

Herpetological Review

Volume 41, Number 1 — March 2010



SSAR Officers (2010)

President

BRIAN CROTHER
Department of Biological Sciences
Southeastern Louisiana University
Hammond, Louisiana 70402, USA
e-mail: bcrother@selu.edu

President-elect

JOSEPH MENDELSON, III
Zoo Atlanta, 800 Cherokee Avenue, SE
Atlanta, Georgia 30315, USA
e-mail: jmendelson@zoatlanta.org

Secretary

MARION R. PREEST
Joint Science Department
The Claremont Colleges
Claremont, California 91711, USA
e-mail: mpreest@jsd.claremont.edu

Treasurer

KIRSTEN E. NICHOLSON
Department of Biology, Brooks 217
Central Michigan University
Mt. Pleasant, Michigan 48859, USA
e-mail: kirsten.nicholson@cmich.edu

Publications Secretary

BRECK BARTHOLMEW
P.O. Box 58517
Salt Lake City, Utah 84158, USA
e-mail: ssar@herplit.com

Immediate Past President

ROY McDIARMID
USGS Patuxent Wildlife Research Center
Smithsonian Institution
P.O. Box 37012
Washington, DC 20113-7012, USA

Directors

PAUL CHIPPINDALE (2010)
TIFFANY DOAN (2010)
TRAVIS LaDUC (2010)
STEPHEN RICHTER (2010)
DAVID CUNDALL (2012)
KEVIN DE QUEIROZ (2012)
PATRICK GREGORY (2012)
ANN PATERSON (2012)

Trustee

GEORGE R. PISANI
University of Kansas, USA

SSAR Editors

Journal of Herpetology

ERIN MUTHS, Co-Editor
U.S. Geological Survey
Fort Collins, Colorado 80526, USA

GAD PERRY, Co-Editor
Texas Tech University
Lubbock, Texas 79409, USA

Contributions to Herpetology

KRAIG ADLER, Editor
Department of Neurobiology & Behavior
Cornell University
Ithaca, New York 14853, USA

Facsimile Reprints in Herpetology

AARON M. BAUER, Editor
Department of Biology
Villanova University
Villanova, Pennsylvania 19085, USA

Herpetological Circulars

JOHN J. MORIARTY, Editor
3261 Victoria Street
Shoreview, Minnesota 55126, USA

Catalogue of American Amphibians and Reptiles

ANDREW H. PRICE, Editor
Texas Natural History Collections
The University of Texas at Austin
Austin, Texas 78758-4445, USA

Herpetological Conservation

JOSEPH C. MITCHELL, Editor
Mitchell Ecological Research Services
P.O. Box 5638
Gainesville, Florida 32627-5638, USA

HERPETOLOGICAL REVIEW

The Quarterly News-Journal of the Society for the Study of Amphibians and Reptiles

Editor

ROBERT W. HANSEN
16333 Deer Path Lane
Clovis, California 93619-9735, USA
HerpReview@gmail.com

Associate Editors

ROBERT E. ESPINOZA
California State University, Northridge

ROBERT N. REED
USGS Fort Collins Science Center

EMILY N. TAYLOR
California Polytechnic State University

MICHAEL F. BENARD
Case Western Reserve University

KERRY GRIFFIS-KYLE
Texas Tech University

MICHAEL S. GRACE
Florida Institute of Technology

GUNTHER KÖHLER
Forschungsinstitut und
Naturmuseum Senckenberg

DEANNA H. OLSON
USDA Forestry Science Lab

PETER V. LINDEMAN
Edinboro University

JESSE L. BRUNNER
State University of New York at
Syracuse

Section Editors

Book Reviews

AARON M. BAUER
Department of Biology
Villanova University
Villanova, Pennsylvania 19085, USA
aaron.bauer@villanova.edu

Geographic Distribution

ALAN M. RICHMOND
Biology Department, Morrill IV South
University of Massachusetts
611 North Pleasant Street
Amherst, Massachusetts 01003-9297, USA
alanr@bio.umass.edu

Geographic Distribution

GUSTAVO J. SCROCCHI
Instituto de Herpetología
Fundación Miguel Lillo, Miguel Lillo 251
4000 Tucumán, Argentina
soniak@unt.edu.ar

Natural History Notes

CHARLES W. PAINTER
New Mexico Dept. of Game & Fish
P.O. Box 25112
Santa Fe, New Mexico 87504, USA
charles.painter@state.nm.us

Copy Editors

RAUL DIAZ
KYLE MILLER HESED
DANIEL PORTIK

Current Research

JOSHUA M. HALE
Department of Sciences
Museum Victoria, GPO Box 666
Melbourne, Victoria 3001, Australia
jhale@museum.vic.gov.au

Geographic Distribution

INDRANEIL DAS
Institute of Biodiversity &
Environmental Conservation
Universiti Malaysia Sarawak
94300, Kota Samarahan, Sarawak, Malaysia
idas@ibec.unimas.my

Zoo View

JAMES B. MURPHY
Department of Herpetology
National Zoological Park
3001 Connecticut Ave., NW
Washington, D.C. 20008, USA
jbmurphy2@juno.com

Natural History Notes

JAMES H. HARDING
MSU Museum
Michigan State University
East Lansing, Michigan 48824, USA
hardingj@msu.edu

Natural History Notes

JACKSON D. SHEDD
699 Eaton Street #34
Oceanside, California 92054, USA
Jackson.Shedd@gmail.com

Current Research

BEN LOWE
Department of EEB
University of Minnesota
St Paul, Minnesota 55108, USA
lowe0160@umn.edu

Geographic Distribution

JERRY D. JOHNSON
Department of Biological Sciences
The University of Texas at El Paso
El Paso, Texas 79968, USA
jjohnson@utep.edu

Herpetological Husbandry

BRAD LOCK
Department of Herpetology
Zoo Atlanta
800 Cherokee Ave., S.E.
Atlanta, Georgia 30315, USA
block@zoatlanta.org

Natural History Notes

JOHN D. WILLSON
University of Georgia
Savannah River Ecology Lab
Drawer E
Aiken, South Carolina 29802, USA
willson@uga.edu

SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

www.ssarherps.org



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

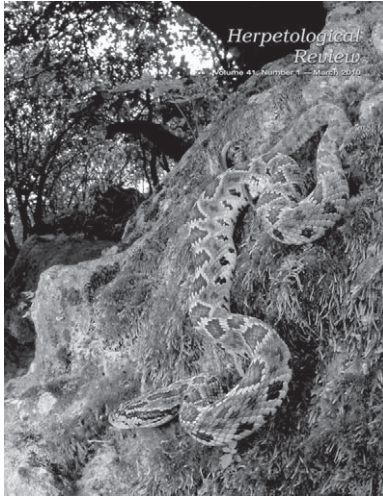
2010 — Providence, Rhode Island, 7–12 July (with ASIH, HL)

2011 — Minneapolis, Minnesota, dates TBA (with ASIH, HL)

2012 — Vancouver, British Columbia, dates TBA (with ASIH, HL, WCH)

About Our Cover: *Crotalus lannomi*

In the summer of 1966, Joseph R. Lannom, Jr. traveled south from the U.S. to collect lizards along the west coast of Mexico for University of Arizona herpetologist Charles Lowe, but spent his evenings searching the roads for snakes. On the night of 26 June, he chanced upon a road-killed rattlesnake in the mountains of western Jalisco. That snake would turn out to be a new species, and the only one of its kind known over the next half century. Countless herpetologists—professionals and amateurs—ventured



into the mountains of western Jalisco in the decades that followed, hoping to find another. But all who tried failed, and *Crotalus lannomi* seemed to take on near-mythic proportions—becoming a sort of “holy grail” of rattlesnakes.

In describing the new species, Wilmer Tanner (1966. *Herpetologica* 22[4]:298–302) noted the morphological similarity to the Sinaloan Long-tailed Rattlesnake, *C. stejnegeri*, another rare rattlesnake occurring farther north in the mountains of Sinaloa; both species were notably characterized by a long, slender tail, terminating in small rattles. Very recently, Jonathan Campbell and Oscar Flores-Villela described *C. ericsmithi*—the Guerreran Long-tailed Rattlesnake—from the Sierra Madre del Sur of Guerrero, roughly 500 km south of the type locality of *lannomi* (Campbell and Flores-Villela 2008. *Herpetologica* 64[2]:246–257). Campbell and Flores-Villela confirmed the alliance of *ericsmithi*, *lannomi*, and *stejnegeri* based on scalation, color pattern, and morphology. These three species occur in lower montane ecotonal habitats—transitional between lower-elevation tropical deciduous forest and upper-elevation oak or pine-oak forests. As a group, the long-tailed rattlesnakes also seem to be rare, with two of the three species (*ericsmithi* and *lannomi*) known only from single types, and the third (*stejnegeri*) known from only about a dozen specimens.

Over the last few years, field searches have intensified to locate populations of *Crotalus lannomi* in various mountain ranges in Nayarit, Jalisco, and Colima. In 2008, five specimens assignable to *C. lannomi* were found at two localities in the foothills of Colima, roughly 50 km from the type locality in adjacent Jalisco. This new material is reported in this issue of *HR* (Reyes-Velasco et al., pp. 19–25), adding significantly to our knowledge of the distribution and natural history of these elusive snakes.

The cover image depicts an adult female (61 cm TL) *Crotalus lannomi* recorded in the field in Colima. The photograph was a collaborative effort by **Ginny Weatherman**, **Jacobo Reyes-Velasco**, **Jason Jones**, and **Chris Grünwald**. The image was recorded with a Nikon D200 DSLR with a Tokina 10–17mm wide angle lens (17mm focal length, f/14, ISO 500), illuminated by a single Nikon SB800 flash with a Gary Fong dome diffuser. Reyes-Velasco is a student at the Universidad de Guadalajara; his herpetological field work in southwestern Mexico has resulted in a number of important finds (e.g., Reyes-Velasco et al. 2009. *Herpetological Review* 40:117–120; Reyes-Velasco and Mulcahy 2010. *Herpetologica* 66[1]:99–110). Weatherman, Jones, and Grünwald have spent considerable time in recent years traveling throughout Mexico; their efforts have yielded many significant herpetological finds.

SSAR is pleased to acknowledge the financial support of Ronald A. Javitch, Montreal, in making possible the publication of the cover image as well as the color figures in the Reyes-Velasco et al. article elsewhere in this issue.

SSAR BUSINESS

SSAR Henri Seibert Awards for 2010

The Henri Seibert Awards were initiated in 1992 to provide recognition for the best student papers presented at the annual meeting of the SSAR. To be eligible, the presented paper must be the result of research by the individual making the presentation. The research must have been conducted while the student was enrolled in either an undergraduate or graduate degree program. Please refer to *Herpetological Review* 28(4):175 and the SSAR website (<http://www.ssarherps.org/pages/seibert.php>) for recommendations to students entering the Henri Seibert Competition. Students entering the competition must be members of SSAR. The presentations will be judged by the SSAR student prize committee. One Henri Seibert Award of US \$200 may be given in each of the following four categories: Systematics/Evolution, Ecology, Physiology/Morphology, and Conservation. Students may win a Henri Seibert award only one time. Please indicate the appropriate category for which you are applying on the abstract submission form. Announcement of winners will be made at the SSAR Business Meeting. All participants should be present at the business meeting. Contact Patrick Owen for further information, patrick.owen@uc.edu.

SSAR Silent Auction Donations

The SSAR announces the Fourteenth Annual Silent Auction to be held at the 2010 Joint Meeting of Ichthyologists and Herpetologists (JMIH) in Providence, Rhode Island, USA, 7–12 July. In previous years, items for the Silent Auction have been limited to frameable art. However, 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 Providence 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 JMIH. Your donations help provide opportunities for students to attend and present their research. If you are interested in donating an item or two (tax deductible for U.S. residents), please contact Matthew D. Venesky (mvenesky@memphis.edu) for more information.

NEWSNOTES

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 biology or any other relevant aspect of upland habitat conservation and management. The amount of the award is variable, but projects up to \$2,000.00 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. Email submissions in word are preferred.

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

Announcing a New Panamanian Field Station

La MICA Biological Station is located in El Copé, Coclé Province, Republic of Panama, near Omar Torrijos Herrera National Park. This area has been important for amphibian and reptile research and offers opportunities for any discipline of terrestrial biology. Much of the area is mid-elevation cloud forest with sites between 200 and 1440 m (station at 400 m). La MICA is situated on the Continental Divide, offering opportunities for studies in the Atlantic and Pacific versants.

La MICA Biological Station welcomes students, researchers, courses, and general tourists from around the world. Our facilities are under development, but currently offer a cabin, bathhouse, and soon a dormitory for 26 people with classroom. Logistics, including local transportation, food, guides/field assistants, and access to remote sites are all in place.

Nearly every position for employment is filled by local residents, thus providing them sustainable, conservation-oriented employment.

Visit the project website at <http://www.lamica.org> for more information.

Kansas Herpetological Society Annual Meeting

The Kansas Herpetological Society held its 36th Annual Meeting at MidAmerica Nazarene University in Olathe, Kansas, on November 7–8, 2009. Over 135 participants attended scientific paper sessions presented by scientists and students from across the nation. Featured speaker was Alexander Pyron (SUNY Stony Brook).

J. Kent Daniel, student at Pittsburg State University, received the 2009 Howard K. Gloyd/Edward H. Taylor Scholarship, honoring the memory of two great biologists with strong ties to Kansas. The 2009 Alan H. Kamb Grant for Research on Kansas Snakes was made to Mindy Walker, Rockhurst University. Paul Rodriguez, University of Nebraska, Omaha, was chosen as the twelfth recipient of “The Suzanne L. & Joseph T. Collins Award for Excellence in Kansas Herpetology.” Emilie Blevins, Kansas State University, was presented with the George Toland Award for the best student paper given at the meeting. In 2010, the Society will meet at the Topeka Zoo, Topeka, Kansas.

MEETINGS

Meetings Calendar

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

22–24 April 2010—57th Annual Meeting, Southwestern Association of Naturalists, Llano River Field Station, Junction, Texas, USA. Information: <http://www.biosurvey.ou.edu/swan/annualm10.html>

7–12 July 2010—Joint Meeting of Ichthyologists and Herpetologists (ASIH / HL / SSAR), Providence, Rhode Island, USA. Information: <http://www.dce.k-state.edu/conf/jointmeeting/>

21–24 July 2010—33rd Annual International Herpetological Symposium, Tucson, Arizona, USA. Information: <http://www.kingsnake.com/ihs/>

10–11 August 2010—Northeast Partners in Amphibian and Reptile Conservation (NEPARC) Annual Meeting, Acadia National Park, Maine, USA. Information: <http://www.pwrc.usgs.gov/nepar/>

22–26 September 2010—VIII National Congress of Societas Herpetologica Italica, Abruzzo, Italy. Information: shiabruzzo2010.iscizioni@gmail.com

12–14 November 2010—5th National Symposium on the Ecology, Status, and Conservation of the Diamondback Terrapin, at Louisiana University’s Marine Consortium (LUMCON) in Chauvin, Louisiana, USA. Hosted by the Diamondback Terrapin Working Group. Information: www.dtwg.org

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; postal and 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.herpllit.com> and click on “Current Herpetological Contents.”

New Frog Family Found in South America

Studies over the last decade have brought to light evidence that the frog family known as “Leptodactylidae” for most of the 20th century is, in fact, wildly polyphyletic. Efforts to rectify this problem have resulted in the erection of numerous new families across Neobatrachia (including a much more exclusive Leptodactylidae). A recent phylogenetic study of a clade containing a subset of the former Leptodactylidae (named

Terrarana by the authors of the study and consisting of New World direct-developing frogs) revealed that one sample represented a deeply divergent and previously unrecognized lineage. Based on morphology, the sample had been assigned to the speciose terraranan genus *Pristimantis*, yet it was recovered as sister to the remainder of Terrarana. During subsequent searches of the locality in Guyana from which the sample in question was taken, one of the authors was able to procure more samples of this frog which they have described as a new genus and species, *Ceuthomantis smaragdinus*, and placed in a new family, Ceuthomantidae. An analysis confirming the placement of the new samples as belonging to a clade sister to the remainder of Terrarana also found a sister relationship between Terrarana and Hemiphraetidae (marsupial frogs), illustrating that direct development was present in the common ancestor of these two groups of New World frogs. Furthermore, based on shared morphological characters, the authors were able to assign two other species of *Pristimantis* from Venezuela's Guiana Shield to the newly-erected family and genus. The discovery of this deeply-divergent lineage illustrates how much biodiversity remains to be discovered in the Guiana Highlands.

HEINICKE, M. P., W. E. DUELLMAN, L. TRUEB, D. B. MEANS, R. D. MACCULLOCH, AND S. B. HEDGES. 2009. A new frog family (Anura: Terrarana) from South America and an expanded direct-developing clade revealed by molecular phylogeny. *Zootaxa* 2211:1–35.

Correspondence to: Blair Hedges, Department of Biology, 208 Mueller Laboratory, Pennsylvania State University, University Park, Pennsylvania 16802, USA; e-mail: sbh1@psu.edu.

Turtles, Salamanders, and Mammals Exhibit an Ancestral Mode of Germ Cell Specification

In most developing vertebrates, competent cells are either induced in the embryo to become specific tissues (“inductive mode;” seen in mammals and salamanders) or exist as a pre-determined germ plasm (“predetermined;” seen in frogs, snakes, and birds). These two different modes of cell differentiation are distinguished by the location of the primordial germ cells (PGCs) on the embryo (determined via *in situ* hybridization). In a few others (notably some Lepidosauria, including *Sphenodon*), PGCs are distributed all around the embryo (called the “circumferential pattern”) and the mode of cell differentiation is unclear and may be either inductive or predetermined (or perhaps even both). The authors of this paper determined that turtles, unlike birds, exhibit the inductive mode of germ cell formation. Furthermore, they reconstructed the evolutionary history of germ cell specification mode in tetrapods. This analysis provided support to the hypothesis that inductive mode is the ancestral condition of tetrapods. Additionally, it was revealed that while germ plasm has evolved several times independently in tetrapods, reversion back to the inductive mode may not be possible. Finally, a change from inductive mode of germ cell formation to the circumferential pattern of PGC distribution occurred in the lineage leading to lepidosaurs.

BACHVAROVA, R. F., B. I. CROTHER, K. MANOVA, J. CHATFIELD, C. M. SHOEMAKER, D. P. CREWS, AND A. D. JOHNSON. 2009. Expression of

Dazl and *Vasa* in turtle embryos and ovaries: evidence for inductive specification of germ cells. *Evolution & Development* 11:524–533.

Correspondence to: Rosemary Bachvarova, Department of Cell and Developmental Biology, Weill Medical College of Cornell University, New York, New York 10065, USA; e-mail: bachva@med.cornell.edu.

Diverse Lines of Evidence Used to Delineate Species of Horned Lizards

Stemming from disagreement among researchers as to which characters are important in species delineation, the Coast Horned Lizard (*Phrynosoma coronatum*) of coastal California and Baja California has undergone several taxonomic rearrangements over the years. The authors of this paper aimed to examine different lines of evidence and generate a hypothesis of species limits compatible with a modern, coalescence-informed understanding of speciation. Morphological (horn shape), genetic (mitochondrial and nuclear DNA), and ecological (environmental) data were procured for samples from across the distribution of the species. Morphological and ecological data were subjected to principal components analyses to identify geographically-cohesive groupings. Analyses of the genetic data were performed to examine evolutionary relationships (Bayesian analysis of mtDNA plus a topology test comparing the recovered phylogeny with an alternate, previously-published, morphologically-based phylogeny which recognizes four species) and to determine levels of gene flow across contact zones (nuDNA). As a criterion for species delineation, the authors looked for corroboration between independent lines of evidence. Based on DNA and ecological data correspondence, three species were recovered (one largely coincident with each of the states of Baja California Sur, Baja California, and California [from south to north]); this hypothesis was found to fit the genetic data far better than the alternate four-species hypothesis. Horn morphology separated the southern species; however, it was not able to differentiate the two northern species from each other. Furthermore, genetic subdivision of the California species recovered in the mtDNA analysis failed to align with other lines of inference and therefore was regarded as intraspecific genetic variation. As the Coast Horned Lizard has suffered precipitous population declines across much of its range, discovering that it is comprised of three genetically isolated species elevates the importance of conserving what remains of its coastal habitat.

LEACHÉ, A. D., M. S. KOO, C. L. SPENCER, T. J. PAPPENFUSS, R. N. FISHER, AND J. A. MCGUIRE. 2009. Quantifying ecological, morphological, and genetic variation to delimit species in the coast horned lizard species complex (*Phrynosoma*). *Proceedings of the National Academy of Sciences* 106:12418–12423.

Correspondence to: Adam Leaché, Genome Center and Section of Evolution and Ecology, One Shields Avenue, University of California, Davis, CA 95616, USA; email: aleache@ucdavis.edu

Communal Egg-laying More Widespread Among Herps than We Thought

Historically, communal egg-laying in reptiles and amphibians has been viewed as an uncommon phenomenon and hypotheses

to explain instances of this phenomenon often have invoked a paucity of suitable oviposition sites. The authors of this paper suggest that this paradigm is false. They performed a meta-analysis of published accounts of communal egg-laying and found the phenomenon to be far more pervasive than previously acknowledged. Failure to recognize the prevalence of communal egg-laying in these groups may stem from a general lack of knowledge of oviposition behavior (reproductive biology is known for perhaps as few as 7% of squamates of the southern continents and Asia). Furthermore, it has long been noted that herp species known to engage in communal egg-laying frequently lay solitarily as well. Through game theory, the authors illustrate scenarios that would maintain both communal and solitary egg-laying strategies in a population. This work demonstrates the scarcity of knowledge about egg-laying and the importance of understanding reproductive behavior in amphibians and reptiles.

DOODY, J. S., S. FREEDBERG, AND J. S. KEOGH. 2009. Communal egg-laying in reptiles and amphibians: evolutionary patterns and hypotheses. *The Quarterly Review of Biology* 84:229–252.

Correspondence to: Sean Doody, Applied Ecology Research Group, University of Canberra, ACT 2601, Australia; e-mail: scott.doody@anu.edu.au.

Niche Tracking and Adaptation in *Liolaemus* Lizards

Animals seem well adapted to their environments and genetic theory suggests that quantitative traits should be able to evolve quickly to fit changing environmental conditions. However, studies of niche evolution repeatedly recover a strong signal of phylogenetic niche conservatism (stasis). To explore this paradox, the authors of this paper collected distribution, physiological (e.g., body temperature, rates of heating and cooling), and ecological (thermal environment) data for 32 species of Chilean *Liolaemus* (Iguania: Liolaemidae). Using a phylogeny of the genus, they reconstructed environmental conditions inhabited by the ancestral lineages along the phylogeny; this was subsequently analyzed for patterns of niche evolution. Physiological data and environmental conditions were also investigated for correlations. Interestingly, temperature preference and physiology seem capable of evolving rapidly to new conditions (i.e., exhibit a strong correlation); however a strong phylogenetic signal of niche conservatism was recovered from the phylogenetic analysis. Given the changes in climatic conditions during the late Cenozoic in South America and the ability of the lizards to adapt quickly, what explains the strong phylogenetic signal? The authors invoke “niche tracking,” changes in distribution to follow favorable conditions, to explain this. Further, they suggest that while adaptation occurs rapidly, perhaps it only allows *Liolaemus* populations to change to a moderate degree; they are therefore unable to adapt to wide fluctuations and must overcome these types of changes via niche tracking. These findings illustrate that perhaps the ability to adapt quickly to new environmental conditions and phylogenetic niche conservatism are not necessarily contradictory.

LABRA, A., J. PIENAAR, AND T. F. HANSEN. 2009. Evolution of thermal physiology in *Liolaemus* lizards: adaptation, phylogenetic inertia, and niche tracking. *The American Naturalist* 174:204–220.

Correspondence to: Antonieta Labra, Department of Biology, Centre for Ecological and Evolutionary Synthesis, University of Oslo, PB1066, 0316 Oslo, Norway; e-mail: antonieta.labra@bio.uio.no.

Patterns of Size Evolution in *Amphiuma* Salamanders

Amphiumidae is a family of aquatic, limb-reduced salamanders from the southeastern United States comprising three species: the one-, two- and three-toed amphiumas. The later two species achieve enormous size (>65 cm in total length and rivaling only members of the family Cryptobranchidae). Using genetic samples from across the range of the family, the authors conducted phylogenetic analyses of this group (both mitochondrial and nuclear DNA, analyzed separately). Interestingly, these analyses revealed that the two large species were not each other's closest relative (contrary to earlier studies); the large two-toed is most closely related to the modest-sized one-toed and more distantly related to the similarly-sized three-toed. This suggests that either the two large species underwent gigantism independently or, alternatively, the one-toed species experienced a size-reversal. Furthermore, as the one- and two-toed amphiumas are sympatric, this finding could represent an example of character displacement, whereby coexisting lineages diverge in some way to reduce interspecific competition. Alternatively, as the two species are rarely syntopic and the one-toed occupies a much smaller range than the other two species, this might represent the evolution of a small specialist from a large generalist (the authors favor this latter hypothesis). Finally, the authors posit that this reduction in body size may have been accomplished through neotony (the retention of juvenile characteristics); as evidence for this, they point to the fact that one-toed amphiuma reach sexual maturity earlier than their larger relatives.

BONETT, R. M., P. T. CHIPPINDALE, P. E. MOLER, R. W. VAN DEVENDER, AND D. B. WAKE. 2009. Evolution of gigantism in amphiumid salamanders. *PLoS ONE* 4(5):e5615. doi:10.1371/journal.pone.0005615.

Correspondence to: Ronald Bonett, Department of Biological Sciences, University of Tulsa, Tulsa, Oklahoma 74104, USA; e-mail: ron-bonett@utulsa.edu.

Hawksbill Turtles Go with the Flow When Dispersing

All species of sea turtles are recognized as either threatened or endangered. Unfortunately, efforts to conserve them are hampered, as little is known about the factors that contribute to hatchling dispersal. Traditionally, studies trying to assign samples from a mixed-stock to separate sources would perform a one-to-many assignment analysis (one stock, many sources). However, as animals from the sources are also going to other, unsampled mixed-stocks, a many-to-many mixed stock analysis is much more appropriate. Using a many-to-many method recently developed to investigate dispersal, the authors of this study analyzed genetic samples accumulated from a foraging aggregation of juvenile hawksbill turtles (*Eretmochelys*) in the Cayman Islands and from likely rookeries throughout the Caribbean Sea. Their findings demonstrate that the Cayman Islands foraging aggregation is

indeed derived from animals from every corner of the Caribbean. Furthermore, results from simulations using high-resolution ocean current data and a passive drift model of dispersal were significantly correlated with the recovered feeding aggregation genetic composition, suggesting that ocean currents play an important role in hatchling dispersal. The simulations also reveal that there is a high degree of dispersal pattern heterogeneity among the rookeries. While these results divulge how complex the system is, these findings also greatly inform sea turtle conservation efforts.

BLUMENTHAL, J. M., F. A. ABREU-GROBOIS, T. J. AUSTIN, A. C. BRODERICK, M. W. BRUFORD, M. S. COYNE, G. EBANKS-PETRIE, A. FORMIA, P. A. MEYLAN, A. B. MEYLAN, B. J. GODLEY. 2009. Turtle groups or turtle soup: dispersal patterns of hawksbill turtles in the Caribbean. *Molecular Ecology* 18:4841–4853.

Correspondence to: Brendan Godley, Centre for Ecology and Conservation, School of Biosciences, University of Exeter Cornwall Campus, Penryn TR10 9EZ, UK; e-mail: b.j.godley@exeter.ac.uk.

Behavior Evolution in *Anolis*

We have known for some time that adaptive radiations often lead species occupying similar microhabitats to evolve similar morphologies (the “ecomorph” paradigm). Does this phenomenon also lead species to evolve similar behaviors? To answer this question, the authors of this study investigated 13 *Anolis* species belonging to various ecomorph types at several Caribbean sites. They collected extensive behavioral and microhabitat data (including territorial display and territory size, visibility, and overlap). Analyses of these data were then performed to reveal correlations between ecomorph type and behavioral traits. Analyses performed include MANOVA (which controls for phylogenetic relationship), regression, and principal components analysis (PCA). Indeed, when the results from the PCA analysis were plotted in two dimensions, the various ecomorphs clustered together. The MANOVA analysis also recovered a strong correlation between ecomorph type and behavior. Post-hoc ANOVAs revealed that the data strongly support a correlation between ecomorph type and amount of male-male territorial overlap but not between ecomorph and display behavior. In particular, male ground-trunk specialists tolerate significantly more males with overlapping territories than male twig specialists do. Furthermore, it was revealed in the regression analyses that *Anolis* species occupying microhabitats with similar visibilities also engage in similar territorial displays. This study definitively demonstrates that like morphology, behavior is reflective of the environment in which the organism exists.

JOHNSON, M. A., L. J. REVELL, AND J. B. LOSOS. 2010. Behavioral convergence and adaptive radiation: effects of habitat use on territorial behavior in *Anolis* lizards. *Evolution* (in press). doi: 10.1111/j.1558-5646.2009.00881.x.

Correspondence to: Michele Johnson, Trinity University, Department of Biology, One Trinity Place, San Antonio, Texas 78212 USA; e-mail: michele.johnson@trinity.edu.

Sister Taxon to New World Pitvipers Revealed

Over the last decade, research into viperid systematics has revealed many new insights. For instance, we now know that New World pitvipers form a clade and likely are derived from a single dispersal across the Bering Land Bridge; however, attempts to discern which group of Asian pitvipers gave rise to them have not succeeded. To investigate this, the authors of this paper accumulated sequence data from seven genes (four mitochondrial; three nuclear) for representatives from every pitviper group. Analyses of these data revealed that New World pitvipers are sister to the genus *Gloydius*; interestingly, members of this genus were once considered congeneric with members of the New World *Agkistrodon*. Furthermore, this analysis found two enigmatic species, *Ovophis okinavensis* and *Trimeresurus gracilis*, falling outside their respective genera and instead forming a clade sister to the *Gloydius* + New World pitviper clade. The authors contend that these two species should be removed from their respective genera and placed together in a new genus (of which they are preparing a description). This study further illustrates the utility of incorporating nuclear data into studies of phylogenetic relationships, particularly in groups where mitochondrial DNA data alone has failed to resolve deeper-level relationships.

MALHOTRA, A., S. CREER, C. E. POOK, R. S. THORPE. 2010. Inclusion of nuclear intron sequence data helps to identify the Asian sister group of New World pitvipers. *Molecular Phylogenetics and Evolution* 54(1):172–178.

Correspondence to: Anita Malhotra, School of Biological Sciences, College of Natural Sciences, Bangor University, 3rd Floor ECW, Deiniol Road, Bangor, Gwynedd LL57 2UW, UK; e-mail: a.malhotra@bangor.ac.uk.

Chytrid Extirpations are Non-random

When *Batrachochytrium dendrobatidis* (*Bd*) infection spreads through a region and causes local extirpations, are the extirpations random or do certain ecological characteristics make one species of frog more prone to be eliminated than another? If species with small distributions are disproportionately affected, *Bd* epizootics should have a homogenizing effect on regional diversity. Using data from eight sites across Panama and Costa Rica, the authors of this study investigated the changes in patterns of frog diversity before and after *Bd* swept through the region. The results of this study show that *Bd* epidemics disproportionately remove locally endemic species and that frog communities are more homogeneous after *Bd* passes through. Prior to *Bd*, the various localities exhibited a strong positive correlation between geographic distance and community dissimilarity; afterward, this correlation was no longer significant. Further analysis revealed that the sites had significantly more similar frog communities after the epizootic than would be expected if the extirpations were randomly distributed. Post-*Bd* homogeneity also extended to familial-diversity, reproductive mode, and microhabitat. This study demonstrates the need to be concerned about not only the local but also the regional impacts of *Bd*.

SMITH, K. G., K. R. LIPS, AND J. M. CHASE. 2009. Selecting for extinction: nonrandom disease-associated extinction homogenizes amphibian biotas. *Ecology Letters* 12:1069–1078.

Correspondence to: Kevin Smith, Tyson Research Center, Washington University in St. Louis, 6750 Tyson Valley Rd, Eureka, Missouri 63025, USA; e-mail: kgs@wustl.edu.

Importance of Venom in Feeding Strategies of Giant Varanids

Recent studies have found that, contrary to previous speculation, the Komodo Dragon (*Varanus komodoensis*) possesses venom and likely does not rely on bacterial infection to subdue prey. However, the degree to which the venom delivery system is developed and the complexity and potency of the venom has remained unclear. To investigate this phenomenon, the authors analyzed the cranial mechanics and venom of *V. komodoensis*. Their results confirmed previous findings that the skull of *V. komodoensis* is unable to sustain large bite forces (relative to similar large reptilian predators such as *Crocodylus*). However, previous studies underestimated potential bite force by assuming that optimal forces were achieved when the mouth was closed; computer simulations conducted in this study showed that maximal bite force occurs when the mouth is open at an angle of 20°. Instead, the skull seems best suited for stresses associated with pulling forces (similar to sharks and saber-toothed cats). Analyses of the venom found it to possess a diverse array of chemicals, including toxins known to exhibit anti-coagulant, hypotensive, hemorrhagic, and shock-inducing properties (many of these proteins have also been found in other members of the clade Toxicofera). Additionally, magnetic resonance imaging revealed large, paired mandibular venom glands (running parallel to the salivary glands), each divided into five compartments and possessing ducts that deliver venom into the spaces between the teeth. These venom glands combined with strong pulling forces and large, serrated teeth provide *V. komodoensis* with a highly effective venom delivery system. As previous studies have shown that squamate lineages that adopt feeding strategies not reliant on venom (e.g., constricting, egg-eating) quickly lose their venom capabilities (as venoms and their accompanying architecture are metabolically expensive), the fact that *V. komodoensis* still possesses a highly-derived, functioning venom apparatus strongly suggests that it remains an essential part of their feeding strategy. Furthermore, as the skeletal morphology of the extinct *Varanus priscus* closely parallels that of *V. komodoensis*, this implies that *V. priscus* also likely utilized venom in its feeding strategy and therefore was the largest venomous animal to have walked the face of the earth.

FRY, B. G., AND COLLEAGUES. 2009. A central role for venom in predation by *Varanus komodoensis* (komodo dragon) and the extinct giant *Varanus (Megalania) priscus*. *Proceedings of the National Academy of Sciences* 106:8969–8974.

Correspondence to: Bryan Fry, Venomics Research Laboratory, Department of Biochemistry and Molecular Biology, University of Melbourne, Parkville, Victoria 3010, Australia; e-mail: bgf@unimelb.edu.au.

ZOO VIEW

Herpetological Review, 2010, 41(1), 6–16.
© 2010 by Society for the Study of Amphibians and Reptiles

Updating the Bookshelves Part V: Biographies and Autobiographies, Amphibian Extinction, Snake Ecology and Conservation, Rattlesnakes, Chelonians, Lizards and Crocodylians, Anoles

JAMES B. MURPHY

Department of Herpetology, Smithsonian National Zoological Park
3001 Connecticut Ave., N.W., Washington, DC 20008, USA
e-mail: jbmurphy2@juno.com

No passion in the world is equal to the passion to alter someone else's draft.
—H. G. Wells

Autobiographies and Biographies

When I was young, one of my favorite pastimes was to read the books of Raymond L. Ditmars, William Beebe, Thomas Barbour, Arthur Loveridge, Alexander Ruthven, and Ivan T. Sanderson and imagine the thrill of traveling to faraway places to search for amphibians, reptiles, and other exotic creatures. As I got older, looked at newer books, and actually had an opportunity to see some of the places mentioned, the pleasure intensified as I compared those experiences between the writers and my own. And if the opportunity to visit these locales did not materialize, then there was always the fallback of visualizing myself in these settings. Listed in Appendix I are some of my favorite titles.

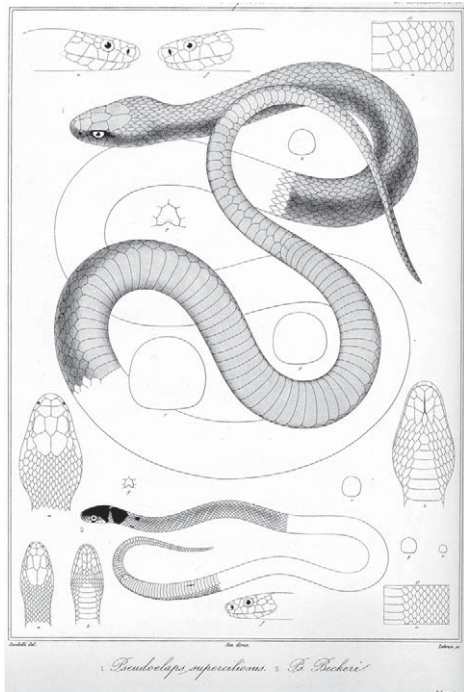
Three new herpetological autobiographies have appeared on the scene. D. Bruce Means has written a lovely book called *Stalking the Plumed Serpent and Other Adventures in Herpetology* (2008, Pineapple Press, Sarasota, Florida; ISBN: 978-1-56164-433-9). Twenty-two vignettes document his travels over 40 years studying amphibians and reptiles, ranging from his experiences with Eastern Diamondback Rattlesnakes to Bushmasters in Costa Rica. How many herpetologists can say that they encountered five of the deadliest Australian terrestrial elapids in the field: Inland Taipan (*Oxyuranus microlepidota*), Coastal Taipan (*O. scutellatus*), Eastern Brown Snake (*Pseudonaja textilis*), Mt. Chappell Island Ti-



D. Bruce Means found that White's Treefrog (*Litoria caerulea*) preys upon the Little-Bent-Winged Bat (*Miniopterus australis*) in a cave in Queensland, Australia. Illustration from John White's *Journal of a voyage to New South Wales, with sixty-five plates of nondescript animals, birds, lizards, serpents, curious cones of trees and other natural productions*.

Imprint: London: Printed for J. Debrett, 1790.

ger Snake (*Notechis ater serventyi*), and King Brown Snake (*Pseudechis australis*). One of his most interesting observations, accompanied by an arresting photograph, was that in addition to a number of snakes preying upon the Little-Bent-Winged Bat (*Miniopterus australis*) in a cave in Queensland, White's Treefrog (*Litoria caerulea*) also preys upon the mammals. Means tells many other stories relating his field experiences with the Moccasin, Alligator Snapping Turtle, Apalachicola Kingsnake named in his honor (*Lampropeltis getula meani*), Eastern Indigo Snake, Alabama Red Hills Salamander, Yucatán Peninsula Rattlesnake, American Alligators, and a number of species from Madagascar. This is a book well worth reading.



D. Bruce Means encountered five of the most dangerous Australian elapids in the field, including the Eastern Brown Snake (*Pseudonaja beckeri*, now *Pseudonaja textilis*). Illustration from *Iconographie générale des ophidiens* / par M. le professeur Jan . . . [en collaboration avec Mr. F. Sordelli.] ...

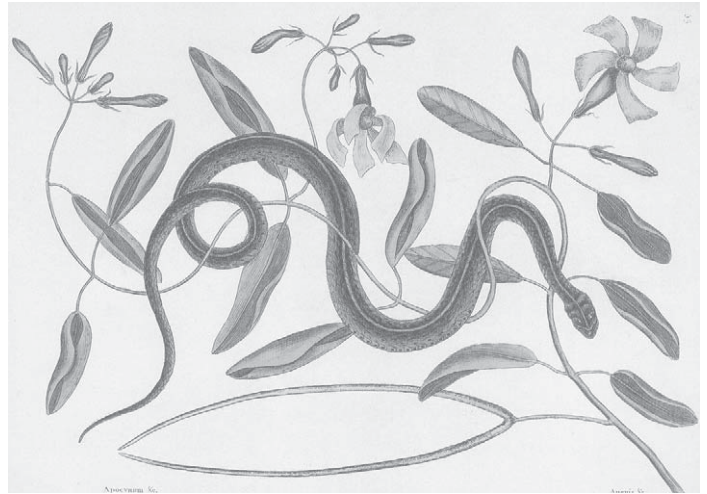
Imprint: Milan: chez l'auteur, [etc., etc.], 1860-1881.

The second autobiography was written by Leslie Anthony and called *Snakebit. Confessions of a Herpetologist* (2008; GreyStone Books; Vancouver, Toronto, Berkeley; ISBN 978-1-55365-236-6). Anthony was trained as a biologist (his herpetological name is Leslie A. Lowcock), working with Robert W. Murphy at the Royal Ontario Museum (ROM) for his doctorate and as a postdoc at McGill University's Redpath Museum in Canada. One of the strongest features of this book is his ability to explain complex biological principles in simple terms so the layman can understand. One example is his clear description of salamander reproductive isolation in Chapter 3 called "A Salamander under a Log."

Upon emergence from hibernation in Manitoba, Canada, hundreds of Red-Sided Gartersnakes (*Thamnophis sirtalis parietalis*) form snake balls where scores of males pursue and envelop a female in order to mate. Females secrete a sexually attractive pheromone which attracts potential mates. These spectacular aggregations are described by Anthony in the chapter "Ode to a Gartersnake"—"A human version of this chemical would be worth billions, its power evident in the almost comical spectacle of "mating balls" observed at dens in the spring, where a single pheromone-secreting female is assailed by up to a hundred males. On second thought, writhing masses of humans would not only look ridiculous but also pose a definite traffic hazard."

He captures our keen fashion sense—"It was déjà vu all over again when I realized [groups of herpetologists] were also executing familiar fashion-suicide pacts. Herpetologists thought cargo pants, with all their loops and sagging pockets, were invented for them, and they'd long taken ownership with gusto. But their almost comical devotion to khaki was more CRAP than GAP; the official uniform of established herpetologists was cargo shorts, Hawaiian shirt, white tube socks, and running shoes that had never been run in."

At the summer herp meetings at University of Michigan in 1988, the



The Common Garter Snake (*Thamnophis sirtalis sirtalis*) includes 12 recognized subspecies, one of which ranges into Manitoba, Canada. The Red-Sided Garter Snake (*T. s. parietalis*) occurs in prodigious numbers and when emerging from den sites in the Spring as described by Leslie Anthony, is one of the most overwhelming snake assemblages in the world.

Illustration from Mark Catesby's *The natural history of Carolina, Florida and the Bahama islands: containing the figures of birds, beasts, fishes, serpents, insects, and plants: particularly the forest-trees, shrubs, and other plants, not hitherto described, or very incorrectly figured by authors. Together with their descriptions in English and French. To which, are added observations on the air, soil, and waters: with remarks upon agriculture, grain, pulse, roots, &c. To the whole, is prefixed a new and correct map of the countries treated of.*

Catesby calls this "*Anguis viridis maculatus*. The green spotted snake." (vol. 2, pl. 53). His description says: "These Serpents sometimes grow to four times the Bigness of the Figure, are said not to be venomous, and are great Robbers of Hen-Roosts, sucking Eggs, tho' their Size seldom enables them to devour the Fowls.

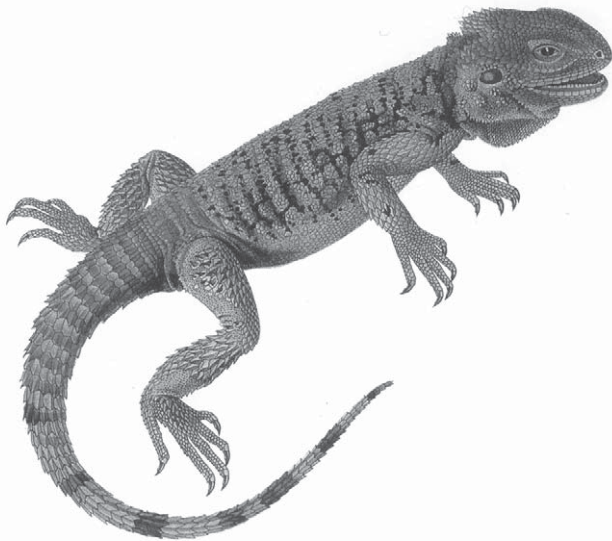
As the change of Marks and Colour in some Serpents cause Confusion in distinguishing them, I would willingly avoid Mistakes, by describing the same Snake twice, and multiplying the Kinds to more than there are: And I am diffident in determinating, whether this be a different Kind from the spotted Ribbon Snake, p. 51. Which somewhat resembles it, tho' of a different Colour."

In the Beehive Press facsimile of selected plates (1974), Joseph Ewan identifies it as *Thamnophis ordinatus* [Linn.] and adds that the plate is cited in L. M. Klauber's discussion of the snake in Copeia 1948, (1):8-10. Today, this taxon is known as the Common Garter Snake (*Thamnophis s. sirtalis*). Credit: Courtesy of Smithsonian Institution Libraries, Washington, DC.

debut of the delightful rock opera ROMMY occurred, watched by ca. 3000 delegates and me. This clever satiric creation, based on conflicting theories of phylogenetics and phenetics, was the brainchild of the ROM group and other Canadian herpetologists who created the characters, wrote the score, and played a variety of instruments for the performance—"Somehow we pulled it off, helped by vast amounts of beer consumed during the performance, and a boozed-to-the-hilt crowd that clapped, laughed, and guffawed from the opening bar."

Anthony describes many experiences with a variety of herps from Tortuga Island Rattlesnakes to Armenian Vipers. One of the most interesting was his encounter with the Bola or Fiji Cobra (*Ogmodon vitianus*), a small, exceedingly rare elapid from the Fiji Islands. His writing style is terrific and his oblique sense of humor permeates the book—I laughed aloud many times. I know some of the herpetologists he mentioned and his descriptions of their eccentricities is spot on. Do pick up a copy.

The next book is entitled *LIZARD MAN. The Life and Adventures of Bert Langerwerf*, by Bert Langerwerf and Russ Gurley (2009, Living Art Publishing, Ada, Oklahoma; www.livingartpublishing.com; ISBN 0-9787556-6-9). The late Bert Langerwerf was an extraordinary reptile breeder, reproducing over 135 species. He was the owner of Agama International, Inc., a seven-acre breeding facility in Alabama where thousands of lizards were produced annually. He personally constructed over

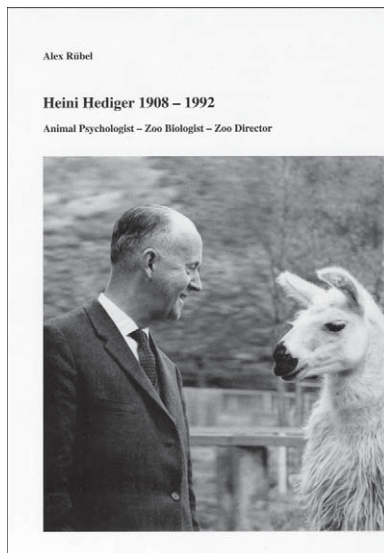


Bert Langerwerf published an account of captive management and reproduction of the Roughtail Rock Iguana (*Agama stellio*, now *Laudakia stellio*) in 1994. Illustration from Georges-Louis Duvernoy, *La Règne Animal par Georges Cuvier, Reptiles volume. Disciple edition. Paris 1842.*

400 outdoor terraria and outbuildings by hand. This book is large: 467 pages, hundreds of photographs, a list of his many papers on captive management, and reasonably priced. For anyone interested in the history of herpetoculture, these photos alone are worth the price of the book as many prominent reptile and amphibian breeders are pictured. His remarkable life is detailed in an obituary published in *Herpetological Review* (2008, 39:400–401).

An excellent biography has also been recently published. Heini Hediger, late Director of the Basel and Zürich Zoos in Switzerland, wrote several seminal books on psychology, psychopathology, and captive management which have influenced zoo biologists. He also published a number of papers in herpetology and his doctoral dissertation “Beiträge zur Herpetologie und Zoogeographie Neu Britanniens und einiger umliegender Gebiete (Contribution to the herpetology and zoogeography of New Britain and some adjacent regions)” included information on the habits of species collected there and the relationship to the environment. The venomous snake *Parapistocalamus hedigeri* was named in his honor by Jean Roux in 1934. Hediger described three taxa: Admiralty Island Webbed Frog (*Discodeles vogti* [Hediger 1934]), Roux’s Skink (*Lipinia rouxi* [Hediger 1934]), and a worm snake (*Typhlops buehleri* Hediger 1933, now *Ramphotyphlops depressus*).

Alex Rübel has published a biography detailing his life and extraordinary contributions to zoo biology. The book is called *Heini Hediger 1908–1992. Animal Psychologist – Zoo Biologist – Zoo Director* (English edition 2009, Sales point: Bookstore Beer AG, St. Peterhofstadt 10, 8022 Zurich, Switzerland; ISBN 978-3-906262-22-2).



Cover of book on life of Heini Hediger.

During the period between 1932 and 1943, Hediger published many papers in herpetology on a variety of topics (Appendix II; Honegger 2009).

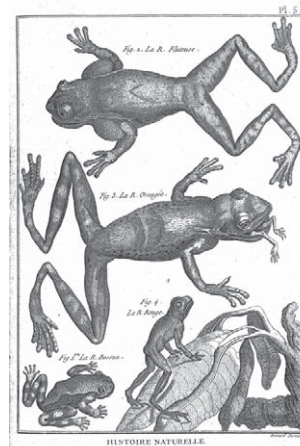
Amphibian Decline and Extinction

We began this project to summarize our understanding of why amphibian populations declined, some to extinction, late in the 20th and early in the 21st century. We know enough now to place this problem in a larger context of historical and present-day biodiversity losses. The knowledge we have raises several final questions: How will humans react to an increased awareness that Earth’s biodiversity is diminishing? What are these losses telling us about our place on the planet, our role in the biosphere? What is our role in conserving biodiversity as we become custodians of a planet that has clear limitations? And how can we pass on to future generations the wisdom needed to make sound environmental decisions? The answers to these questions will tell us much about ourselves, and science will take us only part of the way along that journey.

One mystery yields another.

—James P. Collins and Martha L. Crump

When a zoo visitor hears about the global decline and possible extinction of amphibians, they may ask what non-technical books are available to learn more about the subject. In the past, I have recommended several: *In Search of the Golden Frog* by Marty Crump, *Tracking the Vanishing Frogs: An Ecological Mystery* by Kathryn Phillips, and *A Plague of Frogs: The Horrifying True Story* by William Souder. James P. Collins and Martha L. Crump have added another book to the list which is readable and comprehensible for the layman but is also valuable for the specialist. To achieve this balance, the authors have included hundreds of endnotes to document sources as well as explain situations and concepts in greater detail. Their book is called *Extinction in Our Times. Global Amphibian Decline* (2009, Oxford University Press; ISBN 978-0-19-531694-0). There are many reasons for every zoo herpetologist to own this book. First, the text paints an historical picture of the problem, from the beginning days of skepticism that declines were a real phenomenon to the present day when humans are trying to deal with the potential extinction of an entire class of vertebrates. Second, the role of infectious diseases, climate change, and other deleterious factors are explained in detail. Third, the authors present a primer as to how science policy, future research, and other initiatives should be conducted to address the problem. Finally, they address the role of zoos: “Although they are committed to conservation, for understandable reasons many zoos cannot allocate substantial space or personnel to species with little potential for exhibits. Nevertheless, collection-based institutions are the only ones maintaining species on a continuing basis to ensure their survival, because few governmental agencies have made such commitments. Policies are needed to guide the housing and management of large numbers of threatened or endangered, perhaps non-charismatic, species (p. 180).”

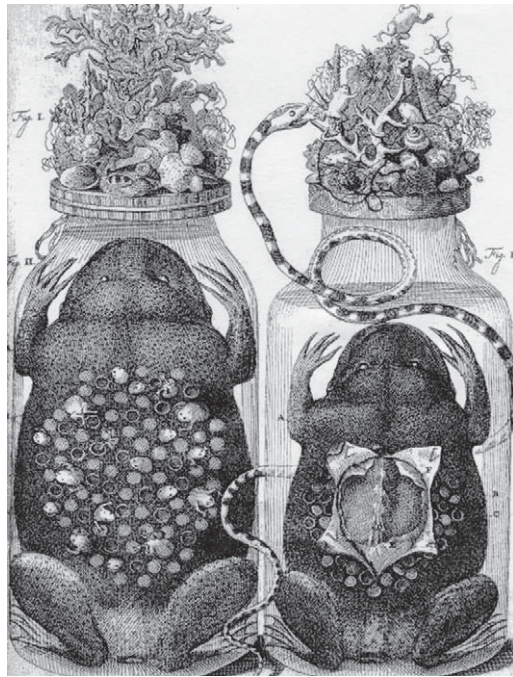


James P. Collins and Martha L. Crump have written a rigorous but sobering overview of global amphibian declines. Illustration from *Tableau encyclopédique et méthodique des trois règnes de la nature ... Erpétologie. / Par m. l'abbé Bonnatere ...*

Imprint: Paris: Chez Panckoucke, 1789. Credit: Library of Roy McDiarmid.

familiar with and conversant about the scope of the problem outlined by the authors in order to facilitate change in zoos and aquariums by convincing administrators and policy makers that greater human and financial resources must be allocated to attack this extraordinary crisis. In fact, it would be a great idea to buy a few extra copies and circulate them among your bosses!

This recent paper is required reading for all zoo and aquarium personnel: Voyles, J., et al. 2009. Pathogenesis of chytridiomycosis, a cause of catastrophic amphibian declines. *Science* 326:582–585.



Collins and Crump present mounting evidence in their book that humans are witnessing an amphibian extinction event. Could it be that the only way that frogs will be seen in the future is like this? Illustration from Frederik Ruysch's book on a natural history cabinet in 1710—*Frederici Ruyschii ... Thesaurus animalium primus = / Het eerste cabinet der dieren / van Frederick Ruysch ...*

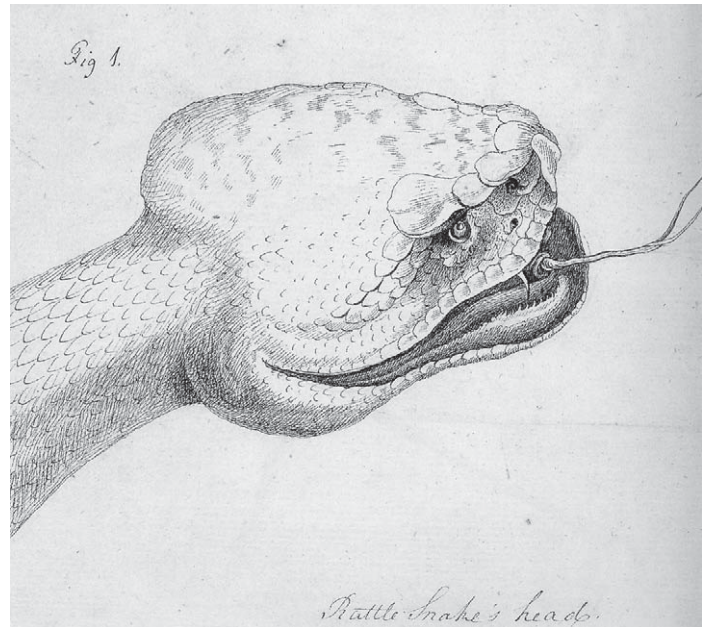
Imprint: Amstelædami, apud J. Wolters. Credit: Courtesy of Smithsonian Institution Libraries, Washington, DC.

Snakes: Ecology and Conservation

When people abroad see a live snake they rush upon it and batter it to death with sticks and stones, as though every inch of it possessed a separate and fifty-



A new book on snakes provides the most current information on ecology and conservation. Illustration from *Naturgeschichte des Thierreichs ... vol. 3.* by Gotthilf Heinrich von Schubert in 1869. Imprint: Esslingen, J.F. Schreiber. Credit: Courtesy of Polly Lasker, Smithsonian National Zoological Park Library Collection.



In 1792, William Bartram describes an encounter with the Timber Rattlesnake (*Crotalus horridus*) in the Catskill Mountains, located in the state of New York, in his book *Travels through North and South Carolina, Georgia, East and West Florida, the Cherokee country, the extensive territories of the Muscogulges, or Creek confederacy, and the country of the Chactaws; containing an account of the soil and natural productions of those regions; together with observations on the manners of the Indian*—“... when at the instant, my father being near, cried out ‘A rattle snake, my son!’ and jerked me back, which probably saved my life. I had never seen one before. That was of the kind which our guide called a yellow one, it was very beautiful, speckled and clouded.” (p. 224). According to librarian and author Judith Magee, this unpublished illustration by Bartram is in the collection of the Natural History Museum in London. It was drawn during his travels in the south. The page measures 150 × 160 mm, but this has been trimmed by someone in the Museum in the past. Figure 2 is the head of a Cottonmouth or Water Moccasin (*Agkistrodon piscivorus*) and she suspects they were drawn together on the same sheet of paper but have subsequently been cut up for mounting. There is no text with these drawings but they were sent to his patron John Fothergill in 1774. Credit: By permission of the Trustees of the Natural History Museum, London.

feline power of life calling for special destruction; then they pick up what is left of it, and after an uncertain interval of time, very often in the broiling midday heat of the tropics, put it into a bottle of cachasse, canha, aguadiante, or some other coarse spirit which disintegrates its actual structure, label it with the wrong name, and send it home.

—Arthur Stradling, On the treatment of snakes in captivity, 1882

In 1987, the book *Snakes—Ecology and Evolutionary Biology* was published and was followed six years later by the next in the series *Snakes: Ecology and Behavior*. The third one has now appeared: *Snakes: Ecology and Conservation*, edited by Stephen J. Mullin and Richard A. Seigel (2009; Comstock Publishing Associates, A Division of Cornell University Press, Ithaca and London; ISBN 978-0-8014-4565-1). Eleven chapters are geared to conservation and present the most current information on molecular phylogeography; population and conservation genetics; distribution and habitat; behavioral ecology; reproductive biology, population viability, and options for field management; captive rearing, translocation, and repatriation; habitat manipulation; and ecosystem properties. [Full disclosure: I contributed to the chapter on combating ophidiophobia.].

