marine living, and conservation. The snakes are then presented geographically: Americas, Eurasia, Africa, Tropical Asia, Australasia, and the Oceans.

An introductory section in *Boas and Pythons* provides current information about evolution, anatomy, diversity and distribution of basal snakes, constriction, giant snakes, man-eating snakes, and conservation. As in the preceding volume, the snakes are covered by geographic region. The book's title is a bit misleading, in that O'Shea includes all basal lineages (Scolecophidia + Alethinophidia), so readers might be surprised to see photos of blindsnakes alongside boas and pythons.

These attractive books are not only for a general readership, but also for herpetologists who will appreciate the beautiful photography of so many interesting species.

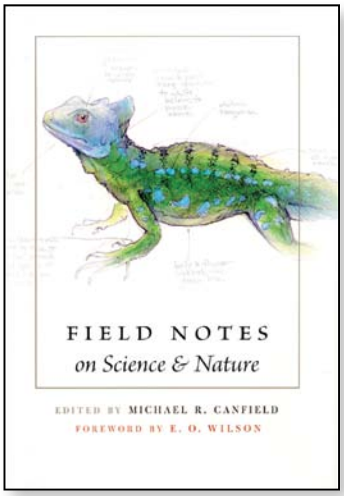
Reptiles de la Provincia de Río Negro, Argentina

by Gustavo J. Scrocchi, Cristian S. Abdala, Javier Nori, and Hussam Zaher. 2010. Fondo Editorial Rionegrino, Nequen. 249 pp. ISBN 978-9-507-67042-8. $140.00 pesos (about US $33.00) plus shipping and handling. Available from Fundación Miguel Lillo (Centro de Información Geobiológico del NOA / Biblioteca: Sra. Mariá Angela Prieto - maprieto@lillo.org.ar).

This is an important contribution documenting the reptiles from an extensive and diverse area from the Argentinian portion of Patagonia. Since many of the species contained in this book are not endemic to this region, it will also be useful for people interested in the reptiles of other Argentinian provinces and the surrounding countries of Chile, Bolivia, Paraguay, Uruguay, and the south of Brazil. This handy-sized book is illustrated by more than 130 color photographs and other images, including maps showing the location of museum specimens from the four major Argentinian museum collections. The book includes a brief description of Río Negro province, including its geography, geology, phytogeography, and a concise account of its land use and location of protected areas. There is an easy to follow and very useful identification key accompanied by illustrations of the diagnostic characters. The guide covers the only turtle known from this province, two amphisbaenians, 17 snakes, and about 50 lizards. For each one of the species there is a brief morphological description, including comparisons with similar species, an account of the localities where the species has been reported, including areas outside Río Negro, conservation status, and, in some instances, ecological information. For some of the species the different vernacular names applied to each species in different areas are presented.

Field Notes on Science & Nature

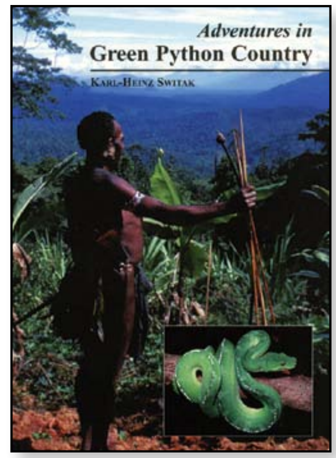
Michael R. Canfield (Editor). 2011. Harvard University Press, Cambridge, Massachusetts. 297 pp. Hardcover, US $27.95. ISBN 978-0-674-05757-9.



Despite the cover illustration, this is not a herpetological title, but nevertheless should appeal to field biologists of all stripes as well as those who simply enjoy observing nature. E. O. Wilson, in sharing examples from his own field notebook, introduces a collection of essays by eminent biologists who take readers into the field, sharing moments of exhilaration and inspiration, along with the inevitable challenges and drudgery that come with field work. All contributors stress the importance of recording field data, which might seem self-evident to most readers, but here we read of examples that emphatically reinforce that point. On display are various methods and systems for recording observations, especially useful for younger workers. George Schaller explains how he approaches study subjects (lions, mountain gorillas, giant pandas, etc.) and includes reproductions of pages from his field notebooks. Legendary birder Kenn Kaufman extols the virtues of list keeping, drawing examples from bird counts, Roger Kitching's skills as an artist/naturalist are displayed, and Jenny Keller offers a brief, but profusely illustrated, tutorial on making drawings in the field. Piotr Naskrecki explains his use of relational databases for organizing field data, likely an attractive option in this era of portable devices. John Perrine and James Patton provide an overview of the "Grinnell Method" of taking field notes, developed in the early 1900s by Joseph Grinnell, the visionary first director of the Museum of Vertebrate Zoology at UC Berkeley. This method has been adopted and adapted by legions of MVZ students and researchers, forming a data-rich historical foundation for vertebrate communities in California. In summary, this is an enjoyable read and an excellent resource for students.

Adventures in Green Python Country

by Karl-Heinz Switak. 2006. Natur und Tier – Verlag GmbH, Münster. 362 pp. Softcover, 39.80 Euros (approx. US $56.60). ISBN 978-3-937285-82-5. Available through Chimaira Buchhandelsgesellschaft mbH (www.chimaira.de).



Although published in 2006, this title remains barely known to most herpetologists. Karl-Heinz Switak is a native German who eventually became Supervising Herpetologist at the Steinhart Aquarium at the California Academy of Sciences in San Francisco. This book is another in a growing list of semi-autobiographical herp-adventure volumes in the spirit of Frank Buck and Carl Kauffeld. Switak recounts his travels to Indonesia, Australia, and most prominently, New Guinea, often in search of Green Tree Pythons. Although the writing at times seems as though from a different era, the large number of color photographs of herpetofauna (especially Green Tree Pythons), as well as people and places, make this a worthy addition to the bookshelves of herpetologists, python-keeping hobbyists, as well as those who enjoy reading about real-life adventures in exotic places.

INFORMATION FOR CONTRIBUTORS

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