Rattlesnakes

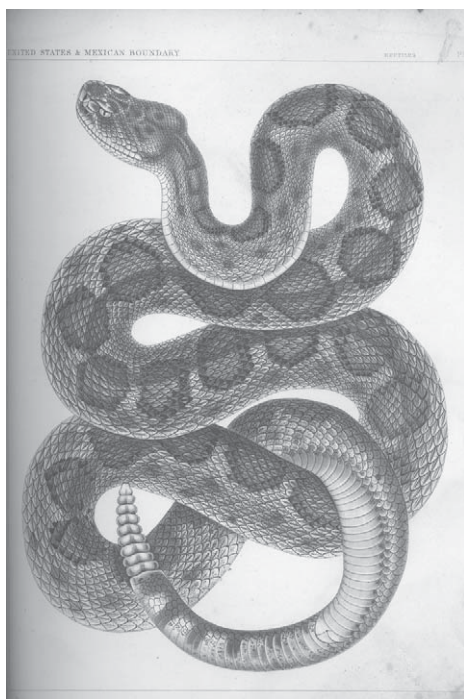
But let us again resume the subject of the rattle snake; a wonderful creature, when we consider his form, nature, and disposition. It is certain that he is capable by a puncture or scratch of one of his fangs, not only to kill the largest animal in

America, and that in a few minutes time, but to turn the whole body into corruption; but such is the nature of this dreadful reptile, that he cannot run or creep faster than a man or child can walk, and he is never known to strike until he is first assaulted or fears himself in danger, and even then always gives the earliest warning by the rattles at the extremity of the tail.

—William Bartram in *Travels...in 1791*

Rattlesnakes being such popular zoo exhibits, there are several books which are essential for the zoo herpetologist's reference library—*The Rattlesnakes, Genera Sistrurus and Crotalus. A Study in Zoogeography and Evolution* by Howard K. Gloyd, 1940; *Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind* by Laurence M. Klauber, 1956; *The Venomous Reptiles of Latin America* by Jonathan A. Campbell and William W. Lamar, 1989; *Biology of the Pitvipers* by editors Jonathan A. Campbell and Edmund D. Brodie, Jr., 1998; *Rattlesnake: Portrait of a Predator* by Manny Rubio, 1998; and *The Venomous Reptiles of the Western Hemisphere* by Jonathan A. Campbell, William W. Lamar, with contributions by Edmund D. Brodie III ... [et al.], 2004.

A new book entitled *The Biology of Rattlesnakes* (2008, Loma Linda University Press, Loma Linda CA; over 600 pages, 50 chapters, and over 90 color images; edited by William K. Hayes, Kent R. Beaman, Michael D. Cardwell, Sean P. Bush, foreword by Gordon W. Schuett; ISBN 978-1594190-011-6), presents the most up-to-date research by nearly one hundred authors specializing in rattlesnake biology. It is not necessary to go into specifics here in terms of content; suffice it to say that virtually every aspect pertaining to the life of a rattler is covered in detail. This is an awesome book, in part because so much original material is included by these researchers. I cannot remember a single book in herpetology with a larger number (>50) of original contributions. The book is divided into Research and History, Systematics, Morphology and Physical Ecology, Learning and Evolution of Behavior, Behavioral Ecology of Feeding and Defense, Population Ecology and Habitat Use, Thermal Ecology, Spatial Ecology, Reproductive Behavior and Ecology, Conservation Ecology and Education, Venom, and Snakebite. Of particular interest to the zoo worker will be the chapter on San Diego Zoo (SDZ) curator and rattlesnake authority Laurence M. Klauber by his granddaughter Janet. Another chapter de-



In the southwestern United States, the attendees at annual rattlesnake roundups destroy thousands of Western Diamondback Rattlesnakes (*Crotalus atrox*). Many herpetologists have never attended one of these events; if they did so, they would be horrified by the barbaric and inhumane treatment accorded the snakes by so-called civilized human beings. Years ago, I watched a young girl, wearing a party dress covered in blood, chop the heads off restrained living snakes with a meat cleaver. What is remarkable and unsettling is that these displays showing the most negative side of human behavior still exist, attract thousands of onlookers, and animal rights groups ignore the carnage. Illustration from *Reptiles of the Boundary ... With Notes by the Naturalists of the Survey* by Spencer F. Baird, 1859.

scribes the many observations contained in his monumental two-volume book which were made with Clarence B. (Si) Perkins and later Charles E. Shaw at the SDZ (see Murphy, 2007 for biographies).

I was pleased to see the names of many zoo people as authors: Allison Alberts, Fred Antonio, Tracey Brown, Nick Clark, Craig Ivanyi, Jeffrey Lemm, Hugh McCrystal, Jean-Pierre Montagne, R. Andrew Odum, Douglas Whiteside, as well as those from the academic community who have collaborated with them on various projects.

Turtles, Tortoises, and Terrapins of the United States and Canada

Everyone recognizes a turtle, of whatever size, shape, color, or origin. Would that the names applied to them were so straightforward—“turtle,” “tortoise,” “terrapin”—they mean one thing to one person, something else to another. Biologically all members of the order Testudines are correctly called turtles. Terrapins and tortoises are certainly turtles; tortoise is usually applied to terrestrial turtles, particularly the larger ones; terrapin is usually applied to edible, more or less aquatic hardshelled turtles.

—Carl H. Ernst, Jeffrey E. Lovich, and Roger W. Barbour, in *Turtles of the United States and Canada* in 1994

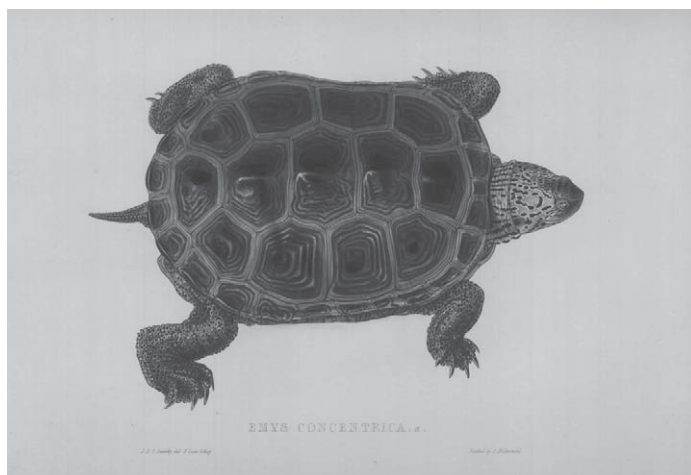
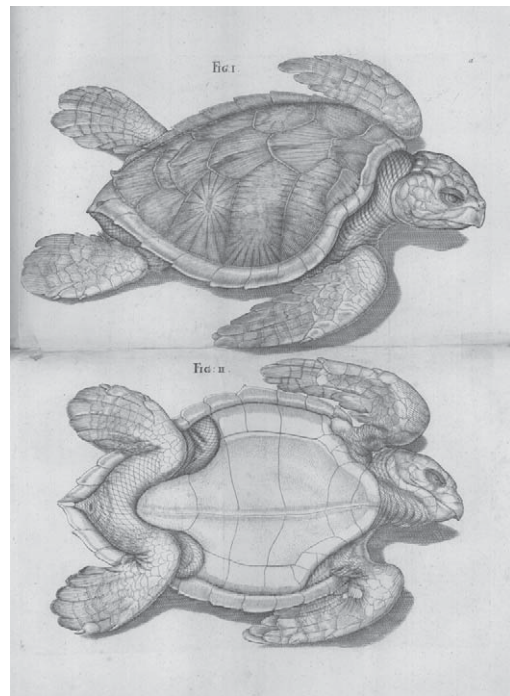
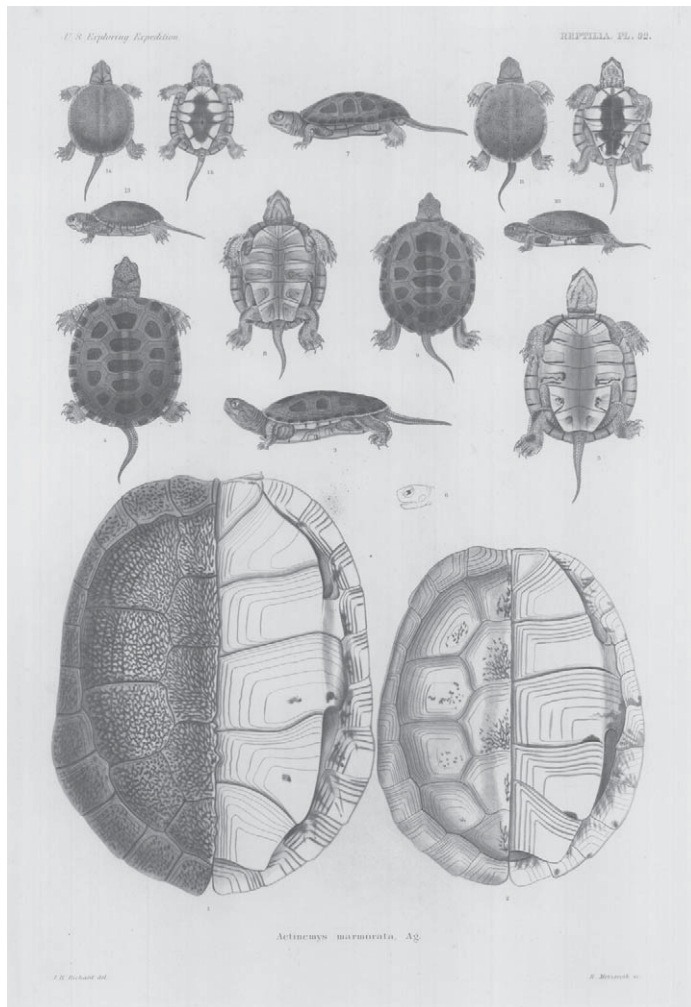
In 1972, Carl H. Ernst and the late Roger W. Barbour published *Turtles of the United States*. Twenty-two years later, an expanded *Turtles of the United States and Canada* appeared by Ernst, Jeffrey E. Lovich, and Barbour. Now, the second edition of *Turtles of the United States and Canada* by Ernst and Lovich has been written and this tome is enormous (2009; Johns Hopkins University Press, Baltimore, Maryland; xii, 827 pp.: ill. (chiefly col.), maps, ISBN 13:978-0-8018-9121-2; 10: 0-8018-9121-3), only approximately 100 pages less than the combined number of pages (which were smaller in size) of the earlier books. Do not be fooled into believing that if you own the first two books, purchasing this second edition is unnecessary—this latest version is dramatically different. Although the sub-categories are essentially the same in each species account (i. e., recognition, karyotype, fossil history, distribution, geographic variation and so on) for all books, the new one is published in a larger format, contains more information, and a greater number of excellent color plates accompany the accounts. Taxonomic name changes after the 1994 edition are included.

There is in this second edition an extensive section on conservation, a topic missing in the earlier books. This addition reflects the increasingly perilous plight of chelonians globally. W. B. Spencer in *The Victorian Naturalist* in 1921 explains the situation applicable to aquatic turtles “... fresh-water fauna is disappearing rapidly, and unless we now make an organized effort it will be too late to study it effectually, and future generations will wonder what manner of people we were not to leave behind us some adequate record of the marvellously interesting forms of animal life which we had succeeded in exterminating . . .”

In the August 2009 issue of *Turtle Survival Alliance Newsletter*, an article by Heather Lowe shows current turtle legislation as it relates to commercial harvest in the eastern United States (pp. 49–52). For membership information, visit www.TurtleSurvival.org and also read the article by Dwight Lawson (2004, Partners in saving turtles: The Turtle Survival Alliance. *Herpetol. Rev.* 35:110).

Lizards and Crocodylians of Southeastern United States

In an earlier issue of *Herpetological Review* (2008, 39:405), I reviewed four books on the amphibians and reptiles of the southeastern United States and enthusiastically recommended all of them for the zoo biologist's library. A new one covering the lizards and crocodylians has been written: *Lizards & Crocodylians of the Southeast* by Whit Gibbons, Judy Greene, and Tony Mills (2009; The University of Georgia Press, Athens, Georgia; ISBN 978-0-8203-3158-4). This book equals the quality of the earlier ones and should be purchased in haste to complete the set.



Many of the chelonians pictured in the revised book by Carl Ernst and Jeffrey Lovich are under siege. Clockwise, from lower left are plate XXXIII—Diamondback Terrapin (*Emys concentrica*, now *Malaclemys terrapin*) from *Tortoises, Terrapins, and Turtles Drawn from Life* by James de Carle Sowerby and Edward Lear, 1872; plate 32—Pacific Pond Turtle (*Emys marmorata*, now *Actinemys [=Clemmys] marmorata*) from *United States Exploring Expedition, Baird/Girard Herpetology*; early drawing of a sea turtle from *Physikalisch-anatomische Bemerkungen über die Schildkröten, aus dem Lateinischen übersezt. Mit 10 Kupfertafeln* by Christoph Gottwald, 1781. All sea turtles are now endangered, mostly due to human causes. Credit: From the collections of the Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

How to Exhibit an Anole

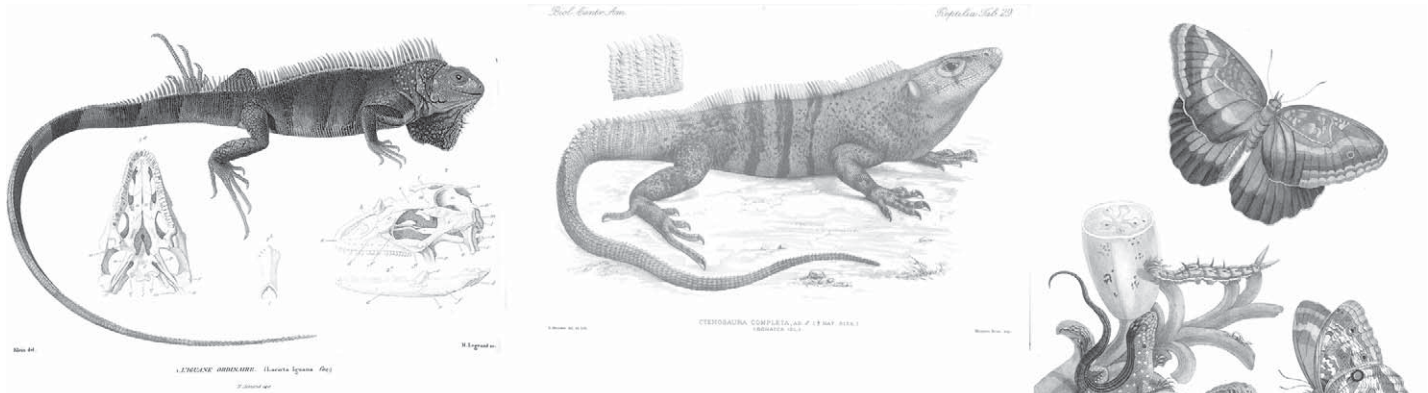
Some of the Anoles make very charming pets. Personally, I think them to be the most beautiful of all Lizards. Those I have fortunate enough to possess have proved themselves hardy while in confinement. They are extraordinarily active, and, for Reptiles, very intelligent: they soon become tame enough to take a fly from the fingers. Owing to their great activity and power of changing colour, mine have several times escaped from their case.

—Reverend Gregory C. Bateman, *The Vivarium*, 1897

During the mid-1950s, I regularly visited the reptile building at the Lincoln Park Zoo in Chicago. In the middle of the public area was a large free-standing planted terrarium housing dozens of American and

Brown Anoles. Throngs of visitors always surrounded this enclosure. The anoline life style was on display—male-male combat with dewlap extension, color change, sexual selection, courtship and copulation, oviposition, hatching, and feeding. Even in this limited space, male Brown Anoles were dominating male American Anoles. It was clearly the most popular exhibit in the building, due in large part to the fact that the lizards were very active, attractive, and familiar.

An anole exhibit is the perfect way to introduce the zoo patron to evolutionary biology, and the task of preparing graphics and other educational elements is now much easier with the recent appearance of a superb reference—*Lizards in an Evolutionary Tree. Ecology and Adaptive Radiation of Anoles* by Jonathan B. Losos (2009; The University



In the southeastern part of the United States, invasive lizard species outnumber native forms by a two-to-one margin. From left to right are three prominent aliens pictured in early publications: Green Iguana (*Iguana iguana*) from Georges-Louis Duvernoy's *La Règne Animal par Georges Cuvier, Reptiles volume. Disciple edition* in 1842; Black Spiny-Tailed Iguana (*Ctenosaura similis*) from *Biologia Centrali-Americana. [7], Reptilia and Batrachia* by Albert C. L. G. Günther in 1885–1902; Spotted Racerunner (*Cnemidophorus lemniscatus*) from Maria Sibylla Merian's *Disertatio de generatione et metamorphosisibus insectorum surinamensium* in 1726.

of California Press, Berkeley, Los Angeles, London; ISBN 978-0-520-25591-3). The book is arranged in 17 chapters and includes the following topics: phylogenetics, evolutionary inference, anole relationships, biogeography, life history, ecology, natural selection and microevolution, form, function, and adaptive radiation, ecomorphs, and so on. Creative informative graphics and interactive displays could be developed using any one of these topics and this book is a critical source of information should one embark on a project of this kind. Anoline lizards, numbering about 380 species, can be effectively used to demonstrate the development of ecological theory, ecological questions of interest, conservation issues, and evolutionary diversification.

An Essential Reference Book

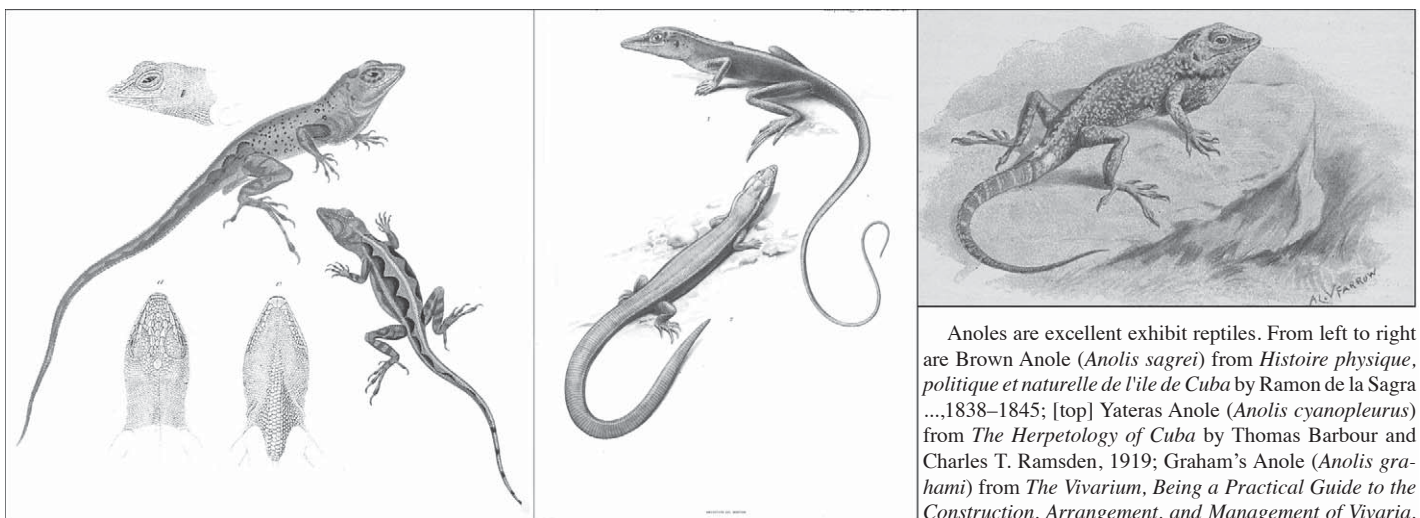
Editors often complain that bibliographies are the most error-filled part of submitted manuscripts. The reason for this may be that authors are so relieved to have finished their paper that adding the bibliography and checking the accuracy of the citations is almost an afterthought. In a thought-provoking paper by Liner and Hutchison (1998), the senior author reviewed 1000 entries and discovered that 20% were in error. Liner and Hutchison describe the proper way that citations should be listed by addressing the following elements—surname, given name, year, title, source, and ethics and professionalism. They conclude: “Although the

errors of existing bibliographies are now history, we hope that this summation of some common problems will lead to increased vigilance on the part of authors, reviewers, and editors, and the incidence of errors will decline.”

This goal is now much easier for an extraordinary new book published by SSAR is now available—*Biology of the Reptilia, Comprehensive Literature of the Reptilia*, Volume 22, edited by Carl Gans and Kraig Adler, compiled by Ernest A. Liner; 1,400 pages. To order this volume, please visit: <http://www.ssarbooks.com>.

The *Biology of the Reptilia* series (21 volumes) is an essential tool for zoo biologists (see HR 2009, vol. 40:17 for details), editors, reviewers, librarians, and others dealing with reptile biology and literature. Over 22,000 references are listed in this new book, compiled from the earlier volumes. There are several important and invaluable features—subject/species and author indices, and cross-reference index to the entire 21-volume series.

Errors can occur by copying citations from previous publications or downloading them from the internet; in both cases, these documents are sometimes erroneously cited and mistakes are perpetuated. The permanence of a printed book with “accurate” citations is essential to meet the challenge of Liner and Hutchison. This tome will be the standard for decades to come; it is unlikely that another book like this will ever again be published.



Anoles are excellent exhibit reptiles. From left to right are Brown Anole (*Anolis sagrei*) from *Histoire physique, politique et naturelle de l'île de Cuba* by Ramon de la Sagra1838–1845; [top] Yateras Anole (*Anolis cyanopleurus*) from *The Herpetology of Cuba* by Thomas Barbour and Charles T. Ramsden, 1919; Graham's Anole (*Anolis grahami*) from *The Vivarium, Being a Practical Guide to the Construction, Arrangement, and Management of Vivaria, Containing Full Information as to all Reptiles Suitable as Pets, How and Where to Obtain Them, and How to Keep Them in Health* by the Rev. Gregory C. Bateman, 1897.

- ANDERSON, U. S., ET AL. 2008. Twenty-five years of Zoo Biology: a publication analysis. *Zoo Biol.* 27:444–457.
- BRAASCH, T. 2009. Schutzbemühungen für Indiens Krokodile: der Madras Crocodile Bank Trust. (Conservation efforts for Indian crocodiles.) *ZGAP Mitteilungen* 25, [No. 1]:20–21. [German, with English summary].
- CHISZAR, D., ET AL. 2008. Response of hatchling Komodo Dragons (*Varanus komodoensis*) at Denver Zoo to visual and chemical cues arising from prey. *Zoo Biol.* 28:29–34.
- COTTLE, L., ET AL. 2009. Feeding live prey to zoo animals: response of zoo visitors in Switzerland. *Zoo Biol.* 28:1–7.
- CUNDALL, D. 2009. Viper fangs: Functional limitations of extreme teeth. *Physiol. Biochem. Zool.* 82(1):63–79. [Much of the data for this paper came from zoo collections.].
- EAZA NEWS magazine, the quarterly publication of the European Association of Zoos and Aquaria, is available to download from the EAZA website <http://www.eaza.net/magazine/EN_intro.html>.
- FERGUSON, G. W., ET AL. 2009. Voluntary exposure of some western-hemisphere snake and lizard species to ultraviolet-B radiation in the field: how much ultraviolet-B should a lizard or snake receive in captivity? *Zoo Biol.* 28:1–18.
- FERNANDEZ, E. J., AND W. TIMBERLAKE. 2008. Mutual benefits of research collaborations between zoos and academic institutions. *Zoo Biol.* 27:470–487.
- GAIKHORST, G., ET AL. 2009. Successful captive breeding of Mitchell's water monitor, *Varanus mitchelli* (Mertens 1958), at Perth Zoo. *Zoo Biol.* 28:1–11.
- HUTCHINS, M., AND S. D. THOMPSON. 2008. Zoo and aquarium research: priority setting for the coming decades. *Zoo Biol.* 27:488–497.
- JENSCH, B., ET AL. 2009. Mindestanforderungen an die artgerechte Haltung von Krokodilen in privaten Terrarien und zoologischen Einrichtungen (Minimum husbandry standards for the appropriate management of crocodiles in private and public institutions.). *Zool. Garten N. F.* 78:102–131.
- KARSTEN, K. B., ET AL. 2009. Panther chameleons, *Furcifer pardalis*, behaviorally regulate optimal exposure to UV depending on dietary vitamin D3 status. *Physiol. Biochem. Zool.* 82:218–225.
- KOUBA, A. J., AND C. K. VANCE. 2009. Applied reproductive technologies and genetic resource banking for amphibian conservation. *Reprod. Fertil. Dev.* 21:719–737.
- LAWSON, D. P., ET AL. 2008. Maximizing the contribution of science in zoos and aquariums: organizational models and perception. *Zoo Biol.* 27:458–469.
- LI, H., ET AL. 2009. A complex enrichment diet improves growth and health in the endangered Wyoming toad (*Bufo baxteri*) *Zoo Biol.* 28:197–213.
- LINDBERG, D. 2008. Reflections on the science of zoo biology. *Zoo Biol.* 27:436–443.
- MANIRE, C. A., ET AL. 2008. Mating-induced ovulation in loggerhead sea turtles, *Caretta caretta*. *Zoo Biol.* 27:213–225.
- MAPLE, T. L. 2008. Empirical zoo: opportunities and challenges to a scientific zoo biology. *Zoo Biol.* 27:431–435.
- NAGASHIMA, H., ET AL. 2009. Evolution of the turtle body plan by the folding and creation of new muscle connections. *Science* 325:193–196.
- PENNISI, E. 2009. The case of the midwife toad: Fraud or epigenetics? *Science* 325:1194–1195.
- PERNETTA, A. P. 2009. Monitoring the trade: Using the CITES Database to examine the global trade in live monitor lizards (*Varanus* spp.). *Biawak* 3(2):37–45.
- RADHAKRISHNAN, S., ET AL. 2009. Endoparasitism in captive wild-caught snakes indigenous to Kerala, India. *Zoo Biol.* 28:253–258.
- RICHARDS-ZAWACK, C. L. 2009. Thermoregulatory behaviour affects prevalence of chytrid fungal infection in a wild population of Panamanian golden frogs. *Proc. R. Soc. B* [doi:10.1098/rspb.2009.1656]
- RIEPPPEL, O. 2009. How did the turtle get its shell? *Science* 325:154–155.
- RÖDDE, D., ET AL. 2008. Environmental gradients explaining the prevalence and intensity of infection with the amphibian chytrid fungus: the host's perspective. *Anim. Conserv.* 11:513–517.
- SEARCY, R. A., ET AL. 2009. Captive reproduction of the Jamaican iguana (*Cyclura collei*). *Zoo Biol.* 28:343–349.
- WARRELL, D. A. 2009. Commissioned article: management of exotic snakebites. *Q. J. Med.* 9 pp.
- WHARTON, D. 2008. The future of zoo biology. *Zoo Biol.* 27:498–504.
- ZHANG, F., ET AL. 2009. Climate warming and reproduction in Chinese alligators. *Anim. Conserv.* 12:128–137.

Acknowledgments.—I am grateful to Emily Becker, Dana Fisher, and James Hanken from the Museum of Comparative Zoology, Harvard University, Judith Magee from the Natural History Museum in London, Kraig Adler, and Roy McDiarmid for providing some of the illustrations. Polly Lasker, Leslie Overstreet, and Daria Wingreen from Smithsonian Institution Libraries searched archival materials to locate biographical information on Catesby. David Cundall and René Honegger kindly sent literature. Judith Block reviewed early drafts and made helpful suggestions for improvement.

LITERATURE CITED

- CAMPBELL, J. A., AND E. D. BRODIE, JR. (editors). 1992. *Biology of the Pitvipers*. Selva, Tyler, Texas.
- , AND W. W. LAMAR. 1989. *The Venomous Reptiles of Latin America*. Comstock Pub. Associates, Ithaca, New York.
- , AND ———. 2004. *The Venomous Reptiles of the Western Hemisphere* // Jonathan A. Campbell, William W. Lamar, with contributions by Edmund D. Brodie III ... [et al.]. Comstock Pub. Associates, Ithaca, New York.
- CATESBY, M. 1731–1743. *The natural history of Carolina, Florida and the Bahama islands: containing the figures of birds, beasts, fishes, serpents, insects, and plants: particularly the forest-trees, shrubs, and other plants, not hitherto described, or very incorrectly figured by authors. Together with their descriptions in English and French. To which, are added observations on the air, soil, and waters: with remarks upon agriculture, grain, pulse, roots, &c. To the whole, is prefixed a new and correct map of the countries treated of.* Printed at the expense of the author, London.
- . 1974. *The natural history of Carolina, Florida, and the Bahama Islands: containing two hundred and twenty figures of birds, beasts, fishes, serpents, insects, and plants* // by Mark Catesby; [rev. by Mr. Edwards]; with an introd. by George Frick; and notes by Joseph Ewan. Beehive Press, Savannah, Georgia.
- CRUMP, M. L. 2000. *In Search of the Golden Frog*. University of Chicago Press, Chicago, Illinois.
- ERNST, C. H., AND R. W. BARBOUR. 1972. *Turtles of the United States*. The University Press of Kentucky, [Lexington].
- , J. E. LOVICH, AND R. W. BARBOUR. 1994. *Turtles of the United States and Canada*. Smithsonian Institution Press, Washington DC. [correctly listed as Ernst, Lovich, Barbour on spine, dust jacket, and copyright page; incorrectly listed as Ernst, Barbour, Lovich on title page].
- GLOYD, H. K. 1940. *The Rattlesnakes, Genera Sistrurus and Crotalus. A Study in Zoogeography and Evolution*. Chicago Academy of Sciences, Chicago, Illinois. [reprinted by Society for the Study of Amphibians and Reptiles, 1978].
- KLAUBER, L. M. 1956. *Rattlesnakes, Their Habits, Life Histories, and Influence on Mankind*. Published for The Zoölogical Society of San Diego by the University of California Press, Berkeley, California. [1972 edition].

- LINER, E. A., AND V. H. HUTCHISON. 1998. Bibliographic accuracy: Importance in herpetological publications. *Herpetol. Rev.* 29:71–74.
- MAGEE, J. 2007. *The Art and Science of William Bartram*. Pennsylvania State University Press In association with the Natural History Museum, University Park, Pennsylvania, London.
- MURPHY, J. B. 2007. *Herpetological History of the Zoo and Aquarium World*. Krieger Publishing Co., Malabar, Florida.
- PHILLIPS, K. 1994. *Tracking the Vanishing Frogs: An Ecological Mystery*. St. Martin's Press, New York.
- RUBIO, M. 1998. *Rattlesnake: Portrait of a Predator*. Smithsonian Institution Press, Washington DC.
- SEIGEL, R. A., AND J. T. COLLINS (editors). 1993. *Snakes: Ecology and Behavior*. McGraw-Hill, New York.
- , ———, AND S. S. NOVAK (editors). 1987. *Snakes—Ecology and Evolutionary Biology*. Macmillan, New York, London.
- SIMMONS, J. E. 1987. *Herpetological Collecting and Collections Management*. *SSAR Herpetol. Circ.* 31 [revised 2002].
- SOUDER, W. 2000. *A Plague of Frogs: The Horrifying True Story*. Hyperion, New York.
- STRADLING, A. 1882. On the treatment of snakes in captivity. *The Zoologist*, Third Series Vol. VI [No. 72]:449–456.
- APPENDIX I. HERPETOLOGICAL AUTOBIOGRAPHIES AND BIOGRAPHIES
- ALLEN, GLOVER M., AND THOMAS BARBOUR. 1904. *Narrative of a Trip to the Bahamas*. F1651 .A4X
Imprint: Privately Printed, Cambridge, Massachusetts.
- ALTIG, RONALD. 1979. *Toads are Nice People*. QL667 .A46
Imprint: Gates House/MANCO, Columbia, Missouri.
- ATTENBOROUGH, DAVID. 1956. *Zoo Quest to Guiana*. Z-A883
Imprint: Lutterworth Press, London.
- BARBOUR, THOMAS. 1913. *Letters Written While on a Collecting Trip in the East Indies*, / by Thomas Barbour... and Mrs. Rosamond Barbour. DS508 .B3X
Imprint: Paterson, New Jersey.
- . 1943. *Naturalist at Large*. QH31 .B3B23
Imprint: Little, Brown and Company, Boston, Massachusetts.
- . 1944. *That Vanishing Eden, a Naturalist's Florida*. QH81 .B23t
Imprint: Little, Brown and Company, Boston, Massachusetts.
- . 1945. *A Naturalist in Cuba*. QL229.C9 B3 1945
Imprint: Little, Brown and Company, Boston, Massachusetts.
- . 1946. *A Naturalist's Scrapbook*. QH31 .B215A3X
Imprint: Harvard University Press, Cambridge, Massachusetts.
- BARTLETT, RICHARD D. 1988. *In Search of Reptiles and Amphibians*. QL651 .B38 1988X
Imprint: E.J. Brill, Leiden; New York.
- BEEBE, WILLIAM. 1920. *Jungle Peace*, foreword by Theodore Roosevelt. QH81 .B33j
Imprint: The Modern Library, New York.
- . 1924. *Galapagos, World's End*. QH123 .B4
Imprint: G. P. Putnam's Sons, New York, London.
- . 1925. *Jungle Days*. QL246 .B35X
Imprint: G. P. Putnam's Sons, New York, London.
- . 1944. *The Book of Naturalists: An Anthology of the Best Natural History*. QH9 .B41
Imprint: Robert Hale, London.
- . 1949. *High Jungle*. QL251 .B4X
Imprint: Duell, Sloan and Pearce, New York.
- . 1950. *Edge of the Jungle*. QH125 .B35 1950X
Imprint: Duell, Sloan and Pearce, New York.
- . 1953. *Unseen Life of New York, as a Naturalist Sees It*. QL195 .B4X
Imprint: Duell, Sloan and Pearce, New York.
- BOULENGER, E. G. 1927. *A Naturalist at the Zoo*. Imprint: Bretano's, New York.
- BRAZAITIS, PETER. 2003. *You Belong in a Zoo! : Tales from a Lifetime Spent with Cobras, Crocs, and Other Creatures*. QL77.5 .B72 2003
Imprint: Villard Books, New York.
- CANN, JOHN. 1986. *Snakes Alive! : Snake Experts & Antidote Sellers of Australia*. QL26 .C22 1986
Imprint: Kangaroo Press, Kenthurst, [N.S.W.], Australia.
- CARNOCHAN, FREDERIC G., AND HANS CHRISTIAN ADAMSON. 1935. *The Empire of the Snakes*. DT440 .C37X
Imprint: Frederick A. Stokes company, New York.
- CARR, ARCHIE F. 1964. *Ulendo; Travels of a Naturalist In and Out of Africa*. QL336 .C37X
Imprint: Knopf, New York.
- . 1979. *The Windward Road: Adventures of a Naturalist on Remote Caribbean Shores*. QL134.5 .C37 1979X
Imprint: University Presses of Florida, Tallahassee, Florida.
- . 1986. *The Sea Turtle: So Excellent a Fish*. QL666 .C5C31 1986
Imprint: University of Texas Press, Austin, Texas.
- . 1994. *A Naturalist in Florida: A Celebration of Eden // Archie Carr*; edited by Marjorie Harris Carr; foreword by Edward O. Wilson. QH105.F6 C35 1994X
Imprint: Yale University Press, New Haven, Connecticut.
- Carroll, David M. 2004. *Self-Portrait with Turtles: A Memoir*. QL666.C5 C369 2004
Imprint: Houghton Mifflin, Boston, Massachusetts.
- CONANT, ROGER. 1997. *A Field Guide to the Life and Times of Roger Conant*. QL31.C66 C66 1997
Imprint: Selva, Tyler, Texas.
- DITMARS, RAYMOND L. 1931. *Strange Animals I Have Known*. QL791 .D54X
Imprint: Brewer, Warren & Putnam, inc., New York.
- . 1933. *The Forest of Adventure*. QH84.5 .D61
Imprint: The Macmillan Company, New York.
- . 1937. *The Making of a Scientist*. QL31 .D5A35X
Imprint: The Macmillan Company, New York.
- DURRELL, GERALD. 1955 [c1954]. *Three Tickets to Adventure*. QL62 .D86 1955X
Imprint: Viking Press, New York.
- . 1960. *A Zoo in My Luggage*. QL62.D866 1960
Imprint: Viking Press, New York.
- . 1964. *Menagerie Manor*. QL77.T7 D8 1964
Imprint: R. Hart-Davis, London.
- . 1976. *Birds, Beasts and Relatives*. QH151 .D78 1976
Imprint: Penguin, Harmondsworth.
- . 2000. *My Family and Other Animals*. QH151 .D8 2000
Imprint: Penguin Books, New York.
- GIBBONS, WHIT. 1983. *Their Blood Runs Cold: Adventures with Reptiles and Amphibians*. QL641 .G5 1983X
Imprint: University of Alabama Press, University, Alabama.
- GREENE, HARRY W. 1997. *Snakes: The Evolution of Mystery in Nature*. QL666.O6 G69 1997X
Imprint: University of California Press, Berkeley, California.
- HYLANDER, CLARENCE J. 1951. *Adventures with Reptiles; The Story of Ross Allen*. QL644 .H9X
Imprint: Messner, New York.

- ILES, GERALD. 1960. At Home at the Zoo.
No ISBN #
Imprint: W. H. Allen, London. [Former director of now defunct Belle Vue Zoo in Manchester, England].
- JACKSON, KATE. 2008. Mean and Lowly Things. Snakes, Science, and Survival in the Congo.
ISBN 13: 978-0-674-02974-3; ISBN 10: 0-674-02974-7
Imprint: Harvard University Press, Cambridge, Massachusetts.
- KAUFFELD, CARL. 1957. Snakes and Snake Hunting.
QL666 .O6K21
Imprint: Hanover House, Garden City, New York.
- . 1969. Snakes: The Keeper and the Kept.
SF459 .S5K22
Imprint: Doubleday, New York.
- KEMNITZER, JOHN W. (author/editor). 2006. Rattlesnake Adventures. Hunting with the Oldtimers.
ISBN: 1-57524-278-8
Imprint: Krieger Publishing Co., Malabar, Florida.
- KURSH, HARRY. 1965. Cobras in His Garden.
QL644 .K96
Imprint: Harvey House, Irvington-on-Hudson, New York. [Biography of William "Bill" Haast].
- LANE, MARGARET. 1964, c1963. Life with Ionides.
QL31 .J6L266 1964
Imprint: Readers Union, London.
- LOVERIDGE, ARTHUR. 1944. Many Happy Days I've Squandered.
QH31 .L75A3X
Imprint: Harper & Brothers, New York, London.
- . 1947. Tomorrow's a Holiday (Kesho siku kuu).
QL337 .T3L6X
Imprint: Harper & Brothers, New York, London.
- . 1953. I Drank the Zambezi.
QL5 .L6X
Imprint: Harper, New York.
- MERTENS, ROBERT. 1951. Zwischen Atlantik und Pazifik; zoologische Reiseskizzen aus Nordamerika.
QL652 .M4X
Imprint: A. Kern, Stuttgart.
- MINTON, SHERMAN A. 2001. Life, Love, and Reptiles: An Autobiography of Sherman A. Minton, Jr., M.D.
QL31.M625 A3 2001X
Imprint: Krieger Pub., Malabar, Florida.
- PERKINS, MARLIN. 1982. My Wild Kingdom: An Autobiography.
QL31 .P43A35 1982X
Imprint: E. P. Dutton, New York.
- PIANKA, ERIC R. 1994. The Lizard Man Speaks.
ISBN: 0-292-76552-5
Imprint: University of Texas Press, Austin, Texas.
- POPE, CLIFFORD H. 1940. China's Animal Frontier.
596 .51P82
Imprint: The Viking Press, New York.
- RUTHVEN, ALEXANDER G. 1931. A Naturalist in a University Museum.
Q105 .R97
Imprint: Alumni Press, University of Michigan, Ann Arbor, Michigan.
- SANDERSON, IVAN T. 1937. Animal Treasure.
QL337 .N5S3X
Imprint: The Viking Press, New York.
- . 1939. Caribbean Treasure.
QL229 .A2S21
Imprint: The Viking Press, New York.
- SEAL, JEREMY. 1999. The Snakebite Survivors' Club: Travels among Serpents.
QL666.O6 S3917 1999
Imprint: Harcourt, New York.
- SPAWLS, STEPHEN. 1979. Sun, Sand, and Snakes.
ISBN: 0 00 262760 4
Imprint: Carvill and Harvill Press, London.
- SUTHERLAND, STRAUN. 1998. A Venomous Life.
ISBN 1 86447 026 7
Imprint: Hyland House, South Melbourne, Australia.
- TAYLOR, EDWARD H. 1975. Edward H. Taylor: Recollections of an Herpetologist.
QL31 .T23A2
Imprint: Museum of Natural History, University of Kansas, Lawrence Kansas.
- TWITTY, VICTOR C. 1966. Of Scientists and Salamanders.
QL31 .T97A1
Imprint: W. H. Freeman, San Francisco, California.
- WHITAKER, ZAI. 1989. Snakeman. The Story of a Naturalist.
India Magazine Books, Bombay. [Biography of Romulus "Rom" Whitaker].
- WOOD, LAURA N. 1944. Raymond L. Ditmars, His Exciting Career with Reptiles, Animals and Insects.
QL31 .D5W6X
Imprint: J. Messner, New York.
- WORRELL, ERIC. 1958. Song of the Snake.
QL663 .A8W92
Imprint: Angus and Robertson, Sydney, Australia.
- WRIGHT, A. GILBERT. 1967. In the Steps of the Great American Herpetologist Karl Patterson Schmidt.
67-18531
Imprint: M. Evans and Company, New York.
- WYKES, ALAN. 1961. Snake Man; The Story of C. J. P. Ionides.
QL666 .O6W98 1961
Imprint: Simon and Schuster, New York.

APPENDIX II. HERPETOLOGICAL PUBLICATIONS BY HEINI HEDIGER AND BIOGRAPHIES ABOUT HIM

- HEDIGER, H. 1958. Kleine Tropenzoologie (Small Tropical Zoology). Aufl. Acta trop., Suppl. I, Basel. 1:1–224.
- . 1964. Wild Animals in Captivity. Dover Publications, Inc., New York.
- . 1968. The Psychology and Behaviour of Animals in Zoos and Circuses. Dover Publications, Inc., New York.
- . 1969 [1970]. Man and Animal in the Zoo; Zoo Biology. Routledge & K. Paul, London.
- . 1964. Wild Animals in Captivity, Dover Publications, New York. [German edition was "Wildtiere in Gefangenschaft," published in 1950 and the English version was translated by G. Sircom. At the time of publication, Hediger was Director of the Basel Zoo, Switzerland].
- . 1990. Ein Leben mit Tieren im Zoo und in aller Welt. Werd Verlag, Zürich. [Hediger's biography contains a wealth of information and anecdotes on herpetology].

Behavior

- HEDIGER, H. 1963. Camouflaged still-fishing. Strange, wormlike lure draws turtle's prey. Natural History 72(6):18–21.
- . 1963. Die Alligator-Schnappschildkröte, die vollkommenste Todesfalle des Tierreiches (The snapping turtle, the most perfect lethal trap of the Animal Kingdom). Das Tier (The Animal) 3(11):4–6.
- . 1968. The Psychology and Behaviour of Animals in Zoos and Circuses. Dover Publications, Inc., New York. [translation of "Skizzen zu einer Tierpsychologie im Zoo und im Zircus" published in 1955 by Butterworths Scientific Publications. Starting on p. 128, a series of photographs of male combat in captive red rattlesnakes at the San Diego Zoo was provided.]

Reproduction

- HEDIGER, H. 1965. Environmental factors influencing the reproduction of zoo animals. In F. A. Beach (ed.), Sex and Behavior, pp. 319–354. John Wiley & Sons, New York, London, Sydney.

General

- GRZIMEK, B. 1975. Grzimek's Animal Life Encyclopedia, In B. Grzimek, H. Hediger, K. Klemmer, O. Kuhn, and H. Wermuth (eds.), Reptiles. New York.
- HEDIGER, H. 1932. Zum Problem der "fliegenden" Schlangen (Regarding the problem of the "flying" snakes). Rev. Suisse Zool. 39:239–246.
- . Ein eigenartiges Biotop von *Lacerta muralis muralis* (Laurenti) (A peculiar biotope of *Lacerta muralis muralis* (Laurenti)). Bl. Aquar. Terrkd. 43:316–317.
- . 1933. Über die von Herrn Dr. A. Bühler auf der Admiralitätsgruppe und einigen benachbarten Inseln gesammelten Reptilien und Amphibien (Concerning the reptiles and amphibians collected by Dr. A. Bühler in the Admiralty Archipelago and several neighboring islands). Ver. naturf. Ges. Basel 44. 2. Teil:1–25.
- . 1934. Beiträge zur Herpetologie und Zoogeographie Neu-Britanniens und einiger umliegender Gebiete (Contributions to the herpetology and zoogeogra-

- phy of New Britain). *Zool. Jb. Syst.* 65:441–582.
- . 1934. Giftschlangen und Schlangengift (Poisonous snakes and snake poison). *Ciba-Z.* 1:265–269.
- . 1936. Die Schlangen Mitteleuropas (The Snakes of Central Europe). *Wiss. Abt. Ges. Chem. Industrie Basel* (Section for the Society of Chemical Industries in Basel [Switzerland]).
- . 1936. Les Serpents de l'Europe Centrale (The Snakes of Central Europe). *Dép. scient. Soc. chem. Industrie Bâle*.
- . 1936. Herpetologische Beobachtungen in Marokko (Herpetological observations in Morocco). *Ver. naturf. Ges. Basel* 46:1–49.
- . 1937. Herpetologische Beobachtungen in Marokko II. Zur Herpetofauna der Umgebung von Ouezzan und Tanger (Herpetological observations in Morocco II. Regarding the herpetofauna in the environs of Ouezzan and Tanger). *Ver. naturf. Ges. Basel* 48:183–192.
- . 1937. Seltsame Reptilien und Amphibien der Salomon-Inseln (Unusual reptiles and amphibians of the Solomon Islands). *Natur. u. Volk* 67:590.
- . 1941. Eine fressende *Farancia* (A feeding *Farancia*). *Zool. Gart. (N.F.)*, Leipzig 13:251–255.
- . 1963. Sind Schlangen eigentlich gefährlich? (Are snakes actually dangerous?). *Das Tier* 3(1):20–22.
- . 1969 [1970]. Man and Animal in the Zoo; Zoo Biology. Routledge & K. Paul, London. [originally published as "Mensch und Tier im Zoo" in 1965].
- HONEGGER, R. E. 1993. Heini Hediger (1908–1992). *Copeia* 1993:584–585.
- . 2009. Heini Hediger (1908–1992) als Forschungsreisender und Herpetologe. *Sekretät* 9(1):3–24.
- . 2001. Heini Hediger (1908–1992). In W. Rieck, G. T. Hallmann, and W. Bischoff (eds.), *Die Geschichte der Herpetologie und Terrarienkunde im deutschsprachigen Raum* (History of Herpetology and Terrarium Science in German-Speaking Areas) - Mertensiella 12:473–474. Deutschen Gesellschaft für Herpetologie und Terrarienkunde e.V. (DGHT).
- MURPHY, J. B. 2007. Herpetological History of the Zoo and Aquarium World. Krieger Publishing Co., Malabar, Florida.

Judith A. Block is the retired registrar from the Smithsonian National Zoological Park in Washington DC. She is a founding (and now honorary) member of the Zoo Registrars' Association (ZRA), an organization in existence for over 25 years. In 2007, the organization established the "Judith Block Professional Excellence Award," a prestigious honor given to select members to recognize significant achievement in this profession; Block was the first recipient. In the following article, she reviews the book by John E. Simmons (*Things Great and Small. Collection Management Philosophies*) from the perspective of a zoo registrar.

Simmons is well known to herpetologists for he was the collections manager for many years at the University of Kansas before retirement. He is the author of two editions of *Herpetological Collecting and Collections Management*, published by SSAR in 1987 and 2002.

—James B. Murphy, Section Editor

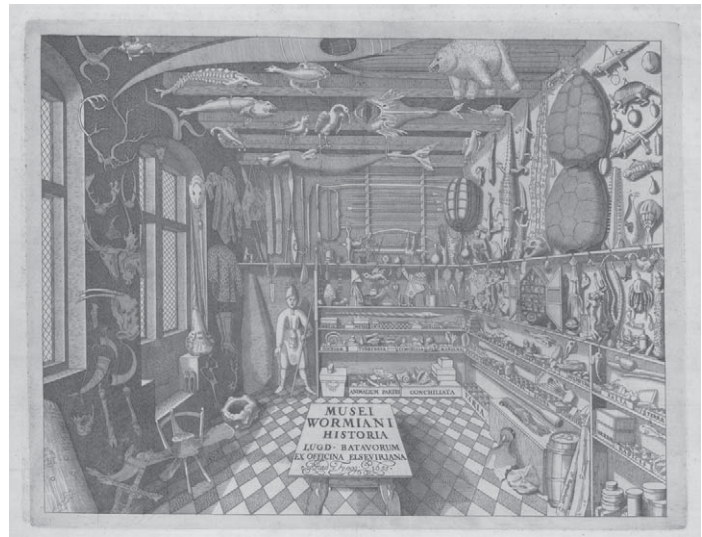
Herpetological Review, 2010, 41(1), 16.
© 2010 by Society for the Study of Amphibians and Reptiles

Essential Reading for Zoo Registrars and Others with Collections Responsibilities

JUDITH A. BLOCK

3100 Connecticut Ave., NW, Washington DC 2008, USA
e-mail: jbmurphy2@juno.com

Things Great and Small: Collections Management Policies, by John E. Simmons (2007; 208 pp.; American Association of Museums; ISBN-13:978-1-033256-03-9; ISBN-10:1-9233253-03-7) is a textbook on collections management policies and it is anything but dry. The book is totally engaging; I found myself making notes, jotting down questions and reflecting on how I would apply what I was reading. The author has a fluid style and a sense of perspective that includes humor, making the sections unexpectedly readable. I even laughed out loud a couple of times.



This frontispiece pictured is the Copenhagen natural history museum or cabinet of curiosities of Oleus Worm in 1655 with snake skins, turtle carapaces and skulls, crocodiles, and lizards hanging on the wall. These private cabinets held biological treasures, arranged in no particular order, to excite wonder. The cover of the Simmons book shows a recreation of the Worm cabinet by Rosamund Purcell for "Two Rooms," Santa Monica Museum of Art, 2003. Worm, Oleus. 1655. *Museum Wormianum; seu, Historia rerum rariorum, tam naturalium, quam artificialium, tam domesticarum, quam exoticarum, quae Hafniae Danorum in aedibus authoris servantur. / Adornata ab Olao Worm ...* Imprint: Lugduni Batavorum, ex officina Elseviriorum, 1655. Credit: From the collections of the Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

This book makes clear what collections management policies are and why they are essential. "Collections management is everything that is done to take care of collections, develop the collections and make the collections available for use." (p. 2) Policies are developed to address aspects of management and other collections-related activities and they clarify who is responsible for each; they are the basis for procedures and collection plans. Each institution has its own requirements and constraints but there are commonalities and this book is a most useful guide for developing comprehensive documents or reviewing existing policies.

Each chapter covers a particular topic, such as authority, acquisitions, dispositions, loans, documentation, access and use, ethics and appraisals. There are apt and amusing quotes at the start of each; the section on authority has Ambrose Bierce (1911), "Accountability is the mother of caution." Interspersed with the text in the chapters are boxes titled, "when policy meets reality" which give surprising and informative examples; some are worthy of "news of the weird" such as the theft of two 40 ton locomotives in the risk management and insurance chapter. Each chapter has its own references, explanatory and summary tables, and relevant examples of actual policies in use by various institutions. At the end of the book are appendices including a glossary, a section on laws and regulations, and an expanded list of resources; the bibliography is thorough, the online references less so because a couple of years have passed since publication.

The book was designed as a textbook for Museum Studies graduate students. It seems to be geared particularly to natural history collections although there are plentiful examples from the art world. While I was disappointed to note that zoos are conspicuous by their absence I found that virtually all of the issues are the same and thus the book can be extremely useful to those with living collections.

Anyone who has stewardship responsibilities or deals with collections in institutions would profit from reading—and applying—this book.

LETTERS TO THE EDITOR

Herpetological Review, 2010, 41(1), 17–18.
© 2010 by Society for the Study of Amphibians and Reptiles

Reexamination of New State Record for *Desmognathus monticola* (Seal Salamander) from Ohio

TIMOTHY O. MATSON

Cleveland Museum of Natural History
1 Wade Oval, University Circle, Cleveland, Ohio 44106, USA
e-mail: tmatson@cmnh.org

RALPH A. PFINGSTEN

Cleveland Museum of Natural History
1 Wade Oval, University Circle, Cleveland, Ohio 44106, USA

ROBERT D. DAVIC

The Ohio State University, School of Environment and Natural Resources
210 Kottman Hall, Columbus, Ohio 43210, USA

and

THOMAS M. PUCCI

Cleveland Museum of Natural History
1 Wade Oval, University Circle, Cleveland, Ohio 44106, USA

Graziano and Reid (2006) reported a range extension of the Seal Salamander (*Desmognathus monticola*) into southern Ohio (Adams County, Monroe Township), the first documentation of the species north of the Ohio River (Pfingsten and Matson 2003). The species verification was made from two specimens collected from two seepages where the closely related *Desmognathus fuscus*, the Northern Dusky Salamander, also was present. No morphological information was provided for either of the specimens, nor was there any discussion of the characters used to distinguish them from the coexisting *D. fuscus*.

Due to the importance of this possible new addition to the herpetofauna of Ohio, and given that the Ohio Department of Natural Resources is now undertaking a major revision of the status of salamanders in the state, we report our collective findings of a reexamination of the two specimens collected by Graziano and Reid (2006). The specimens were deposited at the Fort Hays State University Sternberg Museum of Natural History and were assigned catalog numbers MHP-H 12169 and MHP-H 12170. Both individuals are males with standard lengths (snout-posterior vent lengths) 66.5 and 53.2 mm, respectively.

Both specimens collected by Graziano and Reid are patterned with a dorsal stripe that is most evident posterior to the front legs, a character reported by Hulse et al. (2001) to be lacking in *D. monticola* from Pennsylvania (Fig. 1). Neither specimen has the deeply cut “bold, dark wormy marks” on the dorsum and/or tail that are characteristic of *D. monticola* we have observed and were reported by Petranka (1998). The venter of one of the specimens (MHP-H 12169) has pigmentation with evidence of a reticulate pattern beginning to form, a characteristic of *D. fuscus* as they age. One of us (RAP) has searched for *D. monticola* in southern Ohio counties north of the Ohio River and has collected individuals in Adams County thought to be *D. fuscus* with a dorsal pattern similar to the Graziano and Reid specimens. A “*monticola* like”

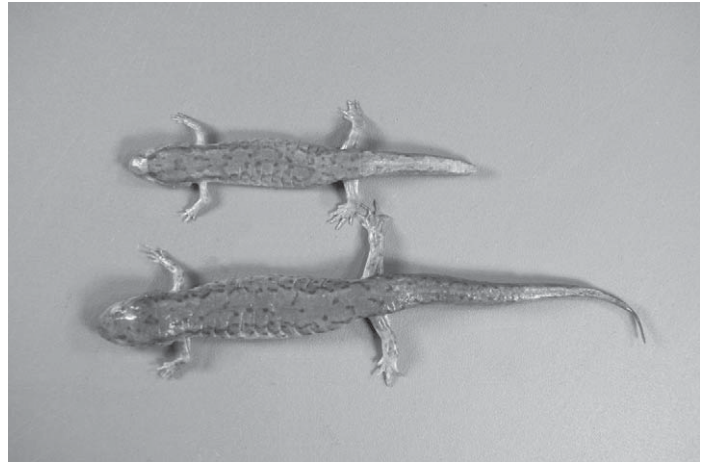


FIG. 1. Specimens of Graziano and Reid (2006) collected from Adams County, Monroe Township, Ohio. Top is Sternberg Museum of Natural History (MHP) 12169, bottom is MHP 12170.

dorsal pattern has been observed by one of us (RDD) in *D. fuscus* populations from northern Ohio (Lake County), approximately 160 km from the closest known *D. monticola* records in western Pennsylvania (Hulse et al. 2001). From our external examination of the specimens collected by Graziano and Reid (Fig. 1), we find no compelling evidence to suggest that either is *D. monticola*.

However, because there can be extreme intraspecific variation in morphology, color, and pattern in the genus *Desmognathus*, we also examined tooth morphology and toe pads as presented by Caldwell and Trauth (1979). They report differences in tooth morphology between *D. fuscus* and *D. monticola* from the posterior half of the dentary that can be used to help distinguish the two species. Figure 1 in Caldwell and Trauth (1979) shows *D. monticola* collected from Kentucky having a pointed and piercing-type tooth crown in the posterior half of the dentary, with the lingual cusp being much higher than the labial cusps. In contrast, the crown is blunt and relatively flat in *D. fuscus* with lingual and labial cusps approximately equal in height.

We compared the tooth morphology of the two specimens collected by Graziano and Reid with those presented in Caldwell and Trauth (1979) with two additional specimens in the collection of the Cleveland Museum of Natural History; CMNH 3307, a *D. fuscus* collected by RAP from Adams County, Ohio very near the collection sites of Graziano and Reid; CMNH 6020, a *D. monticola* collected by RAP from Wayne County, West Virginia. We examined teeth from the most posterior region of the dentary from all four specimens at 150x magnification using a Zeiss Discovery V12 stereomicroscope with photographic capability.

The tooth morphology of the specimens we examined is presented in Fig. 2. The Graziano and Reid specimens (B and C in Fig. 2) have teeth nearly identical to those of the CMNH 3307 (A in Fig. 2), the *D. fuscus* from Adams County, Ohio. Differences in length and width of teeth may be related to sex, age, or some other factor. Neither specimen collected by Graziano and Reid has teeth that are consistent with CMNH 6020 (D in Fig. 2), the *D. monticola* collected from West Virginia nor those collected from Kentucky (fig. 1 of Caldwell and Trauth 1979).

Caldwell and Trauth (1979) also discuss differences in pigmentation of toe pads (friction pads) between *D. monticola* and *D. fuscus*.

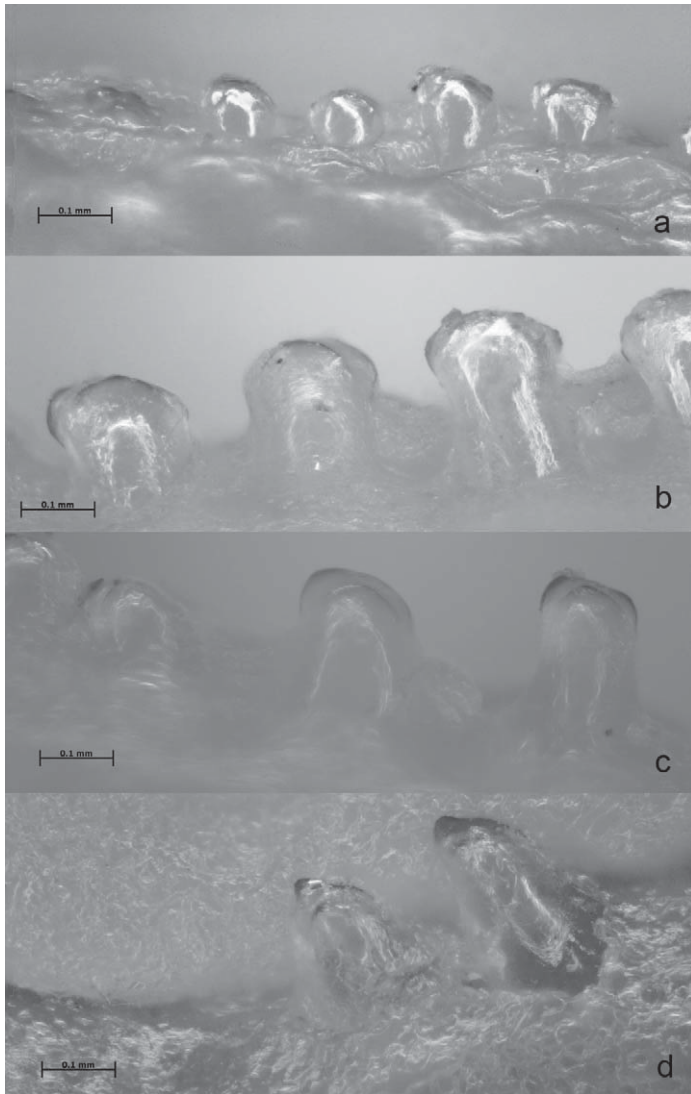


FIG. 2. Tooth morphology from the most posterior region of the dentary of four *Desmognathus* specimens. Label A = *D. fuscus* female from Adams County, Ohio from the collection of the Cleveland Museum of Natural History (CMNH 3307); Label B = MHP 12169 of Graziano and Reid (2006), a male; Label C = MHP 12170 of Graziano and Reid (2006), a male; Label D = *D. monticola* from Wayne County, West Virginia (CMNH 6020), sex undetermined. Both specimens of Graziano and Reid (2006) have teeth nearly identical to those of the cataloged *D. fuscus*.

They report that *D. fuscus* examined from Kentucky (N = 119) was never found to possess friction pads with dark pigmentation at the tip of the toes. If pigmentation was present at the toe tip, it was not significantly darker than surrounding tissue. In contrast, they found dark friction pads were present on at least some of the toes in 94.4% of *D. monticola* examined from Kentucky (N = 62). No evidence of ontological variation was found with dark pigmentation evident in larvae as well as large adults. Our microscopic examination of the 20 total digits of the two specimens of Graziano and Reid (2006) revealed no evidence of dark pigmented friction pads differing from the surrounding tissue. While this character alone is not taxonomically conclusive, we find no evidence of friction pads on the toes of the Graziano and Reid specimens suggesting they are *D. monticola*.

In summary, we conclude from our reexamination of the two Graziano and Reid specimens that they both have attributes of body color and pattern, tooth morphology, and friction pads on the toes that are indicative of *D. fuscus* found in the state of Ohio. We consider this published range extension to be untenable and cannot support recommending that it be used to include *D. monticola* to the list of herpetofauna of Ohio.

Acknowledgments.—We thank the Ohio Department of Natural Resources Division of Wildlife for granting permission to us to examine the two putative specimens of *Desmognathus monticola*. We thank Steve Tilley and Kenneth Wray for providing helpful comments leading to improved readability of the manuscript.

LITERATURE CITED

- CALDWELL, R. S., AND S. T. TRAUTH. 1979. Use of toe pad and tooth morphology in differentiating three species of *Desmognathus* (Amphibia, Urodela, Plethodontidae). *J. Herpetol.* 13:491–497.
- GRAZIANO, M. P., AND M. L. REID. 2006. An addition to the herpetofauna of Ohio. *J. Kansas Herpetol.* 17:6.
- HULSE, A. C., C. J. MCCOY, AND E. J. CENSKY. 2001. *Amphibians and Reptiles of Pennsylvania and the Northeast*. Cornell University Press, Ithaca, New York.
- PETRANKA, J. W. 1998. *Salamanders of the United States and Canada*. Smithsonian Institution Press, Washington, DC.
- PFINGSTEN, R. A., AND F. L. DOWNS (eds.). 1989. *Salamanders of Ohio*. Ohio Biological Survey Bulletin. New Series 7(2), Columbus, Ohio.
- , AND T. O. MATSON. 2003. *Ohio Salamander Atlas*. Ohio Biological Survey Miscellaneous Contributions Number 9, Columbus, Ohio.

Living Reptiles and Amphibians Available from Smithsonian National Zoological Park, Washington DC

The following are available gratis to qualified non-profit institutions: nature centers, living material centers, and academic institutions:

- Gonyosoma oxycephala*, adult female, (Red Tailed Rat Snake)
- Tiliqua scincoides*, 2 adult females, (Blue-tongued Skinks)
- Elaphe obsoleta rossalleni*, 2 adult males, 1 adult female, (Everglades Rat Snakes)
- Eublepharis macularius*, group of five adults, (Leopard Geckos)

Some of the specimens are habituated long-term captives and could be used for demonstrations. Potential recipients will undergo a review process. Shipping costs must be borne by recipient.

If interested, contact curator James B. Murphy for additional details: Department of Herpetology, Smithsonian National Zoological Park, PO Box 37012 MRC 5507, Washington DC 20013-7012; e-mail: murphyj@si.edu; cell phone: 202-327-3767.

Rediscovery of the Rare Autlán Long-Tailed Rattlesnake, *Crotalus lannomi*

JACOBO REYES-VELASCO*

CUCBA, Universidad de Guadalajara
 Carretera a Nogales Km 15.5, Las Agujas
 Nextipac, Zapopan, Jalisco, México
 e-mail: jacobov@crotales.com

CHRISTOPH I. GRÜNWALD*

Careterra Chapala - Jocotepec Oriente #57-1
 Col. Centro, Ajijic, Jalisco 45920, México
 e-mail: trimorphodon111@yahoo.com

JASON M. JONES

16310 Avenida Florencia
 Poway, California 92064, USA
 e-mail: jasonjones@crotales.com

and

GINNY N. WEATHERMAN

9154 W 194 Terrace, Bucyrus, Kansas 66013, USA
 e-mail: ginnykansas@gmail.com

*Corresponding authors

Among Mexico's diverse herpetofauna, the rattlesnakes (*Crotalus* and *Sistrurus*) have intrigued both herpetologists and non-herpetologists alike for centuries. One group of rattlesnakes, however, has remained especially enigmatic. The long-tailed rattlesnake group includes three rare species (*C. stejnegeri*, *C. lannomi*, and *C. ericsmithi*) and is represented in museum collections by fewer than 15 specimens, most of which are *C. stejnegeri* (Campbell and Flores-Villela 2008; Campbell and Lamar 2004). Their unique body structure and unusually long tails have raised numerous questions regarding their natural history and ancestry.

The Autlán Long-tailed Rattlesnake, *C. lannomi*, has been known only from a single specimen, collected in June 1966 by Joseph R. Lannom, Jr. from "1.8 miles west of the pass: Puerto Los Mazos, Jalisco" (Tanner 1966). Despite numerous attempts to locate additional specimens (Campbell and Flores-Villela 2008; Campbell and Lamar 2004), none have been reported since the initial description.

Since 2004, we have searched for rattlesnakes in the western foothills of the Sierra Madre Occidental and associated ranges in Nayarit, Jalisco, and Colima. Over the course of several weeks in July 2008, five additional specimens of long-tailed rattlesnakes were found in the foothills of Colima, México. Based on features of lepidosis, this new material is referred to *Crotalus lannomi*. The snakes were found approximately 50 km SW of the type locality (Fig. 1). Herein, we provide detailed morphological descriptions of the new specimens, notes on natural history, comparisons with the other species of long-tailed rattlesnakes, and review the conservation status of the species.

The new specimens of *Crotalus lannomi* were collected at two localities in Colima: 42 km SE (Site 1) and 48 km ESE (Site 2) by road from Cuautitlan, Jalisco (Fig. 1). Protocols for making scale counts and definitions of external morphological features follow Klauber (1972) and Campbell and Lamar (2004). Measurements were made using a meter stick to the nearest 1 mm or with a digital caliper. All specimens were photographed by digital camera (Nikon D200 and Sony Cyber-Shot F828) and the images were deposited at the University of Texas at Arlington Digital Image Collection (UTADC). One specimen was deposited at the Museo de Zoología, Facultad de Ciencias, UNAM (MZFC 22941).

Measurements for other species of long-tailed rattlesnakes were taken from published sources (Campbell and Flores-Villela 2008; Campbell and Lamar 2004; Dunn 1919; Tanner 1966).

RESULTS

Description of the new material.—The specimens of *Crotalus lannomi* reported herein (N = 5; 3 males, 2 females) agree in most characters with the original description by Tanner (1966). A comparison of morphological characters is given in Table 1. The following is a summary of scutellation in *C. lannomi*: rostral wider

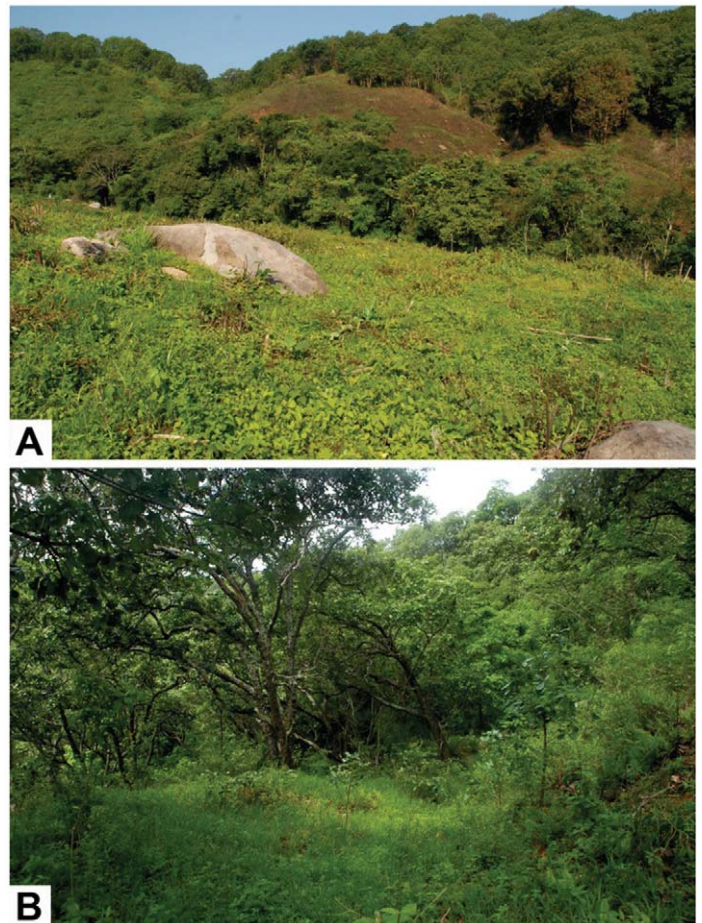


FIG. 1. New localities for *Crotalus lannomi* in Colima, Mexico. A) 42 km by road SE of Cuautitlan, Jalisco. Cleared field in open oak/TFD ecotone, 805 m elevation. B) 48 km by road ESE of Cuautitlan, Jalisco. Steep hillside in open oak/TDF ecotone, 1150 m elevation.

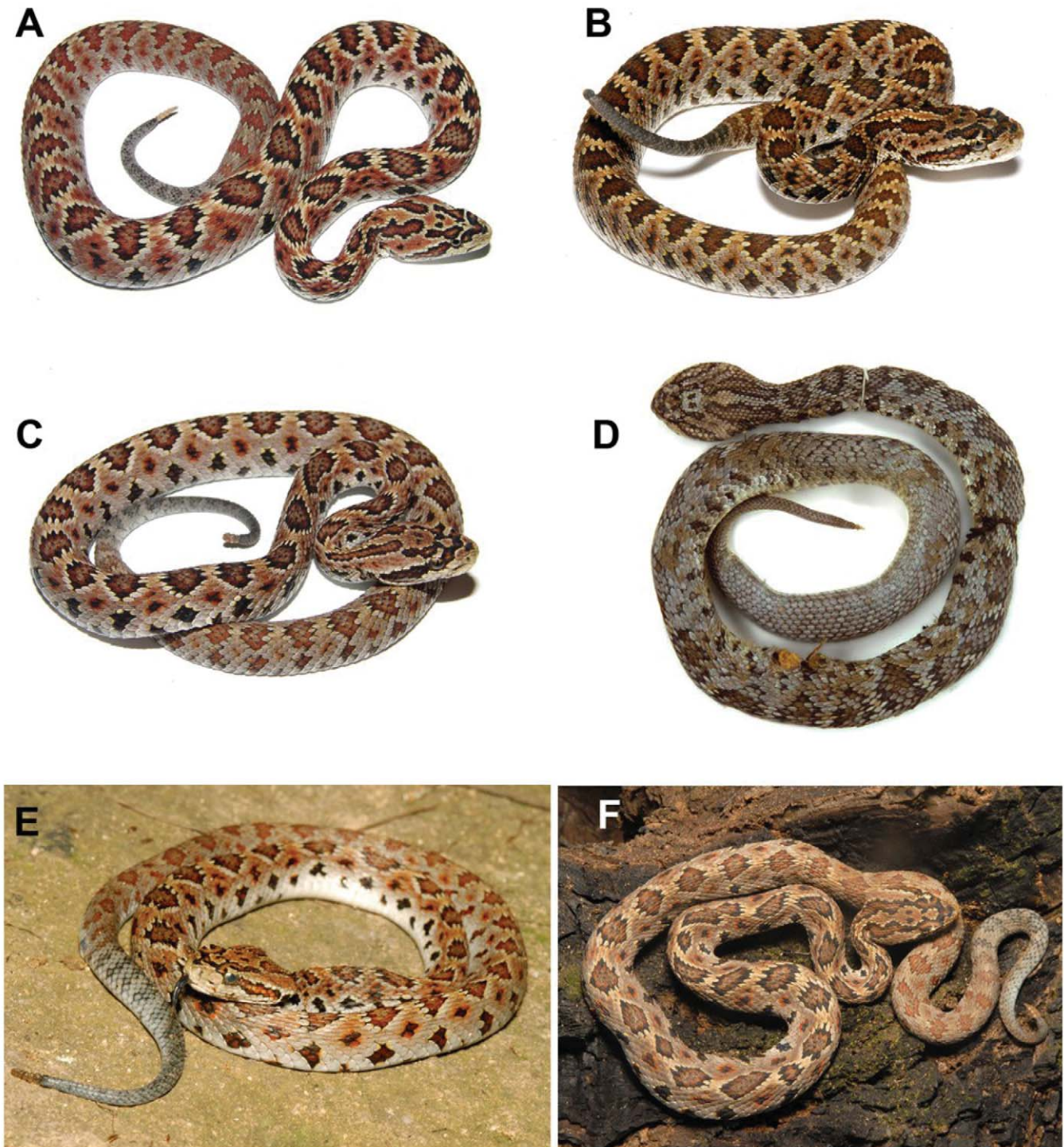


FIG. 2. Known specimens of *Crotalus lannomi*: A) UTADC-4005, female; B) UTADC-4002, female; C) UTADC-4003, male; D) BYU-23800, female, holotype; E) MZFC-22941, male; F) UTADC-4006, male.

than high; canthals moderate to large; 2–4 scales between canthals (but in two specimens canthals in contact); internasals relatively narrow; intersupraoculars 3, 4, or 5 at midlevel; 1–4 scales between intersupraoculars and intercanthals; dorsal scale rows (DSR) extremely variable: midbody 25–29; one head length behind neck 23–27; one head length anterior to cloaca 20–22; ventrals 168–175; subcaudals in males 49; in females 35–36; body slender in both sexes though slightly more stout in females.

Coloration.—In life coloration is as follows: ground color varies from rust-red to various shades of brown and yellow; dorsal blotches 31–35 (31–33 in females, 35 in males); blotches brown with central highlights and dark black or dark brown edges surrounded by a pale cream or white border one scale in width; blotches fade to pale brown or rust with the dark edges and pale border becoming indistinguishable towards the posterior part of the body; primary dorsal blotches 3–10 scales wide and 2–11 scales

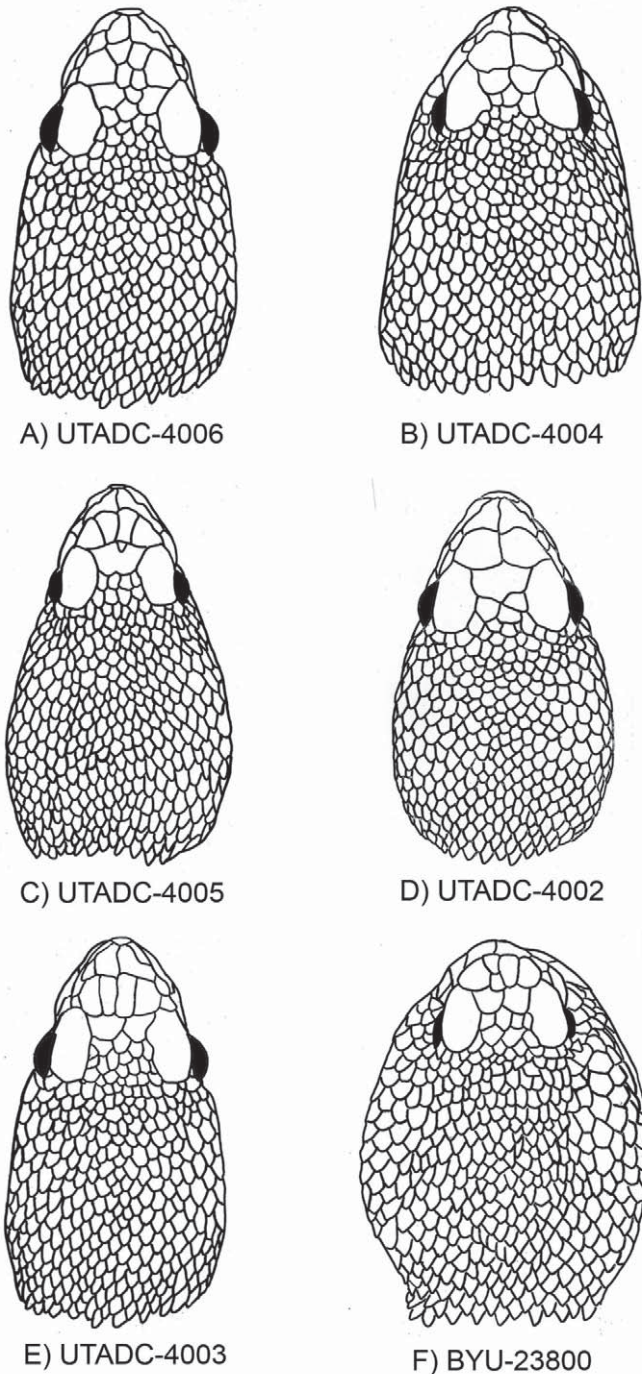


FIG. 3. Head scalation of *Crotalus lannomi*: A) UTADC 4006, male; B) MZFC 22941, male; C) UTADC 4005, female; D) UTADC 4002, male; E) UTADC 4003, female; F) BYU 23800, female, holotype (the unusual appearance can likely be attributed to the snake being run over by a vehicle).

long (9–12 scales wide and 3–5 scales long in the holotype), narrowing towards the posterior of the body; blotches separated by 0.5–4 scales; a dark brown or black spot present on both sides of each dorsal blotch, on scales 2–4; spots become paler on the posterior part of the body; a small dark lateral spot is present, usually on scale rows 4–6 between dorsal blotches, bordered by bright orange on surrounding scales; a secondary row of smaller dark

lateral spots is present just above the ventrals; tail pale blue-gray, with 12–17 gray bands; venter white with an irregular series of two black spots near the margin of each ventral. In preservative most colors turn dull gray or brown.

Habitat.—Both new localities for *Crotalus lannomi* reported here are within an ecotone of tropical deciduous forest (TDF) and oak forest (Fig. 1). The area is characterized by wet canyons harboring tropical semi-deciduous forest with large old growth trees. Areas above 1200 m have medium to dense pine or pine-oak forest. Site 1, at 805 m elev., lies along an arroyo and consists of a cleared field with scattered large boulders, covered by grasses and secondary growth ca. 0.5–1 m high. It is bordered by open oak/TDF (Fig. 1A). Site 2 is a steep hillside in open oak/TDF located at 1150 m elev. (Fig. 1B). It is mostly undisturbed, with the exception of some light grazing and logging. Introduced grasses (*Panicum*, *Hyparrhenia*, *Andropogon*) and small bushes represent the principal vegetation cover at Site 1. Small bushes (*Montano* sp., *Verbesina* sp.) and some herbaceous plants (*Adiantum* sp., *Cheilanthes* sp., *Hemiontis* sp.) form the understory at Site 2. Oak trees (*Quercus magnolifolia*, *Q. iltisii*, *Q. elliptica*) and tropical arborescent species (*Bursera bipinnata*, *Cecopia* sp., *Lysiloma* sp., *Sapium* sp.) represent the principal tree species at both localities.

NATURAL HISTORY

Diet.—Examination of fecal samples from a juvenile specimen (UTADC 4003) revealed lizard scales (*Sceloporus* sp.), arthropod remains, plant matter, and the mandible of a colubrid snake. The colubrid mandible measures 2.3 mm in length and has two posterior fangs with deep grooves.

Reproduction.—Umbilical scars were present in the two juvenile specimens (UTADC 4002, 4003), both of which were found ca. 20 m apart on the same hillside at Site 1 on 15–16 July, respectively. An adult female and male (UTADC 4005, 4006) were found on 24 July 2008 basking together beneath grasses and small ferns at Site 2 (Fig. 1B). The previous day, a single male (MZFC 22941) was observed at this site.

Activity and behavior.—All specimens were found partially hidden beneath vegetation between 1130 and 1300 h, and were quick to rattle and retreat when disturbed. None assumed a defensive posture nor struck when handled. We spent many hours actively searching at night, both in the field and on roads, but were not able to locate any specimens. However, based on published observations of related taxa (Campbell and Flores-Villela 2008; McDiarmid et al. 1976a), we expect this species to be crepuscular and/or nocturnal when weather permits.

DISCUSSION

Comparison with other long-tailed rattlesnakes.—The paucity of specimens available for study coupled with minimal sampling over a wide geographic range has made it difficult to determine relationships within this group. Until now, two of the three species (*C. lannomi* and *C. ericsmithi*) were each known only from a single specimen. Although the specimens reported here add to our understanding of variation in *C. lannomi* (Table 2), further sampling within the expected collective range of the long-tailed species group is needed to confirm the distinctiveness of the cur-

TABLE 1. Morphological variation in *Crotalus lannomi*. Measurements for BYU 23800 were taken from Tanner (1966) and Campbell and Flores-Villela (2008). DSR = Dorsal Scale Rows.

Characters	UTADC-4004	UTADC-4002	UTADC-4006	UTADC-4003	UTADC-4005	BYU-23800
Sex	Male	Male	Male	Female	Female	Female
Rattle segments	6	2	5	2	5	2 remaining
DSR at mid body	25	29	25	29	29	27
DSR 1 head length behind head	—	28	23	27	27	31
DSR 1 head length before cloaca	20	21	21	21	22	22
Ventral scales	175	173	171	175	168	176
Subcaudals	49	49	49	35	36	37
Scales between canthals	In contact	In contact	4	2	2	3
Intersupraoculars	3	3	4	5	4	4
Body blotches	35	35	35	33	32	31
Width of blotches (in scales)	6–10	8–10	6–9	3–4	7–10	9–12
Length of blotches (in scales)	2–4	3–7	3–7	7–11	3–5	3–5
Scales between blotches	1–4	1–2	1–2	1–2	0.5–2	1.5 or less
Tail bands	17	16	12	12	15	—
Total length (mm)	541	346	603	300	612	638
SVL (mm)	470	302	516	272	548	569
Tail length (mm)	71	44	87	28	64	69
Head length (mm)	39	19	31	19	35	31.6
Tail % of total length	13.10%	12.70%	14.40%	9.30%	10.40%	10.80%

rently recognized species.

Coloration of *C. lannomi* is very similar to that of the type specimen of *C. ericsmithi*. The bright orange color of *C. ericsmithi* was one of the most distinctive characters reported in the original description (Campbell and Flores-Villela 2008). Both adult male specimens of *C. lannomi* reported here also display bright orange to reddish coloration (Fig. 2). *Crotalus stejnegeri* is significantly duller in color, although Campbell and Flores-Villela (2008) noted that some specimens had orange-colored scales.

The additional specimens of *C. lannomi* demonstrate that this species is also highly variable in scutellation (Table 1). Previous differences thought to distinguish *C. lannomi* from *C. ericsmithi* have proven unreliable, including size of canthals, number of scales between canthals, number of intersupraoculars, number of ventrals, and general head and body coloration, as all of these characters overlap considerably between the two species. The number of mid-dorsal body blotches was believed to be a distinguishing feature between *C. lannomi* and *C. stejnegeri*. The additional material described here, however, demonstrates an overlap in all three species. *Crotalus lannomi* was believed to have a more stout body than *C. ericsmithi* and *C. stejnegeri*, but this trait seems to be a sexually dimorphic condition unique to females. Conversely, we have found the following characteristics to be useful in distinguishing *C. lannomi* from the other two species of long-tailed rattlesnakes: a reduced number of scales between the intersupraoculars and intercanthals, numbering 1–4 (12 in *C. ericsmithi*, more than 10 in *C. stejnegeri*) and by having fewer prefoveals, 4 (7–8 in *C. stejnegeri*; 5–6 in *C. ericsmithi*). The first pair of infralabials is mostly separated by the mental in *C. ericsmithi*, while it is in broad contact in both *C. lannomi* and *C. stejnegeri*.

Although each of the three species of long-tailed rattlesnakes occupies a very small area, their ranges are undoubtedly far greater than presently understood (Fig. 4). All three species occur at similar elevational and vegetation associations, and in similar climate zones that can be found almost continuously along the western slopes of the sierras from northwestern Durango to Oaxaca. Here we suggest some specific areas for future field efforts, as new material from within range gaps will be important in resolving relationships within the group.

1. The coastal foothills of Guerrero and Oaxaca, south of the low pass of the Sierra Madre del Sur, located near Chilpancingo.

2. The Sierra de Coalcomán in coastal Michoacán is located between the ranges of *C. lannomi* and *C. ericsmithi* and it seems likely that at least one of these species occurs there.

3. Also warranting attention is the Balsas/Tepalcatepec Basin of Jalisco, Michoacán, México, Guerrero, and Morelos, where a humid tropical semi-deciduous forest appears on the southern slopes of the central transverse ranges.

4. No species of long-tailed rattlesnake has been reported from Nayarit, however the state likely has *C. stejnegeri* and potentially *C. lannomi*.

5. Another area of interest is the region where the states of Sonora, Sinaloa, and Chihuahua meet, where we have heard rumors of long-tailed rattlesnakes from east of Álamos, Sonora and near Cosalá, Sinaloa.

Although it is unclear why no additional specimens of *Crotalus lannomi* had been found since the original description, and why long-tailed rattlesnakes in general are so seldom found, the following factors undoubtedly serve to reduce collecting efforts in long-tailed rattlesnake habitat.

TABLE 2. Morphological variation in long-tailed rattlesnakes. Measurement for *Crotalus ericsmithi* and *C. stejnegeri* were taken from Campbell and Flores-Villela (2008).

Characters	<i>Crotalus lannomi</i>	<i>Crotalus stejnegeri</i>	<i>Crotalus ericsmithi</i>
Tail % of TL	Males, 12.7–14.4% Females, 9.3–10.8%	Males, 10.4–14.5% Female, 9.7%	Male, 15.9%
Internasals	Relatively narrow	Broad	Relatively narrow
Size of canthals	Moderate to very large	Moderate	Large
Scales between canthals and intersupraoculars	0–4 3–5	2–3 5–8	3 5
Scales between intersupraoculars and intercanthals	1–4	>10	12
Ventrals	Males, 171–175 Females, 168–175	Males, 172–178 Females, 171–176	Male, 172
Subcaudals	Males, 49 Females, 35–37	Males, 48 Females, 36–37	Male, 41
Dorsal body blotches	Males, 35 Females, 31–33	34–43	35

Social issues.—The narrow band of habitat where long-tailed rattlesnakes are found is favorable for marijuana and opium production (pers. obs.). The type locality of *C. stejnegeri*, for example, has a long history of drug-related violence, as does Mexican Hwy 40, where additional specimens of that species have been collected (Hardy and McDiarmid 1969; McDiarmid et al. 1976). The coastal sierra of Guerrero, the only known locality for *C. ericsmithi*, is an important center for narcotics production, as is the Sierra de Coalcomán in Michoacán. In general, the western sierras of Nayarit, Jalisco, and Colima are somewhat less affected, but still have areas of marijuana and opium poppy harvesting.

Roads.—There are few accessible roads through long-tailed rattlesnake habitat. There are between four and eight paved roads traversing areas inhabited by long-tailed rattlesnakes, several of

which are some of the most dangerous in Mexico. Aside from poor road conditions, domestic livestock, heavy fog, rain and flooding, treacherous curves, and dangerous traffic, highway robberies and kidnappings are not uncommon. Access on dirt roads is more widespread; however, navigating them during the rainy season can be near impossible.

Conservation of Crotalus lannomi.—The tropical foothills of Colima, where the additional specimens of *C. lannomi* were found, are some of the state's last remaining wilderness areas, as most of the lowlands have been severely altered by human activity. Issues affecting the conservation of *C. lannomi* have not been studied, but here we list anthropogenic factors potentially affecting *C. lannomi* habitat:

- Agriculture.—Corn and coffee are being cultivated with some

TABLE 3. Amphibians and reptiles associated with *Crotalus lannomi* at two localities in Colima, Mexico.

Snakes	Lizards	Turtles	Amphibians
<i>Agkistrodon bilineatus</i>	<i>Ameiva undulata</i>	<i>Kinosternon integrum</i>	<i>Chaunus marinus</i>
<i>Boa constrictor</i>	<i>Anolis smithii</i>	<i>Rhinoclemmys pulcherrima</i>	<i>Ollotis marmoreus</i>
<i>Crotalus basiliscus</i>	<i>Aspidocelis linneattissimus</i>		<i>Craugastor augusti</i>
<i>Dryadophis melanolomus</i>	<i>Elgaria kingii</i>		<i>Craugastor hobartsmithii</i>
<i>Drymobius margaritiferus</i>	<i>Eumeces parvulus</i>		<i>Eleutherodactylus nitidus orarius</i>
<i>Enulius flavitorques</i>	<i>Heloderma horridum</i>		<i>Exerodonta smaragdina</i>
<i>Leptodeira maculata</i>	<i>Phyllodactylus lanei</i>		<i>Gastrophryne usta</i>
<i>Leptotyphlops humilis</i>	<i>Sceloporus bulleri</i>		<i>Hyla arenicolor</i>
<i>Manolepis putnami</i>	<i>Sceloporus utiformis</i>		<i>Pachymedusa dacnicolor</i>
<i>Masticophis mentovarius</i>	<i>Sphenomorphus assatus</i>		<i>Rana forreri</i>
<i>Micrurus proximans</i>			<i>Smilisca baudini</i>
<i>Trimorphodon biscutatus</i>			<i>Tlalocohyla smithii</i>
<i>Trimorphodon tau</i>			
<i>Tropidodipsas annulifera</i>			

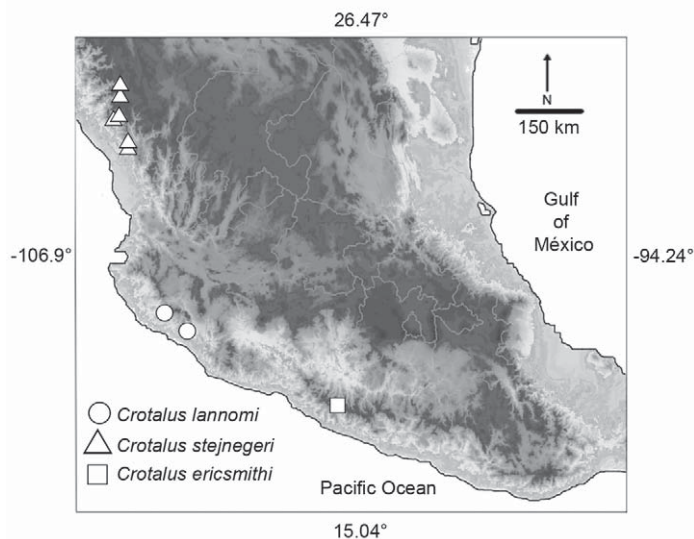


FIG. 4. Distribution of species of the long-tailed rattlesnake group in western Mexico.

frequency at Site 1. However, general inaccessibility and rough terrain limit the threat to most of this area.

- Cattle grazing.—Small-scale cattle grazing is common at both sites. Animals are usually free ranging and feed on native vegetation and introduced grasses. Some hillsides are considerably eroded, presumably due to overgrazing.
- Logging.—Minimal logging for charcoal production occurs in the vicinity of both localities.
- Mining.—Several active ore mines are found throughout the known and predicted range of *C. lannomi*. The expansion of these mining operations represents a potential risk to *C. lannomi* and its habitat.

Crotalus lannomi is listed as threatened by the Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). This is equivalent to the vulnerable category as defined by the IUCN. Although these rankings are assumed to be similar, this species is listed as “data deficient” in the IUCN Red List of Threatened Species (Ponce-Campos and Garcia-Aguayo 2007) rather than vulnerable. We consider *C. lannomi* vulnerable throughout its very limited known range.

Several species of unique plants and animals share the habitat with *Crotalus lannomi*. The tree *Inga colimana* (Fabaceae) is endemic to the area (Padilla Velarde et al. 2005). The Peregrine Falcon (*Falco peregrinus*) is known to nest at similar elevations in western Colima (Santana et al. 2006). This represents the southernmost reported nesting site for the species. At least one Puma (*Puma concolor*) was observed while searching for snakes at night. Some 716 species of plants are reported from a nearby sierra, and of those, 16 are considered to be in some kind of risk category and two are endangered (Padilla-Velarde et al. 2008). We believe that the west-central foothills of Colima should be protected to ensure the conservation not only of *Crotalus lannomi* but the rich flora and fauna sharing its habitat. Further studies are necessary to understand the ecology and natural history of this elusive species and to promote its conservation.

Type locality of Crotalus lannomi.—After an interview with Joseph R. Lannom, Jr. (interviewed by JRV on 6 February 2009), collector of the holotype of *C. lannomi*, it seems likely that the

original locality reported in Tanner (1966) is in error. During the interview, Lannom described the type locality of *C. lannomi* as a bridge where the highway crosses a lush canyon, which he referred to as “Wildcat Canyon.” A canyon fitting his description, known locally as “Arroyo el Tigre” is located at 550 m elevation, 12 km SW by road from the locality given in Tanner (1966). This locality lies within the TDF/oak forest ecotone. This difference might explain why searches at the published type locality, situated in a more arid oak forest, have failed to produce additional specimens.

Common name of Crotalus lannomi.—Tanner (1966) suggested the name “Autlán Rattlesnake” for *C. lannomi*. This name was later changed to “Autlán Long-tailed Rattlesnake” by Campbell and Flores-Villela (2008). The city of Autlán de Navarro, Jalisco, is located a short distance from the type locality of *C. lannomi* (ca. 13 airline km NE), but boasts habitat and climatic conditions significantly different from those at all known collection sites. The city is located in the rain shadow of the Sierra Manantlán, and the habitat is a dry, desert-like thornscrub. We believe it unlikely that *C. lannomi* would inhabit the area surrounding the city of Autlán, and therefore consider the name “Autlán Long-tailed Rattlesnake” inappropriate for this species. Given that both the type locality and the abovementioned collection sites are located in, or associated with, the Sierra de Manantlán, we propose the name “Manantlán Long-tailed Rattlesnake” for *C. lannomi*.

Herpetofauna associated with Crotalus lannomi.—A number of amphibians and reptiles were found at or in proximity to the new localities given here for *Crotalus lannomi*. Table 3 summarizes the herpetofaunal species found at these localities. Most are typically lowland inhabitants, but several (*Elgaria kingii*, *Sceloporus bulleri*, *Exerodonta smaragdina*, and *Hyla arenicolor*) are mid-elevation or highland species in west-central Mexico.

Acknowledgments.—We thank Joseph R. Lannom, Jr. for his insight and most of all for finding the first specimen of *Crotalus lannomi* over 40 yrs ago, which started this quest. We thank Oscar Avila-Lopez, Alexander Hermosillo, Chris Rodriguez, Ana Pacheco, Loreli Nuño, and R. Michel for their assistance in the field. We also thank Jonathan Campbell, Robert Bryson, Carlos Ibarra, Juan Rodriguez, and Jeff Streicher for their support. Special thanks to Oscar Avila and Francisco Santana for identifying some of the plant species at the new localities. Jonathan Campbell, Robert Bryson, Jesse Meik, and Dan Mulcahy kindly reviewed previous versions of the manuscript. Joseph Collins provided the image of the *C. lannomi* holotype. We are deeply indebted to the Michel family, as well as to Leo and Roman for all of their help and hospitality. We are also especially thankful to Oscar Flores for his assistance in reviewing this manuscript. Fieldwork was conducted under a collecting license issued to Oscar Flores by SEMARNAT (FAUT-0015). We gratefully acknowledge the support of Ronald A. Javitch, Montreal, for making possible the publication of color plates.

LITERATURE CITED

- CAMPBELL, J. A., AND O. FLORES-VILLELA. 2008. A new long-tailed rattlesnake (Viperidae) from Guerrero, México. *Herpetologica* 64(2):246–257.
- , AND W. W. LAMAR. 2004. *The Venomous Reptiles of the Western Hemisphere, Volume II*. Cornell University Press. Ithaca, New York. 874 pp.
- DUNN, E. R. 1919. Two new crotaline snakes from western Mexico. *Proc. Biol. Soc. Washington* 32:213–216.

- HARDY, L. M., AND R. W. McDIARMID. 1969. The amphibians and reptiles of Sinaloa, Mexico. Univ. Kansas Publ., Mus. Nat. Hist. 18:39–252.
- KLAUBER, L. M. 1972. Rattlesnakes: Their Habits, Life Histories and Influence on Mankind, 2nd ed. University of California Press, Berkeley and Los Angeles, California. 1533 pp.
- McDIARMID, R. W., J. F. COPP, AND D. E. BREEDLOVE. 1976. Notes on the herpetofauna of western Mexico: New records from Sinaloa and the Tres Marias Islands. Los Angeles Co. Mus., Contrib. Sci. 257:1–17
- PADILLA VELARDE, E., R. CUEVAS GUZMÁN, AND A. SOLÍS MAGALLANES. 2005. *Inga colimana* (Leguminosae): una especie nueva del Occidente de México. Acta Botánica 72:33–38.
- , ———, AND S. D. KOCH. 2008. Plantas vasculares y vegetación de la parte alta del arroyo Agua Fria, Municipio de Minatitlán, Colima, Mexico. Acta Botanica Mexicana 84:25–72.
- PONCE-CAMPOS, P., AND A. GARCÍA AGUAYO. 2007. *Crotalus lannomi*. In IUCN 2008. 2008 IUCN Red List of Threatened Species. <www.iucnredlist.org>. Accessed on 10 April 2009.
- SANTANA, E., H. VERDUGO-MUNGIA, C. IBARRA-CERDEÑA, J. J. NUÑEZ-FIGUEROA, AND O. SANCHEZ-JIMENEZ. 2006. Extension of the known breeding range and breeding season of the peregrine falcon in western North America. J. Raptor Res. 40(3):238–241.
- TANNER, W. W. 1966. A new rattlesnake from western Mexico. Herpetologica 22:298–302.

Herpetological Review, 2010, 41(1), 25–28.
© 2010 by Society for the Study of Amphibians and Reptiles

Checklist of Terrestrial Reptiles in Three Protected Areas in the Kingdom of Saudi Arabia

PETER L. CUNNINGHAM

King Khalid Wildlife Research Centre, Thumamah
P. O. Box 61681, Riyadh, Kingdom of Saudi Arabia
and

Zoological Society of London, Conservation Programmes
Regent's Park London, NW1 4RY, United Kingdom
e-mail: pckkwrvc@yahoo.co.uk

Because of under-collecting and general understudy, there is an overall paucity of data for reptiles in the various protected areas within the Kingdom of Saudi Arabia. Reptile species lists of occurrence (i.e., inventories of species occurring in protected areas or specific conservation areas) have not been published for the Kingdom of Saudi Arabia. However, a provisional checklist for the Mahazat as-Sayd protected area was published by Gaucher and Asmodé (1991). Previous general checklists for the region include Arnold (1986a) [lizards and amphisbaenians], Gasperetti (1988) [snakes]; Hillenius and Gasperetti (1984) [chameleons]; Gasperetti et al. (1993) [turtles], with general publications including reptiles from the Gulf Region by Leviton et al. (1992). Most recently, Egan (2007) published a field guide on the snakes of the Arabian Peninsula. General species-focused publications are more numerous with a number of reptile publications by various authors in the volumes of the Fauna of Saudi Arabia dating from 1979 onwards.

Study area.—A survey using a comprehensive literature review as well as confirmed sightings was conducted for three protected areas (Mahazat as-Sayd, Uruq Bani M'arid and the King Khalid Wildlife Research Centre – Latin transliteration of Arabic follows Child and Grainger 1990) within the Kingdom of Saudi Arabia (Fig. 1). These three areas are described individually:

1. The **Mahazat as-Sayd Protected Area** is a flat, arid desert steppe located ca. 150 km NE of Taif and 700 km W of Riyadh in western central Saudi Arabia (28.25°N, 41.67°E, between 900 and 1100 m above sea level) covering an area of 2190 km² (Child and Grainger 1990). The climate is arid with the annual rainfall (occurring mainly between March and May) highly variable ranging between 50 and 100 mm and the mean monthly minimum and maximum temperatures ranging between 2 and 21°C and 29 and 40°C (Islam et al. 2007). The general area is undulating sandy and gravel plains with shallow stony, often saline, soils with a low organic content and low levels of nitrogen, phosphorous, and potassium (Child and Grainger 1990) and dominated by *Acacia tortilis* trees and *Salsola spinescens* shrubs (Combreau and Rambaud 1994).

2. The **Uruq Bani M'arid Protected Area** is located ca. 750 km SW of Riyadh and 250 km N of Najran bordered on its west by the southernmost extension of the Tuwaiq Escarpment, a remnant Jurassic limestone massif, and to the east by the extensive sands (mainly longitudinal dunes) of the notorious Rub' al-Khali (Empty Quarter), the largest sand sea in the world. The overall size is 12,500 km² (core area 5000 km²) and the entire area is sparsely vegetated (19.13°N, 45.13°E, between 720–940 m above sea level) (Child and Grainger 1990). Trees, mainly *A. tortilis* and *A. ehrenbergiana*, occur in the interdune troughs (*shiqqat* in Arabic) and extend for only a short distance from the escarpment. Dune soils are windblown, sandy and loose with the desert pavement areas (interdune troughs) having high exchangeable sodium content and often saline (Child and Grainger 1990). The rainfall is highly variable and low with a mean of less than 47 mm annually, consequently with the lowest plant growth after the Empty Quarter within Saudi Arabia (Dunham 1997).

3. The **King Khalid Wildlife Research Centre (Thumamah)** is located approximately 70 km N of Riyadh in central eastern Saudi Arabia. The limestone Tuwaiq Escarpment borders the area towards the east with sandy-gravel plains and a belt of sand dunes towards the west (25.217°N, 46.617°E, at 600 m above sea level) (Child and Grainger 1990). Plateau soils (of which the gravel plains are part) are shallow and stony, often saline and with a low organic content

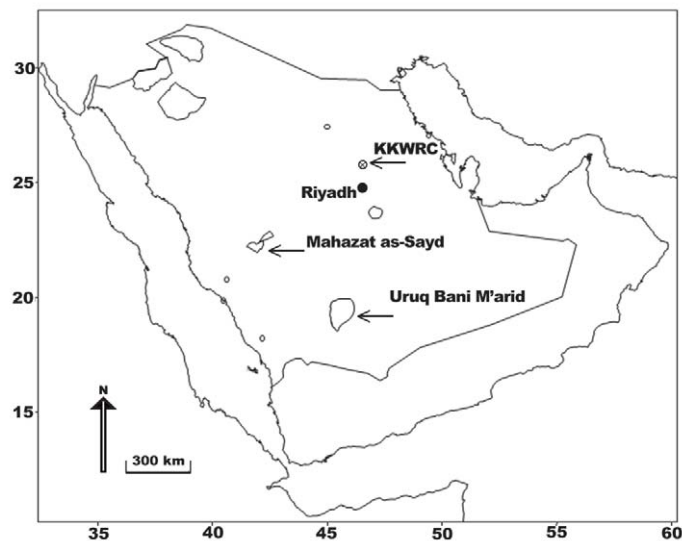


FIG. 1. Map of the Kingdom of Saudi Arabia, indicating the protected areas where the surveys were conducted.

TABLE 1. Checklist of reptiles expected, confirmed or presence unclear in three protected areas in the Kingdom of Saudi Arabia. ¹Identified as *Trapelus mutabilis* by Tilbury (1988) from the Riyadh area; ²According to Arnold (1986a) this species only occurs in north-western Saudi Arabia although Tilbury (1988) recorded it from the Riyadh area; ³Found in the Dhana area, east of Riyadh (Leviton et al. 1992; Tilbury 1988); ⁴Known only from the Al-Kharj area south of Riyadh (Leviton et al. 1992). Reptiles expected from the above mentioned protected areas (general areas) were determined using references to distribution (site localities) and distribution maps by ^aArnold (1986a), ^bGasperetti (1988), ^cTilbury (1988), ^dLeviton et al. (1992), ^eDisi et al. (2001) and ^fEgan (2007). Confirmed sightings using species characteristics include my own observations as well as the provisional checklist by ^gGaucher & Asmodé (1991) (for Mahazat as-Sayd) and personal records from M. Grobler, E. R. Robinson, M. Sher Shah, H. Tatwani (pers comm.).

Species	Mahazat as-Sayd		Uruq Bani M'arid		Thumamah	
	Presence	References	Presence	References	Presence	References
Trogonophidae						
<i>Diplometopon zarudnyi</i>					Expected	c
Agamidae						
<i>Phrynocephallus arabicus</i>	Expected	a,d,e	Confirmed	a,d,e	Expected	a,d,e
<i>Phrynocephallus maculatus</i>					Expected	a,f
<i>Pseudotrapelus sinaitus wernerii</i>	Confirmed	a,d,e,g	Unclear	a,d,e	Expected	a,c,d,e
<i>Trapelus pallidus agnetae</i> ¹	Confirmed				Expected	c
<i>Trapelus flavimaculatus</i>	Confirmed	a,d	Expected	a,d	Expected	a,c,d
<i>Trapelus persicus fieldi</i>	Unclear	d,e			Confirmed	c,d,e
<i>Uromastyx aegyptia</i>	Confirmed	a,d,e,g	Confirmed	a,d,e	Confirmed	a,c,d,e
Gekkonidae						
<i>Bunopus spatularis</i>	Unclear	d			Unclear	d
<i>Bunopus tuberculatus</i>	Confirmed	a,d,e,g			Confirmed	a,c,d,e
<i>Cyrtopodion scabrum</i>	Expected	a,d,e	Expected	a,d,e	Confirmed	a,c,d,e
<i>Hemidactylus turcicus</i>	Expected	a,d	Expected	a,d	Confirmed	a,c,d
<i>Hemidactylus persicus</i>					Expected	c
<i>Pristurus rupestris</i>					Expected	c
<i>Pristurus gasperetti gasperetti</i>	Unclear	d	Confirmed			
<i>Ptyodactylus hasselquistii</i> ssp.	Confirmed	a,d,e,g	Confirmed	a,d,e	Confirmed	a,c,d,e
<i>Stenodactylus arabicus</i>	Unclear	a,d	Expected	a,d	Expected	a,c,d
<i>Stenodactylus doriae</i>	Expected	a,d,e	Expected	a,d,e	Expected	a,c,d,e
<i>Stenodactylus slevini</i>	Confirmed	d,e,g			Confirmed	c,d,e
<i>Tropicolotus stuedneri</i> ²					Expected	c
Lacertidae						
<i>Acanthodactylus boskianus</i>	Confirmed	a,d,e,g	Expected	a,d,e	Confirmed	a,c,d,e,
<i>Acanthodactylus gongrorynchaetes</i> ³					Unclear	a,c,d
<i>Acanthodactylus ophiodurus</i>	Expected	a,d,e	Expected	a,d,e	Expected	a,c,d,e
<i>Acanthodactylus schmidtii</i>	Confirmed	a,d,e,g	Expected	a,d,e	Confirmed	a,c,d,e
<i>Acanthodactylus tilburyi</i>					Expected	a,c,d,e
<i>Mesalina brevirostris</i>	Confirmed	e,g			Expected	c,e
<i>Mesalina guttulata</i>	Unclear	a,e			Expected	a,c,e
Scincidae						
<i>Chalcides levitoni</i> ⁴					Unclear	d
<i>Chalcides ocellatus</i>	Unclear	e			Expected	c,e
<i>Eumeces schneideri princeps</i>					Expected	a,c,d,e
<i>Trachylepis septemtaeniata (Mabuya aurata)</i>					Confirmed	c
<i>Mabuya brevicollis</i>	Expected	a,d			Expected	a,c,d
<i>Scincus scincus mitranus</i>	Confirmed	a,d,e	Confirmed	a,d,e	Expected	a,c,d,e
<i>Scincus scincus conirostris</i>			Expected	a,d	Unclear	a,d
Varanidae						
<i>Varanus griseus griseus</i>	Confirmed	a,d,f	Expected	a,d,f	Confirmed	a,c,d,f
Typhlopidae						
<i>Ramphotyphlops braminus</i>					Expected	b,d,f
Leptotyphlopidae						
<i>Leptotyphlops macrorhynchus macrorhynchus</i>					Expected	b,f
Boidae						
<i>Eryx jayakari</i>	Expected	a,b,f	Confirmed	a,b,f	Confirmed	a,b,c,f

TABLE 1. Continued.

Species	Mahazat as-Sayd		Uruq Bani M'arid		Thumamah	
	Presence	References	Presence	References	Presence	References
Colubridae						
<i>Eirenis coronella fennelli</i>	Unclear	e				
<i>Platyceps elegantissimus</i>	Expected	b,d,e,f			Confirmed	b,d,e,f
<i>Platyceps saharicus</i>	Expected	b,d,e,f	Unclear	b,d,e,f	Expected	b,c,d,e,f
<i>Lytorhynchus diadema</i>	Unclear	b,d,e,f			Expected	b,d,e,f
<i>Malpolon moilensis</i>	Confirmed	b,d,e,f,g			Confirmed	b,c,d,e,f
<i>Malpolon monspessulana insignita</i>	Unclear	d			Confirmed	d
<i>Psammophis schokari</i>	Confirmed	b,d,e,f,g	Unclear	b,d,e,f	Confirmed	b,c,d,e,f
<i>Sparelosophis diadema cliffordi</i>	Expected	b,d,e,f			Confirmed	b,c,d,e,f
<i>Telescopus dhara</i>	Expected	b,d,e,f			Unclear	b,d,e,f
Atractaspididae						
<i>Atractaspis microlepidota engaddensis</i>	Expected	d,e,f				
Elapidae						
<i>Naja haje arabica</i>	Expected	f				
<i>Walterinnesia aegyptia</i>					Confirmed	b,c,d,e
Viperidae						
<i>Cerastes gasperettii</i>	Confirmed	b,d,e,f,g	Expected	b,d,e,f	Confirmed	b,c,d,e,f
<i>Echis coloratus coloratus</i>	Expected	b,d,e,f	Expected	b,d,e,f	Confirmed	b,c,d,e,f

and low levels of nitrogen, phosphorous and potassium (Child and Grainger 1990). The vegetation is dominated by shrubs such as *Ranterium eppaposum* and *Haloloxylon salicornicum* and the grasses *Panicum turgidium* and *Stipagrostis plumosa*. The overall size is 350 km² (fenced) with the KKWRC fenced enclosure within this being approximately 20 km². The rainfall is highly variable and a long-term average of 117 mm per annum has been recorded since 1989/1990 (Robinson 2007).

Methods.—Sampling was done primarily on an *ad hoc* basis while conducting fieldwork on the ecology of the Arabian Sand Gazelle (*Gazella subgutturosa marica*) in the various protected areas, and was not quantitative, thus no attempt at estimating the abundance of species. Consequently, the sampling intensity (i.e., amount of time spent in each protected area including time spent searching for reptiles) varied between protected areas. Sampling was conducted from January to November 2008, with most of the recordings occurring during the warmer months from March to September. Nocturnal observations were made using vehicle headlights while travelling slowly on tracks throughout the areas or on foot using a gas lantern. Individuals were photographed *in situ* or captured by using an extendable fishing rod and noose and photographed for confirmation and identified to species level using a variety of literature available or consulting regional experts listed in acknowledgments. Additional notes were made of the habitats in which each species was observed, and habits of some species were gathered to increase the knowledge regarding the ecology of reptiles within the protected areas. After confirmation of identification, all reptiles captured were released at the point of capture.

Results.—According to the available literature, a total of 52 species were expected to occur in the three protected areas although differences in distribution were expected between these areas due to different habitats. The highest reptile diversity was expected from the King Khalid Wildlife Research Centre, Thumamah area (40 species or 77% of the maximum total number of species expected from the 3 protected areas) followed by Mahazat as-Sayd (27 spe-

cies or 52%) and Uruq Bani M'arid (18 species or 35%). Lizards dominated the expected reptile richness in the three protected areas (34 species or 65%) and included 7 agamas, 12 geckos, 7 lacertids, 7 skinks, and 1 varanid. Gekkonidae dominated the expected lizard richness (12 species or 35%). At least 17 species of snakes were expected in the three protected areas together (pooled) and included 1 Atractaspididae, 1 Boidae, 9 Colubridae, 2 Elapidae, 1 Leptotyphlopidae, 1 Typhlopidae, and 2 Viperidae. Colubridae dominated the expected snake richness (9 species or 53%) and 1 species of Amphisbaenia (*Diplometopon zarudnyi*) was expected.

The survey results confirmed 20, 15, and 6 species from the King Khalid Wildlife Research Centre, Mahazat as-Sayd, and the Uruq Bani M'arid protected areas, respectively. Furthermore (although not yet confirmed) at least another 23, 14, and 12 species are expected while the distribution for 9, 3, and 5 species is unclear in the King Khalid Wildlife Research Centre, Mahazat as-Sayd, and the Uruq Bani M'arid protected areas, respectively (Table 1).

Table 1 presents the reptiles that are expected to occur in the three protected areas as I concluded from Arnold (1986a), Gasperetti (1988), Leviton et al. (1992), Disi et al. (2001), Egan (2007), Tilbury (1988), and Gaucher and Asmodé (1991) and those confirmed by me or positively confirmed by co-researchers (e.g., personal records).

Discussion.—Much of the overall distribution of reptiles throughout the Arabian Peninsula is unknown. Data on even the basic ecology of many species is still lacking aggravating our limited understanding of ecosystem functioning. This preliminary, *ad hoc*, investigation into the biodiversity of reptiles in three protected areas highlights the lack of baseline information on the distribution for most species in Saudi Arabia. The presence of a number of reptiles in the protected areas is unclear but could be confirmed with increased collection and should be encouraged. The overall dry (drought) conditions throughout 2008 in all three protected areas certainly affected the reptile sightings and therefore no general comments are made on the abundance of species observed.

Species of notable conservation importance include *Uromastix aegyptia* whose numbers have declined outside of protected areas due to illegal collecting for food or financial incentives (Sher Shah pers com). Very little is known about the distribution and status of endemics such as the skink, *Chalcides levitoni*, which is only known from one locality in the Al-Kharj area (Leviton et al. 1992)—i.e., a potential endemic to Saudi Arabia—ca. 50 km SE of Riyadh. Rapid development in the general area may negatively affect this species, but this would have to be investigated further. Although not recorded from the Thumamah area, the close proximity to Al-Kharj and lack of any contrary distribution data makes it a possibility. Another potential endemic is the gecko *Pristurus gasperetti gasperetti* now known only from two locations—Makkah area (Arnold 1986b) and Uruq Bani M'arid (this study). The generally unknown lacertid, *Acanthodactylus tilburyi*, has a disjunct distribution in Saudi Arabia with specimens known from the Riyadh area (Tilbury 1988) and Al Jawf in northwestern Saudi Arabia (Leviton et al. 1992). Such understudied species are important as development may decimate their populations before the basic ecology of these species can be elucidated. All snakes, due to a variety of reasons ranging from the obvious to the superstitious, are of concern as they are usually killed on sight. Except for two turtle species (Green and Hawksbill) listed under the IUCN's Red List of Threatened Species, no other reptile's conservation status is listed for Saudi Arabia (IUCN 2007).

Species newly identified for the respective protective areas—i.e., distribution not previously documented from the areas—include *Pristurus gasperetti gasperetti* from Uruq Bani M'arid (Cunningham 2008a), *Trapelus pallidus agnetae* from Mahazat as-Sayd (Cunningham 2008b), and *Trachylepis septemtaeniata* (formerly *Mabuya aurata*) from the Thumamah area (Cunningham 2008c). These sightings and confirmation of the species are viewed as range extensions for the Arabian Peninsula.

Although this publication reports on sporadic observation of reptiles from three protected areas only, it is expected to increase the knowledge of reptile distribution in these areas in Saudi Arabia and it is hoped that it would stimulate further research into this relatively understudied region. Such knowledge can be used to strengthen the importance of protected areas—i.e., indicating the importance of protected areas for overall biodiversity protection—as well as facilitate the holistic management of such areas in Saudi Arabia.

Acknowledgments.—I hereby acknowledge H. H. Prince Bandar bin Saud bin Mohammed Al Saud, Secretary General, NCWCD for his continued support towards conservation efforts in Saudi Arabia. My sincere appreciation goes to Andrew Gardner, Angelo Lambiris, Pritpal Soorae, and Yehudah Werner for assisting with literature and the identification of certain species. I also thank my colleagues Manie Grobler, Robbie Robinson, Moayyad Sher Shah, and Hani Tatwani for passing on their own unpublished records of confirmed reptile sightings. Furthermore, my appreciation goes to Ernest Robinson (Director KKWRC, Thumamah) for commenting on a draft of this note. I have also complied with all institutional animal care guidelines.

LITERATURE CITED

- ARNOLD, E. N. 1986a. Key and annotated check list to the lizards and amphisbaenians of Arabia. *Fauna of Saudi Arabia* 8:385–435.
 ———. 1986b. New species of semaphore gecko (*Pristurus*: Gekkonidae)

- from Arabia and Socotra. *Fauna of Saudi Arabia* 8:352–377.
 CHILD, G., AND J. GRAINGER. 1990. A system plan for protected areas for wildlife conservation and sustainable rural development in Saudi Arabia – Appendix II. NCWCD, Riyadh. 335 pp.
 CUNNINGHAM, P. L. 2008a. Gekkonidae, *Pristurus gasperetti gasperetti*, Gasperetti's semaphore gecko, Arnold 1986 – distribution. *Afr. Herp. News* 45:16–17.
 ———. 2008b. Agamidae, *Trapelus pallidus agnetae*, pale agama, Werner 1929 – distribution. *Afr. Herpetol. News* 45:18–20.
 ———. 2008c. Scincidae, *Trachylepis septemtaeniata*, golden skink, Reuss 1834 (formerly *Mabuya aurata* Linnaeus 1758) – distribution. *Afr. Herp. News* 45:21–23.
 COMBREAU, O., AND F. RAMBAUD. 1994. The houbara bustard programme in Mahazat as-Sayd. Unpubl. report, National Wildlife Research Centre, Taif.
 DISI, A.M., D. MODRÝ, P. NEČAS, AND L. RIFAI. 2001. Amphibians and Reptiles of the Hashemite Kingdom of Jordan. An Atlas and Field Guide. A. S. Brahm Publishers, Frankfurt am Main. 408 pp.
 DUNHAM, K. 1997. Gazelles and oryx in Saudi Arabia. *Re-introduction News* (13):5–6 (January).
 EGAN, D. 2007. Snakes of Arabia. A Field Guide to the Snakes of the Arabian Peninsula and its Shores. Motivate Publishing, Dubai. 208 pp.
 GAUCHER, P., AND J. F. ASMODÉ. 1991. Mahazat as-Sayd reptile provisional checklist. Unpubl. report No 3-1991-076: 6-7, National Wildlife Research Centre, Taif.
 GASPERETTI, J. 1988. Snakes of Arabia. *Fauna of Saudi Arabia* 9:152–450.
 ———, A. F. STIMSON, J. D. MILLER, J. P. ROSS, AND P. R. GASPERETTI. 1993. Turtles of Arabia. *Fauna of Saudi Arabia* 13:170–367.
 HILLENUS, D., AND J. GASPERETTI. 1984. The chameleons of Saudi Arabia. *Fauna of Saudi Arabia* 6:513–527.
 ISLAM, Z.M., A. BOUG, S. ANAGARIYAH, K. ISMAIL, E. R. ROBINSON, AND O. B. MOHAMMED. 2007. Catastrophic drought-induced die-off of reintroduced animals in Mahazat as-Sayd Protected Area in arid central Saudi Arabia. Unpubl. 2007 annual report, National Wildlife Research Centre, Taif.
 IUCN 2007. IUCN Red List of threatened species. <http://www.iucnredlist.org>
 LEVITON, A. E., S. C. ANDERSON, K. ADLER, AND S. A. MINTON. 1992. Handbook to Middle East Amphibians and Reptiles. SSAR, Oxford, Ohio. 252 pp.
 ROBINSON, E. R. 2007. Rainfall at Thumamah. Unpubl. 2007 annual report, King Khalid Wildlife Research Centre, Thumamah.
 TILBURY, C. R. 1988. An annotated checklist of some of the commoner reptiles occurring around Riyadh, Kingdom of Saudi Arabia. *J. Herpetol. Assoc. Afr.* 34:25–34.

A Proposed Weight-Length Relationship for the Common Mudpuppy

ANTHONY J. VANDEVALK^{1,*}
O'Brien & Gere, 5000 Brittonfield Parkway
East Syracuse, New York 13057, USA

and
JEREMY T. H. COLEMAN¹
U.S. Fish and Wildlife Service, 3817 Luker Road
Cortland, New York 13045, USA
e-mail: jeremy_coleman@fws.gov

¹ Cornell Biological Field Station, 900 Shackelton Point Road
Bridgeport, New York 13030, USA

* Corresponding author; e-mail: vandevaj@obg.com

The Common Mudpuppy, *Necturus maculosus maculosus*, is a large (20–30 cm) paedomorphic salamander that is aquatic in all life stages (Conant and Collins 1998). The mudpuppy is found in lakes and streams throughout eastern North America, ranging from the Great Lakes region to eastern Oklahoma and the northern borders of Mississippi, Alabama, and Georgia (Bartlett and Bartlett 2006).

Amphibians play a critical role in food webs, transferring energy from the lowest trophic levels to the higher organisms, and from aquatic to terrestrial systems through predation (Wilbur 1997). The Common Mudpuppy is essentially nocturnal, preying mainly upon fish, fish eggs, crayfish, aquatic insects, snails, and mussels, and residing beneath structures such as logs, rocks, and weeds during the day to avoid predators (Bishop 1941; Petranks 1998). Mudpuppies are reportedly consumed by large fish, Northern Watersnakes (*Nerodia sipedon*), Snapping Turtles (*Chelydra serpentina*), aquatic birds including Double-crested Cormorants (*Phalacrocorax auritus*; Coleman 2009), and possibly River Otters (*Lutra canadensis*) and Mink (*Mustela vison*; Gibbs et al. 2007). In systems where the mudpuppy acts as predator or prey, information regarding its life history and physiology contributes to the understanding of the system's ecological processes.

Bioenergetics models have been used to address a variety of ecological and management questions (Hansen et al. 1993; Kitchell 1983). Model applications vary, but typically require physiologically-based bioenergetics equations with empirically derived parameters (Hansen et al. 1993). For models that estimate predator growth or consumption, predator size and diet are essential parameters. Diet is usually described by examination of stomach contents that identify, to the lowest taxon possible, individual prey items and ideally provides information on prey size (typically length or age). Examination of stomach contents rarely provides direct measures of prey consumption by weight due to weight reduction attributable to digestion. Model consumption and growth estimates are based on weight, so prey length or age is converted to weight using species-specific regressions.

The objective of this note is to propose a weight-length relationship for the Common Mudpuppy. Mudpuppy weight-length information is currently lacking in the literature, so data relating mudpuppy weight to length should improve estimates

from models in which the mudpuppy acts as predator or prey.

Methods.—Weight-length data were recorded from mudpuppies collected from two lakes in New York State. Oneida Lake is located in central New York and is the state's largest inland lake. The lake is 20,700 ha, shallow (mean depth = 6.8 m, max depth = 16.8 m), and polymictic (Mills et al. 1978). Oneida Lake is currently considered a mesotrophic lake (Mayer et al. 2002) and is characterized as a warmwater fishery (VanDeValk and Rudstam 2001). Trout Lake, located 135 km north of Oneida Lake in St. Lawrence County, New York, is a 150-ha lake with a mean depth of 7.4 m and a maximum depth of 33.5 m (Swart and Guetti 1987). The lake provides both coldwater and warmwater fisheries and has a "sustaining of trout" classification (Swart and Guetti 1987).

Mudpuppies were collected from Oneida Lake using trapnets in April 2001 and electrofishing in October and November 2002, and from Trout Lake by electrofishing in October 2001. Mudpuppies were caught incidentally in trapnets set to collect spawning Wall-eyes (*Sander vitreus*) in Oneida Lake. The net design consisted of a 1.8 × 1.8 × 1.8 m crib, outside and inside wings with a combined length of 12.8 m, and a first heart with turnaround that led into a second heart with turnaround that funneled into a third heart in the crib (Kingsbury 1964). The net utilized a 45.4-m lead, and all sections were constructed of 25.4 mm-bar-mesh multifilament netting. Shoreline boat electrofishing surveys were conducted primarily to collect Walleye samples, with mudpuppies as a secondary target. Electrofishing was conducted at night using DC to produce a current of 8 A (354 V, 60 pulses/s).

Mudpuppies were anesthetized using MS-222, and total length (mm) and weight (g) recorded. After data were recorded, mudpuppies from Oneida Lake were placed in a tank with fresh lake water until they recovered, and then released. Mudpuppies from Trout Lake were euthanized and preserved after data collection. Voucher specimens are housed at the Cornell Biological Field Station, Bridgeport, New York.

Weight-length relationships were determined for all data combined and for lake- and season-specific data sets using regression analysis of the log₁₀-transformed data. Linear regression of body mass versus body length is one of the most common methods of describing body condition and has been used in many vertebrate taxa (Schulte-Hostedde et al. 2005). Lake- and season-specific regressions were compared using homogeneity of slopes (Sokal and Rohlf 1969).

Results and Discussion.—Fifty-three mudpuppies were measured and weighed; 30 mudpuppies were sampled from Oneida Lake ranging in length from 215 to 356 mm and 23 mudpuppies were sampled from Trout Lake ranging in length from 133 to 279 mm. The equation describing the pooled weight-length relationship is:

$$\text{Log}_{10}(W) = \text{Log}_{10}(\text{TL}) * 3.47 - 6.43 \quad (1)$$
$$r^2 = 0.94, \text{ df} = 52, p < 0.001$$

where W represents mudpuppy weight and TL represents mudpuppy total length (Fig. 1A). Sample sizes of 30 and 23 are small for describing weight-length relationships. For fish that have body forms similar to that of the Common Mudpuppy, the rule of thumb for minimum sample size for studies investigating the relationship between weight and length is 100 (Quist et al. 2009). However, adequate sample size is related to variance associated with the sample.

Because 94% of the variation in weight of the pooled mudpuppy sample was explained by length, we believe Equation 1 provides a reasonable description of the relationship between mudpuppy weight and length for the range of lengths sampled.

Equation 1 likely describes the weight-length relationship of adult mudpuppies. Bishop (1926) provided lengths-at-age of 185 mudpuppies collected from French Creek, Crawford County, Pennsylvania. None of the specimens sampled attained 130 mm until age 4, and mudpuppies at age 5 ranged from 169–210 mm. Sexual maturity is reached when individuals exceed 200 mm (Bishop 1926). All but three of the mudpuppies sampled in this study were larger than 210 mm and, therefore, were likely adults.

Species weight-length relationships can vary among seasons within a system. The equations describing the spring and the fall weight-length relationships for mudpuppies in Oneida Lake are:

$$\text{Spring: } \text{Log}_{10}(W) = \text{Log}_{10}(\text{TL}) * 2.06 - 2.92 \quad (2)$$

$$r^2 = 0.54, \text{ df} = 19, p < 0.001$$

$$\text{Fall: } \text{Log}_{10}(W) = \text{Log}_{10}(\text{TL}) * 2.85 - 4.88 \quad (3)$$

$$r^2 = 0.94, \text{ df} = 9, p < 0.001$$

For Oneida Lake, a weight-length regression comparison of spring and fall mudpuppies indicated mudpuppies caught in the spring were heavier than mudpuppies caught in the fall (homogeneity of slopes: $\text{df} = 26, t = 2.55, t_{0.05(2), 25} = 2.06$), and the difference in weight at a given length decreased with increasing length (Fig. 1B). A possible explanation for this difference may be attributed to differences in method of collection. Spring mudpuppies were collected from trapnets constructed of 25.4 mm-bar-mesh multifilament netting. It is possible that for smaller mudpuppies, this mesh size was not capable of retaining individuals that were leaner (weighed less) but was capable of retaining larger individuals regardless of their condition. This would result in a spring weight-length regression that would overestimate the calculated weight of smaller mudpuppies. Annual reproductive cycles may offer another possible explanation for the seasonal variability we observed. Although mating generally occurs in the fall, females store sperm and do not oviposit until May or early June (Bishop 1941; Gibbs et al. 2007). Thus, the presence of gravid females in April samples may have resulted in higher weights at a given length than if eggs were already deposited (Welsh et al. 2008). Harris (2008) found female weights at a given length varied within a population of Four-toed Salamanders (*Hemidactylum scutatum*) and attributed this variation to nesting behavior.

An alternative explanation for the differences in spring and fall weights at a given length is the effect of outliers. Visual inspection of the data suggested the smallest mudpuppy in the spring data set was heavier than would be expected. Elimination of this data point from the spring data set increased the slope of the spring regression to 2.68 and increased the r-square to 0.61. Further analysis testing the homogeneity of slopes indicated the spring and fall relationships were not statistically different for Oneida Lake mudpuppies once the outlier was removed ($\text{df} = 25, t = 0.55, t_{0.05(2), 25} = 2.06$). The resulting weight-length relationship of the pooled Oneida Lake data is:

$$\text{Log}_{10}(W) = \text{Log}_{10}(\text{TL}) * 2.82 - 4.78 \quad (4)$$

$$r^2 = 0.84, \text{ df} = 28, p < 0.001$$

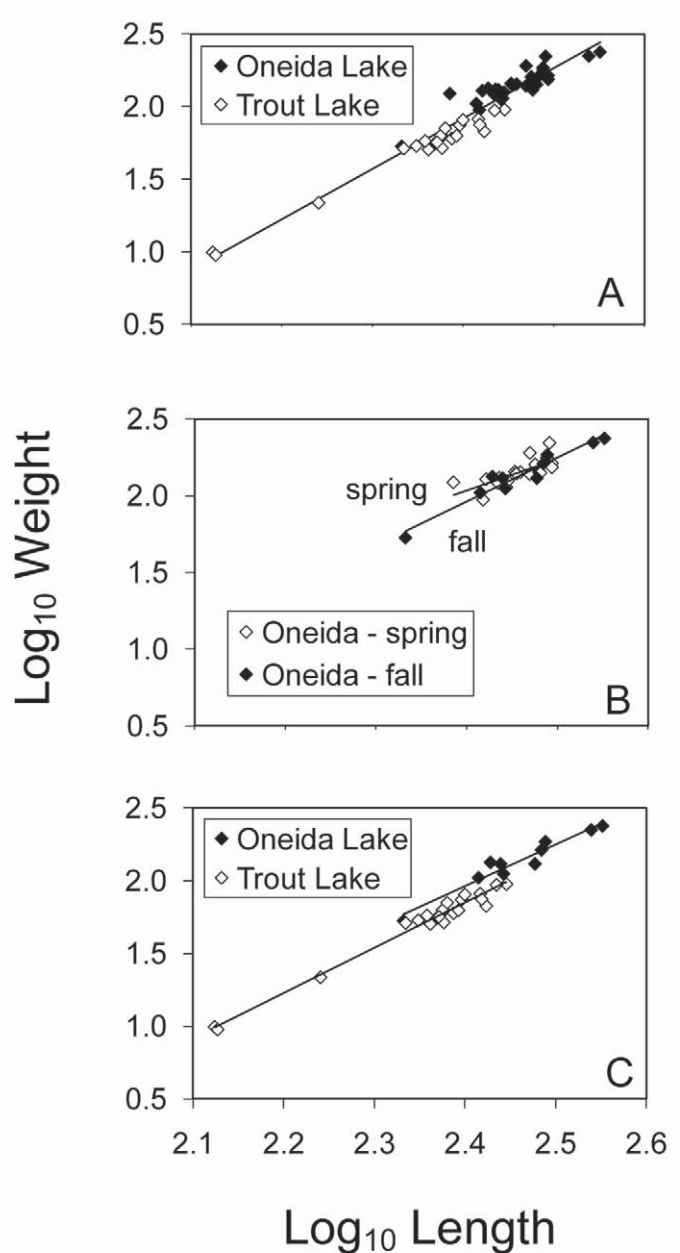


FIG. 1. Weight versus length data (log_{10} transformed) for the Common Mudpuppy (*Necturus maculosus maculosus*) from A) Oneida and Trout lakes, pooled; B) spring and fall from Oneida Lake; and C) Oneida and Trout lakes, fall only.

Empirical data are inherently variable and removal of individual data from data sets needs to be justified. While we cannot identify any reasons, other than nonconformity (possibly due to recording error), to eliminate the smallest mudpuppy from the spring data set, Equation 4 likely provides the most appropriate description of the weight-length relationship for the Common Mudpuppy in Oneida Lake.

Slopes from the weight-length relationships for mudpuppies from Oneida Lake were less than 3.0, suggesting a compressed body form. Mudpuppies sampled from Oneida Lake were observed to have a somewhat flattened body form that was most obvious for larger individuals. This observation is consistent with other published descriptions. Bishop (1941) described mudpuppy body

form as “The body is stout, depressed, and with a distinct median dorsal groove.” Gibbs et al. (2007) describes mudpuppies as having “flat heads” and a “laterally compressed tail.”

Species weight-length relationships can vary among systems. The equation describing the Trout Lake weight-length relationship for mudpuppies caught in the fall is:

$$\text{Log}_{10}(W) = \text{Log}_{10}(TL) * 3.10 - 5.60 \quad (5)$$

$$r^2 = 0.98, df = 22, p < 0.001$$

Lake-specific regression comparison indicated mudpuppies caught in the fall from Trout Lake and Oneida Lake increased in weight with length at a similar rate ($df = 29, t = 0.73, t_{0.05(2), 29} = 2.05$), but that mudpuppies from Oneida Lake were heavier at any given length within the observed length range (Fig. 1C). An explanation for this difference in weight at a given length may be related to differences in lake water temperatures. Salamander growth during the larval (aquatic) stage has been related to temperature, with higher temperatures resulting in increased growth rates (Keen et al. 1984). Similar effects of temperature have been shown for fish (Fry 1971). While no temperature data are available for Trout Lake, the existence of a sustaining coldwater fishery is indicative of a cooler environment than Oneida Lake which supports a warmwater fishery. Regardless, differences in size ranges of mudpuppies captured in Oneida Lake and in Trout Lake limit the conclusiveness of regression comparisons between the two systems.

This study presents the only Common Mudpuppy weight-length information that we are aware of. Because this study provides evidence of differences in weight at a given length between systems, system-specific relationships are desirable for investigative studies. However, in the absence of system-specific relationships, we believe the relationships presented in this paper can be useful for investigations that require information on mudpuppy weight and length. Lake-specific regressions presented in this paper can be used to represent weight-length relationships for mudpuppy populations in lakes with similar characteristics, and the pooled relationship (Equation 1) can serve as a representation for populations in other water bodies. Clearly, collection of mudpuppy weight and length data from other systems will enhance our understanding of this important relationship.

Acknowledgments.—Data collection was supported by the New York State Department of Environmental Conservation through the New York Federal Aid in Sport Fish Restoration Project F-56-R to the Cornell Warmwater Fisheries Unit. Specimen collection was authorized through New York State Fish and Wildlife License Numbers LCP01-553 and LCP02-581 and followed Cornell University Institutional Animal Care and Use Committee protocols. The authors would like to thank the staff at the Oneida Fish Cultural Station for providing mudpuppies collected in the spring from Oneida Lake, and Tom Brooking for providing mudpuppies from Trout Lake. The authors would also like to thank M. Mahoney, T. Pauley, and one anonymous reviewer for their critical and constructive reviews of the manuscript. This is contribution #267 from the Cornell Biological Field Station.

LITERATURE CITED

BARTLETT, R. D., AND P. P. BARTLETT. 2006. Guide and Reference to the Amphibians of Eastern and Central North America (North of Mexico). University Press of Florida, Gainesville, Florida. 283 pp.

BISHOP, S. C. 1926. Notes on the habits and development of the mudpuppy, *Necturus maculosus* (Rafinesque). Bull. New York State Mus. 268:5–60.

———. 1941. The Salamanders of New York. Bull. New York State Mus. 324:18–37.

COLEMAN, J. T. H. 2009. Diving Behavior, Predator-prey Dynamics, and Management Efficacy of Double-crested Cormorants in New York State. Dissertation. Cornell University. Ithaca, New York. 204 pp.

CONANT, R., AND J. COLLINS. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. 3rd ed., expanded. Houghton Mifflin Company, Boston, Massachusetts. 616 pp.

FRY, F. E. J. 1971. The effect of environmental factors on the physiology of fish. In W. S. Hoar and D. J. Randall (eds.), Fish Physiology, Volume 6, pp. 1–89. Academic Press, New York, New York.

GIBBS, J. P., A. R. BREISCH, P. K. DUCEY, G. JOHNSON, J. I. BEHLER, AND R. C. BOTHNER. 2007. The Amphibians and Reptiles of New York State. Oxford University Press, New York, New York. 504 pp.

HANSEN, M. J., D. BOISCLAIR, S. B. BRANDT, S. W. HEWETT, J. F. KITCHELL, M. C. LUCAS, AND J. J. NEY. 1993. Applications of bioenergetics models to fish ecology and management: Where do we go from here? Trans. Am. Fish. Soc. 122:1019–1030.

HARRIS, R. N. 2008. Body condition and order of arrival affect cooperative nesting behaviour in four-toed salamanders *Hemidactylium scutatum*. Anim. Behav. 75:229–233.

KEEN, W. H., J. TRAVIS, AND J. JULIANNA. 1984. Larval growth in three sympatric *Ambystoma* salamander species: Species differences and the effects of temperature. Can. J. Zool. 62:1043–1047.

KINGSBURY, O. R. 1964. Oneida Lake trap net. New York State Conservation Department, unnumbered report, Albany, New York. 10 pp.

KITCHELL, J. F. 1983. Energetics. In P. W. Webb and D. Weihs (eds.), Fish Biomechanics, pp. 312–338. Praeger Press, New York, New York.

MAYER, C. M., R. A. KEATS, L. G. RUDSTAM, AND E. L. MILLS. 2002. Scale-dependent effects of zebra mussels on benthic invertebrates in a large eutrophic lake. J. N. Am. Benthol. Soc. 21:616–633.

MILLS, E. L., J. L. FORNEY, M. D. CLADY, AND W. R. SCHAFFNER. 1978. Oneida Lake. In J. A. Bloomfield (ed.), Lakes of New York State, volume II, pp. 367–451. Academic Press, New York, New York.

PETRANKA, J. W. 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.

QUIST, M. C., K. I. BONVECHIO, AND M. S. ALLE. 2009. Statistical analysis and data management. In S. A. Bonar, W. A. Hubert, and D. W. Willis (eds.), Standard Methods for Sampling North American Freshwater Fishes, pp. 171–194. American Fisheries Society, Bethesda, Maryland.

SCHULTE-HOSTEDDE, A. I., B. ZINNER, J. S. MILLAR, AND G. J. HICKLING. 2005. Restitution of mass-size residuals: Validating body condition indices. Ecology 86:155–163.

SOKAL, R. R., AND F. J. ROHLF. 1969. Biometry. W. H. Freeman, San Francisco, California. 776 pp.

SWART, J., AND K. GUETTI. 1987. New York State Lakes: A Morphometric Atlas of Selected Lakes, Volume 3, Region 6. New York State Department of Environmental Conservation, Albany. New York. 62 pp.

VANDEVALK, A. J., AND L. G. RUDSTAM. 2001. Evolution of the Oneida Lake fishery. Clearwaters 31:26–28.

WELSH, H. H., JR., K. L. POPE, AND C. A. WHEELER. 2008. Using multiple metrics to assess the effects of forest succession on population status: A comparative study of two terrestrial salamanders in the US Pacific Northwest. Biol. Conserv. 141:1149–1160.

WILBUR, H. M. 1997. Experimental ecology of food webs: Complex systems in temporary ponds. Ecology 78:2279–2302.

Sex Differences in the Genitalia of Hatchling *Caiman latirostris*

NOELIA B. NUÑEZ OTAÑO*^{1,2,3}

ALBA IMHOF^{1,2}

PABLO G. BOLCATTO³

Dpto. de Física, Facultad de Ingeniería Química
Universidad Nacional del Litoral, Santiago del Estero 2829
CP 3000, Santa Fe, Argentina

and

ALEJANDRO LARRIERA^{1,2}

¹ Proyecto Yacaré - Laboratorio de Zoología Aplicada: Anexo Vertebrados
(FHUC - UNL / MASPMA), Aristóbulo del Valle 8700, Santa Fe, Argentina

² Facultad de Humanidades y Ciencias, UNL, Paraje el Pozo S/N
CP 3000, Santa Fe, Argentina

³ CICyTTP – CONICET, Dr. Matteri y España, S/N
CP 3105, Diamante, Entre Ríos, Argentina

Corresponding author; e-mail: noelianunezotano@cicytpp.org.ar

Newly hatched crocodylians have a structure called a “cliteropenis” (CTP), which generally is similar in morphology between sexes (Raynaud and Pieau 1985). Neonates of *Caiman crocodilus* and several species of *Crocodylus* display discernable differences between the penis and clitoris (Hutton 1987; Lang et al. 1989; Lang and Andrews 1994; Ziegler and Olbort 2007). The cliteropenis has an asymmetrical structure with a rounded sector (head), supported from the base by an elongated structure (neck). The head has a cleft on the top, in which the tip rests when in a relaxed position, but from which it protrudes when it is erect (Kelly 2002).

The development of the sexual phenotype in crocodylians is also interesting because in all species studied the temperature at which the eggs are incubated determines the sex (Lang and Andrews 1994). Indeed, many reptiles exhibit this temperature-dependent sex determination (TSD). The TSD pattern varies among species and percentage of sexes in nest can be 100% male or 100% female according to the incubation temperature (Janzen and Paukstis 1991), making it difficult to ascertain the sex of individuals without knowing the thermal conditions they experienced during embryonic development.

The Broad-snouted Caiman (*Caiman latirostris*) is the southernmost South American crocodylian, reaching to 32.53°S in its geographic distribution (Melo 2002). This species exhibits the FMF (female – male – female) pattern of TSD (Elf 2003), where females are obtained at 30°C and 34.5°C and males at 33°C (Piña et al. 2003). As in other crocodylians, sexing hatchling *C. latirostris* by cloacal examination is currently possible only when they are larger than 60 cm snout–vent length (SVL) (AL, pers. obs.). However, depending on incubation temperature, genital differentiation in hatchlings varies among species (Allsteadt and Lang 1995; Guillet et al. 1999). Previous studies have even shown differences in size and shape of the CTP in hatchling *Alligator mississippiensis* (Ziegler and Olbort 2007).

The aim of this study was to measure the genitalia of male and female *C. latirostris* at hatching to identify a method of sexing hatchlings by cloacal inspection using digital images. There is no

background research on this issue for *C. latirostris*, which currently requires the sacrifice of hatchlings to ascertain sex. However, the species is a valuable natural resource in Argentina (Larriera 1998) and Brazil (Verdade 2001), where conservation and management programs have stimulated research on many aspects of its biology. We hypothesized that the CTP of hatchlings differs between males and females of *C. latirostris*. In particular, we expected to find sex-related differences in the morphometry of the CTP.

Materials and Methods.— Wild *Caiman latirostris* eggs were collected from the San Cristóbal region (30.197406°S, 61.008717°W), Santa Fe, Argentina, during the 2006 nesting season (December–January) (Larriera and Imhof 2006). Seventy-eight eggs (one week old) from three clutches (the clutches were split evenly between two temperatures) were artificially incubated at constant temperatures of 30°C or 33°C (Larriera et al. 2008) to ensure the availability of females and males, respectively (Piña et al. 2003).

At hatching, each neonate was weighed (OHAUS, CS 200, ± 0.1 g) and snout–vent length (SVL; Vernier caliper ± 0.02 mm) from the tip of snout to posterior edge of the cloaca was measured. Twenty hatchlings (10 males, 10 females) were randomly selected for examination of genital morphology. The neonates were sacrificed for removal of the CTP and examination of the gonads. Gonadal sex was identified by the shape, texture, and color of the gonads and by the presence or absence of oviducts (Guillette et al. 1995).

CTPs were removed using a scalpel and preserved in 4% formalin for two hours. Following preservation, the right and upper sides of CTPs were photographed through a stereoscopic binocular microscope (ARCANO®; 20x). A scale alongside each CTP (+ 0.001 mm) (Fig. 1) allowed calibration of the software used for measurements of digital images (Image Pro Plus Version 4.5.0.20; 1993–2001 Media Cybernetics, Inc.). The software needs to set a calibration unit for the active picture, in this case our unit was 1 mm (obtained from the digital caliper alongside the CTP).

Three dimensions were measured from digital images of preserved CTP tissue: 1) Head Width (HW), measured from the

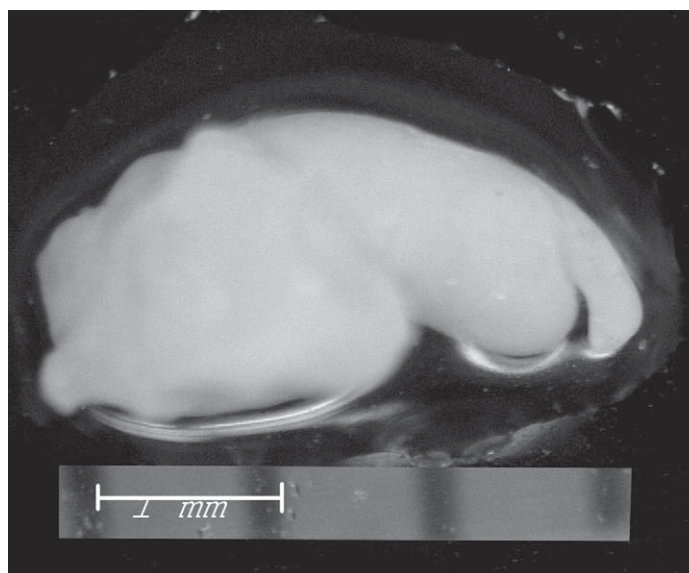


FIG. 1. Preserved CTP of hatchling *Caiman latirostris* removed from the cloaca. The scale below is from the digital caliper positioned in every picture to ensure real scale on the image in the moment of digital treatments. Scale: 1 mm

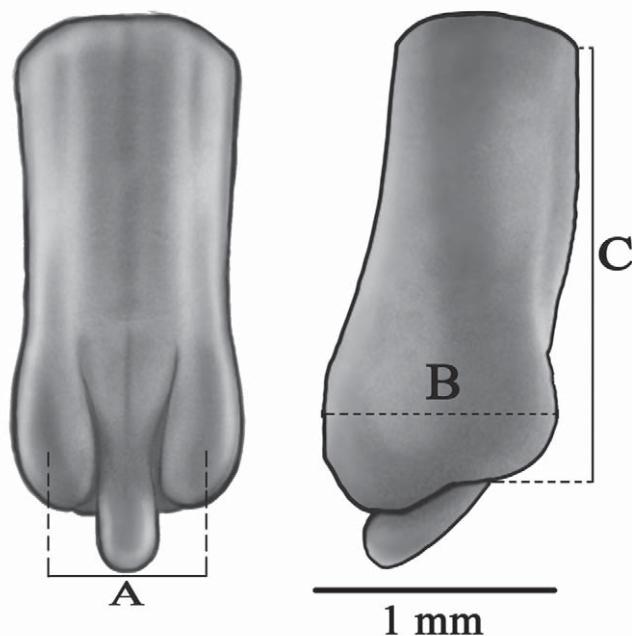


FIG. 2. Dimensions of hatchling cliteropenis *Caiman latirostris* (Left) **A** = Head Width (mm). (Right) **B** = Lateral Width (mm) and **C** = Total length (mm) of the CTP measured as the shortest distance from the base to the beginning of the tip.

upper surface (Fig. 2A); 2) Lateral Width (LW), measured as the maximum vertical width at the midsection of the head (Fig. 2B); and 3) Total Length (TL), measured from the base to the tip where it begins to separate from the head region (Fig. 2C). Also CTP volume was calculated by assuming a cylindrical structure with an ellipsoid base ($V = \pi [LW/2] [HW/2] TL$), which slightly underestimates real volume.

InfoStat/Professional version 1.1 was used for all statistical procedures (F.C.A 1999). All data were checked for normality and homogeneity of variances (Shapiro-Wilks and Levene test). Differences in CTP dimensions between the sexes were evaluated with t-tests (Zar 1999). A discriminant analysis with cross-validation for the variables for both sexes was subsequently run on the data set. Scatter plots were then made to create a key for future assessments of hatchling sex.

Results.— Internal sex identification: female gonads were elliptical and elongate in shape, and light beige in color with a granular texture; Müllerian ducts were clearly visible on the side of each ovary (Fig. 3). Male gonads had a similar shape, except the left testis was more elongate than the right testis (a characteristic of the sex), the color was a dark yellow, and the texture was less granular than ovaries of females; the vasa deferentia were present (Fig. 4). All females (N = 9; one of the samples was damaged in the process and we removed it from the analyses) were produced from constant incubation at 30°C and all males (N = 10) from constant 33°C incubation, consistent with the pattern of TSD in this species (Piña et al. 2003).

Cliteropenis of hatchlings: There was no significant difference in TL of the CTP between males and females ($P = 0.065$), but the CTP of males was significantly wider (t-test: LW, $P < 0.01$; HW, $P < 0.01$), and as a consequence volume was also significantly greater in males than in females ($P < 0.01$) (Table 1).

TABLE 1. Average values of variables for both sexes \pm SD. (*) Significant average values ($\alpha = 0.05$) (t-test).

CTP variables	FEMALES (N = 9)	MALES (N = 10)
Lateral Width (LW*)	(1.08 \pm 0.10) mm	(1.34 \pm 0.07) mm
Head Width (HW*)	(0.57 \pm 0.11) mm	(0.74 \pm 0.13) mm
Total Length (TL)	(2.19 \pm 0.48) mm	(2.73 \pm 0.76) mm
Volume (*)	(1.09 \pm 0.31) mm ³	(2.12 \pm 0.17) mm ³

Discriminant analysis showed the presence of separate groups of males and females and the cross-validation analysis showed evidence of a strong model considering the sample size and the CTP variables (proportion hatchlings correct in classification with cross validation is 0.895 versus initial classification of 0.947). Cross-validation reduces the number of measurements, thereby reducing handling time and stress to the animals and compensates for an optimistic apparent error rate in classifications, defined as the percentage of misclassified observations (MINITAB, 2000)

A homogeneity of covariance matrix test suggested that this analysis is suitable for these data (N = 19; df = 21; $P < 0.05$), with HW the most significant variable in the group discrimination ($F = 9.03$; df = 17; $P < 0.01$). In cross classification results, all males

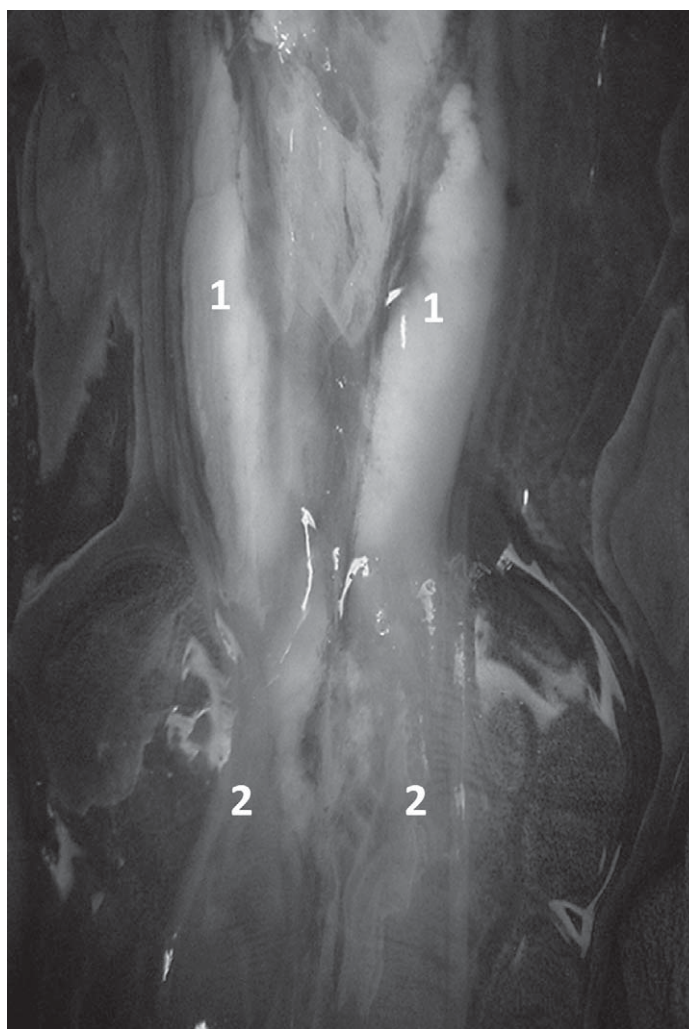


FIG. 3. Gonads of female hatchling *Caiman latirostris*. (1) ovaries, (2) Müllerian ducts.

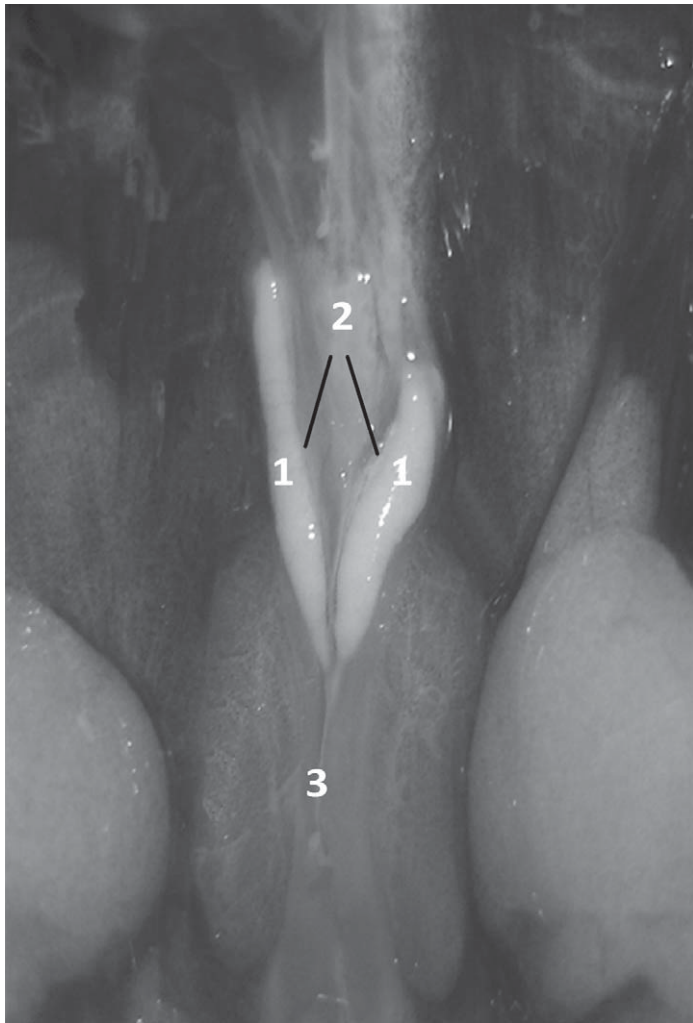


FIG. 4. Gonads of male hatchling *Caiman latirostris*. (1) testicles, (2) adrenal glands, and (3) vasa deferentia.

were classified correctly and only one female of nine was misclassified. Scatter plots of LW and HW of the CTP of hatchling *C. latirostris* revealed two groups: males formed a cluster above and to the right of the female cluster (Fig. 5).

Scatter plots of LW vs. SVL and HW vs. SVL were made to examine the distribution of these two variables in the group of hatchlings tested (Fig. 6). These results are consistent with those obtained in the discriminant analysis. We selected width limits to create a preliminary “key for sex differentiation” to classify hatchlings as males or females based on CTP measures. Of 19 samples, we sexed nine correctly as males and seven as females in the first step of the process. One more sample was classified as a male in the second step but two remained indeterminate (no. 7 and no. 9) using the key. These latter two samples were identified as females upon subsequent inspection of the gonads. Using the size limits on the graphics, we determined sex for 85% of the samples correctly, which is similar to the error rate in the discriminant analysis (i.e., 11%).

Discussion.—Previous studies found that reptiles such as *C. latirostris* exhibit TSD (Crews et al. 1994; Lance 1997; Lang and Andrews 1994; Pieau 1999). We corroborate this finding by obtaining 100% males at 33°C and 100% females at 30°C (Piña et al. 2003) as assessed by gonadal inspection (Ferguson and Joanen

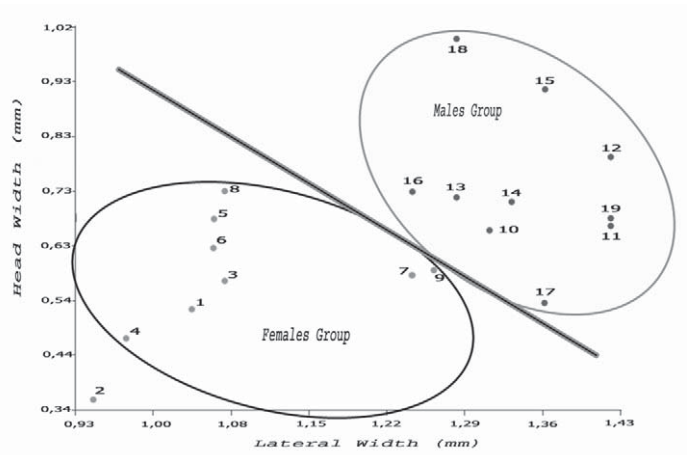


FIG. 5. Scatter plot showing the relationship between Lateral Width (mm) and Head Width (mm) of females (numbered 1–9) and males (numbered 11–19).

1983; Guillette et al. 1995).

Male CTP width and volume dimensions were significantly larger than those for females, which was somewhat surprising because the genital morphology in young crocodiles is similar. Still, prior studies found that incubation temperature affected both genital dimensions and gonadal sex determination in other crocodylians. Hatchling CTPs in *A. mississippiensis* differed in volume between the sexes and increased with increasing temperature of incubation from 30°C to 33°C (Allsteadt and Lang 1995). The CTP in hatchling *C. porosus* differed in HW and LW (Webb et al. 1984) and in size and shape in *C. niloticus* between males and

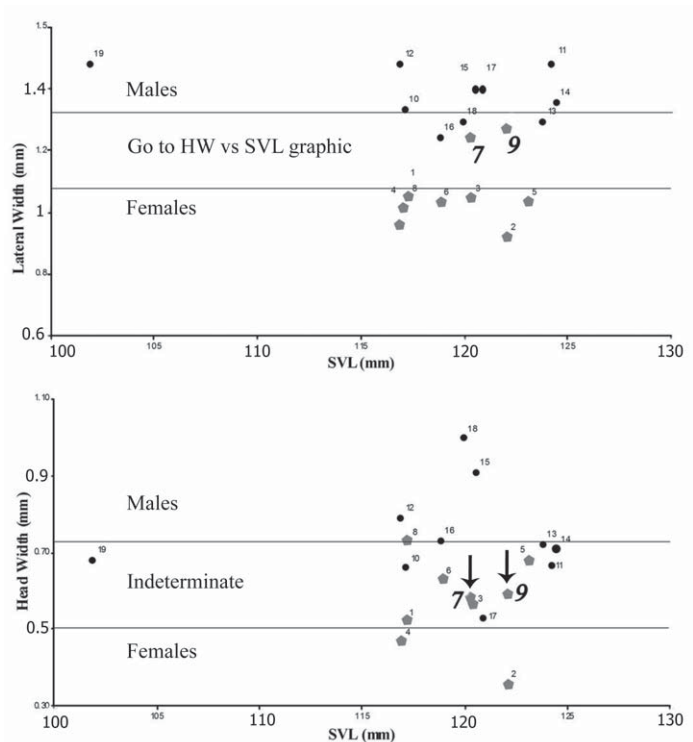


FIG. 6. Scatter plots of LW (mm) vs. SVL (mm) (upper) and HW (mm) vs. SVL (mm) (lower) values for males (black circles) and females (grey pentagons) groups. Arrows indicate hatchlings designated indeterminate by this method, but sex as females by gonadal inspection.

females (Hutton 1987).

To date the discrimination of newly hatched caiman into males and females has not been possible by observing the external genitalia. We show that such separation can be achieved from simple measures that can be recorded on the cliteropenis. The photographic measurement technique detailed herein was also tried on live hatchlings, which decreases stress on the hatchlings compared to measuring with digital calipers. This work continues in that this technique will be tried on live animals measured at hatching for which we will evaluate sex after one year of growth under controlled conditions of temperature, light, and diet.

To determine the sex in this and other species of crocodiles using a simple methodology opens the possibility of analyzing the sex ratio of offspring born in natural conditions, an unfinished agenda so far. This work is an important precedent for *C. latirostris* and similar species and lays the groundwork for a more advanced method of measurement that minimizes manipulation of individuals and measurement errors that can lead us to sex hatchlings incorrectly. Moreover, this new technique eliminates the current need to sacrifice young caimans to sex them for research work, ranching programs, and husbandry activities.

Acknowledgments.—We thank “Proyecto Yacaré” (CONVENIO MUPCN/Government of Santa Fe, Argentina) for permission to use caiman eggs collected by them. We also thank Rafael Ramos for help with 3D models of CTP. Finally, we especially thank Charlie Manolis for suggestions on this manuscript and to Fredric Janzen for English assistance and other important suggestions. We complied with all applicable institutional animal care guidelines.

LITERATURE CITED

- ALLSTEADT, J., AND J. W. LANG. 1995. Sexual dimorphism in the genital morphology of young American alligators, *Alligators mississippiensis*. *J. Herpetol.* 51:314–325.
- CRAIN, D. A., AND L. J. GUILLETTE. 1998. Reptiles as models of contaminant-induced endocrine disruption. *Ann. Reprod. Sci.* 53:77–86.
- CREWS, D. 1994. Temperature, steroids and sex determination. *J. Endocrinol.* 142:1–8.
- ELF, P. K. 2003. Yolk steroid hormones and sex determination in reptiles with TSD. *Gen. Comp. Endocrinol.* 132:349–355.
- FERGUSON, M. W. J. 1985. Reproductive biology and embryology of the crocodilians. In C. Gans et al. (eds.), *Biology of the Reptilia*, Vol. 14, Development A, pp. 329–492. John Wiley and Sons, New York.
- , AND T. JOANEN. 1983. Temperature dependent sex determination in *Alligator mississippiensis*. *Nature* 298:850–853.
- GUILLETTE JR., L. J., T. S. GROSS, D. A. GROSS, A. A. ROONEY, AND H. F. PERCIVAL. 1995. Gonadal steroidogenesis *in vitro* from juvenile alligators obtained from contaminated or control lakes. *Environ. Health Perspec.* 103, Suppl. 4:31–36.
- , A. R. WOODWARD, D. A. CRAIN, D. B. PICKFORD, A. A. ROONEY, AND H. F. PERCIVAL. 1999. Plasma steroid concentrations and male phallus size in juvenile alligators from seven Florida Lakes. *Gen. Comp. Endocrinol.* 116:356–372.
- HUTTON, J. M. 1987. Incubation temperatures, sex ratios, and sex determination in a population of Nile crocodiles (*Crocodylus niloticus*). *J. Zool. London* 211:143–155.
- JANZEN, F. J., AND G. L. PAUKSTIS. 1991. Environmental sex determination in reptiles: ecology, evolution, and experimental design. *Quart. Rev. Biol.* 66(2):149–179.
- KELLY, D. A. 2002. The functional morphology of penile erection: tissue designs for increasing and maintaining stiffness. *Integ. Comp. Biol.* 42:216–221.
- LANCE, V. A. 1997. Sex determination in reptiles: an update. *Am. Zool.* 37:504–513.
- LANG, J. W., AND H. V. ANDREWS. 1994. Temperature sex determination in crocodilians. *J. Exp. Zool.* 270:28–44.
- , ———, AND R. WHITAKER. 1989. Sex determination and sex ratios in *Crocodylus palustris*. *Am. Zool.* 29:935–952.
- LARRIERA, A. 1998. The *Caiman latirostris* ranching program in Santa Fe, Argentina. In *Crocodiles*, pp. 379–385. IUCN/SSC Crocodile Specialist Group, Gland, Switzerland.
- , AND A. IMHOF. 2006. Proyecto Yacaré. Cosecha de huevos para cría en granjas del género *Caiman* en la Argentina. In M. L. Bolkovic and D. Ramadori (eds.), *Manejo de Fauna Silvestre en la Argentina* Programas de uso Sustentable, pp. 51–64. Dirección de Fauna Silvestre, Secretaría de Ambiente y Desarrollo Sustentable, Buenos Aires.
- , ———, AND P. SIROSKY. 2008. Estado actual de los programas de conservación y manejo del género *Caiman* en Argentina. In J. Castroviejo et al. (eds.), *Contribución al Conocimiento de los Caimanes del Género Caiman de Suramérica*, pp. 141–179. Publ. Asociación Amigos de Doñana.
- PENNAK, R. W. 1978. *Freshwater Invertebrates of the United States*. Wiley, New York. 803 pp.
- PIEAU C., M. DORIZZI, AND N. RICHARD-MERCIER. 1999. Temperature dependent sex determination and gonadal differentiation in reptiles. *Cell. Mol. Life Sci.* 55:887–900.
- PIÑA, C. I., A. LARRIERA, AND M. CABRERA. 2003. The effect of incubation temperature on hatching success, incubation period, survivorship and sex ratio in *Caiman latirostris* (Crocodylia, Alligatoridae). *J. Herpetol.* 37:199–202.
- RAYNAUD, A., AND C. PIEAU. 1985. Embryonic development of the genital system. In C. Gans et al. (eds.), *Biology of the Reptilia*. Vol. 15. Development B, pp. 149–300. John Wiley and Sons, New York.
- RASMAWANI, L. S., AND D. JACOB. 1965. Effect of testosterone propionate on the urogenital organs of immature crocodile *Crocodylus palustris*. *Experientia* 21:206–207.
- ROMER, A. S. 1970. *The Vertebrate Body*. W. B. Saunders, Philadelphia, Pennsylvania. 627 pp.
- VAN TIENHOVEN, A. 1983. *Reproductive Physiology of Vertebrates*. Cornell University Press, Ithaca, New York. 491 pp.
- VERDADE, L. 2001. O programa experimental de Criacao em Cativeiro do Jacare de-Papo-Amarelo (*Caiman latirostris*) da ESALQ/USP: Histórico e perspectivas. In W. R. S. Mattos (ed.), *A Producao Animal na Visao dos Brasileiros*, pp. 559–564. Piracicaba, Sociedade Brasileira de Zootecnia, Sao Paulo, Brazil.
- WEBB G. J. W., S. C. MANOLIS, AND G. C. SACK. 1984. Cloacal sexing of hatchling crocodiles. *Aust. Wildl. Res.* 11:201–202.
- ZIEGLER, T., AND S. OLBORT. 2007. Genital structures and sex identification in crocodiles. *Crocodilian Specialist Group Newsletter* 26(3):12–13.
- ZAR, J. H. 1999. *Biostatistical Analysis*, 4th ed. Prentice Hall, Upper Saddle River, New Jersey. 662 pp.

TECHNIQUES

Herpetological Review, 2010, 41(1), 36–42.
© 2010 by Society for the Study of Amphibians and Reptiles

Dual-Energy X-ray Absorptiometry (DXA) as a Non-Invasive Tool for the Prediction of Bone Density and Body Composition of Turtles

MATTHEW D. STONE*

Department of Zoology, Oklahoma State University
430 Life Sciences West, Stillwater, Oklahoma 74078, USA

BAHRAM H. ARJMANDI

Department of Food, Nutrition, and Exercise Sciences
Florida State University, Tallahassee, Florida 32306, USA

and

MATTHEW B. LOVERN

Department of Zoology, Oklahoma State University
430 Life Sciences West, Stillwater, Oklahoma 74078, USA

*Corresponding author; present address:
Department of Biology, Kutztown University
Kutztown, Pennsylvania 19530, USA
e-mail: stone@kutztown.edu

Knowledge of animal body composition is important to studies of energetics, reproduction, and life history (Congdon et al. 1982; Secor and Nagy 2003), because it allows researchers to estimate body condition, parental energy investment, fitness, and productivity throughout an individual's life. Additionally, quantifying body composition is important for clinical studies of nutrition and metabolic disorders (Elowsson et al. 1998). The use of non-destructive techniques to determine body composition is essential for many studies including those involving mark-recapture and endangered species (Secor and Nagy 2003). With growing concern for the status of many species and the increased availability of technology for non-invasive procedures, destructive techniques will become increasingly unpopular.

A need for non-destructive techniques in chelonian research is becoming more apparent. Currently 80 chelonian species are listed as extinct, extinct in the wild, endangered, or critically endangered (IUCN 2007). As long-lived vertebrates with delayed sexual maturity, some turtle populations may be prone to anthropogenic harvest especially when adult survivorship is reduced (Congdon et al. 1993; Heppell et al. 1995). Therefore, the development of techniques that could reduce the permanent harvest of adult turtles for scientific purposes is important in helping reduce impacts to turtle populations. Potentially, dual-energy x-ray absorptiometry (DXA) could provide this service.

DXA was originally developed as a non-invasive tool that predicts bone density and risk of osteoporosis in humans. The physical principles of DXA technology have allowed expansion of its uses to the quantification of body composition in humans and other mammals. Recent applications to snakes and lizards have shown promise for the use of this technique in reptiles (Secor and Nagy 2003; Zotti et al. 2004). In turtles, DXA has been utilized to compare the effects of dietary treatments on bone density (Fledelius et al. 2005). To our knowledge, DXA has not been used to assess

other measures of body composition, nor has the accuracy of DXA estimates been previously validated, in turtles. The morphology of chelonians may preclude accurate determination of body composition with DXA without prior validation. Prediction of body composition analysis, particularly lean tissue and fat mass, may be complicated in chelonians by the bony encasement of the internal organs. The estimation of lean tissue and fat mass is complicated when a large proportion of the scanning area contains bone (Jebb 1997). Moreover, turtles have a higher proportion of bone relative to body mass than most other animal species (Iverson 1984) which, along with their unique morphology, makes them of great interest for bone density research. The development of techniques to assess bone density in turtles is not only relevant to taxon-specific research, but could have broader applications in nutrition, ecology, and physiology, as well as practical applications in veterinary research and practice.

In the present study, we examined the precision and effectiveness of DXA in predicting bone density and body composition of turtles. Our aim was to develop predictive models that can be used to assess body composition from DXA measurements. These models would then be available for researchers to monitor body composition of turtles in settings where destructive techniques are not feasible (e.g. clinical practice, mark-recapture studies). We collected DXA estimates of body composition on 25 male *Trachemys scripta* and then compared these values to estimates determined later by chemical analysis of dried carcasses. Secondly, this study compared the effects of three different techniques of immobilization (anesthesia, cooling, and euthanasia) on DXA body composition estimates because the accuracy of DXA results are known to be influenced by the movement of test subjects during scanning (Engelke et al. 1995).

MATERIALS AND METHODS

Animal Housing & Use.—We obtained an in-house transfer of 25 male *Trachemys scripta* from a previous study conducted at Oklahoma State University (Ligon, Gregory, Kazmaier, and Lovern, unpubl. study). Subjects were originally wild-caught from two populations in Eastern Oklahoma and Southern Texas. *Trachemys scripta* were chosen for this study because of their accessibility, wide distribution, abundance, and well studied life-history. Subjects ranged in straight carapace length (SCL) from 123.9 to 222.8 mm (mean \pm 1 SD = 159.3 \pm 25.7 mm), in greatest width from 102.9 to 168.0 mm (127.4 \pm 16.0 mm), and in mass from 260 to 1525 g (610 \pm 281 g). Turtles were housed individually in plastic storage containers partially filled with water and were fasted for one week prior to DXA scanning to ensure evacuation of gut contents.

DXA Estimation of Body Composition.—To determine the effects of anesthesia, euthanasia, and cooling on DXA estimates, each individual was scanned using all three immobilization techniques. Scanning was performed on a Hologic® QDR-4500A fan-beam scanner equipped with a small-animal software program. Prior to scanning, the densitometer was quality-checked daily using Hologic® calibration models (anthropomorphic spine phantom and small-step phantom). Calibration procedures followed those provided by the manufacturer. Body mass was determined for all individuals prior to scanning. Each individual was scanned four times per day for three consecutive days. During scanning, indi-

viduals were positioned with the plastron inferior (dorsoventral projection). The cranial end of the individuals was facing towards, and 1 cm behind, the laser-alignment crosshair. The individual's midline was positioned directly in the middle of the scanning area. Each day, turtles were scanned twice without movement, repositioned, and then scanned twice more without movement. During the first two days of scanning, individuals were randomly placed in either the "anesthetized" or "cooled" condition. Anesthetized individuals received a 0.1 mg/kg medetomidine-5.0 mg/kg ketamine combination (administered IM) for immobilization during scanning followed by 0.5 mg/kg atipamezole (IM) for recovery (Greer et al. 2001). Cooled individuals were placed in a 4°C incubator for a minimum of 5 h prior to scanning and transported on ice. Individuals that were anesthetized on the first day were cooled on the second day and vice versa. On the third day of scanning, all turtles were euthanized with an overdose of sodium pentobarbital (60–100 mg/kg IP) and scanning was repeated as above. Following the three scanning days, individuals were frozen for subsequent chemical analysis of body composition.

Non-DXA Estimation of Body Composition.—We estimated the following indices of body composition for each turtle: bone mineral content (BMC), fat mass (FM), bone-free lean tissue mass (LTM), fat-free tissue mass (FFM = LTM + BMC or BM-FM), total body water mass (WM), and body mass (BM). To achieve this, individuals were thawed, dissected to remove fat bodies for easier analysis, and then dried to constant mass at 60°C. Body mass was measured after drying (BM_{dry}) to a constant mass and then used to estimate water mass (WM) by subtracting it from wet body mass (BM_{wet}) determined prior to scanning. Carcasses (fat bodies excluded) were then ground and homogenized in a Wiley mill to be used for the determination of fat, lean tissue, and bone content. Fat mass (FM) was estimated by adding the dried mass of fat bodies to total body lipid mass. Total body lipid mass was estimated by determining the average percent lipid content of two 2-g subsamples of the ground carcass, and then multiplying by BM_{dry} . The lipid content of carcass subsamples was determined by the Folch method (Folch et al. 1957). To estimate bone mass, four 1-g subsamples of the ground carcass were ashed in a muffle furnace at 600°C for a minimum of 8 h. The mean percent mineral content of the four samples was used to estimate total body bone mass by multiplying by dried BM. Lean tissue mass was determined by subtraction.

Statistics.—We regressed body mass and straight carapace length against each body composition parameter (determined chemically) using simple least-squares regression in an attempt to develop models that could be used to predict body composition from standard morphometrics. Regression was performed on \log_{10} transformed data, but is presented in original scale by back-transforming regression coefficients. To examine the precision of DXA, intraindividual coefficients of variation (CV) were calculated from two scans without movement, from two scans with movement, and from all four scans for each type of body composition. To examine the effects of immobilization technique on DXA output parameters we performed repeated-measures ANOVA for each DXA parameter. Subject was analyzed as a blocking variable. When significant differences among treatment levels were detected, Tukey multiple-comparisons were used to examine where differences existed. Prior to analysis all variables were tested and deemed significantly

non-normal (Anderson-Darling Test $P < 0.001$). Therefore, we \log_{10} transformed all masses prior to analysis. All results involving transformed data are presented in the untransformed scale using back-transformed means and asymmetric 95% confidence limits (Sokal and Rohlf 1987).

We selected anesthesia as the preferred method of immobilization and all further validation analyses were performed using DXA data of anesthetized turtles. Anesthesia was selected as the most desirable method of immobilization because it reduced difference between DXA and chemical estimates of body composition. Mean \pm 1SD differences between DXA and chemical estimates for combined FM, LTM, and BMC, were 160.0 ± 94.3 , 168.8 ± 101.6 , and 185.4 ± 139.8 g for anesthesia, cooling, and euthanasia, respectively. Additionally, anesthesia generally resulted in more precise measurements compared to cooling (see results).

We performed simple and multiple least-squares regression analysis to develop models predicting chemical body composition (dependent variable) from DXA estimates (independent variable). We employed a best subsets regression procedure to select the variable(s) most useful in creating the predictive models. After generating predictive models we employed a jackknife cross-validation procedure as described by Secor and Nagy (2003). All values are given as mean \pm 1 SD. The level of statistical significance was set at $P < 0.05$. Statistical analyses were performed on Minitab version 13.1.

RESULTS

Water comprised $69.46 \pm 3.25\%$ of total body mass. Body composition of wet body mass was comprised of $84.82 \pm 1.85\%$ lean tissue, $13.83 \pm 1.58\%$ ash, and $1.35 \pm 1.06\%$ fat mass. Of dried body mass, 50.29 ± 2.95 , 45.48 ± 4.78 , and 4.23 ± 2.84 percent, was comprised of LTM, AM, and FM, respectively. The results of the least-squares regression between morphometrics and body composition estimates, determined chemically, are presented in Table 1. All models resulted in significant non-zero slopes ($P \leq 0.002$). All models had strong relationships between morphometric and body composition variables ($r^2 \geq 96.6\%$), with the exception

TABLE 1. Results of least-squares regressions of water mass (WM), fat-free tissue mass (FFM), lean tissue mass (LTM), fat mass (FM), and ash mass (AM), determined chemically, against body mass (BM) and straight carapace length (SCL) in male *Trachemys scripta* (N = 25). All mass units are in grams and length in millimeters.

Regression Coefficients	F	P Value	r^2
WM = 0.863(BM)0.965	2730.7	< 0.001	0.992
FFM = 0.993(BM)0.999	50475.2	< 0.001	1.000
LTM = 0.982(BM)0.977	16040.4	< 0.001	0.999
FM = 0.005(BM)1.125	13.0	0.001	0.361
AM = 0.063(BM)1.125	1038.1	< 0.001	0.978
WM = 2.662*10 ⁻⁴ (SCL)2.799	652.89	< 0.001	0.966
FFM = 2.193*10 ⁻⁴ (SCL)2.907	1168.33	< 0.001	0.981
LTM = 2.686*10 ⁻⁴ (SCL)2.837	935.18	< 0.001	0.976
FM = 3.404*10 ⁻⁷ (SCL)3.284	12.73	0.002	0.356
AM = 4.155*10 ⁻⁶ (SCL)3.302	943.00	< 0.001	0.976

TABLE 2. Mean intra-individual coefficients of variation (%) of DXA scans for the three methods of immobilization and four tissue components in male *Trachemys scripta* (N = 25). Values for movement represent the coefficient of variation (CV) of two repeated measurements where the individual was moved between scans (scans 1 and 3). Still represents the CV of two repeated measurements where the subject was not moved between scans (Scan 1 and 2). The combined data represents the CV of all four scans combined. Values are mean \pm SD. Abbreviations: BMC = bone mineral content, BMD = bone mineral density, FM = fat mass, LTM = lean tissue mass.

Body Composition Type	Anesthesia			Cooling			Euthanasia		
	Movement	Still	Combined	Movement	Still	Combined	Movement	Still	Combined
BMC	1.71 \pm 1.36	1.00 \pm 0.82	1.63 \pm 0.89	2.05 \pm 1.65	1.96 \pm 1.67	2.00 \pm 1.18	1.49 \pm 1.05	0.74 \pm 0.57	1.36 \pm 0.75
BMD	1.81 \pm 1.49	0.97 \pm 0.73	1.59 \pm 1.24	1.54 \pm 1.52	1.53 \pm 1.40	1.63 \pm 1.04	1.34 \pm 1.47	0.70 \pm 0.49	1.23 \pm 1.02
FM	52.11 \pm 42.48	28.54 \pm 24.16	78.89 \pm 63.85	65.7 \pm 58.65	77.38 \pm 62.39	97.03 \pm 60.75	51.58 \pm 45.64	46.0 \pm 51.51	53.72 \pm 41.93
LTM	2.01 \pm 3.00	1.05 \pm 1.45	3.40 \pm 6.03	2.39 \pm 5.43	1.57 \pm 3.36	2.49 \pm 3.65	7.31 \pm 13.33	4.28 \pm 4.80	6.59 \pm 8.01

of models predicting fat mass which showed a poor relationship between variables ($r^2 \leq 36.1\%$).

Precision of DXA.—Mean intraindividual CV was calculated for 4 DXA parameters using all three immobilization techniques (Table 2). Mean intraindividual CV for four combined scans was greater than 53.7% for Fat Mass, but less than 2.0% and 6.6% for BMC and LTM, respectively. CV tended to be highest for cooled individuals and lowest for euthanized individuals when examining BMC, BMD, and FM; however for LTM there was less precision when examining euthanized individuals while anesthesia resulted in more precise measurements (Table 2).

Effects of immobilization technique.—Immobilization technique significantly influenced the use of DXA to determine BMC (repeated-measures ANOVA; $F_{2,48} = 12.07$; $P < 0.001$), BMD ($F_{2,48} = 25.51$; $P < 0.001$), FM ($F_{2,48} = 16.26$; $P < 0.001$), LTM ($F_{2,48} = 15.44$; $P < 0.001$), and body mass ($F_{2,48} = 4.99$; $P = 0.011$). The effect of immobilization method was not consistent among the DXA parameters analyzed (Fig. 1).

Evaluation of DXA accuracy.—DXA estimates of body composition were highly correlated with chemical estimates for bone mass ($r^2 > 0.986$) and lean tissue mass ($r^2 > 0.964$) regardless of the method used to immobilize individuals during DXA scanning (Fig. 2A, B); however DXA estimates were poorly correlated with chemical estimates for fat mass ($r^2 < 0.261$; Fig. 2C). DXA estimates were significantly different than chemical estimates for AM (paired T-test; $T = 112.95$; $P < 0.001$), LTM ($T = 7.71$; $P < 0.001$), BM ($T = 4.42$; $P < 0.001$), and FM ($T = 4.46$; $P < 0.001$). DXA underestimated BMC, but overestimated FM, LTM, and BM regardless of the immobilization method used (Fig. 3).

DISCUSSION

The goal of developing new techniques to quantify observations is to provide users with advantages not afforded by previous methodologies. The application of non-destructive techniques, although non-invasive and therefore desirable, often sacrifices accuracy and precision. The utility of any technique is dependent on its ability to produce accurate and more importantly precise measurements. Accuracy is less important because predictive regression equations can be developed to correct for any biases inherent to the technique. The use of DXA for the quantification of body composition brought great promise because it is non-invasive and has a high degree of precision compared to other in vivo techniques (Jebb 1997).

We assessed the precision and accuracy of DXA in predicting bone density and body composition of turtles. With the exception of fat mass, the precision of tissue components, as determined by DXA, was relatively high and similar to that determined for other species/studies. In our study lean tissue mass, fat mass, and bone mineral content of anesthetized turtles had CV of 1.05, 28.54, and 1.00%, respectively. In mice, CV was similar to this study for BMC (1.60%) and LTM (0.86%), but fat mass (2.20%) was predicted much more precisely than in our study (Nagy and Clair 2000). In rats, mean CV of five rats over a three day period was 1.07% (BM), 12.16% (FM), 2.88% (LTM), and 6.34% (BMC; Rose et al. 1998). DXA also provided precise measurements of BMC (CV = 0.90%) for excised humeri of rats, but other body composition variables were not examined (Kastl et al. 2002). In domestic pigs CV was 0.74%, 0.94%, 1.91%, and 13.51% for BM, LTM, BMC, and FM, respectively (Elowsson et al. 1998). Studies investigating DXA precision of non-mammalian vertebrates, although less prevalent, suggest similar degree of precision. Korine et al. (2004) measured CV of 1.28%, 1.87%, and 4.92% for BM, LTM, and FM, respectively for live specimens of two species of birds. Precision of body composition estimates for snakes were also similar to that of this study for BMC (CV = 1.0%) and LTM (CV = 0.6%; Secor and Nagy 2003). Overall, precision of body composition estimates determined in this study fall within or below ranges found in other studies. The most notable exception is fat mass which has high intraindividual variability. Although the precision of DXA fat mass estimates are discouraging, the similar degree of precision in estimating other indices of body composition in turtles is promising. The similarity of precision compared to that of other species in particular humans and rodents, for which software was originally designed, is promising for the continued application of DXA in research involving chelonians.

Influence of immobilization.—Use of DXA requires that subjects remain motionless during the entire scanning process. Subject movement during scanning significantly and unpredictably influences the accuracy and precision of body composition estimates (Cawkwell 1998; Koo et al. 1995). A goal of this study was to determine which, if any, of the immobilization techniques resulted in the most precise and accurate measurements while at the same time reducing negative consequences associated with immobilization. Negative consequences associated with immobilization include: cost, ease of use, recovery rate, and potential for harm of test subject. Ignoring precision and accuracy, cooling is the most

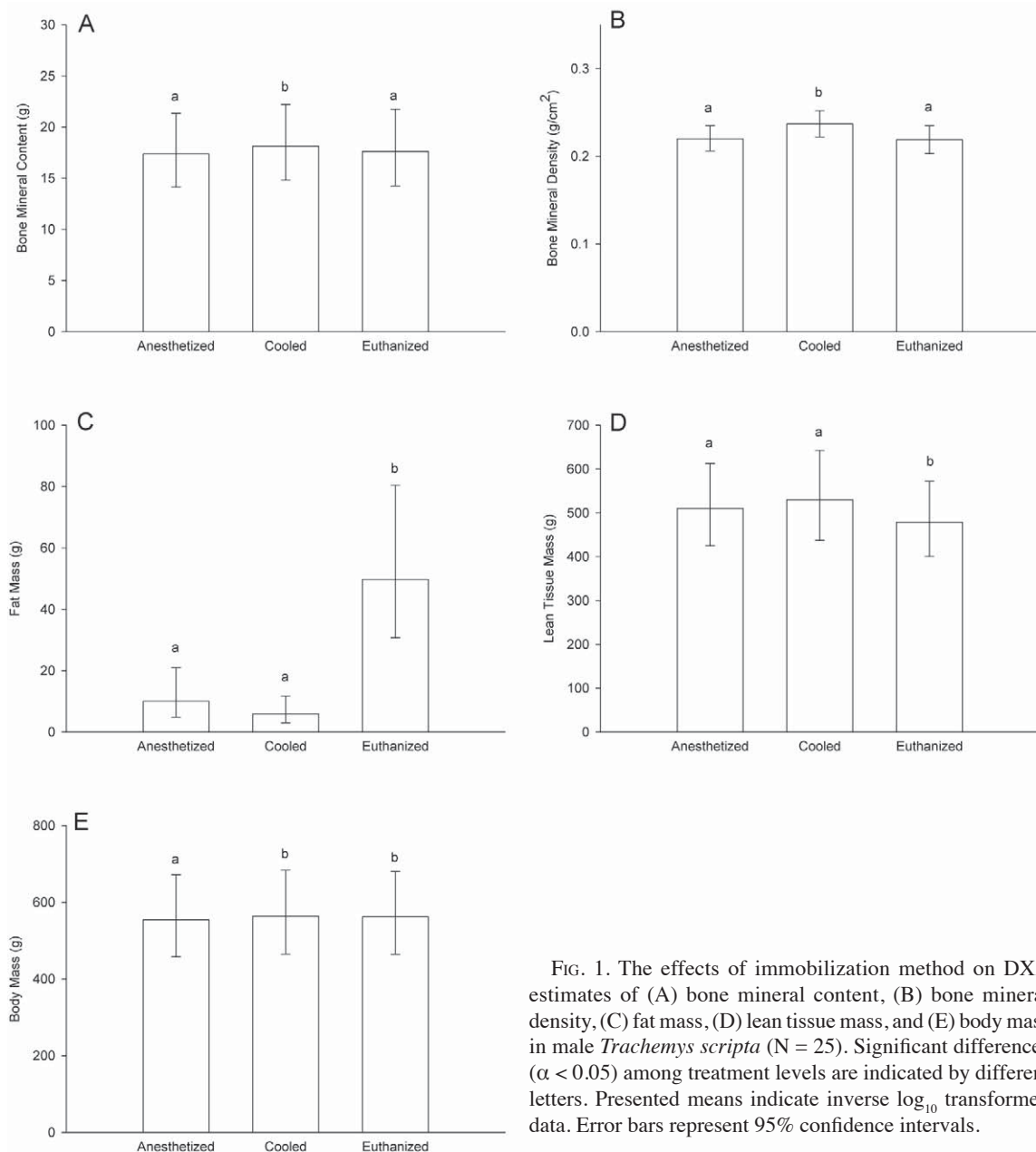


FIG. 1. The effects of immobilization method on DXA estimates of (A) bone mineral content, (B) bone mineral density, (C) fat mass, (D) lean tissue mass, and (E) body mass in male *Trachemys scripta* (N = 25). Significant differences ($\alpha < 0.05$) among treatment levels are indicated by different letters. Presented means indicate inverse \log_{10} transformed data. Error bars represent 95% confidence intervals.

desirable method of immobilization, because it eliminates the cost of narcotics associated with anesthesia/euthanasia, is easy to perform, results in virtually no mortality if cooling is monitored, and has quick recovery rates. A negative consequence of using cooling is a relatively reduced effectiveness on immobilization compared to the other techniques used in this study. We found cooled individuals were more likely to move during scanning (personal observation) and could account for the lower precision of body composition estimates. Anesthesia effectively produces immobilization if a sufficient dose is given for induction; however, anesthesia can be less predictable in reptiles, occasionally producing long recovery periods, variable induction dosages, and increased mortality compared to mammalian species (Bennett 1998; Read 2004). Despite these limitations, anesthesia produces more precise and accurate estimates of body composition than cooling. Euthanasia, although required in this study for comparisons, is the least desirable method of immobilization with DXA because it necessarily defeats the

purpose of using non-destructive techniques. Although the influence of immobilization technique produced significant differences in estimates and noticeable variation in precision, each technique correlated well with chemical estimates and therefore each is generally acceptable if predictive equations are produced.

Limitations of DXA.—The results of this study suggest that accurate prediction of fat mass and, to a lesser degree, lean tissue mass using DXA is questionable in chelonians. The morphology of chelonians precludes the ability to effectively determine fat mass, due to the method that DXA utilizes to estimate fat mass. Fat and bone-free lean tissue mass can be distinguished and are calculated from the ratio of attenuation from the low and high-energy beams when calculations are performed on non-bone areas; however, when calculations are performed where lean tissue, fat, and bone overlap, the calculations of fat and lean tissue components are indirect, leading to less reliable estimates (Jebb 1997). Fat and lean tissue mass estimates are less accurate when a large portion

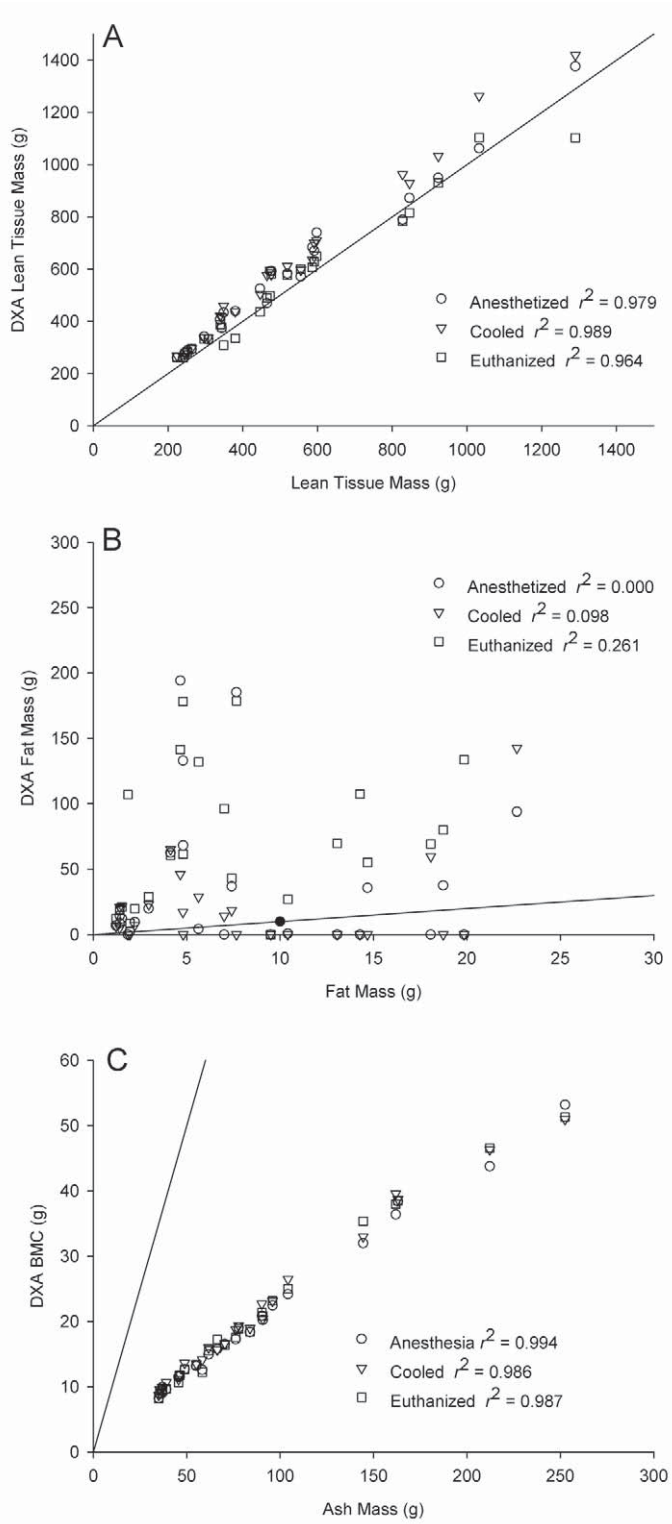


FIG. 2. Correlation between DXA and chemical estimates of (A) lean tissue mass, (B) fat mass, and (C) bone mass for all three methods of immobilization in male *Trachemys scripta* (N = 25). The solid line represents a slope of 1.

of the pixel area contains bone, such as in the thoracic region and brain in humans (Jebb 1997). The scanning of chelonians results in nearly 100% of the scanning pixels containing bone, depending on whether the appendages are extended beyond the margins of the carapace. Therefore, DXA cannot use non-bone-containing

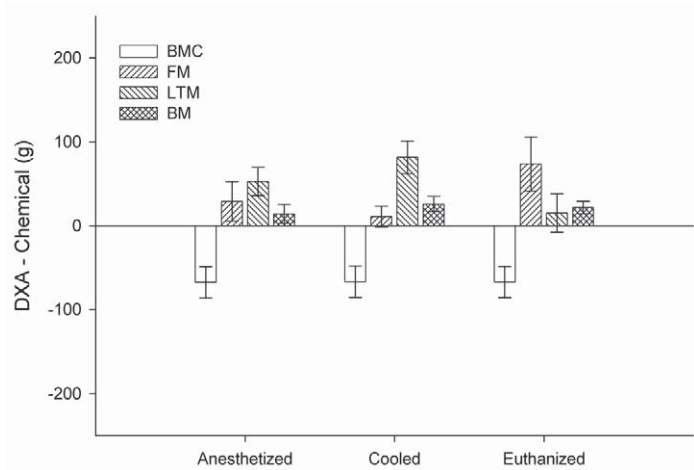


FIG. 3. Mean difference between DXA and chemical estimates of bone mineral content (BMC), fat mass (FM), lean tissue mass (LTM), and body mass (BM) for the three methods of immobilization in male *Trachemys scripta* (N = 25). Error bars represent 95% confidence intervals.

neighbor pixels to calculate the proportion of fat to be used for the majority of pixels that contain bone. Thus the unique morphology of turtles most likely prevents the use of current DXA technology to accurately estimate fat mass. Our data corroborate this view, particularly when compared to another reptile. Secor and Nagy (2003) found a relatively low CV when using DXA to measure FM in snakes (9.2% versus 28.5–97.0% in this study). Because current DXA technology precludes the use of this tool for the prediction of fat mass in turtles, chelonian research with primary interests in obtaining fat estimates will have to use other established methods. The establishment of triple or multiple-energy x-ray absorptiometry may solve this issue in turtles by using a three compartment system rather than the two compartment approach of DXA (Swanpalmer et al. 1998). Another potential approach that may help overcome this caveat could be to position the individuals such that the x-ray beams will pass craniocaudal. This approach would reduce the total scanning area that contains bone and therefore could allow for a more accurate estimate of fat and lean tissue components; however this has not been attempted and at this point is limited to speculation.

Future Research.—Future studies should examine the variation among scanners. We developed models linking body composition and DXA estimates; however the utility of these models for users of other DXA brand scanners is unknown. Significant effects of DXA manufacturers, hardware, and software have been documented (Tothill et al. 1994a; Tothill et al. 1994b; Jebb 1997; Tothill and Hannan 2000). Further validation of these predictive models on other brands of DXA scanners is needed before they can be applied to research using other brands. We also suspect that there may be interspecies variation, and separate predictive models should be developed for individual species. The use of these predictive equations, developed for *T. scripta*, with species differing drastically from the emblematic turtle morphology (e.g. soft-shelled turtles) will likely provide erroneous estimates of body composition.

In conclusion, DXA could potentially be used for a variety of evolutionary, ecological, nutritional, physiological, and diagnostic applications in animals. However, a poor ability to predict fat mass in turtles severely limits some of its application to energetic and nutrition studies until advances in technology overcome the

TABLE 3. Predictive models for chemically determined body composition variables in male *Trachemys scripta* (N = 25) determined by the regression of chemical estimates of body composition against DXA estimates for anesthetized individuals. Predictor variables were selected using best-subsets regression. The simplest model was included and multivariate models were added if they had more explanatory power. Values for difference represent the average difference between actual tissue mass determined chemically and predicted tissue mass determined from the regression or cross-validation model. Values for percent difference represent the absolute difference represented as a percentage of total mass for the tissue component in question. Abbreviations: AM = ash mass, BMC = bone mineral content, LTM = lean tissue mass, FM = fat mass, FFM = fat-free tissue mass, WM = water mass.

Model	r^2	Regression Model		Cross-validation	
		difference (g)	difference (%)	difference (g)	difference (%)
AM = 4.81BMC _{DXA} - 8.75	0.994	3.24 ± 3.07	4.03 ± 3.08	3.69 ± 3.75	4.41 ± 3.34
LTM = 0.98LTM _{DXA} - 39.66	0.979	31.62 ± 24.17	6.44 ± 3.99	34.14 ± 25.41	6.89 ± 4.14
LTM = 0.89LTM _{DXA} + 0.70FM _{DXA} - 15.76	0.992	16.84 ± 18.26	3.30 ± 2.69	20.11 ± 22.70	3.76 ± 3.08
FM = FM _{DXA} + 8.14	0.00	5.46 ± 3.56	152.23 ± 175.50	5.86 ± 3.77	162.22 ± 184.00
FM = 0.04LTM _{DXA} - 0.03FM _{DXA} - 0.62BMC _{DXA} - 1.51	0.528	3.60 ± 2.68	85.40 ± 87.70	4.43 ± 3.11	100.81 ± 94.9
FFM = 1.13FFM _{DXA} - 60.20	0.978	39.96 ± 28.10	6.81 ± 3.58	43.86 ± 30.97	7.34 ± 3.71
WM = 0.79LTM _{DXA} - 30.07	0.969	31.80 ± 23.22	8.13 ± 5.23	34.31 ± 24.40	8.70 ± 5.43
WM = 0.68FM _{DXA} + 0.71LTM _{DXA} - 7.11	0.987	19.34 ± 16.85	4.86 ± 3.7	22.72 ± 20.87	5.48 ± 4.06

difficulties of distinguishing the soft tissues in species containing a high proportion of bone. Although the use of DXA in turtles is limited by soft tissue, DXA is still effective at measuring bone content and density, and therefore would prove useful for studies of bone dynamics in turtles. From an applied approach DXA could be used in the identification of metabolic bone disease in a clinical setting. The ability to monitor an individual's bone density over a lifetime could provide a wealth of information on the long-term dietary impacts on bone density. In short, the potential applications of DXA in scientific research are many; however, continued validation is required before DXA can be put into practical use for chelonian research.

Acknowledgments.—We thank Dena Hartzell and Lindsay Pascal for their assistance in the field and lab. Day Ligon provided turtles for use in this study. This study was partially supported by the Chelonian Research Foundation Linnaeus Fund, Southwestern Association of Naturalists, and Oklahoma State University Zoology Graduate Student Society. The OSU Department of Nutritional Sciences provided logistical support and access to DXA equipment. This research was approved by the OSU IACUC (permit AS0413).

LITERATURE CITED

BENNETT, R. A. 1998. Reptile anesthesia. *Semin. Avian Exot. Pet. Medicine* 7:30–40.

CAWKWELL, G. D. 1998. Movement artifact and dual x-ray absorptiometry. *J. Clin. Densitom.* 1:141–147.

CONGDON, J. D., A. E. DUNHAM, AND D. W. TINKLE. 1982. Energy budget and life histories of reptiles. In C. Gans and F. H. Pough (eds.), *Biology of the Reptilia*, Vol. 13 Physiology D, pp. 233–271. Academic Press, New York, New York.

———, ———, AND R. C. VAN LOBEN SELS. 1993. Delayed sexual maturity and demographics of Blanding's turtles (*Emydoidea blandingii*): implications for conservation and management of long-lived organisms. *Cons. Biol.* 7:826–833.

ELOWSSON, P., A. H. FORSLUND, H. MALLMIN, U. FEUK, I. HANSSON, AND J. CARLSTEN. 1998. An evaluation of dual-energy x-ray absorptiometry and underwater weighing to estimate body composition by means of carcass analysis in piglets. *J. Nutr.* 128:1543–1549.

ENGELKE, K., C. C. GLUER, AND H. K. GENANT. 1995. Factors influencing short-term precision of dual x-ray bone absorptiometry (DXA) of spine

and femur. *Calcif. Tissue Int.* 56:19–25.

FLEDELIUS, B., G. W. JØRGENSEN, H. E. JENSEN, AND L. BRIMER. 2005. Influence of the calcium content of the diet offered to leopard tortoises (*Geochelone pardalis*). *Vet. Rec.* 156:831–835.

FOLCH, J., M. LEES, AND G. H. SLOANE STANLEY. 1957. A simple method for the isolation and purification of total lipides from animal tissues. *J. Biol. Chem.* 226:497–509.

GREER, L. L., K. J. JENNE, AND H. E. DIGGS. 2001. Medetomidine-ketamine anesthesia in red-eared slider turtles (*Trachemys scripta elegans*). *Contemp. Top. Lab. Anim. Sci.* 40:8–11.

HEPPELL, S. S., L. B. CROWDER, AND J. PRIDDY. 1995. Evaluation of a fisheries model for the harvest of hawksbill sea turtles, *Eretmochelys imbricata*, in Cuba. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-5, 48 p.

IUCN. 2007. IUCN Red List of Threatened Species. <www.iucnredlist.org>. Downloaded on 28 May 2008.

IVERSON, J. B. 1984. Proportional skeletal mass in turtles. *Florida Sci.* 47:1–11.

JEBB, S. A. 1997. Measurement of soft tissue composition by dual energy x-ray absorptiometry. *Brit. J. Nutr.* 77:151–163.

KASTL, S., T. SOMMER, P. KLEIN, W. HOHENBERGER, AND K. ENGELKE. 2002. Accuracy and precision of bone mineral density and bone mineral content in excised rat humeri using fan beam dual-energy x-ray absorptiometry. *Bone* 30:243–246.

KOO, W. W. K., J. WALTERS, AND A. J. BUSH. 1995. Technical considerations of dual-energy x-ray absorptiometry-based bone mineral measurements for pediatric studies. *J. Bone Miner. Res.* 10:1998–2004.

KORINE, C., S. DANIEL, I. G. VAN TETS, R. YOSEF, AND B. PINSHOW. 2004. Measuring fat mass in small birds by dual-energy x-ray absorptiometry. *Physiol. Biochem. Zool.* 77:522–529.

NAGY, T. R., AND A. -L. CLAIR. 2000. Precision and accuracy of dual-energy x-ray absorptiometry for determining in vivo body composition of mice. *Obes. Res.* 8:392–398.

READ, M. R. 2004. Evaluation of the use of anesthesia and analgesia in reptiles. *J. Am. Vet. Med. Assoc.* 224:547–552.

ROSE, B. S., W. P. FLATT, R. J. MARTIN, AND R. D. LEWIS. 1998. Whole body composition of rats determined by dual energy x-ray absorptiometry is correlated with chemical analysis. *J. Nutr.* 128:246–250.

SECOR, S. M., AND T. R. NAGY. 2003. Non-invasive measure of body composition of snakes using dual-energy x-ray absorptiometry. *Comp. Biochem. Physiol. Mol. Integr. Physiol.* 136:379–389.

SOKAL, R. R., AND F. J. ROHLF. 1987. *Introduction to Biostatistics*. 2nd ed. W. H. Freeman and Co., New York, New York. 363 pp.

- SWANPALMER, J., R. KULLENBERG, AND T. HANSSON. 1998. Measurement of bone mineral using multiple-energy x-ray absorptiometry. *Phys. Med. Biol.* 43:379–387.
- TOTHILL, P., A. AVENELL, J. LOVE, AND D. M. REID. 1994a. Comparisons between Hologic, Lunar and Norland dual-energy x-ray absorptiometers and other techniques used for whole-body soft tissue measurements. *Eur. J. Clin. Nutr.* 48:781–794.
- , ———, AND D. M. REID. 1994b. Precision and accuracy of measurements of whole-body bone mineral: comparisons between Hologic, Lunar and Norland dual-energy x-ray absorptiometers. *Brit. J. Radiol.* 67:1210–1217.
- , AND W. J. HANNAN. 2000. Comparisons between Hologic QDR 1000W, QDR 4500A, and Lunar Expert dual-energy x-ray absorptiometry scanners used for measuring total body bone and soft tissue. *Ann. New York Acad. Sci.* 904:63–71.
- ZOTTI, A., P. SELLERI, P. CARNIER, M. MORGANTE, AND D. BERNARDINI. 2004. Relationship between metabolic bone disease and bone mineral density measured by dual-energy x-ray absorptiometry in the green iguana (*Iguana iguana*). *Vet. Radiol. Ultrasound* 45:10–16.

Herpetological Review, 2010, 41(1), 42–45.
© 2010 by Society for the Study of Amphibians and Reptiles

The Biology of Crawfish Frogs (*Lithobates areolatus*) Prevents the Full Use of Telemetry and Drift Fence Techniques

JENNIFER L. HEEMEYER
VANESSA C. KINNEY
NATHAN J. ENGBRECHT
and
MICHAEL J. LANNOO

*Indiana University School of Medicine—TH, Rm. 135 Holmstedt Hall
Indiana State University, Terre Haute, Indiana 47809, USA*

*e-mail: heemeyerj@gmail.com
e-mail: vkinney1@indstate.edu
e-mail: nengbrecht@indstate.edu
e-mail: mlannoo@iupui.edu*

One assumption, implicit or explicit, often made by researchers when designing field studies is that techniques that work well in one species will work without qualification in other species, often closely related, in which they have never been employed. This is not always true. During our ongoing work to understand the natural history and life history of Crawfish Frogs (*Lithobates areolatus*) on reclaimed surface coal mines in Indiana, we employed two techniques—internal transmitters for a radiotelemetry-based movement study and drift fences with pitfall traps for a mark-recapture demographic study—that are recommended and proven tools for amphibian field research (Dodd and Scott 1994; Gibbons and Bennett 1974; Gibbons and Semlitsch 1981; Madison 1997; Richards et al. 1994), though not without qualification (Bull 2000; Dodd 1991; Goldberg et al. 2002; Weick et al. 2005). In fact, both drift fence and radiotelemetry studies have been used successfully with closely related species, Gopher Frogs (*L. capito*; Palis 1998; Roznik and Johnson 2009) and Dusky Gopher Frogs (*L. sevosus*; Richter and Seigel 2002; Richter et al. 2001). We report here two previously undescribed difficulties with the implementation of these techniques in Crawfish Frogs.

We have discovered that surgically weakened abdominal musculature following the implantation of internal transmitters can

lead to visceral herniation through the incision site in calling male Crawfish Frogs. Secondly, we have observed that upon exiting wetlands and encountering a drift fence, postbreeding Crawfish Frogs do not usually move laterally along the drift fences to then fall into buckets. Instead—perhaps because they must travel in a specific direction, often over great distances, to find a burrow (J. Heemeyer, unpubl. telemetry data)—they often remain against the fence until early in the morning when they then turn around to re-enter the wetland or surrounding vegetation. This appears to be the first time that these two issues have been reported in amphibian field studies.

Transmitter implantation can result in visceral herniation.—The advantages of radiotelemetry are well known, with the one limitation most cited being transmitter longevity, which is related to transmitter size (Richards et al. 1994; Van Nuland and Claus 1981). Smaller transmitters, often necessary for use in smaller animals such as amphibians, have smaller batteries, which have a shorter life, either making for short-term studies or adding to the number of transmitter replacements. External harnesses have been used successfully on Gopher Frogs (Richter et al. 2001; Roznik and Johnson 2009). However, because Crawfish Frogs at our study site must negotiate densely vegetated upland prairie habitat and use small burrows (made by crayfish), we felt external harnesses might interfere with mobility and decided to implant transmitters intraperitoneally.

Intraperitoneal transmitter implantation is often used in amphibians and may be the most effective way of tracking these animals for long periods (Goldberg et al. 2002; Johnson 2006; Madison 1997; Richards et al. 1994; Weick et al. 2005). However, problems can arise both during and after surgery (Goldberg et al. 2002; Weick et al. 2005). Complications among anuran species arise from response to anesthesia (Goldberg et al. 2002; Weick et al. 2005), infection (Werner 1991), tearing of sutures, lesions around sutures, and transmitter expulsion (Weick et al. 2005). Goldberg et al. (2002) note that many anuran telemetry studies fail to discuss deleterious effects of implantation surgeries.

In the present study, Crawfish Frogs (72–188 g) were captured during the spring of 2009 either on their way into breeding wetlands (drift fences) or in breeding wetlands (minnow traps). Because Crawfish Frogs will often quit calling at the least sign of disturbance (Parris and Redmer 2005), and because intraperitoneal transmitters had been considered safe in calling frogs (Goldberg et al. 2002; Lamoureux and Madison 1999), we decided to implant a subset of males (8 out of 59 Crawfish Frog males encountered entering the pond) in order to identify wetland calling sites and where animals find refuge when they are not calling. We implanted animals with Holohil Systems Ltd. (Carp, Ontario) PD-2 transmitters with internal helical antennae (average weight of 3.8 g). Implantation surgeries were initially practiced (by JLH) on Southern Leopard Frogs (*L. sphenoccephalus*) under the supervision of a researcher with over 20 years experience with animal surgeries (MJL). Richards et al. (1994) recommend the use of transmitters weighing no more than 10% of body weight; Goldberg et al. (2002) recommend no more than 5%. Our transmitters accounted for 2–5% of total body weight.

Knowing the potential negative effects of anesthesia on anurans (Goldberg et al. 2002), we started with a concentration of 200 mg/L MS-222 (ethyl 3-aminobenzoate methanesulfonic acid salt;

Sigma-Aldrich, St. Louis, MO) dissolved in a buffer solution (500 ml phosphate buffered saline [PBS], pH 7.2, giving the anesthetic solution a pH of 6.8) at room temperature. We observed the animal for 20–30 min and if it was still responsive we added 200 mg/L MS-222. This continued every half hour until the animal became fully anesthetized, indicated by loss of righting reflex and lack of pain response to toe pinching (Johnson 2006). After several surgeries, we were able to determine that a concentration of 600 mg/L was optimal. At this concentration, animals usually took 20–30 min to become anesthetized and remained anesthetized through the duration of the surgery (~30 min). Transmitters were placed intraperitoneally by making a left side, off-midline abdominal incision through the skin and a parallel incision through the rectus abdominus (Johnson 2006). After transmitter insertion, the rectus abdominus was closed with five or six continuous (Weick et al. 2005) sutures (Vicryl™ [polyglactin 910] 5-0 RB1, #36; Ethicon, Somerville, NJ), and the skin was closed with five or six continuous sutures (Vicryl™) and glued (Vetbond™ [n-butyl cyanoacrylate] adhesive). Postoperatively, animals were placed in deionized water and observed until they awoke. They were allowed to recover overnight in a cold, dark environment (a cooler placed in a refrigerator) to minimize stress, and then released on the inside (opposite side) of the drift fence, or near the minnow trap, where they were captured.

Postoperatively, we periodically examined animals in the field. At various times following surgeries (5–27 days), we observed asymmetrical ventral swellings in five animals. Swellings were caused by a hard mass of tissue (Figs. 1A, B), not by fluid or air accumulation. We collected these animals, anesthetized them, did exploratory surgery, and found visceral herniations through the rectus abdominus at the point of surgical incision. The liver had herniated in all animals; the left lung, stomach, and/or intestine herniated in a subset of animals. To repair these herniations, the viscera were carefully re-inserted into the peritoneal cavity, the incised edges of the rectus abdominus were trimmed (ensuring blood flow and enabling healing in case the wound was dehiscid), the muscle and skin were individually sutured closed as before, and Vetbond™ was applied to the skin. The animals were again kept overnight before they were released at their respective capture locations.

All five animals exhibiting herniations were males entering or trapped in breeding wetlands. The three other males implanted at the same time did not show signs of herniation. Herniations were not, and have not been at any time, seen in females (four females were implanted at the time and eight more females have been subsequently implanted). We (JLH and MJL) observed one of the implanted males calling (distended vocal sacs) and in amplexus prior to discovering its hernia. The breeding call of male Crawfish Frogs has enormous energy, generating sound capable of carrying over a kilometer under favorable acoustic conditions (Busby and Brecheisen 1997; Minton 2001). We suspect the abdominal pressure necessary to generate these calls (Wells 2007) caused the viscera to herniate through the healing incision and the sutures in the muscular wall.

Four of the five reconstructive surgeries were successful. A herniation in one animal was initially misdiagnosed as internal swelling underneath the muscle layer (necropsy showed liver herniation); this animal died the next day. Of the four surviving

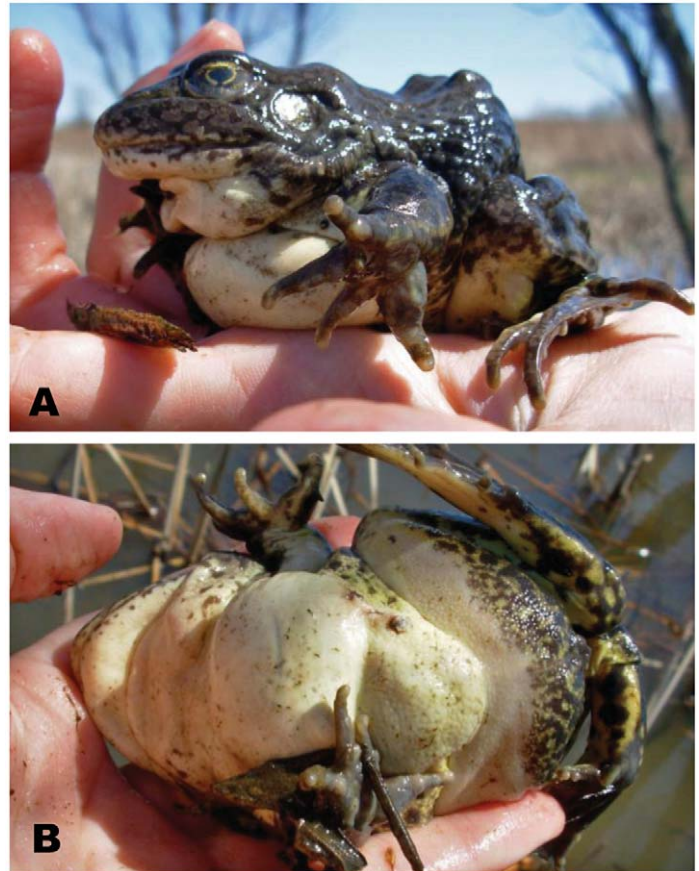


FIG. 1. A) Left lateral oblique view of a male Crawfish Frog (93 mm SVL) showing external appearance of visceral herniation through the rectus abdominus. B) Ventral view of same animal. The more anterior bulge is due to liver herniation and the posterior bulge is due to intestinal herniation.

animals, the transmitter in one was removed during surgery. This frog was returned to its wetland and was captured three days later at the drift fence as it was leaving; it was behaving normally. The three remaining animals were released postoperatively at the point of capture; one died two and a half weeks later from unknown causes. At the time of this writing (~150 days post surgery), the two remaining herniated frogs with transmitters had been tracked since their release and are behaving similarly to implanted animals that did not suffer visceral herniations. One of the two animals was examined 12 days (Fig. 2A) and 40 days (Fig. 2B) after hernia reconstruction and showed no signs of recurrent herniation. Its cutaneous incision had completely healed, although portions of suture material and Vetbond™ remained adherent. These have since dissolved or been worn away.

Drift fences inhibit postbreeding migrations.—Drift fences in combination with pitfall traps constitute a useful tool for amphibian biologists interested in the timing and demographics of breeding populations, as well as measures of reproductive success (Dodd and Scott 1994; Gibbons and Bennett 1974; Richter and Seigel 2002; Semlitsch et al. 1995). One assumption with this technique is that upon encountering a drift fence, an animal will turn left or right to move laterally along the fencing until they tumble into a pitfall trap to be captured and processed by the researcher. Crawfish Frogs entering breeding wetlands seemed to do this, but Crawfish Frogs

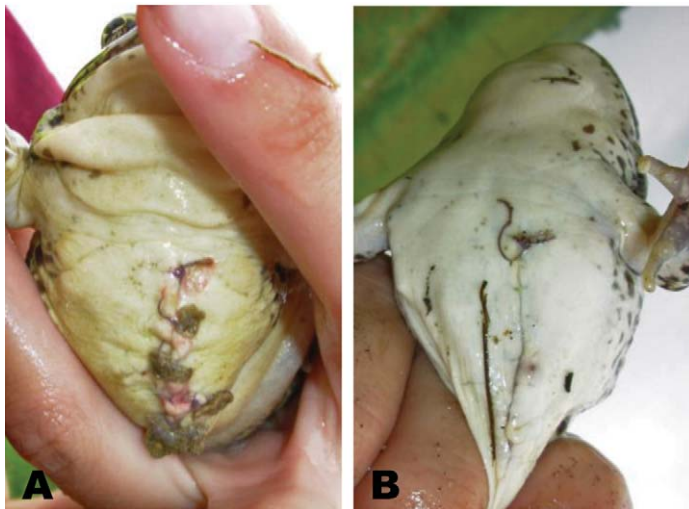


FIG. 2. Ventral view of a male Crawfish Frog (85 mm SVL) showing healing following hernia repair surgery on 16 April 2009. A) The scar on 28 April, 12 days following surgery. B) The scar on 26 May, 40 days after surgery.

exiting wetlands often did not. Difficulties with capturing animals in pitfall traps had not been specifically reported in studies that involved the closely related Gopher Frogs (Palis 1998) and Dark Gopher Frogs (Richter et al. 2001; Richter and Seigel 2002).

On the night of 12–13 April (11°C with 2.0 cm of rainfall), several postbreeding frogs were observed on the inside of the silt drift fence after having left their breeding wetland. Despite this potential emigration activity, on the morning of 13 April, no Crawfish Frogs were found in pitfall traps at this wetland. We suspected escapes, but had had no evidence that frogs trespassed entering this wetland and so doubted Crawfish Frogs could negotiate fences upon leaving. After noting emigration behavior, but an absence of frogs in pitfall traps, we began returning to our study ponds during night-



FIG. 3. Head-on view of Crawfish Frog (103 mm SVL) whose snout was abraded during attempts to negotiate a direct route through drift fencing.

time rains. We found that when emigrating animals encountered the silt drift fence they often tried to work their way through the fence to continue their direction, sometimes laboring until, if at the aluminum hardware cloth portion of our fences, they abraded their snouts (Fig. 3). The hardware cloth—installed in drainage areas to prevent washing out of the silt fences—comprises two sections at one pond (2.86 m, 1.14% of the whole fence) and four sections at the second pond (4.87 m, 1.87% of the whole fence). The silt fence itself, made from woven polypropylene composite, did not injure frog snouts. After realizing this, we began to relocate emigrating Crawfish Frogs across fences. One night alone (19–20 April) we transferred a total of 40 (23 at one wetland, 17 at a second) postbreeding Crawfish Frogs to the outside of fences (a total of 97 animals entered our two drift-fenced breeding wetlands). Overall, 35% of emigrating Crawfish Frogs were relocated in this way, the other 65% were caught in pitfall traps. The use of drift fences may lengthen the duration of Crawfish Frogs in breeding wetlands, and therefore bias results.

Recommendations.—The advantages of telemetry and drift fence trapping techniques will typically outweigh disadvantages if certain precautions are heeded (e.g., Gibbons and Bennett 1974). Several measures can be taken to adapt the telemetry and drift fence modifications described here to Crawfish Frogs, which in turn could also be useful for research on other species. In our opinion, implantation of transmitters remains a viable method for Crawfish Frogs, however, we suggest only implanting postbreeding animals to avoid the possibility of visceral herniation. We also recommend using interrupted sutures (Weick et al. 2005), which may provide stronger closure, to close the peritoneal incision. We have wondered whether the notoriously unstable, acidic, nutrient poor, and droughty soils of mine spoils (Brothers 1990) stressed Crawfish Frogs to the point of hindering healing and producing these herniations. At the present time we have no data to support this idea.

Drift fence studies for Crawfish Frogs must be accompanied by all-night visual encounter surveys for emigrating adults during or following rainfall. Animals at, or approaching, fences should be captured and relocated to the opposite side. To prevent abrasion, we recommend using softer perforated fencing in areas where water accumulates, or attaching strips of cloth or Gorilla Tape® (Gorilla Glue Inc., Cincinnati, Ohio) across the bottom of the hardware cloth. A height of two inches would provide ample protection for Crawfish Frogs, and still allow water flow through the fence.

When utilizing field techniques, even well-established techniques, we recommend not assuming that techniques that have worked well on other species will work well on novel species. We suggest incorporating either a period of preliminary analysis or an intense initial observational component to prevent unintended animal injury.

Acknowledgments.—We thank John Crawford for the early consultation on study design; Zach Terrell, Alex Robinson, John Crawford, Bill Peterman, Susie Lannoo, Pete Lannoo, and Jessica Creeden for assistance in constructing and checking the drift fences. We thank M. J. Mahoney, W. B. Blihovde, and two anonymous reviewers for comments on an earlier draft of this manuscript. This research was conducted under IACUC number 3-24-2008 issued by Indiana State University, and Scientific Purposes License Permit number 09-0084 issued by the Indiana Department of Natural Resources. This project was funded by a U.S. Fish and Wildlife

Service State Wildlife Grant, contract number E2-08-WDS13. Special thanks to Katie Smith and Ron Ronk, Indiana Department of Natural Resources, for enabling this project.

LITERATURE CITED

- BROTHERS, T. S. 1990. Surface-mine grasslands. *Geograph. Rev.* 80:209–225.
- BULL, E. L. 2000. Comparison of two radio transmitter attachments on Columbia Spotted Frogs (*Rana luteiventris*). *Herpetol. Rev.* 31:26–28.
- BUSBY, W. H., AND W. R. BRECHISEN. 1997. Chorusing phenology and habitat associations of the crawfish frog, *Rana areolata* (Anura: Ranidae), in Kansas. *Southwest. Nat.* 42:210–217.
- DODD, C. K., JR. 1991. Drift fence associated sampling bias of amphibians at a Florida sandhills temporary pond. *J. Herpetol.* 25:296–301.
- , AND D. E. SCOTT. 1994. Drift fences encircling breeding sites. In W. R. Heyer, M. A. Donnelly, R. W. McDiarmid, L-A. C. Hayek, and M. S. Foster (eds.), *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*, pp. 125–130. Smithsonian Institution Press, Washington, D.C.
- GIBBONS, J. W., AND D. H. BENNETT. 1974. Determination of anuran terrestrial activity patterns by a drift fence method. *Copeia* 1974:237–243.
- , AND R. D. SEMLITSCH. 1981. Terrestrial drift fences with pitfall traps: an effective technique for quantitative sampling of animal populations. *Brimleyana* 7:1–16.
- GOLDBERG, C. S., M. J. GOODE, C. R. SCHWALBE, AND J. L. JARCHOW. 2002. External and implanted methods of radio transmitter attachment to a terrestrial anuran (*Eleutherodactylus augusti*). *Herpetol. Rev.* 33:191–194.
- LAMOUREUX, V. S., AND D. M. MADISON. 1999. Overwintering habitats of radio-implanted green frogs, *Rana clamitans*. *J. Herpetol.* 33:116–120.
- JOHNSON, J. 2006. Success of intracoelomic radiotransmitter implantation in the treefrog (*Hyla versicolor*). *Lab Animal* 35:29–33.
- MADISON, D. M. 1997. The emigration of radio-implanted spotted salamanders, *Ambystoma maculatum*. *J. Herpetol.* 31:542–552.
- MINTON, S. A., JR. 2001. *Amphibians and Reptiles of Indiana*. Indiana Academy of Science, Indianapolis, Indiana. 404 pp.
- PALIS, J. G. 1998. Breeding biology of the gopher frog, *Rana capito*, in western Florida. *J. Herpetol.* 32:217–223.
- PARRIS, M. J., AND M. REDMER. 2005. *Rana areolata*. In M. J. Lannoo (ed.), *Amphibian Declines: The Conservation Status of United States Species*, pp. 526–528. University of California Press, Berkeley, California.
- RICHARDS, S. J., U. SINSCH, AND R. A. ALFORD. 1994. Radio tracking. In W. R. Heyer, M. A. Donnelly, R. W. McDiarmid, L-A. C. Hayek, and M. S. Foster (eds.), *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*, pp. 155–158. Smithsonian Institution Press, Washington, D.C.
- RICHTER, S. C., AND R. A. SEIGEL. 2002. Annual variation in the population ecology of the endangered gopher frog, *Rana sevosia* Goin and Netting. *Copeia* 2002:962–972.
- , J. E. YOUNG, R. A. SEIGEL, AND G. N. JOHNSON. 2001. Post-breeding movements of the dark gopher frog, *Rana sevosia* Goin and Netting: Implications for conservation and management. *J. Herpetol.* 35:316–321.
- ROZNIK, E. A., AND S. A. JOHNSON. 2009. Canopy closure and emigration by juvenile gopher frogs. *J. Wildl. Manage.* 73:260–268.
- SEMLITSCH, R. D., J. W. GIBBONS, AND T. D. TUBERVILLE. 1995. Timing of reproduction and metamorphosis in the Carolina gopher frog (*Rana capito capito*) in South Carolina. *J. Herpetol.* 29:612–614.
- VAN NULAND, G. J., AND P. F. H. CLAUS. 1981. The development of a radio tracking system for anuran species. *Amphibia-Reptilia* 2:107–116.
- WEICK, S. E., M. G. KNUTSON, AND B. C. KNIGHTS. 2005. A comparison of internal and external radio transmitters with northern leopard frogs (*Rana pipiens*). *Herpetol. Rev.* 36:415–421.

- WELLS, K. D. 2007. *The Ecology and Behavior of Amphibians*. The University of Chicago Press, Chicago, Illinois. 1148 pp.
- WERNER, J. K. 1991. A radiotelemetry implant technique for use with *Bufo americanus*. *Herpetol. Rev.* 22:94–95.

AMPHIBIAN DISEASES

This section offers a timely outlet for streamlined presentation of research exploring the geographic distribution, host range, and impact of emerging amphibian pathogens, especially the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) and ranaviruses. *Bd* is an emerging pathogen linked to mass mortality and declines of amphibians worldwide, yet *Bd* has also been detected in amphibians without disease. Ranaviruses also cause mass mortality, but have not yet been linked to large-scale declines. We know relatively little about their global distribution, host range, or impacts on host populations. To improve our understanding of the scope of this issue, we encourage submission of studies that illuminate the geographic distribution, host ranges, and impact of these pathogens on amphibian populations, including research on individual species or groups of species, wild or captive animals, native or non-native species, live animals or museum specimens, environmental samples, and, provided there is sufficient sampling¹, reports of non-detections.

We ask authors to: 1) restrict the Introduction of their paper to a **maximum** of two paragraphs to highlight the context of their study; 2) briefly include both field and laboratory Methods; 3) present Results in a Table, although a map might also be useful, and limited text; and 4) have a short discussion of a **maximum** of three paragraphs to touch upon key findings. Please include the following information in submissions as appropriate: coordinates and description of sampling areas (or please note if locations are extremely sensitive to reveal, and provide general area instead); species name(s) and life history stages examined, as well as other species present; whether samples were collected randomly or just from dead or moribund animals; date of specimen collection; evidence of unusual mortality; numbers of positive and negative samples; disposition of voucher specimens; name of collaborative laboratory or researcher conducting histological sections or PCR analyses; and names of cooperative land owners or land management agencies. We encourage researchers to conduct post-mortem examinations when possible to identify the cause of death when reporting mortalities. We aim to expedite the review and publication process! Please e-mail submissions directly to Associate Editor, Dr. Dede Olson: dedeolson@fs.fed.us.

¹If a sample of 30 individuals of a particular life history stage of a particular species yields no positive results, and the diagnostic test is highly sensitive, one can conclude that the prevalence of infection is less than 10% with 95% confidence. With a sample of 10 an infection in one of four individuals could go undetected. We encourage researchers to collect sufficient samples that negative results are meaningful.

Herpetological Review, 2010, 41(1), 45–47.
© 2010 by Society for the Study of Amphibians and Reptiles

***Batrachochytrium dendrobatidis* in Adult *Notophthalmus viridescens* in North-Central Alabama, USA**

KRISTIN A. BAKKEGARD*

*Department of Biological and Environmental Science, Samford University
800 Lakeshore Drive, Birmingham, Alabama 35229, USA*

and

ALLAN P. PESSIER

*Wildlife Disease Laboratories
San Diego Zoo's Institute for Conservation Research
P.O. Box 120551 San Diego, California 92112-0551, USA*

*Corresponding author; e-mail: kbakkega@samford.edu

Batrachochytrium dendrobatidis (*Bd*) has devastated many amphibian populations, especially in tropical areas (Berger et al. 1998; Daszak et al. 1999). However, the geographic distribution of

this emerging pathogen is not well known (see <http://www.spatalepidemiology.net/Bd-maps/information/#PD>). There is currently only one published report of *Bd* in Alabama, USA, at Horseshoe Bend National Park located in Tallapoosa Co. (Byrne et al. 2008); the affected species was the semi-terrestrial *Eurycea cirrigera* (Southern Two-lined Salamander). Rothermel et al. (2008) found *Bd* across the southeastern United States, but Alabama was not sampled. However, they found *Bd*-infected *Notophthalmus viridescens* (Eastern Newt) in Georgia, North Carolina, and Virginia. Additional reports have detected *Bd* in anurans and caudates in eastern Georgia (Timpe et al. 2008) and southwestern Tennessee (Venesky and Brem 2008). We report on a haphazard collection of dead adult *Notophthalmus viridescens* discovered during a field zoology class trip conducted by KAB in Birmingham, Alabama.

Methods.—On 25 February 2009, seine and dipnet sampling were conducted at Red Lakes, Ruffner Mountain Nature Preserve, Birmingham, Alabama (33.5623°N, 86.6900°W). Many (30–40) live adult Eastern Newts in breeding condition (smooth skin; males with nuptial pads) were sampled. We also noticed a number of recently deceased newts. The dead animals were slightly bloated, presumably due to dying in the water, were floating just above the bottom of the shallow pond (ankle to thigh deep, 15–90 cm), but otherwise appeared normal (no loose or peeling skin, no discoloration, no signs of trauma). Twelve dead newts were collected, and we saw at least another 15 dead newts. Nine newts were fixed in formalin, then stored in 70% ethanol. Three newts were preserved by freezing at -10°C. *Ambystoma maculatum* (Spotted Salamander) egg masses were present in the pond where the dead newts were collected and two large adult Spotted Salamanders (appeared healthy) were found in the woods approximately 40 m away from the pond and released after examination. Presumably, this pond also is used by anurans as a breeding site because it is fishless and periodically dries due to evaporation when there is a hot, dry summer.

Two formalin-fixed newts were examined by APP. The fixed carcasses were demineralized in hydrochloric acid (RDO Rapid Decalcifier, Apex Engineering Corporation, Aurora, IL USA), followed by preparation of serial transverse histological sections through the entirety of head and body and longitudinal sections through the hindlimbs and feet. Body, limb and foot slices were then automatically processed for histology, embedded in paraffin, sectioned at 5–6 µm and stained with hematoxylin and eosin. Liver from 2 frozen newts was submitted to the Amphibian Disease Laboratory at the San Diego Zoo for real-time PCR for ranaviruses using previously described techniques (Pallister et al. 2007).

Results.—Lesions in the two formalin-fixed newts examined histologically were limited to the skin. Changes were diffuse and involved over 90% of the skin surfaces examined (which included multiple sections of dorsal and ventral skin from the head, torso, legs, feet, and tail) and consisted of mild to moderate orthokeratotic hyperkeratosis and epidermal hyperplasia with moderate numbers of fungal organisms in cells of the stratum corneum (superficial keratinized skin layers) typical of *Batrachochytrium dendrobatidis*. Features of these organisms considered to be diagnostic of *Bd* included colonial thalli and flask-shaped zoosporangia with prominent discharge papillae (Longcore et al. 1999). Skin lesions were significantly more severe than the relatively focal and minimal lesions observed in *Bd* infected, but healthy American bullfrogs

(Hanselmann et al. 2004) and were similar to those associated with mortality in naturally and experimentally infected anurans (Nichols et al. 2001). Lesions were also subjectively more severe than those previously observed by one of the authors (APP) in other salamander species (Davidson et al. 2003; Vasquez et al. 2009). Other tissues examined histologically, including but not limited to, brain, liver (including subcapsular hematopoietic tissue), kidney, spleen, gastrointestinal tract, bone and skeletal muscle were considered to be within normal limits. Specifically, no lesions typical of a lethal *Ranavirus* infection (Green et al. 2002) or of the *Ichthyophonus*-like infections previously reported in *Notophthalmus viridescens* (Raffel et al. 2006) were observed. The examined newts were determined to be in good nutritional condition based on abundant coelomic cavity fat stores. Real-time PCR for ranaviruses was negative. Based on these findings, chytridiomycosis was determined to be the likely cause of death. However, the small number of newts sampled for diagnostic investigation means that other potential causes for this mortality event, including but not limited to, other unidentified infectious agents and events such as chemical exposure or altered water quality. Chemical and environmental changes especially may not result in distinctive lesions that can be identified by histologic examination.

Discussion.—This report is significant in documenting the presence of *Bd* in another salamander species 110 km from the nearest known locality, Tallapoosa Co. Alabama. This is the first report of a mortality event associated with *Bd* in Alabama. Ruffner Mountain is currently used as a nature education center and is also the second largest urban nature preserve in the United States (S. McCracken, pers. comm.). However, iron ore mining was conducted here from 1886–1953 and it served as a limestone quarry through the 1920s (White 1981). Red Lakes (there were once six, now two remain) where the infected newts were found, was originally a settling pond for the water used in a beneficiation process that separated high quality from low quality ore (S. McCracken, pers. comm.). The water is a rust-red color and stains field equipment. Although we did not test for industrial contaminants such as heavy metals, pH was 8.4 (water temp = 10.1°C, air temp 13.4°C, RH = 52.5%). The pH optimum for *Bd* is 6–7 with less growth at a pH of 8, the highest pH tested (Piotrowski et al. 2004). Future work should examine potential linkages between environmental contaminants and the incidence and/or severity of *Bd* infections in aquatic amphibians.

Acknowledgments.—The Amphibian Disease Laboratory at the Zoological Society of San Diego is supported in part by grant LG-25-08-0066 from the Institute of Museum and Library Services. Any views, findings, conclusions or recommendations expressed in this publication do not necessarily represent those of the Institute of Museum and Library Services. Thanks to Ruffner Mountain Nature Preserve for use of their pond, S. McCracken for providing history of the area, and J. R. Mendelson III for suggesting the collaboration.

LITERATURE CITED

- BERGER, L., R. SPEARE, P. DASZAK, D. E. GREEN, A. A. CUNNINGHAM, C. L. GOGGIN, R. SLOCOMBE, M. A. RAGAN, A. D. HYATT, K. R. McDONALD, H. B. HINES, K. R. LIPS, G. MARANTELLI, and H. PARKES. 1998. Chytridiomycosis causes amphibian mortality associated with population declines in the rain forests of Australia and Central America. *Proc. Natl. Acad. Sci.* 95:9031–9036.

- BYRNE, M. W., E. P. DAVIE, and J. W. GIBBONS. 2008. *Batrachochytrium dendrobatidis* occurrence in *Eurycea cirrigera*. Southeast. Nat. 7:551–555.
- DASZAK, P., L. BERGER, A. A. CUNNINGHAM, A. D. HYATT, D. E. GREEN, and R. SPEARE. 1999. Emerging infectious diseases and amphibian population declines. Emerg. Infect. Dis. 5:735–748.
- DAVIDSON, E. W., M. PARRIS, J. P. COLLINS, J. E. LONGCORE, A. P. PESSIER, and J. L. BRUNNER. 2003. Pathogenicity and transmission of chytridiomycosis in tiger salamanders (*Ambystoma tigrinum*). Copeia 2003:601–607.
- GREEN, D. E., K. A. CONVERSE, and A. K. SCHRADER. 2002. Epizootiology of sixty-four amphibian mortality events in the USA, 1996–2001. Ann. New York Acad. Sci. 969:323–339.
- HANSELMANN, R., A. RODRÍGUEZ, M. LAMPO, L. FAJARDO-RAMOS, A. ALONSO AGUIRRE, A. MARM KILPATRICK, J. PAUL RODRÍGUEZ, and P. DASZAK. 2004. Presence of an emerging pathogen of amphibians in introduced bullfrogs *Rana catesbeiana* in Venezuela. Biol. Conserv. 120:115–119.
- LONGCORE, J. E., A. P. PESSIER, and D. K. NICHOLS. 1999. *Batrachochytrium dendrobatidis*, gen. et. sp. nov., a chytrid pathogenic to amphibians. Mycologia 91:219–227.
- NICHOLS, D. K., E. W. LAMIRANDE, A. P. PESSIER, and J. E. LONGCORE. 2001. Experimental transmission of cutaneous chytridiomycosis in dendrobatid frogs. J. Wildl. Dis. 37:1–11.
- PALLISTER, J., A. GOULD, D. HARRISON, A. D. HYATT, J. JANCOVICH, and H. HEINE. 2007. Development of real-time PCR assays for the detection and differentiation of Australian and European ranaviruses. J. Fish Dis. 30:427–438.
- PIOTROWSKI, J. S., S. L. ANNIS, and J. E. LONGCORE. 2004. Physiology of *Batrachochytrium dendrobatidis*, a chytrid pathogen of amphibians. Mycologia 96:9–15.
- RAFFEL, T. R., J. R. DILLARD, and P. J. HUDSON. 2006. Evidence for leech-borne transmission of amphibian *Ichthyophonus* sp. J. Parasitol. 92:1256–1264.
- ROTHERMEL, B. B., S. C. WALLS, J. C. MITCHELL, C. K. DODD JR., L. K. IRWIN, D. E. GREEN, V. M. VAZQUEZ, J. W. PETRANKA, and D. J. STEVENSON. 2008. Widespread occurrence of the amphibian chytrid fungus *Batrachochytrium dendrobatidis* in the southeastern USA. Dis. Aquat. Org. 82:3–18.
- TIMPE, E. K., S. P. GRAHAM, R. W. GAGLIARDO, R. L. HILL, and M. G. LEVY. 2008. Occurrence of the fungal pathogen *Batrachochytrium dendrobatidis* in Georgia's amphibian populations. Herpetol. Rev. 39:447–449.
- VASQUEZ, V., B. ROTHERMEL, and A. P. PESSIER. 2009. Experimental infections of North American plethodontid salamanders with the fungus *Batrachochytrium dendrobatidis*. Dis. Aquat. Org. 84:1–7.
- VENESKY, M. D., and F. M. BREM. 2008. Occurrence of *Batrachochytrium dendrobatidis* in southwestern Tennessee, USA. Herpetol. Rev. 39:319–320.
- WHITE, M. L. 1981. The Birmingham District: An Industrial History and Guide. Birmingham Historical Society, Birmingham, Alabama.

***Batrachochytrium dendrobatidis* Detected in Amphibians from National Forests in Eastern Texas, USA**

DANIEL SAENZ
BRENDAN T. KAVANAGH

Southern Research Station, Forest Service, U.S. Department of Agriculture
506 Hayter Street, Nacogdoches, Texas 75965-3556, USA

and

MATTHEW A. KWIATKOWSKI

Stephen F. Austin State University, Department of Biology
1936 North Street, Nacogdoches, Texas 75962-3050, USA

*Corresponding author; e-mail: dsaenz@fs.fed.us

The amphibian disease chytridiomycosis, caused by the pathogenic fungus *Batrachochytrium dendrobatidis* (*Bd*, Longcore et al. 1999), is well known as a major threat to amphibians resulting in mass die-offs and population declines throughout the world (Berger et al. 1998; Blaustein and Keisecker 2002; Daszak et al. 2003; McCallum 2005; Rachowicz et al. 2006). *Batrachochytrium dendrobatidis* has been detected on amphibians from sites across North America (Ouellet et al. 2005; Woodhams et al. 2008) and appears to be most prevalent in the western and the northeastern United States (Longcore et al. 2007; Schlaepfer et al. 2007). Whereas infected anurans also have been found throughout the southeastern US (Green and Dodd 2007), there have been no reports of *Bd* from amphibians in eastern Texas, a broad area encompassing 10,000,000 ha. We sampled amphibians for the presence of *Bd* in four National Forests in eastern Texas (approximately 31°N latitude).

Amphibians were sampled for *Bd* from 9 January to 27 May 2009 in the Angelina, Davy Crockett, and Sabine National Forests, and the Stephen F. Austin Experimental Forest (Fig. 1). The Stephen

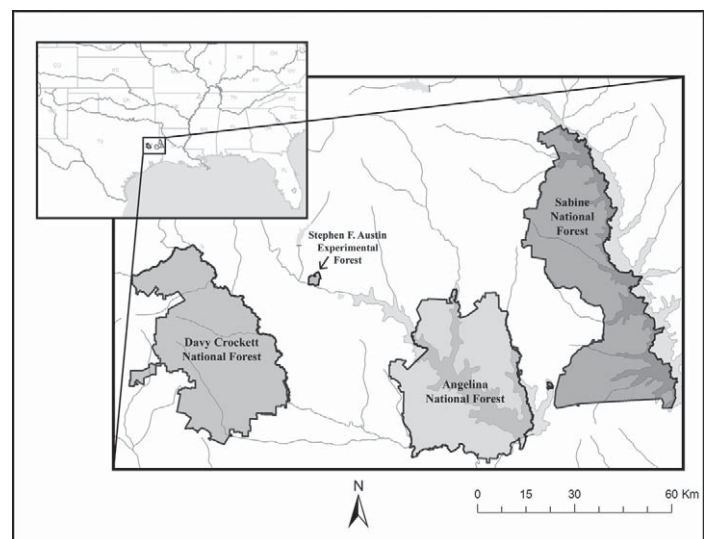


FIG. 1. Locations of the Angelina, Davy Crockett, Sabine National Forests, and the Stephen F. Austin Experimental Forest where 6 of 18 amphibian species tested positive for the amphibian chytrid fungus, *Batrachochytrium dendrobatidis*.

TABLE 1. Amphibian species tested for the presence of *Batrachochytrium dendrobatidis* (*Bd*) within Angelina, Davy Crockett, and Sabine National Forests, and the Stephen F. Austin Experimental Forest, Texas. Bold font indicates that *Bd* was detected in the species.

Family	Species	No. animals	No. animals	No. animals	No. animals
		infected/examined	infected/examined	infected/examined	infected/examined
		Angelina National Forest	Davy Crockett National Forest	Sabine National Forest	Stephen F. Austin Experimental Forest
Ambystomatidae	<i>Ambystoma maculatum</i>	0/5	-	-	-
	<i>Ambystoma opacum</i>	0/10	0/2	0/5	0/10
	<i>Ambystoma talpoideum</i>	0/2	-	-	-
Plethodontidae	<i>Eurycea quadradigitata</i>	0/8	-	0/8	3/10
Salamandridae	<i>Notophthalmus viridescens</i>	0/1	-	-	0/2
Bufonidae	<i>Anaxyrus woodhousii</i>	1/7	0/10	-	0/1
	<i>Incilius nebulifer</i>	0/3	0/8	0/1	-
Hylidae	<i>Acris crepitans</i>	1/10	1/10	-	-
	<i>Hyla cinerea</i>	0/10	0/6	-	0/10
	<i>Hyla versicolor</i>	0/8	0/10	-	0/8
	<i>Pseudacris crucifer</i>	0/10	1/10	-	0/10
	<i>Pseudacris fouquettei</i>	3/5	-	-	2/10
Microhylidae	<i>Gastrophryne carolinensis</i>	0/5	-	-	0/2
Ranidae	<i>Lithobates catesbeianus</i>	0/1	0/6	-	1/1
	<i>Lithobates clamitans</i>	0/2	0/4	-	0/2
	<i>Lithobates palustris</i>	-	-	0/1	0/4
	<i>Lithobates sphenoccephalus</i>	0/8	0/7	-	0/10
Scaphiopodidae	<i>Scaphiopus huerteri</i>	-	0/1	-	-
	TOTAL	5/95 (5.3%)	2/76 (2.6%)	0/15 (0.0%)	6/80 (7.5%)

F. Austin Experimental Forest is a disjunct unit of the Angelina National Forest, administered by the Southern Research Station, US Forest Service. The dominant habitats of these areas include secondary growth Loblolly (*Pinus taeda*), Longleaf (*P. palustris*), and Shortleaf (*P. echinata*) upland pine forests and mixed deciduous bottomland forests. East Texas experiences occasional freezing temperatures, warm winter days, and extremely hot summers (Chang et al. 1996). From 1901 to 1993, the overall mean air temperatures for January and August are 8.4°C and 27.8°C, respectively (Chang et al. 1996). In winter, cold air masses often meet warm moist air pushed up from the Gulf of Mexico resulting in frequent rain events, placing the study sites in one of the wettest regions of Texas (Bomar 1995).

We searched for amphibians near ponds, streams, moist lowland areas, and upland pine forest habitat. We captured specimens by hand. Each individual was handled with a new pair of sterile nitrile gloves. We sampled for *Bd* by rubbing a sterile cotton swab on the dorsum, ventral surfaces, and feet of each frog for approximately 30 seconds, after which the animal was released at its place of capture. The swab was then immediately placed in a sterile microcentrifuge tube containing 1 ml of 70% ethanol and later sent to Pisces Molecular Laboratory (Boulder, Colorado, USA) for PCR analyses. Global positioning system (GPS) coordinates were taken at each capture site using a Garmin® GPS unit.

Overall, we sampled a total of 266 adult amphibians of 18 different species, from 8 different families (Table 1). Of these 18 species,

six had at least one individual that tested positive for *Bd*. Thirteen of the 266 individuals tested positive for an overall detection rate of 4.8%. The Stephen F. Austin Experimental Forest had the highest detection rate among the four areas sampled, with six of 80 (7.5%) individuals testing positive for *Bd* (Table 1). During sampling, no sick or dead frogs were observed at any sites.

We found similar *Bd* detection rates for anurans and caudates (4.93% and 4.76%, respectively), although the only salamanders to test positive for *Bd* were three individuals of *Eurycea quadradigitata* from the Stephen F. Austin Experimental Forest. Despite 34 ambystomatids being sampled, none tested positive for *Bd*.

Five of the 15 (33.33%) *Pseudacris fouquettei* samples tested positive for *Bd*, which was the highest detection rate among anuran species, including species which were breeding at the same time and place where the *Bd*-positive *Pseudacris fouquettei* were found. Individuals of both *P. crucifer* and *Lithobates sphenoccephalus* were collected at locations where *Bd*-positive *P. fouquettei* were found, yet no *L. sphenoccephalus* and only one of 30 (3.33%) *P. crucifer* samples tested positive for *Bd*. However, small sample sizes make it difficult to assess whether there is actually a higher detection rates among *P. fouquettei* than other species.

Batrachochytrium dendrobatidis has been present in North American amphibian populations since at least the early 1960s (Ouellet et al. 2005). Yet, within the United States, *Bd* has been associated with amphibian die-offs predominantly in western states (e.g., Bradley et al. 2002; Briggs et al. 2005; Muths et al. 2003).

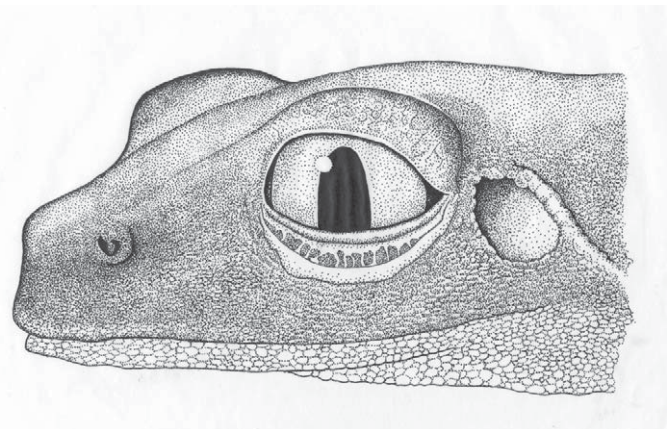
Although the fungus is present in the southeastern United States, to our knowledge no amphibian declines have been attributed to chytridiomycosis in this region. Several studies have detected higher rates of *Bd* infections during the fall or winter months (McDonald et al. 2005; Ouellet et al. 2005; Retallick et al. 2004), a phenomenon possibly explained by the fact that amphibian immune systems function less effectively at cooler temperatures (Carey 2000; Cooper et al. 1992; Maniero and Carey 1997). It is possible that the immune systems of amphibians inhabiting eastern Texas are more capable of resisting *Bd* infections because of the relatively warm winters and hot summers.

Also, it is possible that the fungus may never reach an epizootic state in eastern Texas because the warm air temperatures are less than optimal for *Bd* growth and infection of amphibians (Kriger and Hero 2006; Longcore et al. 1999; Retallick et al. 2004). Evidence for an enzootic state includes the relative low incidence of detection in PCR samples and the fact that no sick or dead frogs were encountered. Amphibians appeared to be abundant at all four of our study sites. Follow-up population and *Bd* sampling is needed to confirm what impacts *Bd* may be having on the National Forests in Texas.

Acknowledgments.—We thank T. Hall, T. Cotten, S. Wahlberg, and R. Adams for assisting with field sampling. Also, we thank C. Adams, D. Laurencio, K. Floyd, and an anonymous reviewer for constructive comments on an earlier draft of this manuscript.

LITERATURE CITED

- BERGER, L., R. SPEARE, P. DASZAK, D. E. GREEN, A. A. CUNNINGHAM, C. L. GOGGIN, R. SLOCOMBE, M. A. RAGAN, A. D. HYATT, K. R. McDONALD, H. B. HINES, K. R. LIPS, G. MARTANTELLI, AND H. PARKES. 1998. Chytridiomycosis causes amphibian mortality associated with population declines in the rain forests of Australia and Central America. *Proc. Nat. Acad. Sci.* 95:9031–9036.
- BLAUSTEIN, A. R. AND J. M. KEISECKER. 2002. Complexity in conservation: lessons from the global decline of amphibian populations. *Ecol. Lett.* 5:597–608.
- BOMAR, G. 1995. The climate of the Texas hill country and East Texas. In J. Norwine, J. R. Giardino, G. R. North, and J. B. Valdes (eds.), *The Changing Climate of Texas, Predictability and Implications for Future*, pp. 76–91. Geobooks, Texas A&M University, College Station, Texas.
- BRADLEY, G. A., P. C. ROSEN, M. J. SREDL, T. R. JONES, AND J. E. LONGCORE. 2002. Chytridiomycosis in native Arizona frogs. *J. Wildl. Dis.* 38:206–212.
- BRIGGS, C. J., V. T. VREDENBURG, R. A. KNAPP, AND L. J. RACHOWICZ. 2005. Investigating the population-level effects of chytridiomycosis: an emerging infectious disease of amphibians. *Ecology* 86:3149–3159.
- CAREY, C. 2000. Infectious disease and worldwide declines of amphibian populations, with comments on emerging diseases in coral reef organisms and in humans. *Enviro. Health Perspect.* 108(Suppl. 1):143–150.
- CHANG, M., L. D. CLENDENEN, AND H. C. REEVES. 1996. Characteristics of a humid climate: Nacogdoches, Texas. Center for Applied Studies in Forestry, College of Forestry, Nacogdoches, Texas.
- COOPER, E. L., R. K. WRIGHT, A. E. KLEMPAU, AND C. T. SMITH. 1992. Hibernation alters the frog's immune system. *Cryobiology* 29:616–631.
- DASZAK, P., A. A. CUNNINGHAM, AND A. D. HYATT. 2003. Infectious disease and amphibian declines. *Diversity and Distributions* 9:141–150.
- GREEN, D. E., AND C. K. DODD, JR. 2007. Presence of amphibian chytrid fungus *Batrachochytrium dendrobatidis* and other amphibian pathogens at warm-water fish hatcheries in southeastern North America. *Herpetol. Cons. Biol.* 2:43–47.
- KRIGER, K. M., AND J. M. HERO. 2006. Large-scale seasonal variation in the prevalence and severity of chytridiomycosis. *J. Zool. (Lond.)* 271:352–359.
- LONGCORE, J. E., A. P. PESSIER, AND D. K. NICHOLS. 1999. *Batrachochytrium dendrobatidis* gen. et sp. nov., a chytrid pathogenic to amphibians. *Mycologia* 91:219–227.
- LONGCORE, J. R., J. E. LONGCORE, A. P. PESSIER, AND W. A. HALTEMAN. 2007. Chytridiomycosis widespread in anurans of northeastern United States. *J. Wildl. Manage.* 71:435–444.
- MANIERO, G. D., AND C. CAREY. 1997. Changes in selected aspects of immune function in the leopard frog, *Rana pipiens*, associated with exposure to cold. *J. Comp. Phys. B* 167:256–263.
- MCCALLUM, H. 2005. Inclusion of chytridiomycosis as the agent in widespread frog declines. *Conserv. Biol.* 19:1421–1430.
- MCDONALD, K. R., D. MÉNDEZ, R. MÜLLER, A. B. FREEMAN, AND R. SPEARE. 2005. Decline in the prevalence of chytridiomycosis in upland frog populations in North Queensland, Australia. *Pacific Conserv. Biol.* 11:114–120.
- MUTHS, E., P. S. CORN, A. P. PESSIER, AND D. E. GREEN. 2003. Evidence for disease-related decline in Colorado. *Biol. Conserv.* 110:357–365.
- OUELLET, M., I. MIKAEELIAN, B. D. PAULI, AND J. RODRIGUE. 2005. Historical evidence of widespread chytrid infection in North American amphibian populations. *Conserv. Biol.* 19:1431–1440.
- RACHOWICZ, L. R., R. A. KNAPP, J. A. T. MORGAN, M. J. STICE, V. T. VREDENBURG, J. M. PARKER, AND C. J. BRIGGS. 2006. Emerging infectious disease as a proximate cause of amphibian mass mortality. *Ecology* 87:1671–1683.
- RETALICK, R. W. R., H. MCCALLUM, AND R. SPEARE. 2004. Endemic infection of the amphibian chytrid fungus in a frog community post-decline. *PLoS* 2:1965–1971.
- SCHLAEPFER, M. A., M. J. SREDL, P. C. ROSEN, AND M. J. RYAN. 2007. High prevalence of *Batrachochytrium dendrobatidis* in wild population of lowland leopard frogs *Rana yavapaiensis* in Arizona. *Ecohealth* 4:421–427.
- WOODHAMS, D. C., A. D. HYATT, D. G. BOYLE, AND L. A. ROLLINS-SMITH. 2008. The northern leopard frog *Rana pipiens* is a widespread reservoir species harboring *Batrachochytrium dendrobatidis* in North America. *Herpetol. Rev.* 39:66–68.



Agalychnis callidryas (UMRC 79-257, 41 mm SVL). Mexico: Quintana Roo: 8 km N Felipe Carrillo Puerto. Lateral view of head, showing the vertically elliptical pupil and the reticulate palpebral membrane. Illustration by Julian C. Lee.

HERPETOLOGICAL HISTORY

Herpetological Review, 2010, 41(1), 50–51.
© 2010 by Society for the Study of Amphibians and Reptiles

Very Early Photographs of Reptiles

MANFRED NIEKISCH

Frankfurt Zoo, Bernhard-Grzimek-Allee 1
60316 Frankfurt, Germany
e-mail: manfred.niekisch@stadt-frankfurt.de

Following a publication by John Edwards in *Herpetological Review* (1998) of three early photographs of living reptiles, dated 1865, Kraig Adler and Harold Cogger (1998) presented another, even older photograph. It shows the German-born herpetologist Gerard Krefft with three live reptiles and was taken in the year 1864 by the Sydney photographer William Hetzer. Adler and Cogger invited readers to a contest to find the earliest photograph of a living reptile. Herein, I follow this invitation and contribute to the contest.

Francis Frith was born in 1822 in Chesterfield, Derbyshire, England. Not very successful at school and in an apprenticeship in a cutlery, he had a nervous breakdown, then traveled a few years in his home country, and in 1850 he set up his own printing business in Liverpool. That business thrived and he sold it in 1856 to his major competitor. The substantial profit he realized made him independent and he started his career as a photographer with a first trip to Egypt in this very year. His inaugural book, “Egypt and Palestine Photographed and Described,” began to appear in 1858 and was completed in 1860, consisting of 25 parts with 76 albumen prints altogether. Among these photographs there is one of a living adult crocodile, *Crocodylus niloticus*, on a sand bank presumably along the Nile River (Fig. 1). It was taken in 1857 as can be seen from the remark “Frith-Photo, 1857” underneath the published photograph in the first volume of his two-volume book. Frith writes: “I am satisfied that they never attack mankind

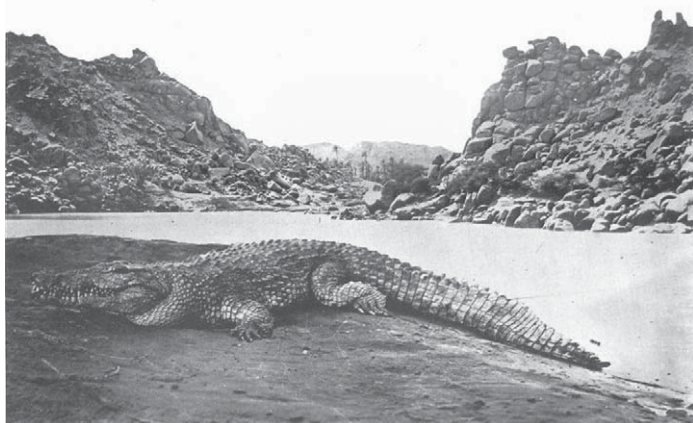


FIG. 1. The precise location in Egypt where Frith took this photograph of a *Crocodylus niloticus* is unknown. Additionally, it is not known if he was aware that he was perhaps the first photographer to take a picture of a living reptile.

openly, although, no doubt, if they had an opportunity of seizing a man without exposing themselves, they would be dangerous.” The main objects of Frith’s photographs are buildings (both antique and contemporary) and landscapes. Only very few of his studies portray wildlife (such as a dead flamingo in the hands of an Arab “sportsman” and a cook). This is understandable also in the light of the fact that wildlife move and photographic equipment then posed serious technical limitations to wildlife photography. A large crocodile resting on a sand bank seems to be the ideal object, presenting—as compared to birds and mammals—several advantages for early photographers from this point of view. So for now this seems to be the oldest known photograph of a living reptile.

The earliest photograph of a *herpetological specimen* I found is even older and falls in the earliest times of photography. It shows two stuffed specimens of monitor lizards, indicated below the photograph as “*Varanus Bellii* Duméril et Bibron” and “*Varanus Varius*. Merrem. Duméril et Bibron” (Fig. 2). Both are referable to *Varanus varius* (White, 1790). The two *Varanus* are clearly identifiable as dead specimens. The left one shows a crack in the skin above the left foreleg and the stuffing material is visible inside it. This photograph was first published in March 1853 in an atlas of zoological photographs which was meant to document and show the treasures of the Museum of Natural History in Paris (“Photographie zoologique ou Représentation des Animaux Rares des Collections du Muséum d’Histoire Naturelle”) by L. Rousseau and A. Devéria, and then again published in 1854 in the *Bulletin de la Société d’Encouragement pour l’Industrie Nationale, Paris* (Vol. 53, Ser. 2, Volume I). This *Bulletin* is as a historical source at least as interesting as the atlas itself because it contains two articles directly relevant here. First, there is an article (pp. 117–119) by Claude Félix Abel Niepce de Saint-Victor (1805–1870). He was the son of the first cousin of Joseph-Nicéphore Niepce (1765–1833) who is considered to be the inventor of photography, as he was the first one to take a picture with a camera obscura and to get it fixed and light resistant on a metal plate. Niepce called this technique heliogravure as it was “written with sunlight.” In this article entitled “Gravure héliographique,” Abel Niepce describes some improvements to Joseph-Nicéphore’s process (referring to him as his “uncle”) developed by him together with the engraver Augustin-François Lemaître (1797–1870) who had already worked with Joseph-Nicéphore Niepce doing the etchings. After the death of Joseph-Nicéphore Niepce it was Louis Daguerre (1787–1851)—who had worked with both Joseph-Nicéphore and Abel Niepce—to develop Niepce’s invention further and to bring it to a commercial stage. This Daguerrotype process was presented formally to the French Academy of Science and finally bought by the French Government as a “gift to the world” in 1839.

Abel Niepce’s article is followed by one on “Photographie zoologique,” written by Louis Pierre Rousseau and Achille Devéria (1800–1870), the authors of the atlas with the same title, which relates the history of this atlas.

According to their article, the first plates of photography applied to natural history (“photographie appliquée aux sciences naturelles”) were received by the Académie des Sciences in Paris on March 14, 1853. Indeed, the minutes of the meeting of the Academy (Compte Rendu des Séances de l’Académie des Sciences, Tome trente-sixième. Janvier – June 1853, p. 500) state that these two gentlemen presented at the meeting “divers spécimens

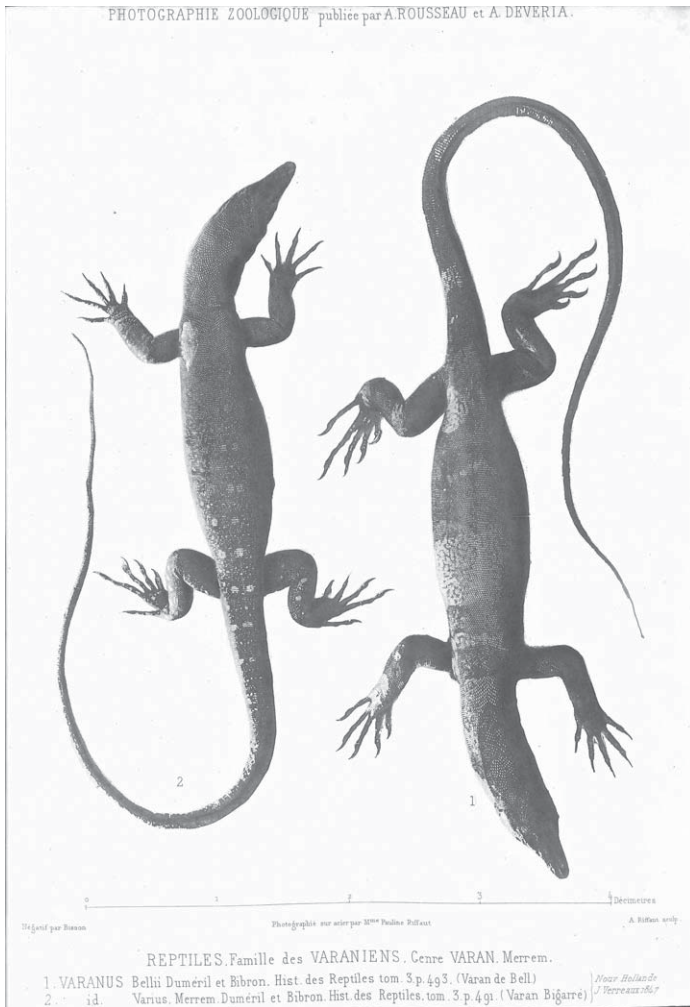


FIG. 2. The caption to this photograph published in the “Bulletin de la Société d’Encouragement pour l’Industrie Nationale (1854)” differs from that in the atlas “Photographie zoologique” (1853) in the following: While here above the indication of the animals the artists involved are mentioned (from left to right): Négatif par Bisson - Photographié sur acier par Mme Pauline Riffaut - A. Riffaut sculp, in the atlas this line is lacking and below the animal description the photographers and editing companies are indicated (from left to right): Bisson frères Photographes - Paris, chez Masson_Londres, chez Gambart - Lemerrier, Paris.

Note the crack in the skin of the left specimen showing the stuffing material.

de photographie appliquée aux sciences naturelles” and that these plates, printed on paper, showed skeletons or parts thereof and other complete individuals belonging to the principal divisions of the animal kingdom.

The Bisson brothers had produced the negatives and Pauline Riffaut transferred the pictures to the steel plates. Once the acid had etched the metal plate, it was still necessary to do the finishing by hand, which was done by engraver A. Riffaut who is the third party mentioned under the prints.

In the session of June 6, 1853, the commission consisting of the zoologists Isidore Geoffroy Saint-Hilaire (1805–1861) and Achille Valenciennes (1794–1865), Henri Victor Regnault (1810–1878), a chemist and physicist who became in 1854 the founding president of the Société Française de Photographie, and zoologist Henri Milne Edwards (1800–1885) as the rapporteur received the report

of Rousseau and Dévéria on the completed, but not yet edited, work and discussed it. The minutes (Compte Rendu des Séances de l’Académie des Sciences, Vol. Janvier - June 1853, pp. 991–994) give a very good idea of the enthusiasm with which the work was received. For example found the committee that even the best painter would not have the patience and ability to make visible all the details and structures of the polypes visible in the photograph which shows the object enlarged (as compared to natural size). The committee discussed the potential and advantages of the new technique at length, but it was also said that there was still something left to do by the authors to give their work the “stabilité désirable.” The committee expressed confidence that the authors, with the appropriate instruments and means at their disposition, would soon reach results very useful to science, and vividly wished that photography becomes of “emploi usuel pour les zoologists.” Rousseau was then “aide-naturaliste” at the Museum while Dévéria was artist at the Bibliothèque impériale.

Both *Varanus* specimens shown in the photograph (Fig. 2) are still extant in the collection of the Muséum d’Histoire Naturelle (MNHN) in Paris and registered as “*Varanus varius* (White, 1790),” the left one—ocellated, number 2—in the photograph bearing number MNHN 8284 (formerly 1551), the right one—banded, number 1—MNHN 8281 (formerly 1560), and were collected between 1842 and 1847 in “Nouvelle-Hollande” (New Holland) by Jules Pierre Verreaux (1807–1873) (Roger Bour, in litt.). Verreaux was a famous French biologist, collector of and professional trader in a wide range of natural history specimens and the Muséum d’Histoire Naturelle in Paris was a good client of his. In 1864 he obtained the position of an assistant naturalist there.

Dead animals, here in the form of two *Varanus*, or a lazy, sun-basking crocodile certainly were ideal objects in the early times of photography, given the required long exposure time. Interestingly enough, this (as far as is known) first photograph of a living reptile was taken during an expedition which was described by Manchip White (1980) as the “world’s first methodically planned and executed safari” while the production of the even earlier photograph of dead reptiles described here directly involved true pioneers of photography and was published in the first book on zoological photography ever issued.

Acknowledgments.—I thank Kraig Adler for comments on the manuscript, Roger Bour for the information on the two *Varanus* in the MNHN collection, and Jasper Köcke for drawing my attention to the Frith publication containing the crocodile photograph.

LITERATURE CITED

- ADLER, K., AND H. COGGER. 1998. Early reptile photography—a new entry. *Herpetol. Rev.* 29:204.
- EDWARDS, J. 1998. Early reptile photography. *Herpetol. Rev.* 29:134–135.
- FRITH, F. 1858–1860. Egypt and Palestine—Photographed and Described. James S. Virtue, City of London. 25 parts, containing 76 albumen prints.
- MANCHIP WHITE, J. E. 1980. Foreword to the plates. *In* Egypt and the Holy Land in Historic Photographs. Views by Francis Frith. Dover Publications, New York
- VAN HAFTEN, J. 1980. Introduction and Bibliography. *In* Egypt and the Holy Land in Historic Photographs. Views by Francis Frith. Dover Publications, New York

HERPETOLOGICAL HUSBANDRY

Herpetological Review, 2010, 41(1), 52–58.
© 2010 by Society for the Study of Amphibians and Reptiles

Observations on the Captive Reproduction of the Horned Marsupial Frog *Gastrotheca cornuta* (Boulenger 1898)

RONALD GAGLIARDO*

Atlanta Botanical Garden, 1345 Piedmont Avenue, Atlanta, Georgia 30309, USA

EDGARDO GRIFFITH

El Valle Amphibian Conservation Center, El Valle de Antón, Panama

ROBERT HILL

Atlanta Botanical Garden, 1345 Piedmont Avenue, Atlanta, Georgia 30309, USA

HEIDI ROSS

El Valle Amphibian Conservation Center, El Valle de Antón, Panama

JOSEPH R. MENDELSON III

Zoo Atlanta, 800 Cherokee Avenue SE, Atlanta, Georgia 30315, USA

ELIZABETH TIMPE

Department of Ecology and Evolutionary Biology, University of Connecticut
75 Eagleville Road, Unit #3043, Storrs, Connecticut 06269, USA

BRAD WILSON

Veterinary Clinic West, 763 Whitlock Avenue, Marietta, Georgia 30064, USA

*Corresponding author; present address: Amphibian Ark, Zoo Atlanta
800 Cherokee Avenue SE, Atlanta, Georgia 30315, USA
e-mail: ron@amphibianark.org

The marsupial frogs (Family Hemiphractidae) from Latin America are some of the most intriguing anuran species known. As their name implies, females of these frogs bear a dorsal pouch in which they carry eggs, tadpoles, and/or froglets. In this family, there are 93 species contained in five genera ranging from Costa Rica through South America to Brazil and northwestern Argentina (Frost 2009). The natural history and reproductive behavior of marsupial frogs is well documented in only a few taxa, mostly through wild-collected specimens brought into captivity at different stages. *Flectonotus pygmaeus*, *Gastrotheca riobambae*, and *G. argenteovirens* were observed in the field and laboratory (Duellman and Maness 1980). The Ecuadorian species *G. riobambae*, has been the most heavily studied by far. This species carries eggs until they develop into tadpoles (taking up to 120 days) that are released into a small body of water (usually a shallow depression or pond). Reproduction in captivity has been reported and has afforded several opportunities for documentation of breeding, gestation, and parturition (Auber-Thomay and Letellier 1986; Boonman 1985; Fitzgerald et al. 1979). Reproduction of *Gastrotheca plumbea* was also observed in the laboratory, including the positioning of eggs in the pouch of the female and birth of fully formed froglets (Auber-Thomay et al. 1986).

Differences in gestation times, fertility, and pouch morphology among taxa have been reviewed along with role of the male in assisting with inserting eggs into the pouch in *F. pygmaeus* and *G. riobambae* (Duellman and Maness 1980).



FIG. 1. Adult Horned Marsupial Frog *Gastrotheca cornuta*. Photo by Brad Wilson.

We recently began working with captive populations of the Horned Marsupial Frog, *Gastrotheca cornuta* (Boulenger 1898; Fig. 1). Historically, this species ranged from Costa Rica to Ecuador; however, in many localities, it has become increasingly rare during the past two decades.

In the field, *G. cornuta* is difficult to encounter. It is thought that this shy species stays high in the canopy of old growth forests, far from anthropogenic disturbance. Juveniles are hardly ever encountered and adults only rarely. In El Valle de Antón, Provincia de Coclé, Panama, we encountered two gravid females (eggs visible through the skin of the abdomen) and one female with eggs inside the pouch in primary forest in close proximity to the Río María ca. 1.5 m above the forest floor during June and July 2005. In June 2006, we observed an amplexant pair of *G. cornuta* ca. 10 m above the ground. Newly emerged froglets have not been found to date in this area. However, in early 2006, we encountered two juveniles ca. 2 m above the ground; these may be offspring born in late 2005.

Marsupial frogs exhibit multiple modes of parental care depending on species (Duellman 1970). In some species, such as *G. riobambae*, the female parent carries tadpoles in the pouch until they are released at late stages of growth into a water source. In other species, the female carries and delivers fully developed froglets, as in the case of *G. cornuta*. Considering all species of *Gastrotheca* and *Flectonotus*, there are six morphological pouch types based on size, position, and degree of coverage (del Pino 1980; Mendelson et al. 2007). The evolution of each of the differing types of pouch morphology and reproductive behavior bears further study for contributions to the science of natural history, evolution, and phylogenetics. Application of these findings to captive reproduction will have implications for *ex situ* conservation and potentially survival of threatened species.

The pouch develops from the skin of the dorsum and can extend nearly up to the back of the skull or even to the lateral lymph spaces. After eggs are inserted into the pouch, usually by the male, the interior skin of the pouch becomes vascularized and in some cases



FIG. 2. Enclosure for maintaining *Gastrotheca cornuta*. Photo by Robert Hill.

forms partitions between embryos (del Pino 1980). Species, such as *G. cornuta*, that undergo direct development of eggs to frogs within a pouch, exhibit an interesting example of a life history completely free of any significant body of water—a method far removed from the plesiomorphic and most common amphibian strategy involving the deposition of eggs directly into water (Wells 2008). Presumably this life history allows species to live under less than favorable environmental conditions with respect to availability of bodies of water, and may reduce exposure of developing offspring to water-borne threats such as predation or disease. Wells (2008) provided a thorough summary of the evolutionary and ecological aspects of this important question, and Todd (2007) proposed an important role of disease and parasites as selective agents in the evolution of alternative reproductive strategies in amphibians.

As the scope of the crisis of global amphibian extinctions becomes clear (Stuart et al. 2004) and the threat of emerging infectious diseases such as amphibian chytridiomycosis become more apparent (Daszak et al. 2003), a collaborative effort of the International Union for the Conservation of Nature (IUCN), Captive Breeding Specialist Group (CBSG), and World Association of Zoos and Aquariums (WAZA) has brought about the Amphibian Ark organization (www.amphibianark.org). The Amphibian Ark is dedicated to safeguarding the species that cannot currently be saved in nature; this is accomplished by managed breeding programs to safeguard species while threats can be further mitigated. In some cases, managed populations may serve as a stopgap for many spe-

cies heading for extinction. The IUCN Amphibian Conservation Action Plan (Gascon et al. 2007) specifically calls for captive breeding and research programs for threatened amphibians. The use of captive breeding programs as a conservation tool is not new and summaries can be found in Zippel et al. (2002) and Gagliardo et al. (2008).

As chytridiomycosis entered the range of *G. cornuta* (Lips et al. 2006), adversely affecting this and other species (Gagliardo et al. 2008), a conservation breeding program was launched. In 2005, specimens of *G. cornuta* were legally exported from Panama to the Atlanta Botanical Garden (ABG), and in 2006 similar specimens were collected and moved to the El Valle Amphibian Conservation Center (EVACC) in El Valle de Antón, Panama. Here we present an overview of our program, some interesting behavioral observations (e.g., toe tapping, male and female vocalizations, egg fertilization and deposition), along with husbandry challenges for long-term care in captivity we have encountered.

RESULTS AT THE EL VALLE AMPHIBIAN CONSERVATION CENTER IN PANAMA

Adults at EVACC were maintained in top-opening glass enclosures (60 cm × 30 cm × 40 cm). The substrate consisted of a “false bottom floor” constructed of plastic light diffuser material covered with soft fiberglass screen secured in place with plastic “zip” ties. Non-bleached paper towel was used as covering on the bottom of this false bottom. Potted plants including *Philodendron* and *Heliconia* were added along with pieces of cork bark or half-inch PVC for refuge and perching sites. Two 96-watt power compact fluorescent lights provided lighting and the temperature was maintained at 23–25°C. The frogs were misted automatically 10 times daily with filtered water. Males and females were housed separately until breeding attempts were made, at which time a male was introduced in late afternoon to the female’s enclosure. The male vocalized occasionally during the day but mostly in the early evening and throughout the night. All adults were fed katydids (*Neoconocephalus saturatus*) every other day. Because of observed cannibalism, the males were kept individually until placed with a female. On several occasions we noted that the dominant male would attempt to consume another male. In one case, the whole front limb (all the flesh off the bones) and part of the back (partially) of the less dominant male were partially digested. During this process the less dominant male (attributed to its proclivity to hiding rather than perching in the open) was still alive despite being partially digested by its cage mate.

Information on specimens used in breeding event:

Female *Gastrotheca cornuta* (EVACC 001-3) was collected from Río María on 17 June 2006 (found in amplexus with a male) and male *G. cornuta* (EVACC 001-5) collected (also from Río María) on 20 June 2006.

Female history:

On 29 December 2006, the female (EVACC 001-3) was observed to be gravid. Different males (EVACC 001-8, 001-7, and 001-6) were placed with the female individually over the course of several weeks but removed when the male did not amplex the female. On 28 January 2007 amplexus was noted with male EVACC 001-6. On 4 February 2007 the female had eggs in her pouch. Fertiliza-

tion was not observed. On the morning (0800 h) of 20 April 2007, froglets (N = 14) were observed in the enclosure along with two incompletely formed young that were apparently aborted.

2008 Breeding event:

21 February: Male *G. cornuta* (EVACC 001-5) placed in tank with resident female (EVACC 001-3).

22 February: Male and female observed in axillary amplexus. Male had all hand digits in axillary position except one (unclear exactly which due to position and ambient light levels), which was on top of female's front limb.

23 February, 1429–41 h: Male and female observed in axillary amplexus on paper towel at bottom of terrarium. Male arched hind limbs to about a 50° angle while female started to rock (i.e., pushing movement) for about 10 seconds (s). Female maintained front limbs out in front of her, underneath her body (i.e., "praying" position). Male maintained the 50° position for about 5 s, and then settled in so that his legs were held tightly against his body, with his head resting perfectly on top of female's head.

1441–49 h: Male placed his feet on female's back and pushed hind limbs in the air in a 50–60° angle. The male inflated himself, and then raised his legs so that his heels were touching, and maintained position for about 10 s. Female remained motionless during this time, until 1449 h when she pushed against the ground with her back limbs, while the male moved his limbs slightly (15° angle).

1450 h: Male inflated and engaged in movement for 45 s.

1510 h: Female's cloaca reddened and pushed out with male's movement.

1512 h: Male inflated again and engaged in movement for 4 s.

1514 h: Appeared as if the male's movements were an attempt to help the female push out eggs. Female's cloaca tilted upward and aligned with male's swollen cloaca. No egg was released but male moved his hind leg as if to find an egg.

1519–24 h: Male inflated, then female moved her hind legs to 45°. Male inflated again, and then female's cloaca could be seen moving in a pulsing manner.

1525–29 h: Female lifted cloaca. Male touched female cloaca (raising hind limbs) with his left toes making sweeping motion on female's back. Male's feet (toes) were in the vicinity of female's pouch. Female then spread her hind limbs a bit farther apart and assumed a broader stance.

1530–34 h: Male inflated, then deflated, and a gel-like substance appeared. It was not clear if this originated from the cloaca or from the skin. It appeared that the male was glistening first and then after some time it was apparent that the female was coated with this substance as well. The male rubbed substance all over the lower back and pouch of the female with his toes.

1535–54 h: Male began cycles of inflation and deflation. Female moved forward and moved her hind legs; they still maintained a 45° angle but heels were now closer together. Male proceeded to rub the gel-like substance all over the female with his toes.

1555–1601 h: Female rearranged her feet, first right then left in a motion (position) similar to as if preparing to jump. Male and female cloacas aligned with each other. Male continued cycles of inflation and deflation, and continued to spread gel over female's body with his toes. The side of female glistened

with the gel-like substance. Male's body was also covered by the substance, which did not appear to dry.

1602–05 h: Female's body was observed to contract. Female pushed forward while the male rose up and down (but did not inflate). Male moved his cloaca into a position directly dorsal to female's cloaca.

1607–14 h: Female arched body, raising her cloaca above the angle of her feet, and cycles of body contractions were observed. Male continues to inflate and deflate. Male then slid forward, pushing female downward and continued to spread the gel over her.

1617–22 h: Male continued inflating and deflating, and rubbing the gel over female with his feet. Then a round egg could be seen in the aperture of female's cloaca. Female rearranged her hind legs, and raised her cloaca while male inflated and deflated. Male moved to bring his cloaca in alignment with that of female.

1628 h: Male deflated. Egg inside of female's cloaca slightly visible as male pushed down. Male moved his toes toward female's pouch.

1630–53 h: Female's body continued with cycles of contractions, and male continued to inflate and deflate. The egg could be seen alternately appearing and disappearing at the aperture of female's cloaca.

1655 h: First egg emerged from female's cloaca, while her body appeared to be in a strong contraction. Male cradled the egg with his body, and maneuvered it into female's pouch with his hind toes. Male continued to inflate and deflate.

1701 h: Male pushed down on female. A second egg almost emerged from female's cloaca.

1706 h: The second egg emerged, and was pushed into the pouch by the male using his feet.

1711 h: Third egg emerged, and male trapped it with his cloaca and pushed it toward the pouch opening. Male used hind legs to position it in female's pouch.

1719 h: Fourth egg emerged, and male repeated behavior to insert it into female's pouch. It appeared as if the male's toes were inserted inside of the pouch, at least dextrally.

1724 h: Male engaged in head bobbing behavior.

1726 h: Fifth egg emerged, and male observed to insert toes into the pouch while inserting the egg.

1729–1834 h: Pair maintained amplexus, male continued to inflate and deflate and began to perform a "rocking" motion, but no additional eggs were produced. The female changed position in minor ways several times before disengaging amplexus.

RESULTS AT THE ATLANTA BOTANICAL GARDEN

As part of a pilot study aimed at learning the logistics of an ex situ response to the rapid spread of the amphibian chytrid-iomycosis through pristine amphibian populations in Panama, several threatened amphibian taxa were exported to facilities at the ABG and Zoo Atlanta in 2005 (Gagliardo et al. 2008). The original breeding group of six male and two female *G. cornuta* was maintained at the ABG where several breeding events have occurred. Adults were maintained in either 60 × 30 × 60 cm or 60 × 60 × 90 cm front-opening glass enclosures for maintenance (smaller) or breeding (larger). The substrate consisted of a "false

bottom floor” constructed of plastic light diffuser material covered with soft fiberglass screen secured in place with plastic “zip” ties. Potted plants including *Philodendron*, *Heliconia*, and *Calathea* were added for hiding places. Pieces of driftwood or similar twigs were provided for perching sites (Fig. 2). Two 96-watt power compact fluorescent lights provided lighting and the temperature was maintained between 18°C and 27°C. The frogs were misted twice daily with filtered water either through an automated system or by hand sprayer bottle. A 15–20 cm diameter, 6-cm-deep shallow water dish containing smooth river stones was refreshed with clean water daily. The stones afforded a climb-out option for not only the frogs after soaking in water but also food items that happened to fall into the water. Males and females were housed separately until breeding attempts were made, at which time a male was introduced in late afternoon to the larger enclosure containing one female. Male vocalization, a very loud, single note similar to the sound of removing a cork from a bottle, was common in early evening.

The first breeding event occurred in April 2006, less than 48 h after introducing a male into a female’s enclosure. Both individuals were exposed to an imposed “dry season” simulated by six weeks of slightly warmer temperatures and lower humidity achieved by less frequent misting of the enclosure and increasing ambient day time temperatures from 20–25°C. There were no signs of courting or amplexus before the female was discovered in the early morning (0700 h) on the second day after introduction of the male. Fourteen eggs appeared to have been inserted into the female’s pouch (Fig. 3) and there were two infertile eggs found on the surface of a leaf in the tank. The recovered eggs were approximately 1.0 cm in diameter, not unexpected as this species is reported to produce the largest anuran egg known (Duellman and Trueb 1986). Immediately following this breeding event, the male was moved to separate enclosure to reduce stress on the gravid female.

Video surveillance of this first attempt did not record any breeding activity but did record evident toe tapping of the female who upon sight of a live, moving cricket (*Acheta domestica*), became keenly interested in the prey and began to tap and motion with toes of her hind feet. Pedal luring (Bertoluci 2002; Murphy 1976; Radcliffe et al. 1986) and providing a vibrational stimulus resulting in prey movement and ultimately prey detection (Sloggett and Zeilstra 2008) are two hypotheses for toe twitching and toe tap-



FIG. 3. Female *Gastrotheca cornuta* with eggs in pouch. Photo by Brad Wilson.



FIG. 4. Newly emerged *Gastrotheca cornuta*. Photo by Heidi Ross and Edgardo Griffith.

ping in anurans. Although toe twitching and tapping are thought to be a common behavior among many frogs and toads (Sloggett and Zeilstra 2008), and have been reported in numerous anuran genera from several different families, including Batrachophrynidae (Radcliffe et al. 1986), Bufonidae (Hagman and Shine 2008; Radcliffe et al. 1986; Sloggett and Zeilstra 2008), Dendrobatidae and Hylidae (Bertoluci 2002), this is the first documentation of pedal luring in the Hemiphractidae.

An additional breeding event occurred in Atlanta in the spring of 2008. On 14 April a male was introduced to an enclosure containing a visibly gravid female. Within 24 h, amplexus was observed, followed overnight by eggs being visible in the pouch. These eggs incubated until 15 June 2008 when thirteen live froglets and two infertile eggs were discovered in the enclosure.

GESTATION, BIRTH, AND HANDLING OF OFFSPRING

Gestation periods ranged from 60–80 days over the course of several breeding events. In the final week before froglets emerged from the pouch, it was possible to see movement of the limbs of the embryos just beneath the skin of the pouch. At both ABG and EVACC, the newly born offspring were approximately 1.0 cm in length and averaged 400 mg in mass (Fig. 4). Upon their birth, offspring were separated into individual enclosures to avoid predation by the female and offered a variety of prey items including fruit flies, houseflies, and small (3–5 mm) crickets. Food items were dusted alternately with vitamins (Men’s Health® multivitamin, once per week) and calcium supplements (RepCal® with Vitamin D3, twice per week).

ABORTION OF DEVELOPING OFFSPRING

Case 1: On 20 June 2007, a gravid female ca. 50 days post-breeding aborted five developing offspring and seven non-developed eggs. There were no outward physical signs of any problems prior to this event. The pouch remained partially inverted for approximately 48 h before repositioning to its normal state (Fig. 5). The developing offspring displayed long, 2–4 cm filamentous gills attached through the skin under the throat (Fig. 6).

Case 2: An abortion of eggs occurred immediately following



FIG. 5. Inverted pouch of female *Gastrotheca cornuta* less than 24 h after emergence of froglets. Photo by Ron Gagliardo.

a July 2008 breeding event. Although our attempts to record the breeding event via night-vision video were unsuccessful (likely due to disturbance caused by shifting of blinds, camera tape changes, noise, etc.) and we did not capture the breeding event on film, we did observe vocalization by the female that consisted of a single soft “bop” periodically prior to amplexus. This could be an encounter call and although we found this unusual, encounter calls have been documented in other anurans (Quiguango-Ubillús and Coloma 2008). Five eggs were never inserted into the pouch and the seven eggs successfully moved into the pouch were aborted within 72 h. We noted that in contrast to the previous case, the lining of the pouch was not extruded possibly because the pouch never became vascularized. Attempts to artificially incubate five eggs on sterile paper toweling or sphagnum moss failed and the eggs disintegrated within 24 h.

OBSTACLES FOR LONG-TERM CAPTIVE MANAGEMENT

Whereas the captive reproduction of *Gastrotheca cornuta* proved much less difficult than expected, raising offspring has been extremely challenging. Most losses occurred during the first 5–20 weeks after birth. Necropsy results indicated a range of issues including internal parasites (mostly rhabditiform nematodes), squamous metaplasia (“short-tongue syndrome” possibly indicative of Vitamin A deficiency), and signs of metabolic bone disease. Currently, there are 11 captive-born offspring in existence,



FIG. 6. Partially developed offspring of *Gastrotheca cornuta* that were aborted during the final weeks of development. The bell gills that characterize this group of frogs are clearly visible. Photo by Ron Holt.

6 at EVACC and 5 at ABG. The five frogs at ABG are over one year in age, weigh between 7.1–12.7 grams and have snout–vent lengths (SVL) of 42–55 mm. Specimens appear to be in overall good health, but have grown very slowly and show some slight rear limb deformities possibly attributable to improper vitamin and mineral supplementation, and/or inadequate exposure to UV-B. At EVACC, the offspring are 12–15 months of age and five of the six also exhibit problems consistent with metabolic bone disease and other skeletal deformities. One frog, (a single survivor from a clutch that emerged on 27 May 2008) has received exposure to UV-B radiation (45 minutes daily from an Eiko® 50-watt halogen bulb with lens removed and positioned atop enclosure) and has not developed any obvious skeletal deformities. The slightly deformed animal from the first clutch born in April 2007 actively hunts and is now calling (Fig. 7). Experiments with Vitamin A supplementation and UV-B exposure currently underway are aimed to mitigate these problems. It is crucial to the survival of these colonies to decipher the husbandry issues, raise offspring to adulthood, and produce subsequent generations.



FIG. 7. Juvenile captive born *Gastrotheca cornuta* exhibiting skeletal deformity. Photo by Brad Wilson.

In comparison to other anuran families such as Dendrobatidae and Ranidae, relatively little is known about the natural or captive reproduction of hemiphractine frogs. Mating behavior in captive specimens of *Gastrotheca riobambae* by Matthews (1957), Deckert (1963), and Hoogmoed (1967), as summarized by Means et al. (2009), was similar to what we have described here, in the male producing a fluid that is rubbed over the posterior area of the female (from cloacal region extending to the anterior limit of the brood pouch) and using his hind legs to insert eggs into the pouch as they are extruded. We speculate that the clear fluid observed by Means et al. (2009) and by us in Panama might have been produced by the male. We should not rule out the possibility that such secretions from the male may contain hormones or other chemicals that stimulate observed contractions in the females. In addition, the vocalization of the female during amplexus remains a mystery. Clearly, these interesting observations should be subject to future investigation.

Along with the actual physical reproductive behavior in hemiphractine frogs such as *Flectonotus* and *Gastrotheca*, we should consider how the natural history affects the developmental physiology of these taxa. Some species are known to bask only while incubating embryos, thus exposing themselves to UV-B radiation (Auber-Thomay et al. 1990). Does this suggest that eggs or developing froglets need UVB or heat for proper development? There are also reports of infection of tadpoles by rhabditiform nematodes while incubating inside the pouch (Auber-Thomay et al. 1990).

WHAT ARE THE IMPLICATIONS OF SUCH PARASITISM IN THE WILD OR CAPTIVITY?

Over half of the 57 known species of *Gastrotheca* are exhibiting population declines (www.iucnredlist.org). The IUCN Red list categorizes *G. cornuta* as Endangered, and a more recent prioritization by the Panamanian government and the Amphibian Ark placed it among the top Panamanian species in need of *ex situ* intervention (Amphibian Ark 2009; IUCN 2009). This highly threatened status warrants continued searches in Panama and elsewhere for additional founder specimens to increase genetic variability of managed colonies. Clearly, the phylogenetically, taxonomically, and physiologically unusual masterpieces that are *Gastrotheca* (Fig. 9) are worthy of conservation efforts. In cases where threats in nature cannot be mitigated in time, managed *ex situ* populations may be the only hope for safeguarding these species until such threats are reversed or until other methods for re-establishing these species in nature are developed. Learning more about the complex natural history and physiology will certainly be of great assistance in the future conservation of these and other endangered amphibian species. We also offer that our natural history and behavioral observations presented here are unlikely to have been documented in the wild, thus supporting the claim that captive programs provide real opportunities for basic research (Chiszar et al. 1993), in this case relating to natural history and behavior. As such, these programs function as a crucial component of the “multidisciplinary approaches to conservation” (Gans 1994).

Acknowledgments.—We thank the personnel and government of the Republic of Panama including R. Ibáñez, and the staff of Hotel Campestre.

Collecting permits were granted by the Autoridad Nacional del Ambiente (permit SEX/A-81-05), with considerable logistical assistance from O. Arosemana of the Smithsonian Tropical Research Institute. We also express our sincere gratitude to Ron Holt for his photographic consultation. Additionally, we thank Marcela Sepulveda Tirado, Jennifer Cruse-Sanders, and Danté Fenolio for their assistance during efforts to film breeding behaviors at Atlanta Botanical Garden. All field observations were made by EG and HR. We dedicate this paper to the memory of Julia Beth Kaylock (1980–2009), who dedicated herself to the conservation and captive husbandry of many Panamanian amphibians, including *G. cornuta*.

LITERATURE CITED

- ALTIG, R. 2006. Tadpoles evolved and frogs are the default. *Herpetologica* 62(1):1–10.
- AMPHIBIAN ARK. 2009. Panama species prioritization. <<http://portal.isis.org/partners/AARK/Lists/Species%20prioritization%20%20Panama/AllItems.aspx>>. Accessed on 03 July 2009.
- AUBÉR-THOMAY, M., L. A. COLOMA, AND G. ONORE. 1990. Elevage d'une rainette marsupiale arboricole des forêts nuageuses équatoriennes *Gastrotheca plumbea* (Boulenger). *Revue Française d'Aquariologie* 17(2):57–62.
- , AND F. LETELLIER. 1986. Observations sur le développement de la rainette marsupiale, *Gastrotheca riobambae* (Hylidés). *Revue Française d'Aquariologie* 13(3):79–86.
- BERTOLUCI, J. 2002. Pedal luring in the leaf-frog *Phyllomedusa burmeisteri* (Anura, Hylidae, Phyllomedusinae). *Phyllomedusa* 1(2):93–95.
- BOONMAN, J. 1985. *Gastrotheca riobambae*, de buidekikker in het terrarium. *Lacerta* 43(11–12):189–204.
- BOULENGER, G. 1898. *Nototrema cornutum*. *Proc. Zool. Soc. Lond.* 1898:124.
- CHISZAR, D., J. B. MURPHY, AND H. M. SMITH. 1993. In search of zoo-academic collaborations: a research agenda for the 1990's. *Herpetologica* 49(4):488–500.
- DASZAK, P., A. A. CUNNINGHAM, AND A. D. HYATT. 2003. Infectious disease and amphibian population declines. *Diversity and Distributions* 9:141–150.
- DECKERT, K. 1963. Die Paarung des Beutelfrosches (*Gastrotheca marsupiatia*). *Zoologische Garten (NF)* 28:12–17.
- DEL PINO, E. M. 1980. Morphology of the pouch and incubatory integument in marsupial frogs (Hylidae). *Copeia* 1980(1):10–17.
- DUPELLMAN, W. E. 1970. The Hylid Frogs of Middle America. *Mus. Nat. Hist., Univ. Kansas, Monogr.* 1:1–752.
- . 2001. The Hylid Frogs of Middle America (reprint + supplement). *SSAR Contrib. Herpetol.* 18. 1159 pp. + 92 plates.
- , AND S. J. MANESS. 1980. The reproductive behavior of some hylid marsupial frogs. *J. Herpetol.* 14(3):213–222.
- , AND L. TRUEB. 1986. *Biology of the Amphibians*. McGraw-Hill, New York. 800 pp.
- ELINSON, R. P., E. M. DEL PINO, D. S. TOWNSEND, F. C. CUESTA, AND P. EICHHORN. 1990. A practical guide to the developmental biology of terrestrial-breeding frogs. *Biol. Bull.* 179(2):163–177.
- FITZGERALD, K. T., L. J. GUILLETTE JR., AND D. DUVALL. 1979. Notes on birth, development and care of *Gastrotheca riobambae* tadpoles in the laboratory (Amphibia, Anura, Hylidae). *J. Herpetol.* 13(4):457–460.
- FROST, D. R. 2009. *Amphibian Species of the World: an Online Reference*. Version 5.2 (accessed 15 July 2009). Electronic database: <http://research.amnh.org/herpetology/amphibia/index.php>. American Museum of Natural History, New York.
- GAGLIARDO, R., P. CRUMP, E. GRIFFITH, J. MENDELSON III, H. ROSS, AND K. ZIPPEL. 2008. The principles of rapid response for amphibian conservation, using the programmes in Panama as an example. *Int. Zoo Yb.* 42:125–135.
- GANS, C. 1994. Directions for future research at academic institutions. *In* J. B. Murphy, K. Adler, and J. T. Collins (eds.), *Captive Management*

- and Conservation of Amphibians and Reptiles. pp. 391–395. SSAR Contrib. Herpetol. 11.
- HAGMAN, M., AND R. SHINE. 2008. Deceptive digits: the functional significance of toe waving by cannibalistic cane toads, *Chaunus marinus*. Anim. Behav. 75(1):123–131.
- HOOGMOED, M. S. 1967. Mating and early development of *Gastrotheca marsupiata* (Duméril and Bibron) in captivity (Hylidae, Anura, Amphibia). Brit. J. Herpetol. 4:1–7.
- IUCN 2009. 2009 IUCN Red List of Threatened Species. <www.iucnredlist.org>. Accessed on 03 July 2009.
- LIPS, K. R., F. BREM, R. BRENES, J. D. REEVE, R. A. ALFORD, J. VOYLES, C. CAREY, L. LIVO, A. P. PESSIER, AND J. P. COLLINS. 2006. Emerging infectious disease and the loss of biodiversity in a Neotropical amphibian community. Proc. Natl. Acad. Sci. 103:3165–3170.
- , P. A. BURROWES, J. R. MENDELSON III, AND G. PARRA-OLEA. 2005. Amphibian population declines in Latin America: a synthesis. Biotropica 37:222–226.
- MARTIN A., AND G. F. WATSON. 1971. Life history as an aid to generic delimitation in the family Hylidae. Copeia 1971:78–89.
- MATTHEWS, L. H. 1957. Viviparity in *Gastrotheca* (Amphibia: Anura) and some considerations on the evolution of viviparity. Bull. Soc. Zool. France 82:317–320.
- MEANS, D. B., W. E. DUELLMAN, AND V. CLARK. 2008. Ovipositing behavior in the egg-brooding frog *Stefania ayanganae* (Anura, Hemiphractidae). Phyllomedusa 7(2):143–148
- MENDELSON III, J. R., H. R. DA SILVA, AND A. M. MAGLIA. 2007. Phylogenetic relationships among marsupial frog genera (Anura: Hylidae: Hemiphractinae) based on evidence from morphology and natural history. Zool. J. Linn. Soc. 128:125–148.
- MURPHY, J. B. 1976. Pedal luring in the leptodactylid frog, *Ceratophrys calcarata* Boulenger. Herpetologica 32:339–341.
- QUIGUANGO-UBILLUS, A., AND L. A. COLOMA. 2008. Notes on behaviour, communication, and reproduction in captive *Hyloxalus toachi* (Anura: Dendrobatidae), an endangered Ecuadorian frog. Int. Zoo. Yb. 42:78–89.
- RADCLIFFE, C. W., D. CHISZAR, K. ESTEP, J. B. MURPHY, AND H. M. SMITH. 1986. Observations on pedal luring and pedal movements in leptodactylid frogs. J. Herpetol. 20(3):300–306.
- SAVAGE, J. M. 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.
- SLOGGETT, J. J., AND I. ZEILSTRA. 2008. Waving or tapping? Vibrational stimuli and the general function of toe twitching in frogs and toads (Amphibia: Anura). Anim. Behav. 76(5):e1–e4.
- TODD, B. D. 2007. Parasites lost? An overlooked hypothesis for the evolution of alternative reproductive strategies in amphibians. Am. Nat. 170:793–799.
- WELDON, P. J., B. J. DEMETER, AND R. ROSSCOE. 1993. A survey of shed skin-eating (dermatophagy) in amphibians and reptiles. J. Herpetol. 27(2):219–228.
- ZIPPEL, K. C. 2002. Conserving the Panamanian golden frog: Proyecto Rana Dorada. Herpetol. Rev. 33:11–12.
- , R. LACY, AND O. BYERS (eds.) 2006. CBSG/WAZA amphibian ex situ conservation planning workshop final report. IUCN/SSC Conservation Breeding Specialist Group. Apple Valley, Minnesota.

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.

Electronic submission of manuscripts is requested (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments). 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: **Marc P. Hayes** (crocodilians, lizards, and *Sphenodon*; mhayesrana@aol.com); **Charles W. Painter** (amphibians; charles.painter@state.nm.us); **Andrew T. Holycross** (snakes; AndrewHolycross@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). 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. Joglear. 2008. *Eleutherodactylus richmondi*: reproduction. Herpetol. Rev. 39:460.

CAUDATA — SALAMANDERS

ANEIDES FERREUS (Clouded Salamander). **ARBOREAL ACTIVITY.** *Aneides ferreus* inhabits the forests of western Oregon and extreme northwestern California. Although thought to be primarily terrestrial, *A. ferreus* has occasionally been found as high as 60 m up in trees (Jones et al. 2005. Amphibians of the Pacific Northwest. Seattle Audubon Society. 227 pp.), and two recent reports suggest that it may be more arboreal than previously believed (Spickler et al. 2006. Herpetol. Conserv. Biol. 1:16–26; Forsman and Swingle 2007. Herpetol. Conserv. Biol. 2:113–118). However, it is difficult to evaluate the amount of arboreal activity by this species because almost all sampling efforts have been focused on terrestrial habitats.

On 23 May 2008 near the Coquille River in southwest Oregon we observed two adult *A. ferreus* in a cavity 75 m above ground in a Douglas-fir tree (*Pseudotsuga menziesii*) that was 78 m tall and 195 cm diameter at breast height (43.1797°N, 123.8122°W; WGS 84). Exposed when a limb broke off, the small cavity in the trunk contained copious amounts of Red Tree Vole (*Arborimus longicaudus*) fecal pellets. Two days later we photographed what we presumed to be the same two salamanders in the cavity (Fig. 1). Based on the shape of their heads, we suspected they were a male and female. These observations add to the increasing evidence that *A. ferreus* is more active in the canopy of Douglas-



FIG. 1. *Aneides ferreus* inside a cavity 75 m above ground in the top of an old-growth Douglas-fir (*Pseudotsuga menziesii*), Coquille River, Oregon, USA.

fir forests than is generally known and also support the hypothesis that nests of arboreal rodents may be important microhabitats for *A. ferreus* (Spickler et al. 2006, *op. cit.*; Forsman and Swingle 2007, *op. cit.*). It remains unknown if use of the forest canopy by *A. ferreus* is restricted to foraging and shelter, or includes occasional breeding as well.

Submitted by **WILLIAM W. PRICE**, 1110 SW 197th Avenue, Beaverton, Oregon 97006, USA (e-mail: groupb@gmail.com); **CLINTON P. LANDON**, P.O. Box 2049, Clackamas, Oregon 97015, USA (e-mail: cplandon@gmail.com); and **ERIC D. FORSMAN**, U.S. Forest Service, Pacific Northwest Research Station, 3200 SW Jefferson Way, Corvallis, Oregon 97331, USA (e-mail: eforsman@fs.fed.us).

CRYPTOBRANCHUS ALLEGANIENSIS ALLEGANIENSIS (Eastern Hellbender). **SECRETION PRODUCTION.** Of the potential antipredator mechanisms exhibited by amphibians, noxious skin secretions are considered the most effective against potential predators (Brodie et al. 1979. *Copeia* 1979:270-274). Many species produce toxic and irritating skin secretions as adults, but the larvae of many salamanders are palatable to various predators because toxic and distasteful secretions generally do not develop until after metamorphosis (Formanowicz and Brodie 1982. *Copeia*



FIG. 1. Larval Eastern Hellbenders (*Cryptobranchus alleganiensis alleganiensis*) immediately after producing a white secretion composed of sticky and foamy components.

1982:91–97).

Adult *Cryptobranchus alleganiensis* are large amphibians (60+ cm) and probably have few predators. When stressed or being captured, adult hellbenders often produce a milky secretion that is bitter and distasteful when applied to the tongue (Brodie 1971. *Herpetol. Rev.* 3:8), and the secretion may be unpalatable to predators. Larval hellbenders hatch between 23 and 30 mm total length and metamorphose 1.5–2 yrs after hatching, and are probably highly vulnerable to predation due to their small size and slow developmental rate (Nickerson and Mays 1973. *The Hellbenders*. Milwaukee Public Museum. Wisconsin. 106 pp.). It is unknown when the ability to produce secretion develops in hellbenders. In Oct–Nov 2007 several Eastern Hellbender egg clutches were collected in Missouri for captive rearing. On 29 April 2008 at 0900 h, 12 larval hellbenders (25 weeks post hatching, mean TL \pm SE = 91.75 \pm 1.8 mm) were collected in a small net for transport to a separate container for behavioral observations. The larvae immediately produced copious amounts of a secretion that appears to have two components. The first component was water-soluble and had a “foamy soap” appearance (Fig. 1). The second component was very sticky and was not soluble in water (Fig. 1); it remained adhered to the individual hellbenders for up to 48 h. Both components are similar in appearance to those produced by adult hellbenders (Nickerson and Mays 1973, *op. cit.*).

Immediately after secretion production, BGG put a small amount of the foamy secretion on his tongue and experienced a strong bitter sensation lasting for ca. 5 sec. The sensation was not accompanied with burning or numbness. The larval secretion tasted very similar to that produced by adult hellbenders.

Our observations suggest that, unlike most salamanders with aquatic larvae, larval hellbenders are capable of producing noxious skin secretions that might function to deter potential predators.

Submitted by **BRIAN G. GALL**, 5305 Old Main Hill, Logan, Utah 84322, USA (e-mail: gall@biology.usu.edu); **ADAM L. CRANE** (e-mail: AdamCrane@MissouriState.edu) and **ALICIA MATHIS** (e-mail: AliciaMathis@MissouriState.edu), 901 S. National, Springfield, Missouri 65897, USA

SIREN INTERMEDIA (Lesser Siren). **DROUGHT SURVIVAL.**

Adult sirens are able to survive prolonged exposure to drought conditions with larger animals being more successful at surviving laboratory-induced aestivation than smaller conspecifics (Gehlbach et al. 1973. *Am. Midl. Nat.* 89:455–463; Etheridge 1990. *Herpetologica* 46:407–414). Larger Greater Sirens (*Siren lacertina*) can possibly survive droughts for 2–3 years and very small sirens (~1 g) are likely able to survive droughts of 146 days (Etheridge 1990, *op. cit.*). Despite the numerous reports of aestivating sirenids in the literature, it remains unknown whether small, young of the year sirens can survive short drought conditions under field conditions. In 2007, many isolated wetlands on the Savannah River Site in Barnwell County, South Carolina, USA, dried completely as a result of a severe drought in the southeastern United States. Even some of the most permanent wetlands on the site dried completely for the first time in nearly 10 years. One of these semi-permanent wetlands, Craig's Pond, is a 72.8-ha Carolina Bay wetland that is the largest natural bay on site. We visited Craig's Pond on 23 Feb 2008 from 2100–2300 h after a series of heavy rains passed through the area. There was a film of dried organic matter floating on the surface of the bay that was presumably formed when the bay dried, the water was uncharacteristically clear and the bottom of the wetland was still comprised of cracked mud and (now submerged) green terrestrial grasses (indicating that the water in the wetland was mostly, if not all, from recent rainwater). During this time, we saw a few *Siren intermedia* moving along the wetland bottom. Judging from Gehlbach and Kennedy's (1978. *Southwest. Nat.* 23:423–429) estimates of year class data, these were likely individuals that would have hatched in 2006 (~20 g). On a subsequent visit on 12 March 2008 from 2100–2300 h we captured two *S. intermedia* that were yearlings from 2007 (~5 g) and sighted several more small sirens. The presence of the two smallest size classes from the previous year's population in Craig's Pond indicates that even the smallest *S. intermedia* were able to successfully survive a short term wetland dry down from ca. November 2007 to February 2008. Additionally, many fish were present in Craig's Pond prior to the drought, including Redfin Pickerel (*Esox americanus*), and cyprinids. Despite several person-hours of searching on both nights, no fish were seen. This suggests that no temporary waterways connected Craig's Pond with other water sources where fish or sirens may have persisted. Consequently, it is likely that the small sirens we observed in Craig's Pond were in fact drought survivors and not dispersers from connected waterways. To our knowledge, this is the first record of juvenile sirens surviving drought conditions in the field.

We thank John Maerz and the University of Georgia's Herpetology class of 2007. Salamanders were captured under scientific research permit 56-2003 from the South Carolina Department of Natural Resources. Funding for this research was provided by 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.

Submitted by **THOMAS M. LUHRING**, Biological Sciences, 105 Tucker Hall, University of Missouri, Columbia, Missouri 65211, USA (e-mail: tmlhwb@mizzou.edu); and **BRIAN D. TODD**, Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, 100 Cheatham Hall, Blacksburg, Virginia 24061, USA.

AGALYCHNIS CALLIDRYAS (Red-eyed Treefrog). **EGG PREDATION.** Red-eyed Treefrogs are found in low elevation tropical forests from the southern Yucatan through Panama. Females deposit clutches of eggs on leaves that overhang ponds, and eggs spontaneously hatch after 5–8 days (Savage 2002. *The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two*



FIG. 1. Upper: Juvenile *Cupiennius getazi* in close proximity to a clutch of *Agalychnis callidryas* eggs. Lower: Close-up of spider consuming the developing embryo.

Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). Eggs are often attacked by aerial (wasp: Warkentin 2000. *Anim. Behav.* 60: 503–510) and arboreal (snake: Donnelly and Guyer 1994. *Oecologia* 98:291–302; Warkentin 1995. *Proc. Natl. Acad. Sci. USA* 92:3507–3510) predators. Here we present an account of predation of an *Agalychnis callidryas* embryo by a spider.

While conducting field work in the Researcher's Swamp at La Selva Biological Station near Puerto Viejo de Sarapiquí, Costa Rica, we observed a spider occupying a territory (i.e., seen on consecutive days within a limited area) on a leaf that contained a clutch of *A. callidryas* eggs (26 June–1 July 2008). On the fourth day after oviposition, the spider appeared to defend the clutch by moving rapidly into a position on top of the eggs as we approached. The following evening (28 June, ca. 2200 h), we witnessed the spider consuming one of the embryos from the egg clutch (Fig. 1). Although vibrational cues are known to trigger hatching in *A. callidryas* eggs (Savage 2002, *op. cit.*; Warkentin 2005. *Anim. Behav.* 70:59–71), none of the eggs hatched during this predation event. Before the onset of spontaneous hatching (1 July), we collected and preserved the spider, and it was later identified as a juvenile *Cupiennius getazi* (Family Ctenidae).

This is the first account of spider predation on eggs of *A. callidryas*, and to our knowledge, the only account of a spider consuming amphibian eggs. The spider was deposited at the La Selva Biological Station Museum (collection code MG.08.06; specimen LS814539). We thank Carlos Viquez (INBio, Costa Rica) for identifying the spider.

Submitted by **MEGAN E. GIBBONS** (e-mail: mgibbons@bsc.edu), **KIMBERLY P. FARRIS** (e-mail: kpfarris@bsc.edu), and **PETER A. VAN ZANDT** (e-mail: pvanzand@bsc.edu), Birmingham-Southern College, Department of Biology, Box 549022, Birmingham, Alabama 35254, USA.

BUFO MELANOSTICTUS (Asian Common Toad). **RECORD SIZE.** *Bufo melanostictus* is known to be the largest toad in South China, attaining an SVL of “about 10 cm” (Karsen et al. 1998. *Hong Kong Amphibians and Reptiles*, Provisional Urban Council, Hong Kong, China). The largest published record available is 106 mm SVL (Fei [ed.] 1999. *Atlas of Amphibians of China*, Henan Science and Technology Press, Zhengzhou, China). On 11 Aug 2008, at night after a rain at Wuzhi Shan (Five Finger Mountain) National Nature Reserve (18.83333°N, 109.55°E; ca. 900 m elev., WGS 84), Hainan Island (Province), we captured a female toad of great size. Pressed flat on a table, snout tip against the wall, she measured 115 mm SVL (relaxed view: Fig. 1). Identity of the species, gender, and measurement were verified by James Lazell. We had no collecting permit and released this toad to grow even larger. The photograph is accessioned at the Museum of Comparative Zoology (MCZ K-959). Our field work was sponsored in part by the Falconwood Foundation and by the grant from the Natural Science Foundation of Guangdong Province (No. 06025054). We thank J. Rosado and J. Lazell, MCZ, for photo accession assistance.

Submitted by **WENHUA LU**, The Conservation Agency, 6 Swinburne Street, Jamestown, Rhode Island 02835, USA, hq@theconservationagency.org, and **NING QING**, Department of

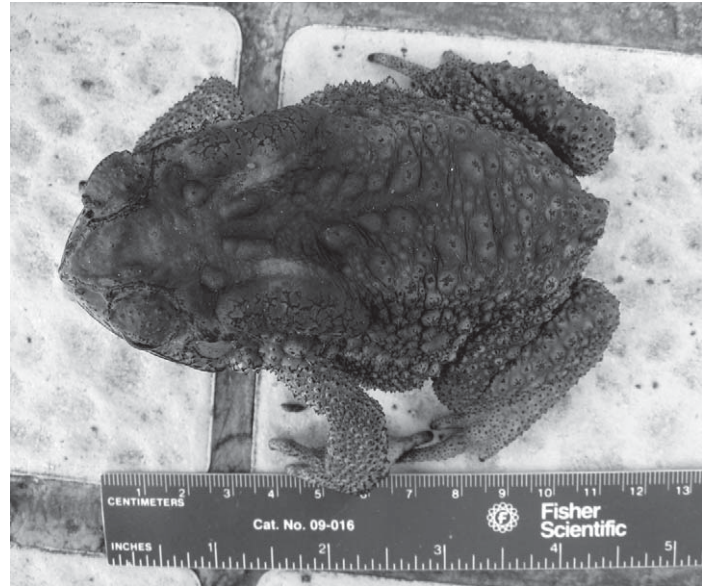


FIG. 1. Record size *Bufo melanostictus* from Hainan Island, South China.

Biology, South China Normal University, Guangzhou, Guangdong 510631, China.

CENTROLENE PROSOBLEPON (Glass Frog). **REPRODUCTION.** *Centrolene prosoblepon* is a neotropical frog ranging from Honduras to Ecuador (Frost 2008. *Amphibian Species of the World*, ver. 5.3. <<http://research.amnh.org/herpetology/amphibia/index.html>> Accessed 14 Aug 2008). There are no data available on reproductive characteristics of this species including the number of the egg per clutch, egg size, and color of embryos at an early stage of development, i.e., less than Gosner Stage 10 (Gosner 1960. *Herpetologica* 16:183–190). Herein, we report this information collected near Falan (5.11666°N, 74.96666°W; WGS 84), Tolima, Colombia. Between November 2007 and May 2008, we found more than 200 egg clutches of *C. prosoblepon* laid on the top of leaves over a stream along a 600 m transect. Of these, we collected data from 40 clutches. We recorded an average of 32 eggs per clutch



FIG. 1. Egg clutch of *Centrolene prosoblepon* from near Falan, Tolima, Colombia.

(range: 25–47), mean diameter of the eggs was 2.56 mm (N = 27), and all embryos were pale yellow (Fig. 1).

Submitted by **MANUEL HERNANDO BERNAL BAUTISTA** (e-mail: mhbernal@ut.edu.co), **EVER EDREY HERNÁNDEZ-CUADRADO** (e-mail: edouglas09@hotmail.com), and **MANUEL GILBERTO GUAYARA BARRAGÁN** (e-mail: jaimar74@gmail.com), Laboratorio de Herpetología and Eto-Fisiología, Universidad del Tolima, Ibagué, Colombia.

CENTROLENE PROSOBLEPON (Glass Frog). **FUNGAL INFECTION.** Amphibian decline is a global phenomenon caused by multiple factors (Stuart et al. 2004. *Science* 306:1783–1786). Some declines have been attributed to the infectious disease caused by the fungus *Batrachochytrium dendrobatidis*, which is found in the oral disc of larvae and the skin of adults (Zellmer and Richards 2008. *Herpetol. Rev.* 39:196–199; Zippel and Tabaza 2008. *Herpetol. Rev.* 39:192–193). It is less detectable in newly metamorphosed frogs and may not be reliably detected in some species until two to three weeks after metamorphosis (Chestnut et al. 2008. *Herpetol. Rev.* 39:202–204). Few data are available regarding the fungal pathogens of embryos. Kiesecker and Blaustein (1997. *Conserv. Biol.* 11:214–220) reported *Saprolegnia ferax* on embryos of three anurans (*Bufo boreas*, *Rana cascadae*, and *Hyla regilla*) common to the Pacific Northwest, USA, and suggested that eggs in communal masses are highly susceptible to infection with *S. ferax*.



FIG. 1. Embryos of *Centrolene prosoblepon* infected by *Saprolegnia* sp.

Between November 2007 and March 2008, we found 20 different egg clutches of *Centrolene prosoblepon* infected by fungus (Fig. 1) near Falan, Tolima, Colombia (5.11666°N, 74.96666°W; WGS 84). We recorded between 25 and 35 dead embryos per clutch. We collected some of these clutches and transported them to the University of Tolima where the fungus was identified as *Saprolegnia* sp. Thus, mortality of embryos from fungal pathogens other than *B. dendrobatidis* may contribute to the global amphibian population decline.

We thank Oscar Cardozo and Gloria Palma for the identification of the fungus.

Submitted by **MANUEL GILBERTO GUAYARA BARRAGÁN** (e-mail: jaimar74@gmail.com), **MANUEL HERNANDO BERNAL BAUTISTA** (e-mail: mhbernal@ut.edu.co), and **EVER EDREY HERNÁNDEZ-CUADRADO** (e-mail: edouglas09@hotmail.com), Laboratorio de Herpetología and Eto-Fisiología, Universidad del Tolima, Ibagué, Colombia.

DENDROPSOPHUS MICROCEPHALUS (Yellow Cricket Tree Frog) **BEHAVIOR.** *Dendropsopus microcephalus* is a small nocturnal, yellowish frog that inhabits humid and dry lowlands along the Pacific slope of Costa Rica. It is generally found in open areas, perching in vegetation over water bodies (Savage 2002. *The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas*. University of Chicago Press, Chicago, Illinois. 934 pp.) Little is known about the ecology of dry-season aestivation for this and many other tropical anurans.

During the peak of the dry season during February 2004, we visited Palo Verde dry forest to observe the diurnal and nocturnal activity of *D. microcephalus* around a waterhole, and to observe behavior that might suggest a period of aestivation for this species. During the December–May dry season (Hartshorn 1983. *In* D. Janzen [ed.], *Costa Rican Natural History*, pp. 118–157. University of Chicago Press, Chicago, Illinois), the reduction of water bodies in this area leaves widely scattered pools that become very important for water-dependant organisms (Vaughan et al. 1997. *Int. J. Trop. Biol. Cons.* 45:1679–1682). We observed *D. microcephalus* perching between 1730 h and 0530 h, in aggregations of individuals in *Ardisia revoluta* shrubs around the waterhole. At all times the individuals stayed motionless and did not emit vocalizations or show conspicuous foraging activity. Between 0530 h and 1730 h, the individuals hid under the leaf-litter and remained motionless and silent as well. Such inactivity was constant throughout the peak of the dry season. Variation in water availability has been shown to induce behavioural responses in anurans to control evaporative water loss. This implies that amphibians respond to water shortage by adopting water-conserving postures (Pough et al. 1983. *Ecology* 64:244–252; Storey 2002. *Comp. Biochem. Physiol. Part A* 133:733–754). Hence, we suggest that *D. microcephalus* may be aestivating through the adoption of water-conserving postures around the waterhole, a limited resource during the driest months of the year.

Moreover, we observed that most individuals perched in the interior of the crowns of *A. revoluta*. We created categories to study the location of these perches to determine if individuals preferred perching in the interior of the crowns. We suggest that selecting perches that are less exposed in the vegetation might

serve as a strategy to avoid water loss. Our classification was based on two parameters: height and position of the perch in the crown of the shrub. Perch height was described in terms of three categories: Higher stratum (Hstr, the higher third of the crown), Middle stratum (Mstr, the intermediate third of the crown), and Lower stratum (Lstr, the lower third of the crown). Perch position was also placed in one of three categories: Periphery Zone (the external third of the crown, using the trunk as reference), Middle zone (the third that is found between the periphery and the internal part of the crown), and Inner zone (the third that is located in the internal part of the crown, next to the trunk). We expect that most individuals will select perches in the inner zone and the middle stratum.

Most individuals selected perches in the interior part (Middle stratum and Inner Zone) of the crown of *A. revoluta* (Higher stratum = 16 individuals, Middle stratum = 52 individuals, Lstr = 33 individuals; $\chi^2 = 19.26$, $df = 1$, $p < 0.05$) (Periphery zone = 6 individuals, Middle zone = 47 individuals, Inner zone = 48 individuals; $\chi^2 = 554$, $df = 1$, $p < 0.05$). Additionally, we used ANOVA to determine there was no relation between body size and perch selection, both in perch height ($F_{2,98} = 0.65$, $p = 0.52$) and perch position ($F_{2,98} = 0.56$, $p = 0.57$). This suggests that there is no evidence for size-mediated intraspecific competition for more protected perches, which may be because aestivation is characterized by a general lack of activity that could preclude active selection and defence of desirable perches.

We thank the OTS Ecology and Conservation course, 2004, where most data were collected and analyzed. We also thank James I. Watling for valuable comments on the manuscript.

Submitted by **BRANKO HILJE**, Biology Department, University of Puerto Rico, Río Piedras, P.O. Box 23360, San Juan, Puerto Rico, 00931-3360 (e-mail: bhilje@yahoo.com); and **MARIEL YGLESIAS**, Escuela de Ciencias Biológicas, Universidad Latina de Costa Rica, San Pedro de Montes de Oca, Costa Rica (e-mail: mariel_yglesias@yahoo.es).

ELEUTHERODACTYLUS ALTAMAZONICUS (NCN). **REPRODUCTION.** *Eleutherodactylus* species undergo direct development, forgoing an aquatic larval stage. It is generally assumed that species deposit eggs in trees within cavities or bromeliads, or on the ground amid moisture-retaining leaf litter or under rotting logs. However, records of oviposition by most species of *Eleutherodactylus* are rare.

On 26 May 2005, at 0830h we encountered a male (22.3 mm SVL, 0.66 g) and female (34.5 mm SVL, 2.03 g) *E. altamazonicus* in amplexus at the base of a large tree in primary, terra firma forest within Yasuní National Park in Ecuador (Provincia de Orellana). The pair was positioned over a small depression in the ground. The cavity was circular in shape, devoid of leaf litter, and roughly 3 cm in diameter and 1 cm deep. The pair was captured, placed together in a ziplock bag and taken back to the laboratory so measurements could be taken. Overnight, the female deposited 38 unpigmented eggs ca. 3.5 mm in diameter inside the bag. The eggs were returned to the depression from which the frogs were originally taken the next day. The study period ended 4 days after the pair was found. Therefore, we were not able to observe whether the eggs hatched. On 27 May, we encountered a second gravid *E. altamazonicus*

female (32.1 mm SVL, 2.78 g) less than 100 m from the spot the first two individuals were encountered. These observations support previous suggestions that the beginning of the rainy season marks the onset of breeding in this species (Duellman 1978. Misc. Publ. Univ. Kansas, Mus. Nat. Hist. 65:1–352).

To our knowledge, only three clutches have been previously described for *E. altamazonicus*. The clutch size reported here is much greater and the eggs larger than those clutches (mean number of eggs in other reported clutches = 18.7, mean size = 2.8 mm) (Duellman 1978, *op. cit.*). This difference may be attributable to the large size of the female or potential geographic variation in reproduction in this species.

We thank the staff at Yasuni Research Station for logistical support and Amo Enomenga for field assistance. This observation was made during dissertation research supported by grants from the Conservation, Food and Health Foundation and the Louisiana Governor's Office of Environmental Education.

Submitted by **JESSICA L. DEICHMANN** and **G. BRUCE WILLIAMSON**, Department of Biological Sciences, Louisiana State University, 107 Life Sciences Building, Baton Rouge, Louisiana 70803, USA, and Biological Dynamics of Forest Fragments Project, Instituto Nacional de Pesquisas da Amazônia and Smithsonian Tropical Research Institute, C.P. 478, Manaus, AM, Brazil (e-mail: jdeich1@lsu.edu).

HYLA AVIVOCA (Bird-voiced Treefrog). **DISTANCE FROM BREEDING SITE.** Essentially nothing is known regarding the distance *Hyla avivoca* moves from the breeding habitat after the breeding season. Smith (1961. Illinois Nat. Hist. Surv. Bull. 28:1–298) speculated that *H. avivoca* inhabits breeding sites year-round. Observations by Rossman (1960. Quart. J. Florida Acad. Sci. 22:207–225) and Redmer et al. (1999. Illinois Nat. Hist. Surv. Bull. 36:37–66) also suggest that *H. avivoca* remains at or near breeding sites outside the breeding season.

In contrast to these observations, I encountered two *H. avivoca* in Johnson County, Illinois, USA, away from breeding sites. I found an adult female on 8 May 2007 perched 1.2 m above the ground on a *Lonicera maackii* within a narrow strip of forest between a shrubby fallow field and a pasture (37.372778°N, 88.975°W). The female was 440 m west of the nearest *H. avivoca* breeding chorus located in June 2008 (37.3725°N, 88.97°W). On 20 May 2008, I heard a male *H. avivoca* diurnally vocalize from *Acer saccharinum*-dominated riparian forest (37.326003°N, 88.922953°W) 695 m from the nearest breeding site (37.332222°N, 88.921667°W).

The congeners, *H. versicolor* and *H. chrysoscelis* are known to make long-distance movements from breeding sites. Johnson et al. (2007. Biol. Cons. 140:250–258) followed a radio-tagged *H. versicolor* 271 m from its breeding site and Ritke et al. (1991. J. Herpetol. 25:123–125) documented movement of *H. chrysoscelis* up to 630 m between breeding sites. My observations indicate that *H. avivoca* is also capable of long-distance movements, suggesting that terrestrial habitat might provide essential resources outside the breeding season. Long-distance movements by *H. avivoca* might also allow exchange of individuals among disparate breeding choruses. This is especially important in southern Illinois where breeding locations of this state-threatened species are often separated by considerable distances.

I thank John Petzing and Floyd Scott for providing copies of difficult-to-procure literature, and the Illinois Endangered Species Protection Board for supporting Bird-Voiced Treefrog surveys.

Submitted by **JOHN G. PALIS**, P.O. Box 387, Jonesboro, Illinois, USA (e-mail: jpalis@yahoo.com).

HYLA SQUIRELLA (Squirrel Treefrog). **REPRODUCTION.** Clutch size is an important aspect of an organism's reproductive strategy and population biology. However, few studies report clutch sizes for *Hyla squirella*. Wright (1932. Frogs of the Okefinokee Swamp, Georgia. Macmillan Co., New York) reported clutch sizes of 942 and 972 eggs for two females allowed to oviposit in the laboratory. Subsequently, Livezey and Wright (1947. Am. Midl. Nat. 37:179–222) suggested clutches > 950 eggs. Martof et al. (1980. Amphibians and Reptiles of the Carolinas and Virginia. Univ. North Carolina Press, Chapel Hill. 264 pp.) speculate that clutches contain approximately 1000 eggs. The best estimate of *H. squirella* clutch size is from five females in Florida with a mean of 1059 (311 SD) eggs (Brugger 1984. Aspects of Reproduction in the Squirrel Treefrog. Unpubl. Master's thesis. University of Florida, Gainesville). Herein, I report the clutch sizes of four females from South Carolina.

I caught 10 female and 10 male *H. squirella* on 13 July 2005 from a small pond on the Savannah River Site in Barnwell County, South Carolina, USA. When captured, females were not in amplexus and all appeared to be gravid. Individuals were brought back to the Savannah River Ecology Laboratory (SREL) where males and females were paired in plastic containers (20.3 × 7.6 × 7.6 cm) with pond water. Five of the females oviposited within 36 hours of capture, but one clutch was excessively disturbed by the adults preventing an accurate count of the eggs. The four remaining clutches had a mean of 1511 eggs. This mean clutch size is considerably greater than those previously described. The snout-vent length (SVL) for three individuals was 32.0, 32.5, and 35.5 mm and they oviposited 1277, 1392, and 1592 eggs. One individual escaped prior to measurement. Although the sample size is small, clutch size appears positively correlated with female body size and warrants further investigation.

I thank Tom Luhring and Rachel Mahan for help catching animals and SREL for use of their facilities.

Submitted by **DANIEL J. HOCKING**, 105 Tucker Hall, Division Biological Sciences, University Missouri, Columbia, Missouri, 65211, USA; e-mail: djhocking@mizzou.edu.

HYPYSIBOAS ALBOMARGINATUS (White-edged Treefrog). **PREDATION.** Amphibians are frequently preyed upon by many types of predators, from carnivorous plants to large vertebrates. They provide a food source for many snake species and complement the diet of birds and mammals (Aucone and Card 2002. Herpetol. Rev. 33:48; Haddad et al. 2008. Atlantic Forest Amphibians. Neotropica, São Paulo, 243 pp.). *Hypsiboas albomarginatus* is widely distributed in Brazil, occurring in the Atlantic Forest from Rio Grande do Norte to Santa Catarina (Lutz 1973. Brazilian Species of *Hyla*. University of Texas, Austin). Reproduction occurs throughout the year in temporary ponds near the forest. During the

day, individuals are observed sleeping in bromeliads or shrubs next to the breeding site or are found in trees at more distant sites. The Black Tufted-ear Marmoset, *Callithrix penicillata*, ranges from southeastern Maranhão and Piauí state, throughout most of Bahia, Minas Gerais, and Goiás state (Rylands et al. 1996. In Norconk et al. [eds.], Primates of the Atlantic Forest: Origin, Distributions, Endemism, and Communities, pp. 21–51. Plenum Press, New York). *Callithrix penicillata* is adapted to forest patches, gallery forests, scrub forests, and degraded forests in the Cerrado. This marmoset is omnivorous, feeding mainly on gum, fruits, arthropods, bird eggs, and small vertebrates. Herein, we report predation of an adult of *H. albomarginatus* by *C. penicillata* at Parque Estadual da Ilha Anchieta (23.5408889°S, 45.0658611°W; WGS 84), Ubatuba municipality, São Paulo state, southeastern Brazil. This monkey is an exotic species that was introduced in 1983 by the Fundação Parque Zoológico de São Paulo. Currently, *C. penicillata* occurs in high abundance on Ilha Anchieta and can severely affect the native fauna. In March 2007, an adult *C. penicillata* was observed eating an adult *H. albomarginatus* in a tree 2 m above ground. While holding the treefrog by its abdomen, the marmoset bit its head, and after eating the head, ate the forelimbs and the abdomen. The treefrog might have been sleeping when attacked. *Hypsiboas albomarginatus* has not been reported previously as prey for *C. penicillata*, since those animals did not occur in sympatry.

Submitted by **PAULO J.P. CICCHI** (e-mail: paulocicchi@yahoo.com.br) and **JORGE JIM**, Depto. de Zoologia, Instituto de Biociências, Universidade Estadual Paulista, CEP 18.618-000, Botucatu, São Paulo, Brazil; **FERNANDA C. CENTENO**, Laboratório Especial de Ecologia e Evolução, Instituto Butantan, Av. Dr. Vital Brazil, 1500, CEP 05503-900, São Paulo, São Paulo, Brazil.

LEPTODACTYLUS OCELLATUS (Butter Frog). **BARN OWL PREDATION.** *Leptodactylus ocellatus* is a large frog characterized by black dots irregularly distributed over an olive green dorsum, which allows camouflage in the environment (Izecksohn and Carvalho-e-Silva 2001. Anfíbios do município do Rio de Janeiro. Editora UFRJ, Rio de Janeiro. 148 pp.). The species is widely distributed, occurring in most of South America east of the Andes (Frost 2007. Amphibian Species of the World: an Online Reference. Version 5.1; 10 Oct 2007. Electronic Database accessible at <http://research.amnh.org/herpetology/amphibia/index.php>. American Museum of Natural History, New York).

The stomach contents of a Barn Owl (*Tyto alba*, MBML 7380 [Museu de Biologia Prof. Mello Leitão]) were examined on 25 June 2008, and the almost intact legs and sacral region of *L. ocellatus* were found; only the forearms and head were digested. The Barn Owl was run over at km 53 of the Rodovia do Sol, a highway located at Municipality of Guarapari (20.6666667°S, 40.4975°W), State of Espírito Santo, Brazil, and was collected on 26 Oct 2007 at 2325 h. The Barn Owl is nocturnal and is found in a variety of habitats, including open areas and human modified environments (Sick 1999. Ornitologia Brasileira. Ed. Nova Fronteira, Rio de Janeiro, Brazil). Its diet is composed mainly of small mammals and invertebrates. Amphibians are also found, but in small quantities (Motta-Junior 2006. Rev. Brasil. Ornitol. 14[4]:359–377; Roda 2006. Rev. Brasil. Ornitol. 14[4]:449–452). This is the first report of *L. ocellatus* in the diet of *T. alba*. We

thank Rodosol S.A. for donation of material to the Museu Prof. Mello Leitão.

Submitted by **MIKAEL MANSUR MARTINELLI** (e-mail: mansurmartinelli@yahoo.com.br) and **GUSTAVO MACHADO PRADO** (e-mail: gmprado@ig.com.br), Setor de Zoologia, Museu de Biologia Prof. Mello Leitão, Avenida José Ruschi, 4, CEP 29650-000, Santa Teresa, Espírito Santo - Brazil.

OOPHAGA PUMILIO (Poison Dart Frog). **NOCTURNAL ACTIVITY.** *Oophaga pumilio* is found over the leaf-litter of the Atlantic lowlands of Nicaragua, Costa Rica, and Panamá. It is usually seen in abandoned open areas and undisturbed forests throughout its range. This species has been characterized by its high abundance and diurnal habits by field studies mainly carried out at OTS, La Selva Biological Station in Sarapiquí, Costa Rica (Donnelly and Guyer 2004. *Amphibians and Reptiles of La Selva, Costa Rica and the Caribbean Slope: A Comprehensive Guide*. Univ. California Press, California, 367 pp.; Savage 2002. *The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas*. Univ. Chicago Press, Chicago, 934 pp.). Territoriality occurs in males of this species, as activity is constrained to an area that is defended from intruders (McVey et al. 1981. *Copeia* 1981[1]:1–8; Prohl 1997. *Amphibia-Reptilia* 18[4]:437–442.). Such defense has been associated with intraspecific competition related to resource availability (Donnelly 1989. *Ecol. Monogr.* 59[3]:207–221; Donnelly 1989. *Oecologia* 81[2]:212–218). Intrusions arise at different hours during the day, causing energetically expensive displays from resident frogs to repel the intruders (Gardner and Graves 2005. *J. Herpetol.* 39[2]:248–253). Male territories usually vary between 6 and 16 m² at La Selva Biological Station, and are maintained through vocalizations (Savage 2002, *op. cit.*).

The territorial behavior of *O. pumilio* includes vocalizations (Bunnell 1973. *Copeia* 1973[2]:273–284) and direct resident-intruder pinning, chasing, grappling, and tracking, among other agonistic behaviors. Postures such as body elevation using the forelimbs and statue behavior are also agonistic behaviors present in male-male interactions. Resident frogs usually remove the intruders, displaying greater dominance (Baugh and Forester 1994. *Behavior* 131[3–4]:207–224). Savage (2002, *op. cit.*) described a resident-intruder encounter, in which both males wrestle facing one another, and seizing each other's forelimbs. Generally the resident pins the intruder and the latter is released from the territory.

On 15 July 2003, we observed variations in the described behavior of *O. pumilio* at El Surá Trail in La Selva Biological Station (10.433°N, 83.983°S). We observed a nocturnal fight starting at 2008 h and finishing at 2143 h. The encounter started as both individuals were emitting vocalizations, an unexpected behavior since this species is regarded as diurnal. The encounter occurred as one individual (resident and intruder could not be identified) approached his opponent with several head bashes, making the latter fall on his back. This agonistic behavior has not been described previously. It consisted of both individuals facing each other a few centimeters away and abruptly colliding their heads without grasping each other's limbs. Subsequent to the attack, the offended individual bounced back and their heads collided again. A few minutes later, the individuals assumed a position that resembled

an amplexus, eventually with one individual's pelvic region joined with the other's head. Both emitted vocalizations very different from those emitted against intruders during the day. Next, the individuals performed occasional leaps, in which one individual jumped from a perch to make the other fall on his back. The fight occurred intermittently as both males ceased the aggressions erratically and after a few minutes returned to the described behavior. At 2143h rain interrupted the encounter. After three minutes of inactivity, one individual emitted a loud vocalization from a 1m perch. His opponent, presumably the intruder, did not respond and abandoned the territory. All agonistic interactions occurred in a 1.5 × 1.5 m leaf-litter plot.

The described interactions show behavior variations from those described in earlier studies. Hence, there may be important variations in activity patterns, as well as in resident-intruder interactions during agonistic encounters.

Submitted by **BRANKO HILJE**, Biology Department, University of Puerto Rico, Rfo Piedras, P.O. Box 23360, San Juan, Puerto Rico, 00931-3360; (e-mail: bhilje@yahoo.com); and **MARIEL YGLESIAS**, Escuela de Ciencias Biológicas, Universidad Latina de Costa Rica, San Pedro de Montes de Oca, numero, Costa Rica; (e-mail: mariel_yglesias@yahoo.es).

PELOPHYLAX PEREZI (Iberian Green Frog). **POLYDACTYLY.** Teratological aberrations are common in Iberian amphibians, although data regarding this condition in *Pelophylax perezii* is scarce in natural populations (reviewed in García-París et al. 2004. *Amphibia. Lissamphibia*. In Ramos et al. [eds.], *Fauna Ibérica* Vo. 24. MNCN-CSIC, Madrid. 639 pp.). However, in introduced populations from the Canary Islands a large portion of the population shows morphological abnormality.

On 02 Feb 2006 an adult male *P. perezii* with a supernumerary toe was found in an eutrophic permanent pond from Central Spain (vicinity of Sieteiglesias de Tormes, province of Salamanca; 40.7282861°N, 5.6207972°W; 820 m elev.). The animal displayed another well-developed toe on the right hand (polydactyly; Meteyer 2005. *Field Guide to Malformations of Frogs and Toads with Radiographic Interpretations*. Biol. Sci. Rep. USGS/BRD/BSR-2000-0005. U.S. Geological Survey, Madison, Wisconsin. 18 pp.), between the fourth and fifth toe of a normal hand. After releasing, this frog was not recaptured in consecutive surveys.

Between 2001 and 2008 we monitored the amphibian population of this area, mainly in eutrophic ponds and recorded ca. 350 *P. perezii*. Only this one individual had any deformity (0.29% of the population) indicating this was an isolated case.

This malformation has not been previously described in this species. A high incidence of teratological cases was reported in an introduced population of the species in the Canary Islands (Luis and Báez 1987. *Vieraea* 17:295–296), however, polydactyly was not reported in any individuals.

We have no data to assess the cause of these malformations although limb abnormalities are mostly related to environmental pollution, genetic or developmental factors (also in synergy with the previous factor), parasites, or a failure in the regeneration processes (Álvarez et al. 1995. *Arch. Environ. Cont. Tox.* 28[3]:349–356; Blaustein and Johnson 2003. *Front. Ecol. Environ.* 1[2]:87–94; Meteyer 2005, *op. cit.*; Johnson et al. 2006. *Ecology* 87[9]:2227–2235).

Submitted by **PABLO GARCÍA** and **ISABEL MATEOS**, C/ N nuez de Zamora, 12-14, 1D, 30073 Salamanca, Spain (e-mail: garciap@usal.es).

RANA CLAMITANS (Green Frog). **COLORATION.** Herein I describe an unusual color pattern in a *Rana clamitans* that was found at the Edmund Niles Huyck Preserve in Rensselaerville, Albany County, New York, USA. Rather than the characteristic combination of brown and olive green, this individual displayed brilliant yellow across much of its dorsum. The abnormal frog (47.6 mm SVL) was found during Sept 2007, along a spring-fed stream (42.52545°N, 74.1594333°W). The front and back legs were more typical *R. clamitans* coloration, as was a large spot in the center of the animal's back (Fig. 1). Although most *R. clamitans* have a speckled venter, this individual had a creamy yellow underside, free of spots. Blue morphs of this species have been reported throughout New York State (Gibbs et al. 2007. *Amphibians and Reptiles of New York State: Identification, Natural History, and Conservation*. Oxford University Press, New York). Berns and Narayan (1990. *J. Morphol.* 132:169–180) determined that the blue morphs have reduced carotenoids and that xanthophores are absent or lacking carotenoid vesicles. The underlying mechanisms that led to the yellow coloration of the individual described here is unknown, as it is the first description of such coloration in New York State. It is unclear whether the morph seen here suffers from the loss or under expression of certain pigments.

I thank P. Ducey, A. Breisch, and J. Gibbs for their assistance in preparing this note.



FIG. 1. Unusual color pattern of *Rana clamitans* found in Albany County, New York.

Submitted by **REBECCA PINDER**, University at Albany, 1400 Washington Avenue, Albany, New York 12222, USA; e-mail: rf729243@albany.edu.

RANA DRAYTONII (California Red-legged Frog). **PREY.** On 19 June 2004 in a large cattle pond in Morgan Territory Regional Preserve, Alameda County, California, USA (37.82°N, 121.79°W), I observed an adult *Rana draytonii* (ca. 95 mm SVL) eat a Western Toad (*Bufo boreas*) tadpole. It was unclear if the frog simply snapped at the motion of the tadpole which had swam underneath the frog's chin, or had deliberately sought out the tadpole.

I returned to the pond five days later and observed 10 adult *R. draytonii* sitting in the shallows at the edge of the pond in an area with large numbers of *B. boreas* tadpoles. In 30 min I observed three instances of *R. draytonii* eating *B. boreas* tadpoles. One adult frog was observed twice in that time eating toad tadpoles. A second adult frog was observed jumping forward into an aggregation of tadpoles, using its front feet to help push tadpoles into its mouth. The frog paused with the tail of a toad tadpole hanging out of its mouth, and then swallowed. There was no indication in any of these instances that the tadpoles were in any way unpalatable or distasteful. Since *R. draytonii* and *B. boreas* often share ponds, predation by *R. draytonii* on bufonid tadpoles may not be an uncommon event. Because *R. draytonii* is only recently recognized as a full species (Schaffer et al. 2004. *Mol. Ecol.* 13:2667–2677) there is limited dietary information available for the species (Hayes and Tennant 1985. *Southwest. Nat.* 30:601–605; Hayes and Jennings 2006. *Herpetol. Rev.* 37:449).

This report points to a mystery. Given that ranid frogs and *Bufo* often share the same ponds, and *Bufo* tadpoles are potentially an abundant source of food at certain times, why are there not more reports of ranid frogs eating *Bufo* tadpoles? Bufonid tadpoles contain skin chemicals that make them unpalatable to at least some predators (Brodie et al. 1978. *Herpetologica* 43:369–373). However, a recent review of tadpole palatability experiments concluded that *Bufo* tadpoles are rarely unpalatable to predators, and no more so than other families of anurans (Gunzburger and Travis 2005. *J. Herpetol.* 39:547–571). A review of the predation sections of the natural history accounts for North American *Bufo* in Lannoo [ed.] (2005. *Amphibian Declines: Conservation Status of United States Species*. Univ. California Press, Berkeley. 1094 pp.) found only one report of ranid frog predation on *Bufo* tadpoles, that of Mountain Yellow-legged Frog (*Rana muscosa*) consuming Yosemite Toad (*Bufo canorus*) tadpoles (Mullally 1953. *Copeia* 1953[3]:182–183), and only a single other report of an anuran predator on *Bufo* tadpoles—that of Great Plains Toad tadpoles (*Bufo cognatus*) being eaten by Mexican Spadefoot tadpoles (*Spea multiplicata*) (Bragg 1940 *Am. Nat.* 74:322–349). Pearl and Hayes (2002 *Am. Midl. Nat.* 147:145–152) observation of Oregon Spotted Frogs (*R. pretiosa*) frequently eating recently metamorphosed *B. boreas* appears to be the only report in the literature of an anuran predator on *B. boreas*.

Submitted by **CARLOS DAVIDSON**, Environmental Studies Program, San Francisco State University, 1600 Holloway Ave., San Francisco, California 94132, USA; e-mail: carlosd@sfsu.edu.

RANA PICTURATA (Yellow-spotted Frog). **PREDATION.** Among invertebrates, spiders are one of the most important predators of amphibians (Wells 2007. *The Ecology and Behavior of Amphibians*. Univ. Chicago Press, Chicago, Illinois. 647 pp.). Predation of spiders on amphibians has often been reported (Duryea



Fig. 1. Right: A dead adult male *Rana picturata* wrapped up by spider's thread. Left: Huntsman spider (*Heteropoda* sp.) feeding on *Rana picturata*.

et al. 2008. *Herpetol. Rev.* 39:209–210), but records from Southeast Asia are few, probably due to paucity of natural history surveys in the region. We observed a huntsman spider (*Heteropoda* sp.) preying on an adult male *Rana picturata* (SVL 39.1 mm) in Takah Selow Waterfall, Selai, in the Endau-Rompin National Park, Johor, Peninsular Malaysia (2.4427778°N, 103.2419444°E, 111 m elev.) at 2215 h on 2 Aug 2008. *Rana picturata* is common in this area, and males were found calling perched on stones, fallen wood, or leaves of shrubs close to stream edges. The frog was found dead, wrapped up in the spider's thread (Fig. 1), on the side of vertical dead trunk (3.5 cm diam.). It was located ca. 1.5 m above the surface of a rocky stream. The spider ran away when disturbed, leaving the dead frog behind. We stopped observation to continue our amphibian survey, but when we returned the spider was found feeding on the frog (Fig. 1). We collected the spider and the frog for further examination. Like members of other genera in the family Heteropodidae, *Heteropoda* do not build webs and are ambush predators, killing their prey by injection of venom. The other genus within the family reported to have preyed upon amphibians is *Olios* (giant crab spider) from Puerto Rico (Formanowicz et al. 1981. *Herpetologica* 37[3]:125–129). The spider was retained by H. Ono, Natural Science Museum, Tokyo, for identification.

Field work was conducted with permission of the Economical Planning Unit (EPU), and financed by the Japan Society for the Promotion of Science (JSPS: No. 20405013) and by Universiti Kebangsaan Malaysia to MM. We are grateful to Yong Hoi Sen (University of Malaya) and H. Ono for help in identification of the spider.

Submitted by **AMIR HAMIDY** (e-mail: amir.hamidy@at5.ecs.kyoto-u.ac.jp), **MASAFUMI MATSUI** (e-mail: fumi@zoo.zool.kyoto-u.ac.jp), and **KANTO NISHIKAWA** (e-mail: hynobius@zoo.zool.kyoto-u.ac.jp), Graduate School of Human and Environmental Studies, Kyoto University, Yoshida Nihonmatsu Cho, Sakyo Ku, Kyoto 606-8501, Japan; **DAICUS BELABUT** (e-mail: daicus@um.edu.my), Institute of Biological Sciences, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia; and **NORHAYATI AHMAD** (e-mail: noryati@ukm.my), School of Environment and Natural Resource Sciences, Faculty of Science and Technology, National University of Malaysia, Bangi 43600, Selangor, Malaysia.

RHACOPHORUS DULITENSIS (Jade Tree Frog). **PREDATION.** Tree frogs of the genus *Rhacophorus* are distributed from India to Japan, the Indomalayan archipelago, and the Philippines. Due to their arboreal lifestyle, most species are seldom encountered and there is little information available regarding their natural history. *Rhacophorus dulitensis* is endemic to Borneo (Harvey et al. 2002. *Herpetol. Monogr.* 16:46–92), where it occurs in primary and old secondary forests. Herein, I report predation on this species by the tree snake, Kopstein's Bronzeback (*Dendrelaphis kopsteini*).

On 12 Dec 2007 between 1330 and 1355 h I observed an adult *R. dulitensis* being preyed upon by a subadult *D. kopsteini* (total length ca. 70 cm) in the top of a medium-sized tree, about seven meters above the ground in the alluvial forest near the headquarters of Gunung Mulu National Park, Sarawak, East Malaysia (Borneo). When the observation started the snake had already grabbed the frog by one of its hind limbs. After a few minutes it maneuvered the frog in its mouth with chewing motions, until the posterior part of the frog's trunk was between its jaws. Then it began to devour the frog (Fig. 1). The frog remained alive at least until it was completely swallowed.

I thank the Sarawak Forest Department for permission to conduct research in Gunung Mulu National Park. Field work was supported by a grant from the German Academic Exchange Service

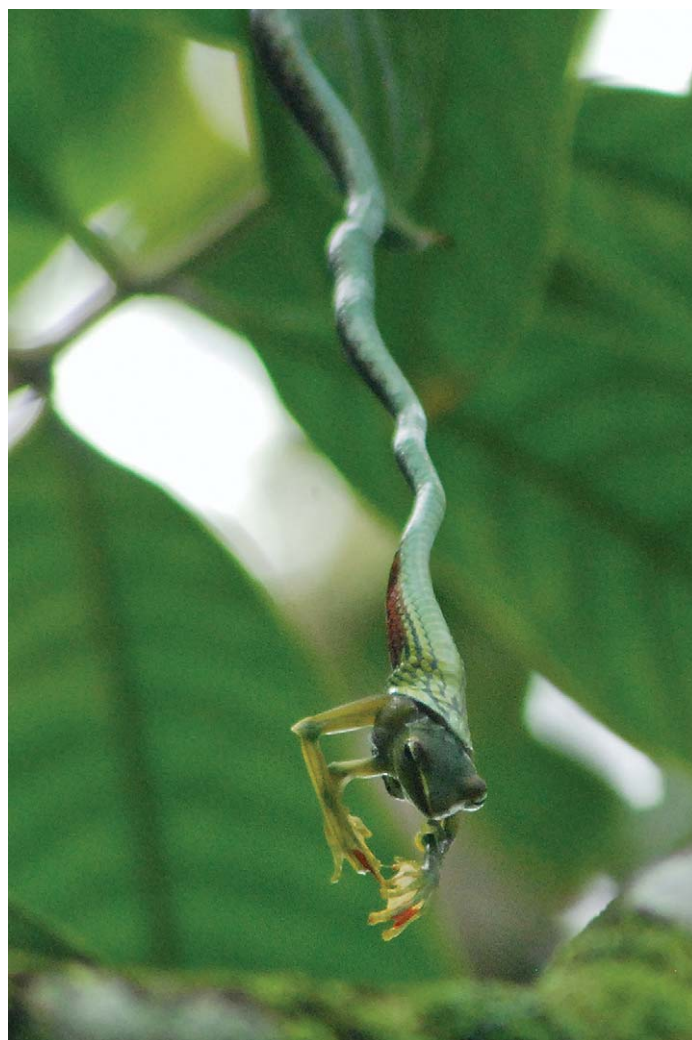


Fig. 1. Predation on *Rhacophorus dulitensis* by *Dendrelaphis kopsteini*.

(DAAD).

Submitted by **JONAS MAXIMILIAN DEHLING**, Dept. Animal Ecology and Tropical Biology, Biocentre, University of Würzburg, Am Hubland, D-97074 Würzburg, Germany; e-mail: maxdehling@web.de.

RHACOPHORUS GAUNI (Short-nosed Tree Frog). **EGG MORTALITY.** To prevent predation by aquatic predators, many frog species do not place their eggs directly in the water but deposit them in foam nests either floating on the water's surface or attached to vegetation above the water. Outside the water, however, frog eggs are exposed to a large number of invertebrate and vertebrate predators (Wells 2007. *The Ecology and Behavior of Amphibians*. University of Chicago Press, Chicago and London. 1148 pp.). Fly larvae have been reported to be very destructive on these foam nests. Investigations in Central and South America, Australia, and Taiwan have shown that in foam nests of particular frog species the prevalence of fly larvae infestation and the mortality caused by it can be very high (Wells 2007, *op. cit.*). Herein I report predation by fly larvae on the eggs of *Rhacophorus gauni*. All Bornean members of the genus *Rhacophorus* lay their eggs in foam nests attached to leaves overhanging water (Malkmus et al. 2002. *Amphibians and Reptiles of Mount Kinabalu [North Borneo]*. Koeltz Scientific Books, Königstein. 424 pp.), apart from *R. kajau* which attaches its eggs directly to leaves without producing a foam nest (pers. obs.). So far, there have been no reports of predation on eggs of Bornean *Rhacophorus*.

Observations were made in Gunung Mulu National Park, Sarawak, East Malaysia (Borneo). Adult *R. gauni* were found in abundance along sections of two rivers, Sungai Melinau near Camp Five and Sungai Melinau Paku near Deer Cave. Frogs were sitting on leaves 2–6 m above ground. Calling males and recently produced foam nests were regularly observed from October 2007 to January 2008, indicating that breeding is prolonged and perhaps occurs throughout the year. Two foam nests sampled on 7 Oct 2007 at Sungai Melinau Paku and on 4 Dec 2007 at Sungai Melinau contained fully developed tadpoles, numbering 9 and 13. There were no signs of infestation by parasites or predators. On 7 Jan 2008, I



FIG. 1. Foam nest of *Rhacophorus gauni*, heavily infested with fly larvae.

found two foam nests at the Sungai Melinau Paku site. In both, fly larvae (Diptera) were visible from the outside. Closer examination revealed that the nests were heavily infested with fly larvae (Fig. 1). No living frog embryos, but only the remains of undeveloped eggs were found within the nests. According to these preliminary observations, the prevalence of fly larvae infestation seems to be moderate in foam nests of *R. gauni*. Mortality of eggs, however, appears to be absolute in infested nests.

I thank the Sarawak Forest Department for permission to conduct research in Gunung Mulu National Park. Field work was supported by a grant from the German Academic Exchange Service (DAAD).

Submitted by **JONAS MAXIMILIAN DEHLING**, Dept. Animal Ecology and Tropical Biology, Biocentre, University of Würzburg, Am Hubland, D-97074 Würzburg, Germany; e-mail: maxdehling@web.de.

CROCODYLIA – CROCODYLIANS

CROCODYLUS SIAMENSIS (Siamese Crocodile). **DIET.** Few published observations are available on the diet, feeding, or predatory habits of *Crocodylus siamensis*, among the most critically endangered and least known of crocodylians (Ross [ed.] 1998. *Crocodyles. Status Survey and Conservation Action Plan*. 2nd ed. IUCN, Gland. 96 pp.). A study of 291 fecal samples from Cambodia provides the only published dietary data for *C. siamensis*, and which recorded the remains of snakes (in 35.7% of samples), fish (31.6%), insects (18.6%), mammals (11.0%), and birds (5.2%), suggesting *C. siamensis* is a generalist feeder similar to many other *Crocodylus* (Daltry et al. 2003. *Status of the Siamese Crocodile in the Central and Southern Cardamom Mountains, Cambodia. Findings of Recent 'Kropeu Phnom' Surveys*. FFI/Department of Forestry and Wildlife, Phnom Penh; Simpson and Han 2004. *In Proc. 17th Working Meeting Crocodile Specialist Group*. pp. 110–120. IUCN, Gland). Dietary studies based only on feces present a biased view of crocodylian diet due to the variable digestibility of prey (keratinous and chitinous substances are commonly recorded in feces while soft-bodied prey [e.g., frogs] are absent) and of digestion times among differently sized crocodiles, which prevent analysis of food preferences and the contribution of individual prey species to total mass of food consumed (Fisher 1981. *Paleobiology* 7:262–275; Shoop and Ruckdeschel 1990. *Am. Midl. Nat.* 124:407–412; Webb et al. 1991. *J. Herpetol.* 25:462–473; Webb et al. 1982. *Aust. J. Zool.* 30:877–899; Santos et al. 1996. *The Herpetological J.* 6: 111–117). Yet in the absence of studies involving live wild crocodiles, fecal samples provide preliminary insight on dietary habits, and for *C. siamensis*, are particularly useful because extant populations are so depleted that wild individuals are rarely observed or caught.

Here I report on the contents of seven *C. siamensis* fecal samples collected during crocodile surveys in the Lao People's Democratic Republic (hereafter 'Laos') (Bezuijen et al. 2006. Preliminary status review of the Siamese Crocodile [*Crocodylus siamensis* Schneider, 1801] [Reptilia: Crocodylia] in the Lao People's Democratic Republic. LARReC/WCS/MWBP, Vientiane. 114 pp.; Bezuijen et al. 2006. *Strengthening Siamese crocodile conservation in Lao PDR. Crocodile Specialist Group Newsletter* 25:10–11).

Crocodylus siamensis feces were collected in the dry season at three permanent, freshwater lakes (elevations 120–150 m elev.) with extensive macrophyte growth: Bung Pulone Lake (14.70888°N, 106.46555°E), Attapu Province, 13 April 2005 (N = 5 samples), and Kout Mark Peo Lake (16.35250°N, 105.22083°E), 12 March 2005 (N = 1) and Xe Lat Nyai Lake (16.44722°N, 105.19277°E), 20 September 2006 (N = 1), Savannakhet Province. These lakes are located on floodplains of the Mekong River and are subject to extensive seasonal changes in water level. Six fecal samples were located along seasonally-exposed lake margins and one, at Kout Mark Peo Lake, was on a mat of floating vegetation. Fecal diameter (widest point of bolus) ranged from 30–45 mm (Table 1), representing a range of differently sized crocodiles. Feces were initially dry and hard, and were subsequently soaked in water. They were then broken apart and observed under a dissecting microscope.

Six of seven samples contained prey items; the sample from Xe Lat Nyai Lake contained no prey remains. Prey items and their frequency of occurrence were: mammal (86%, N = 6 samples), fish (71%, N = 5), and snake (57%, N = 4) (Table 1). The chitinous fragments of coleopteran elytra (beetle forewings) were present in four samples. A small amount of plant matter and four sand grains <1 mm diameter were found in six and one sample respectively. It is unclear whether the insects were deliberately caught as prey; the plant matter and sand were probably secondarily ingested.

No prey items could be identified to species level. Bone fragments present in one sample, including one incisor (3 mm length) and intact vertebrae (3–4 mm diameter excluding transverse processes) were identified as those of a rodent (Muridae). To identify the mammalian hair present in six samples, mounted slide cross-sections and longitudinal-sections from 10–15 hairs in each sample were prepared by H. Brunner and examined under ×470 magnification, following Brunner and Coman (1974). The Identification of Mammalian Hair. Inkata Press, Melbourne. 173 pp.), and compared against a hair reference database (Ecobyte Pty Ltd et al. 2002. Hair ID vers. 1.00. CSIRO Publishing, Collingwood, Victoria). No commercial hair reference database is available for Southeast Asia and the current database, although developed principally for Australian mammals, was used because it includes datasets for several orders of Asian mammals. All hair samples were from the same prey species, a rodent (not *Rattus*), and possessed the following features: a two-tiered layer of relatively long (15–20 mm), stiff, primary guard-hairs, brown-black and tinged red, with a cross-sectional diameter of 175–200 μm, and shorter, finer, grey under-hairs. These hair features, the size of bone fragments (presumably from the same prey species), and the habitat where feces were located, suggests a medium-sized, ubiquitous rodent common in lowland wetlands of the Mekong Basin, such as *Bandicota indica* (Greater Bandicoot Rat) (Francis 2008. A Field Guide to the Mammals of Thailand and South-East Asia. Asia Books Co., Ltd, Bangkok. 392 pp.).

Fish remains comprised the scales of at least two species (Table 1), which, based on scale size and shape, and wetland habitat, were possibly *Channa* spp., one of few fish genera able to tolerate dry-season conditions of these floodplain lakes (Hill 1995. Nat. Hist. Bull. Siam Soc. 43: 263–288; Kottelat 2001. Fishes of Laos. WHT Publications [Pte] Ltd., Colombo. 198 pp.). Snake remains comprised dorsal and ventral scales.

In addition to data derived from fecal samples, on 13 March

TABLE 1. Contents of seven *Crocodylus siamensis* fecal samples from Laos.

Site	Dung size (mm)	Contents
Bung Pulone Lake	85 × 37	Mammal hair; fish scales (sp. A—scales transparent, thin, 3–5 mm diameter)
Bung Pulone Lake	95 × 45	Mammal hair; fish scales (sp. A); snake scales; insect chitin fragments; plant matter
Bung Pulone Lake	125 × 30	Mammal hair; fish scales (sp. A); snake scales; insect chitin fragments; plant matter
Bung Pulone Lake	175 × 40	Mammal hair; fish scales (sp. A+B—scales brown, opaque, thick, 6 mm diameter); plant matter
Bung Pulone Lake	150 × 45	Mammal hair, bone (incisor, vertebrae, other fragments); fish scales (sp. B); snake scales; insect chitin fragments; plant matter
Kout Mark Peo Lake	180 × 43	Mammal hair; snake scales; insect chitin fragments; plant matter; sand particles
Xe Lat Nyai Lake	130 × 40	Plant matter

2005 at 2130 h, I briefly observed a wild hatchling *C. siamensis* catching insects at the water surface near the margin of Kout Mark Peo Lake.

The small sample size of these data precludes comparison with other studies, although the identified remains indicate a broad diet, and the high frequency of occurrence of mammalian remains compared with Cambodian samples may be of note. Further collection and analysis of *C. siamensis* fecal samples from Laos, as well as examination of the fresh stomach contents of wild-caught individuals, would be required to ascertain any seasonal differences in diet or prey preference between *C. siamensis* of different age, size, or geographic distribution.

Fecal samples were collected during crocodile conservation activities by the Laos Department of Forestry/Wildlife Conservation Society, and Laos Department of Livestock and Fisheries/WWF Laos, respectively. I am grateful to Hans Brunner for preparing and analyzing hair samples. Roger Mollot gave advice on fish identification, and Jennifer C. Daltry, Jackson Shedd, Boyd Simpson, and John B. Thorbjarnarson provided critical comments which improved the draft manuscript.

Submitted by **MARK R. BEZUIJEN**, P.O. Box 183, Ferny Creek, Victoria, Australia; e-mail: bezuijen@dodo.com.au.

TESTUDINES — TURTLES

APALONE MUTICA (Smooth Softshell). **PREDATION.** Around 1300 h on 2 July 2006 on the Buffalo River in Marion County, Arkansas, USA, we observed an adult *Apalone mutica*, ca. 30 cm in carapace length, being attacked by a group of otters (*Lontra canadensis*). This event occurred in riffle habitat about one meter deep below debris from two fallen trees. We were standing in the stream about 3–4 m from the attack, but our presence did not appear to disrupt the behavior of the animals. The turtle was clearly

alive and trying to escape from 2–3 otters that were biting its shell and continually pulling it below the surface of the water. The turtle appeared disoriented and exhausted. The otters in the stream were also vocally communicating with 1–2 otters that were on the bank, at least one of which did not appear to be an adult. After observing the encounter for about five minutes, the turtle was carried upstream by the otters, which had apparently subdued it.

Submitted by **ADAM L. CRANE**, Missouri State University, 901 S. National, Springfield, Missouri 65897, USA (e-mail: AdamCrane@MissouriState.edu); and **BEN PARNELL**, Missouri Department of Conservation, 783 Thunder Mountain Road, Camdenton, Missouri 65020, USA (e-mail: Todd.Parnell@mdc.mo.gov.edu).

CHELYDRA SERPENTINA (Snapping Turtle). **CLEANING SYMBIOSIS.** The removal of ectoparasites, necrotic tissue, and epibionts from marine turtles by reef fishes (Grossman et al. 2006. *Chelon. Conserv. Biol.* 5:284–288; Losey et al. 1994. *Copeia* 1994:684–690) and invertebrates (Davenport 1994. *J. Mar. Biol. Assoc. U.K.* 74:735–737) has been well documented. Cleaning symbioses involving freshwater turtles are also known (Moll and Moll 2004. *The Ecology, Exploitation, and Conservation of River Turtles*. Oxford Univ. Press, New York. 393 pp.); however, observations of these interactions in freshwater species are rare in the literature compared with those of marine turtles. Here, I report an apparent episode of mutualistic cleaning between a *Chelydra serpentina* and Bluegill Sunfish (*Lepomis macrochirus*).

On 06 June 2007 at 1830 h, I observed a *C. serpentina* (ca. 20 cm SCL) in shallow water along the shoreline (39.33882°N, 82.34693°W; WGS 84) of Lake Hope at Lake Hope State Park, Vinton County, Ohio, USA. When first encountered, the turtle was floating just below the surface in open water. The limbs and tail of the turtle were extended out and downwards from the body and its neck was fully extended horizontally. A school of ca. 9 *L. macrochirus* surrounded the turtle. As the fish slowly swam around the *C. serpentina*, they frequently oriented towards the turtle and approached to within 2–3 cm of it. The fish appeared to inspect the *C. serpentina* and individuals were twice seen nipping at the turtle. The fish primarily concentrated on the posterior and inguinal regions of the turtle; however, they would occasionally swim to the anterior of the carapace and axillary areas. Interactions between the turtle and fish were observed and photographed for ca. 30 min before the *C. serpentina* became aware of my presence and submerged. During the observation period, the turtle did not appear bothered by the actions of the fish; it made no movements except to raise its head to breathe and slowly turn to examine its surroundings. The *C. serpentina* did not attempt to strike at the fish despite the fact that several individuals ventured close to the turtle's head.

Facultative cleaning behavior is not unusual in *L. macrochirus* and other centrarchid fishes (Powell 1984. *Copeia* 1984:996–998; Spall 1970. *Trans. Amer. Fish. Soc.* 99:599–600; Sulak 1975. *Anim. Behav.* 23:331–334). Bluegills have previously been reported to bite at resting turtles (Kaufmann 1991. *Herpetol. Rev.* 22:98; Powell, *op. cit.*). However, to my knowledge, this observation represents the first report of a turtle that appeared to encourage attention from *L. macrochirus*. The neck extension and behavior

of the *C. serpentina* were similar to the posture and movements described by Kaufmann (*op. cit.*) for *Glyptemys* (= *Clemmys*) *insculpta* being cleaned by Blacknose Dace (*Rhinichthys atratulus*). Snapping turtles are frequent hosts for leeches (Brooks et al. 1990. *J. Parasitol.* 76:190–195; McCoy et al. 2007. *Southeast. Nat.* 6:191–202) and epizootic algae (Edgreen et al. 1953. *Ecology* 34:733–740). Both items appear in the diet of sunfish (Etnier 1971. *Trans. Amer. Fish. Soc.* 100:124–128), suggesting a possible route for opportunistic cleaning symbiosis to develop between these species. Given the widely overlapping distributions of *C. serpentina* and *L. macrochirus*, this relationship may be common but previously unrecognized.

Submitted by **JEFFREY E. DAWSON**, Reptiles/Shores Region, Columbus Zoo and Aquarium, 4850 W. Powell Road, P. O. Box 400, Powell, Ohio 43065, USA; e-mail: jeff.dawson@columbuszoo.org.

CHELYDRA SERPENTINA (Common Snapping Turtle). **SURVIVAL AFTER INJURY.** We here report an adult *Chelydra serpentina* from Wethersfield Cove, Wethersfield, Connecticut, USA, missing most of its lower jaw (Fig. 1). This old injury to the jaw would presumably disable both the suction-feeding apparatus (by reducing flow speed during strike and increasing backflow during buccopharyngeal compression) described for this species (Lauder and Prendergast 1992. *J. Exp. Biol.* 164:55–78) and eliminate bite force (Herrel et al. 2002. *J. Evol. Biol.* 15:1083). Yet this turtle weighed 17.5 kg and had a carapace length of 44.5 cm; visual examination showed ample fat deposits indicating that this turtle was in good condition despite its injury. The turtle was apparently able to heal and grow after the loss of the lower jaw, thus compensating for the lack of normal biting and prey-handling behaviors.



FIG. 1. Male Common Snapping Turtle missing most of its lower jaw, Wethersfield Cove, Hartford, Connecticut, USA (44.5 cm carapace length, 17.5 kg). This animal apparently healed and grew without being able to suction feed or produce bite force.

Submitted by **TOBIAS LANDBERG** (e-mail: tobias.landberg@huskymail.uconn.edu), and **COLIN J. CARLSON**, Ecology & Evolutionary Biology, University of Connecticut, Storrs, Connecticut, USA; **KYLER ABERNATHY**, The National Geographic Society, Washington D.C., USA; **CHRISTIAN LUGINBUHL**, Luginbuhl Foundation, Tolland, Connecticut, USA; **PAUL GEMME**, Our Piece of the Pie, Hartford, Connecticut, USA; and **CRAIG MERGINS**, Riverfront Recapture, Hartford, Connecticut, USA.

GLYPTEMYS INSCULPTA (Wood Turtle). **MAXIMUM ADULT SIZE.** On 21 June 2009, we captured an adult male *Glyptemys insculpta* in a tributary of the Kennebec River in Somerset County, Maine, USA. This turtle had been captured and radiotracked as a subadult by BWC in 1998 (Compton 1999. Ecology and Conservation of the Wood Turtle [*Clemmys insculpta*] in Maine. Unpubl. M.S. thesis, Univ. of Maine, Orono). Age estimates from plastral annuli in 1998 and 2009 indicate that the animal was ca. 25 years old upon recapture in 2009. Carapace and plastron dimensions were measured using a 12-inch dial caliper and the animal was subsequently released at the capture location. Shell dimensions (to nearest 0.1 mm) were as follows: straightline carapace length (SCL)(from cranial end of nuchal scute to caudal end of seam between 12th marginal scutes): 240.0; maximum carapace length (MCL)(from cranial edge of 1st or 2nd marginal scute to caudal end of 12th marginal scute): 251.0; straightline plastron length (from cranial end of seam between gular scutes to caudal end of seam between anal scutes): 200.9; maximum plastron length (from cranial edge of left gular scute to caudal edge left anal scute): 220.2; plastron width (at seam between humeral and pectoral scutes): 89.4; carapace width (at 8th marginal scutes): 180.3. Body mass was 1895 g. This turtle is markedly larger than the ten adult male *G. insculpta* measured at this site by Compton (1999) (MCL median = 215.0 mm; MCL max = 232.5 mm) and 48 adult male *G. insculpta* from New Hampshire (MCL median = 190.8; MCL max = 208.8) and 198 adult male *G. insculpta* from Massachusetts (MCL median = 188.5; MCL max = 213.9) measured by MTJ (Jones 2009. Spatial Ecology, Population Structure, and Conservation of the Wood Turtle in Central New England. Unpubl. Ph.D. dissertation, Univ. of Massachusetts, Amherst). The animal's current shell dimensions appear to be larger than most or all reported measurements from across the range of *G. insculpta*. Saumure (1992. Herpetol. Rev. 23:116) reported two extremely large males from Pontiac Co., Québec, with carapace lengths of 238.0 and 234.5 mm. In a review of the status of Wood Turtles in Québec, where the species appears to attain a relatively large adult size, Galois and Bonin (1999. Rapport sur la situation de la tortue des bois (*Clemmys insculpta*) au Québec. Faune et Parcs Québec, Direction de la faune et des habitats, Québec) reported a maximum carapace length of 244 mm. The authors did not indicate whether this represented SCL or MCL in the sense outlined above.

This research was conducted under Wildlife Scientific Collection Permit #2009-278 from the State of Maine Department of Inland Fisheries and Wildlife.

Submitted by **MICHAEL T. JONES**, Massachusetts Division of Fisheries and Wildlife, Westborough, Massachusetts 01581, USA (e-mail: michael.t.jones@state.ma.us); and **BRADLEY W.**

COMPTON, Department of Natural Resources Conservation, University of Massachusetts, Amherst, Massachusetts 01003, USA (e-mail: bcompton@nrc.umass.edu).

KINOSTERNON SUBRUBRUM (Eastern Mud Turtle). **MASS MOVEMENT AND MORTALITY.** About 0930 h on 25 April 2009, after a night of heavy rain, we began a survey of paved secondary roads south of Winnie in Chambers County, Texas, USA looking for shorebirds (Scolopacidae, etc.) in rice fields. We drove west on St. Rd. 1985 and then north to and back east on St. Rd. 65, parallel roads about 13 km apart, and beginning and ending on the north-south running St. Rd. 124.

We found few shorebirds, but instead encountered an extraordinary mass movement and associated road mortality of the mud turtle *Kinosternon subrubrum*. Especially on the eastern ends of both roads, and mostly on 1985, we saw hundreds of dead and smashed turtles, some moribund, and perhaps 20 or so more trekking across the roads. The movement we saw of live turtles was entirely north to south across the east-west running roads; we noticed little, if any similar mortality on Rd. 124.

We estimated a very conservative 300 dead and dying mud turtles; the total was possibly much higher than this. Even crude quantification was difficult because of heavy local farm traffic, but at times it was possible to count 20–30 dead turtles in a stretch of 20 m; the circumstances also prevented us from examining specimens and determining sex ratios.

This was a monospecific event, as we otherwise noted only two large cooters (*Pseudemys* sp.), one living and one dead; we also saw a snake (*Nerodia* sp.) that successfully crossed the road before we could turn around to identify it. We are familiar with similar mass movements (and mortality) following rains by toads, frogs, and salamanders, but saw none of these in this instance, and we had not previously witnessed such a movement by turtles. Reports of other significant (though much smaller) movements of *K. subrubrum* seem associated with drying habitat (e.g., Strecker and Gibbons et al. *In* Ernst et al. 1994. Turtles of the United States and Canada, p. 172. Smithsonian Inst. Press, Washington, DC).

Interpretation of the phenomenon we observed was confounded by the inundation of thousands of the surrounding hectares in 2–3 m of salt water during the storm surge of Hurricane Ike on 13 September 2008. We overheard residents talking of flooding fields to leach the salt before rice could be planted. Nevertheless the movement we saw was coincident with a local deluge of rain. The nearest official rain gauge in Beaumont, Texas, 38 km to the east, recorded only 0.52 inches of rain 24–25 April (Donna Work, Texas Forest Service, pers. comm., 20 May 2009), but around Winnie the total was manifestly much more than that; we heard local commentary on the extraordinary rainfall the night of 24–25 April and saw abundant evidence in flooded fields and residential yards, and water overflowing drainage ditches onto the roads, so the local rainfall must have been considerable.

We are grateful to D. Bruce Means and Lora L. Smith for helpful suggestions.

Submitted by **ROBERT L. CRAWFORD**, 208 Junius St., Thomasville, Georgia 31792, USA (e-mail: rlcrwfd@rose.net); and **MICHAEL J. DOYLE**, 31 Clandon Drive, Eastleigh, Hants S050 4QQ, UK.

PODOCNEMIS EXPANSA (Giant South American River Turtle). **PRE-NESTING BASKING BEHAVIOR.** *Podocnemis expansa* is a freshwater pleurodiran turtle native to the Amazon basin. This species was historically common and could be observed basking and nesting in large numbers, but this is now a rare occurrence over most of the Amazon (Rueda-Almonacid et al. 2007. *Las Tortugas y los Crocodilianos de los Países Andinos del Trópico*. Serie de Guias Tropicales de Campo n° 6. Conservación Internacional. Editora Panamericana, Formas y Impresos. Bogotá, Colombia, 538 pp.). In this species, basking behavior is reportedly restricted to the period just prior to, or during, nesting (although RCV has one record of a juvenile ca. 8 cm in carapace length basking on a log in Anavilhanas National Park, Amazonas Brazil, 23 February 1989). In many areas of the Amazon, pre-nesting basking is no longer observed, a behavioral change possibly in response to human predation (Vogt 2008. *Tartarugas da Amazônia*. Grafica Biblos, Lima, Peru. 104 pp.) However, on the Trombetas River, Pará, Brazil, basking behavior prior to nesting is still observed, perhaps due to the efforts of the Brazilian Environmental National Institute (IBAMA) to protect the nesting beaches against human predation.

Here we report basking observations during the reproductive season of 2008, from 30 September to 2 November (230 h of observations) on the Praia do Jacaré (1.530494°S, 55.473148°W; WGS84). The average number of turtles basking per day was 106 (min. 7 – max. 295; SD = 87). The turtles started basking on 30 September in small numbers (7–15), increasing over subsequent days until they reached a peak on 21 October (295 turtles). At this point the nesting season began (21 October) and the average number of turtles basking daily dropped to 51, and continued to decrease until basking ceased on 3 November. During the basking period, the turtles aggregated in large groups, including the turtles on the beach as well as those in the water. Basking behavior in this circumstance may increase the metabolic rate of the female, accelerating egg development and ovulation (Vogt 1980. *Tulane Stud. Zool. Bot.* 22:17–48). Despite living in warm waters (mean water temperature = 30.2°C [RCV, unpubl. data] from 3538 temperature recordings in the field in Trombetas Reserve from Nov–September), the physiological advantages of basking to the turtles apparently outweigh the risks involved from the increased exposure to predation.

Submitted by **CAMILA R. FERRARA** (e-mail: ferrara@terra.com.br), **LARISSA SCHNEIDER**, and **RICHARD C. VOGT** (e-mail: vogt@inpa.gov.br), Instituto Nacional de Pesquisas da Amazônia (INPA), Caixa Postal 478, CEP 69011-970, Manaus, Amazonas, Brazil.

SQUAMATA — LIZARDS

AMEIVA AMEIVA (Giant Ameiva). **PREDATION.** Despite its broad distribution in South America (Vitt and Colli 1994. *Can. J. Zool.* 72:1986–2008) and various aspects of natural history having been described (Colli 1991. *Copeia* 1991:1002–1012), few data exist on the predators of *Ameiva ameiva* (Martins and Oliveira 1998. *Herpetol. Nat. Hist.* 6:78–150). Hence, we add to the limited data on *A. ameiva* predators with an observation of predation by a Pearl Kite (*Gampsonyx swainsonii*).

On 27 April 2008 at ca. 1200 h, while conducting an ornithologi-

cal survey as a part of the Environmental Impact Study of the Foz do Apiaças Hydroelectric Power Plant in Mato Grosso State, Brazil, we collected an adult *G. swainsonii* with a pressure gun from a grassland area of Paranaíta, Mato Grosso (57.1092°W, 9.4155°S, datum: SAD69; elev. 701 m); dissection revealed two juveniles *A. ameiva* (40.82 mm and 34.93 mm, SVL) in the stomach. The grasslands were surrounded by rain forest dominated by Babaçu Palms (*Orbignya oleifera*).

Gampsonyx swainsonii are known to prey on insects, birds and lizards (Sick 2001. *Ornitologia Brasileira*. Editora Nova Fronteira. Rio de Janeiro, Brazil. 862 pp.), but to our knowledge, none of the lizards recorded as prey were identified to species.

The *G. swainsonii* specimen (JB 395 – collection license 10698-1/IBAMA) (length: 22.5 cm) and its stomach contents were deposited in Laboratório de Ornitologia, Campus of Cuiabá, Universidade Federal de Mato Grosso (UFMT).

We thank M. Hayes for valuable suggestions on the manuscript and we are grateful to Biodinâmica Engenharia e Meio Ambiente for logistical support.

Submitted by **JOÃO BATISTA DE PINHO** (e-mail: pinho@cpd.ufmt.br), **MILENE GARBIM GAIOTTI** (e-mail: enelim@gmail.com), **PAULA FERNANDA ALBONETTE DE NÓBREGA** (e-mail: pnbio@yahoo.com.br), Laboratório de Ornitologia, Núcleo de Estudos Ecológicos do Pantanal, IB, Universidade Federal de Mato Grosso, Avenida Fernando Corrêa, s/n° Coxipó CEP 78060-900, Cuiabá, MT, Brazil.

AMEIVA AMEIVA (Giant Ameiva). **SAUROPHAGY.** *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 (Vanzolini et al. 1980. *Répteis das Caatingas*. Acad. Bras. de Ciênc., Rio de Janeiro, Brazil. 161 pp.; Vitt and Colli 1994. *Can. J. Zool.* 72:1986–2008). The diet of *A. ameiva* is composed mainly of arthropods (Vitt and Colli 1994, *op. cit.*). Gastropods and plant matter (fruits and leaves) are also commonly present (Vitt 1995. *Occ. Pap. Oklahoma Mus. Nat. Hist.* 1:1–29; Zaluar and Rocha 2000. *Ciência e Cultura* 52:101–107). Orthopterans, termites, beetles, and insect larvae are the most numerically important items in the diet of the populations of this species within different Brazilian ecosystems (Gainsbury and Colli 2003. *Biotropica* 35:503–519; Vitt and Colli 1994, *op. cit.*). Volumetrically, cockroaches, beetles, insect larvae, spiders, and orthopterans were among the most important items in a great number of studies (Vitt and Colli 1994, *op. cit.*; Zaluar and Rocha 2000, *op. cit.*). In addition to invertebrates and plant matter, *A. ameiva* occasionally feeds on small vertebrates (Vitt 1995, *op. cit.*), including lizards (Vitt 2000. *Herpetol. Monogr.* 14:388–400; Zaluar and Rocha 2000, *op. cit.*). Here, we report on the ingestion of a lizard previously unrecorded as prey for *A. ameiva* in the caatinga at the Ecological Station of the Seridó (ESEC Seridó), in the municipality of Serra Negra do Norte, Rio Grande do Norte, Brazil.

During the ecological study of a population of *A. ameiva* in the ESEC Seridó (06.5767°S, 37.2558°W, datum: WGS84; elev. 192 m), a total of 18 stomachs were analyzed. A gymnophthalmid lizard, *Vanzosaura rubricauda* (24.0 mm SVL, 35.0 mm in total length, 6.0 mm in width and 659.4 mm³ in volume) was found in

the stomach contents of an adult female (125.7 mm SVL) captured on 29 March 2009, near decomposing trunks in herbaceous vegetation.

In an analysis of 55 stomachs of *A. ameiva* conducted by Zaluar and Rocha 2000 (*op. cit.*) in a restinga ecosystem in southeastern Brazil, juveniles of two sympatric lizard species (*Tropidurus torquatus* and *Mabuya agilis*) were found in the stomachs of two adult males. Vitt 2000 (*op. cit.*) reports on the predation of two *Kentropyx striata* adults by an adult *A. ameiva* in an Amazonian savanna in northern Brazil. Owing to the large body size of *A. ameiva* compared to many sympatric lizard species throughout its wide distribution, saurophagy may be more common than is currently represented in the literature (Vitt 2000, *op. cit.*).

The *A. ameiva* (CHBEZ 2507) was deposited in the herpetological collection of the Universidade Federal do Rio Grande do Norte, Natal, Brazil. We thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for financing the PELD-Caatinga Program entitled Structure and Functioning, and for the research scholarship granted to RFDS (process 127543/2008-2), LBR (process 141993/2006-5) and EMXF (process 304077/2008-9); and to PROPESQ/UFRN for the research scholarship awarded to HWBA. IBAMA provided a permit (Permit 206/2006 and Process 02001.004294/03-15).

Submitted by RAUL F. D. SALES (e-mail: raulsales17@gmail.com)¹, LEONARDO B. RIBEIRO (e-mail: ribeiro.lb@gmail.com)^{1,2}, HUGO W. B. ALMEIDA¹ and ELIZA M. X. FREIRE (e-mail: elizajuju@ufrnet.br)^{1,2}, ¹Laboratório de Herpetologia, Departamento de Botânica, Ecologia e Zoologia, Centro de Biociências, Universidade Federal do Rio Grande do Norte, Campus Universitário, 59072-970, Natal, RN, Brazil; ²Programa de Pós-graduação em Psicobiologia/UFRN, 59078-970, Natal, RN, Brazil.

AMPHISBAENA VERMICULARIS (NCN). **PREDATION.** Amphisbaenians are little known and secretive animals, but it is recognized that elapid snakes of the genus *Micrurus* are important predators. *Amphisbaena vermicularis* is a small amphisbaenian (325 mm total length) known from the Brazilian states of Pará to Minas Gerais, Mato Grosso, and Mato Grosso do Sul, usually in Caatinga domains (Uetanabaro et al. 2007. *Biota Neotropica* 7:279–289; Vanzolini et al. 1980. *Répteis das Caatingas*. Acad. Bras. de Ciênc., Rio de Janeiro, 161 pp.). Here, we document the predation of *A. vermicularis* by the elapid *Micrurus ibiboboca*, a widespread reptile within the Caatinga region of eastern Brazil (Roze 1996. *Coral Snakes of the Americas: Biology, Identification, and Venoms*. Krieger Publ. Co., Malabar, Florida. 328 pp.; Vanzolini, *op. cit.*) and a known amphisbaenian predator (Gomes et al. 2005. *Herpetol. Rev.* 36:170).

At 2100 h on 23 August 2007, one of us (CMCAL) collected an adult female *M. ibiboboca* that was in a residence in the municipality of Natal (3.1221°S, 43.2122°W; datum: SAD69; elev. 41 m). The residence's owner killed the snake, exposing its stomach which contained the recently ingested amphisbaenian prey. The prey was 203 mm SVL, 25 mm tail length, 4.54 g and the snake was 577 mm SVL, 34 mm tail length and 46.2 g.

The snake and amphisbaenian prey were deposited in the herpetological collection of Universidade Federal do Rio Grande do Norte, Natal municipality, under numbers CHBEZ 1910 and

CHBEZ 1911, respectively.

Submitted by CAROLINA M. C. A. LISBOA (e-mail: carolisboabio@yahoo.com.br), and ELIZA M. X. FREIRE (e-mail: elizajuju@ufrnet.br), Departamento de Botânica, Ecologia e Zoologia, Centro de Biociências, Universidade Federal do Rio Grande do Norte, 59072-970, Natal, RN, Brazil.

BARISIA IMBRICATA (Transvolcanic Alligator Lizard). **RECORD LITTER SIZE.** The viviparous anguid lizard *Barisia imbricata* occurs in the Mexican Transvolcanic axis (Flores-Villela 1993. *Spec. Publ. No. 17*, Carnegie Museum of Natural History, 73 pp). The species is widespread in several states that are a part of this axis, including Morelos, Mexico, Michoacán, Puebla, Oaxaca, Veracruz, Hidalgo, and Distrito Federal (Smith and Taylor 1966. *Herpetology of Mexico. Annotated Checklist and Keys to the Amphibians and Reptiles*. Eric Lundberg, Asthon, Maryland). Lizards of the genus *Barisia* have been poorly studied in aspects of their reproduction; however, there are data available for litter sizes among various subspecies of *B. imbricata*. For example, it has been reported that *B. imbricata imbricata* has a mean litter size of 6.9 (Guillette and Casas-Andreu 1987. *Herpetologica* 43:29–38), and there is a single report for a litter of 10 neonates (Navarro-López et al. 2003. *Bol. Soc. Herpetol. Mex.* 11:51–52). Other subspecies are recorded to have similar mean litter sizes: 6.9, *B. i. ciliaris*; 7.2, *B. i. jonesi*; 7.7, *B. i. planifrons* (Guillette and Casas-Andreu, *op. cit.*).

On 12 May 2009, during a field trip to El Pedregal, Municipality of Coyoacac, Mexico State, Mexico (19.24594°N, 99.45181°E; datum WGS84; elev. 2614 m), two gravid females were found in oak-pine forest with snout-vent lengths (SVL) of 132.4 mm and 123.0 mm, and body mass of 42.0 and 40.0 g, respectively. They were collected and housed in the laboratory in a terrarium. Two weeks later (May 26), the first female gave birth to 20 offspring (mean SVL = 32.8 mm [29.5–35.2 mm]; mean weight = 0.546 g [0.41–0.68 g]; mean tail length (TL) = 45.5 mm [38.0–50.7 mm] Fig. 1). The second female also gave birth to 20 offspring (May 31) (mean SVL = 33.4 mm [30.6–35.7 mm]; mean weight = 0.759



FIG. 1. Fifteen of 20 offspring from a single litter of *Barisia imbricata* from El Pedregal Municipality of Mexico State, Mexico.

g [0.65–0.87 g], mean TL = 45.7 mm [38.7–49.2 mm]). Offspring of the first female had a lower collective body mass than that of the combined offspring of the second female ($t = 11.7$, $P < 0001$), but the two litters were similar in SVL and TL ($P = 0.313$). These records for *B. imbricata* litter size suggest that variation exists in the reproductive characteristics among populations of this species.

We thank A. Leyte Manrique for logistical assistance, and Jackson Shedd for improving the manuscript. We also thank the projects CONACYT-S 52552-Q and FOMIX-CONACYT-43761.

Submitted by **CHRISTIAN BERRIOZABAL-ISLAS** (e-mail: bitiscaudalis@hotmail.com), **AURELIO RAMÍREZ-BAUTISTA** (e-mail: aurelior@uaeh.edu.mx), and **URIEL HERNÁNDEZ-SALINAS** (e-mail: uherndez3@gmail.com), Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A.P. 1-69 Plaza Juárez, C.P. 42001, Pachuca, Hidalgo, México.

BARISIA LEVICOLLIS (Chihuahuan Alligator Lizard). **REPRODUCTION.** *Barisia levicollis* is currently known only from the state of Chihuahua, Mexico where it is limited to the Sierra Madre Occidental at elevations of about 2500 m (Lemos Espinal and Smith 2007. Amphibians and Reptiles of the State of Chihuahua, Mexico. Universidad Nacional Autónoma de México, Comisión Para el Conocimiento y uso de la Biodiversidad, México, D.F. 613 pp.). The purpose of this note is to provide the first information on its reproduction.

One *B. levicollis* female (142 mm SVL) was examined from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California (LACM 75502). It was collected 14 September 1971 in Chihuahua, 17 km NE El Largo (29.6833°N, 108.4500°W, WGS84; elev. 2150 m).

A small slit was made in the lower part of the abdomen to expose the ovaries. A total of 13 vitellogenic eggs (5 mm diameter) were counted (*in situ*). This September evidence of ovarian activity indicates *B. levicollis* exhibits an autumn reproductive period similar to some New World anguils: *Barisia imbricata* (Guillette and Casas-Andreu 1987. Herpetologica 43:29–38), *Elgaria kingii* (as *Gerrhonotus kingi*) (Goldberg 1975. Southwest. Nat. 20:412–413), and *E. paucicarinata* (Goldberg and Beaman 2004. S. California Acad. Sci. 103:144–146).

I thank C. Thacker (LACM) for permission to examine *B. levicollis*.

Submitted by **STEPHEN R. GOLDBERG**, Department of Biology, Whittier College, Whittier, California 90608, USA; e-mail: sgoldberg@whittier.edu.

CALOTES ROUXI (Forest Dwarf Calotes). **CAPTIVE REPRODUCTION AND BREEDING BEHAVIOR.** On 5 May 2008, during one of our field studies in the forest belt of the village of Kanakumbe (15.6933333°N, 74.2166667°E; WGS84), Western Ghats in Karnataka State, India (2500 m elev.), *Calotes rouxi* were observed on tree trunks. Nuptial coloration was evident in males in that the head and nuchal area were brick red. Some females appeared gravid based on the bulge of their abdomens. We collected one male (SVL 7.34 cm; body mass 10 g) and one gravid female

(SVL 6.26 cm; body mass 8 g) and brought them to our laboratory and maintained them in an outdoor terrarium. All sides of the terrarium were made up of aluminum mesh except for the bottom, which had sand substratum of ~ 8 cm. The terrarium housed dry twigs that served as perches for the lizards and small herbs and grasses grew on the substratum. It also housed broken earthen pots and bricks that provided refugia for the lizards. The lizards were fed insects including grasshoppers and moths every other day. On 29 July 2008, 30 days after they were housed in the terrarium, the female appeared to have laid the eggs based on her flattened abdomen. Upon searching the substratum, we found five eggs. The eggs were about 3 cm deep in the nest. Apparently, the female had dug the nest in the soil, oviposited eggs, and then covered them with soil as we have observed in other agamid species including *Calotes versicolor*, *Psammophilus dorsalis*, and *Sitana ponticeriana*. These eggs were retrieved from the nest and incubated on moist sand substratum in a plastic box at ambient temperature following the procedure adopted for *C. versicolor* (Radder et al. 2002 Amphibia-Reptilia: 23:71–82). All eggs hatched on day 45 following oviposition. Mean snout–vent length (SVL) of these hatchlings was 23.3 ± 0.32 mm and mean body mass was 400 mg.

Interestingly, the day after oviposition, the adult male in the terrarium developed brick red nuptial coloration in the anterior part of the body including the head, began exhibiting courtship behavior composed of characteristic four-legged push-up and gular displays, and attempted to mate with the female, but was unsuccessful. The coloration disappeared soon after the male ceased courtship behavior. However, the next day, on 30 July 2008, the red nuptial coloration reappeared and a successful mating was observed between the pair. The male then lost his nuptial coloration again soon after the mating. Within a week of that mating, abdominal palpation revealed gravidity of the female. The female retained eggs for ~ 60 days and laid a second clutch of seven eggs on 2 September 2008 following heavy rainfall. All eggs hatched successfully after 44 days of incubation. The hatchling SVL measured 23.4 ± 0.13 mm and weight was 314.29 ± 14.29 mg.

This study is the first report on breeding behavior and reproduction in this species. The fact that the same female laid more eggs in the second clutch suggests that the food (insects) provided was adequate and met the energy requirements for reproduction under captive conditions. We have been successful in rearing and breeding captive born *Calotes versicolor* in the outdoor terraria for the last 6–7 years. The present study demonstrates that outdoor terraria meant for captive breeding of *C. versicolor* was equally congenial for breeding of wild caught *C. rouxi* as well.

This work was supported by UGC-SAP II (DRS) Program of University Grants Commission, New Delhi.

Submitted by **BHAGYASHRI A. SHANBHAG** (e-mail: Bhagyashrishanbhag@gmail.com), **VEENA H. F. AMMANNA** and **SRINIVAS K. SAIDAPUR**, Department of Zoology, Karnatak University, Dharwad- 580 003, India.

CNEMIDOPHORUS OCELLIFER (Spix's Whiptail). **USE OF SCORPIONS AS PREY IN AN UNSTABLE ENVIRONMENT.** Whiptail lizards (*Cnemidophorus*) are terrestrial, active-foraging teiids that consume primarily sedentary prey, such as termites and insect larvae (Vitt 1991. J. Herpetol. 25:79–90). *Cnemidophorus*

ocellifer exploits termites, orthopterans and spiders in the dry forests (Caatinga) of Northeastern Brazil (Vitt 1995. Occas. Pap. Oklahoma Mus. Nat. His. 1:1-29). We recorded a high frequency of predation on scorpions by this lizard on alluvial terraces of the lower São Francisco River, in Sergipe, Brazil (Caatinga Dominion).

Data were collected at the Monumento Natural Grota do Angico (9.662222°S, 37.669722°E; datum SAD-69), on the right bank of the São Francisco River, where alluvial terraces are formed by sand deposited during river floods, believed to occur naturally once a century (Dominguez and Brichta 1997. Estudos sedimentológicos a montante da UHE de Xingó. Sergipe: Cad. Arqueol. MAX). However, following the construction of the Xingó hydroelectric dam in 1994, 15 km upriver from the site, floodgates are opened every few years (most recently in 2003), flooding the terraces downriver and replenishing associated biota, but leaving sandy shores with sparse vegetation along the river bank.

Between October and November 2008, ten specimens of *C. ocellifer* were collected during the dry season. The examination of stomach contents revealed the presence of scorpions in seven lizards, ranging from one to three scorpions per stomach, as well as fragments. Coleoptans and orthopterans were recorded in four specimens, and spiders and ants in three. No termites were recorded. According to A.P.L. Giupponi (Museu Nacional, Rio de Janeiro, pers. comm.), at least two species of scorpions occur in the area, *Bothriurus rochai* and *Rhopalurus rochai*. It is relevant to note that *Cnemidophorus* are diurnal lizards, while scorpions are strictly nocturnal. This suggests that *C. ocellifer* may be targeting scorpion shelters during active foraging, possibly due to a scarcity of other resources in a poor and unstable environment, caused by frequent flooding and accentuated by the severe dry season at Caatinga, exhibiting considerable ecological flexibility.

We are grateful to Alessandro Ponce de Leão Giupponi for information on the scorpions of the Monumento Natural Grota do Angico and to Steve Ferrari for the careful revision of the manuscript.

Submitted by **SIDNEY FEITOSA GOUVEIA** (e-mail: sidneyfgouveia@superig.com.br), **FABÍOLA FONSECA ALMEIDA GOMES** (e-mail: bibiolagomes@gmail.com), **BRUNO DUARTE DA SILVA** (e-mail: makebio@gmail.com), **RENATO GOMES FARIA** (e-mail: renatogfaria@gmail.com); **CRIZANTO BRITO DE CARVALHO** (e-mail: pererekbio@yahoo.com.br), Núcleo de Pós-Graduação em Ecologia e Conservação- NPEC, Universidade Federal de Sergipe, São Cristóvão, Sergipe, Brazil.

COPHOSAURUS TEXANUS (Greater Earless Lizard). **MORTALITY.** *Cophosaurus texanus* is distributed from southern portions of Arizona, New Mexico, and Texas and south from northeastern Sonora and Chihuahua to northern San Luis Potosí and western Tamaulipas, Mexico (Conant and Collins 1998. Reptiles and Amphibians of Eastern/Central North America. 3rd ed., Houghton Mifflin Co., Boston, Massachusetts 450 pp.; Lemos Espinal and Smith 2007. Anfíbios y Reptiles del Estado de Coahuila, México. CONABIO. México. 550 pp.). *Cophosaurus texanus* is known to prey on at least 12 different arthropod taxa (Maury 1995. J. Herpetol. 29:266–272; Kasson 2001. Herpetol. Rev. 32:40). Saurophagy has been reported (Castañeda et al. 2005.



FIG. 1. Partial carcass of an adult *Cophosaurus texanus* found in Nuevo Leon, Mexico. Cause of death appears attributable to ingestion of a red rubber balloon, remains of which are clearly visible within the decomposing body.

Herpetol. Rev. 36:174).

On 8 February 2009, during an arachnid faunal survey at La Huasteca in the municipality of Santa Catarina in Nuevo Leon, Mexico, we encountered the trunk and limbs of a dead *C. texanus* (57 mm length, 17 mm width, 2.48 g) at 1330 h with a piece of red rubber balloon (49 mm length and 16 mm width) inside the decomposing body (Fig. 1), this material apparently being the cause of death. This locality is frequently visited by a large number of local tourists whose poor ecological and conservation practices result in a great amount of litter. The rubber balloon was apparently ingested by the lizard, but why and how remain a mystery.

A probable case of envenomation resulting in death of *C. texanus* caused by the ingestion of honeybees (*Apis mellifera*) has been documented (Mata-Silva et al. 2006. Herpetol. Rev. 37:464). Here we document for the first time the death of an adult *C. texanus* by an anthropogenic product and note the impact of litter on herpetofauna.

The lizard was collected, identified, measured, weighed, photographed, and deposited in the herpetological collection of the Facultad de Ciencias Biológicas/UANL (UANL 6997). We thank Pamela Gonzalez del Pliego Castañeda for use of the photograph.

Submitted by **JERÓNIMO A. CHÁVEZ CISNEROS**, **DAVID LAZCANO** (e-mail: dlazcanov@hotmail.com), and **M. ALEJANDRA SALINAS CAMARENA**, Universidad Autónoma de Nuevo León, Facultad de Ciencias Biológicas, Laboratorio de Herpetología, Apartado Postal - 513, San Nicolás de los Garza, Nuevo León, C.P. 66450, México.

CORYTOPHANES CRISTATUS (Smooth Helmeted Iguana). **ENDOPARASITES.** *Corytophanes cristatus* is known from lowland and premontane areas of central Veracruz and the Yucatán Peninsula, Mexico south to northwestern Colombia; it is strictly arboreal (Savage 2002. The Amphibians and Reptiles of Costa Rica. A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.).

To our knowledge, there is one report of helminths; Bursey et al. (2007. Comp. Parasitol. 74:108–140) reported *Cyrtosomum longicaudatum* and *Macdonaldius grassii* in specimens of *C. cristatus* collected in Panama. The purpose of this note is to add to the helminth list of *C. cristatus*.

Four *C. cristatus* (SVL = 97.5 mm ± 8.3 SD, range = 89–106 mm) were borrowed from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California and examined for helminths (LACM 131039–131042 collected August 1979, in Costa Rica, Limón Province ca. 46 km W Tortuguero, 10.4166°N, 83.6000°W, WGS84; elev. 25 m). The body cavity was opened by a longitudinal incision and the digestive tract was removed, and the stomach and intestines were opened and examined using a dissecting microscope. Only nematodes were present. These were placed on microscope slides, cleared in glycerol, coverslipped, and studied under a compound microscope.

Found in LACM 131040 (large intestine) were 220 *Cyrtosomum longicaudatum* (prevalence = number infected lizards/number lizards examined = 25%) and 199 *Cyrtosomum mega* (prevalence = 25%); LACM 131042 (large intestine) contained 128 *Africana telfordi* (prevalence = 25%). Voucher endoparasites were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as *Cyrtosomum longicaudatum* (USNPC 102114), *Cyrtosomum mega* (USNPC 102115) and *Africana telfordi* (USNPC 102116).

Cyrtosomum longicaudatum was described from *Ctenosaura similis* collected in Costa Rica by Brenes and Bravo Hollis (1960. Libro Homenaje al Dr. Eduardo Caballero y Caballero. Universidad Autónoma de México, México City, pp. 451–464) and is frequently reported from Central American lizards; a host list will be found in Bursey et al. (*op. cit.*). *Cyrtosomum mega* was described from *Cyclura carinata* from the Caicos Islands, West Indies by Bowie and Franz (1974. J. Parasitol. 60:628–631). *Corytophanes cristatus* is the second host reported to harbor this nematode. *Africana telfordi* was described from *Enyalioides heterolepsis* from Panama by Bursey and Goldberg (2002. J. Parasitol. 88:926–928). It was also reported in *Gonatodes albogularis* from Panama by Bursey et al. (*op. cit.*). *Corytophanes cristatus* is the third known host to harbor this nematode.

Species of *Africana* and *Cyrtosomum* are nematodes that do not utilize an intermediate host (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission, 2nd ed. CABI Publishing, Wallingford, UK. 650 pp.). Infection likely occurs by ingestion of eggs from contaminated substrate. Pearce and Tanner (1973. Great Basin Nat. 33:1–18) considered species of *Cyrtosomum* to be commensals that feed on fecal matter in the large intestine rather than parasites. *Corytophanes cristatus* represents a new host record for *Africana telfordi* and *Cyrtosomum mega*. Costa Rica is a new locality record for both species.

We thank C. Thacker (LACM) for permission to examine specimens and C. Nava (Whittier College) for assistance with dissections.

Submitted by **STEPHEN R. GOLDBERG**, Department of Biology, Whittier College, Whittier, California 90608, USA (e-mail: sgoldberg@whittier.edu); and **CHARLES R. BURSEY**, Department of Biology, Pennsylvania State University, Shenango Campus, Sharon, Pennsylvania 16146, USA (e-mail: cxb@psu.edu).

CTENOTUS REGIUS (Regal Striped Skink). **PREDATION.** The largest group of lizards in Australia belong to the genus *Ctenotus*, which contains close to 100 species. The species in this genus occur throughout much of Australia, particularly in arid and semi-arid regions (Cogger 2000. Reptiles and Amphibians of Australia, 6th ed. Reed New Holland, Sydney, 808 pp.). The ecology of many of these species remains poorly known, including predators and description of predation events. Here we present an observation of an immature Grey Butcherbird (*Cracticus torquatus*) preying on *Ctenotus regius*.

At 1230 h on 13 April 2009, south of Lake Becking, Murray-Sunset National Park (Victoria, Australia) (35.0380°S, 141.7138°E), in degraded *Allocasuarina/Callitris* woodland on red sands, bordering mallee country, a Grey Butcherbird flew from a mallee *Eucalyptus* ~25 m to the ground beneath another mallee. The butcherbird stayed on the ground for ~10 seconds where it became obvious that it had captured a skink, later identified as *Ctenotus regius*. The butcherbird then flew to the lower branch of a dead *Callitris* with the *C. regius* in its bill. It proceeded to hop up the branches and wedged the skink in the fork of the frayed hollow spout of the tree and began tearing at the skink. This method is commonly used by butcherbirds for handling larger prey items and for caching (Higgins et al. [ed] 2006. Handbook of Australian, New Zealand and Antarctic Birds Vol. 7 Boatbill to Starlings. Oxford Univ. Press, Melbourne. 1992 pp.). Upon our approach to photograph and identify the skink, the butcherbird hurriedly tore off the rear half of the skink and flew off (Fig. 1).

Grey Butcherbirds prey on invertebrates, mainly insects, and small vertebrates, especially small birds and their nestlings (Higgins et al. 2006, *op. cit.*). Grey Butcherbirds are known to take skinks (e.g., Barker and Vestjens 1991. The Food of Australian Birds 2. Passerines. CSIRO, Canberra, 557 pp.; Davis and Recher 1998. West. Aust. Nat. 22:135–136; Lea and Gray 1935. Emu 35:335–347; Rose 1999. Aust. Bird Watcher 18:164–178) but the identity of the skink species are rarely recorded. No *Ctenotus* species have been recorded in the diet of Grey Butcherbirds nor other *Cracticus* species, including the widespread and well-studied Australian Magpie (*C. tibicen*) (Higgins et al. *op. cit.*).

Ctenotus regius occurs in Australia's semi-arid interior in woodlands and shrublands on heavy to sandy reddish soils in association with spinifex (Swan and Watharow 2005. Snakes, Lizards and Frogs of the Victorian Mallee. CSIRO Publishing, Collingwood. 104 pp.; Wilson and Swan 2008. A Complete Guide to Reptiles in Australia 2nd ed., New Holland, Sydney. 512 pp.) and overlaps with the range of Grey Butcherbirds throughout much of its distribution. *Ctenotus regius* and other *Ctenotus* species occurring in this range (e.g., Coventry 1996. Proc. Roy. Soc. Victoria 108:107–119) are likely to be prey for this and other *Cracticus* species.

Aumann (2001. Wildl. Res. 28:379–393 and supplementary appendices) found that a number of diurnal raptor species took a small number of *Ctenotus* species in arid central Australia. However, Pianka (1969. Ecology 50:1012–1030) believed it “doubtful” that many *Ctenotus* in the Great Victoria Desert species fall prey to birds or mammals due to the unlikelihood that these predators would pursue the skinks into dense *Triodia* tussocks. Pianka (1969, *op. cit.*) found the main predators of *Ctenotus* in that region to be *Varanus* monitors and elapid snakes. Read (1998. Aust. J. Zool. 46:617–629) suggested that larger *Ctenotus* such as *C. regius*



FIG. 1. A Regal Striped Skink (*Ctenotus regius*) wedged in the fork of a tree and dismembered by a Grey Butcherbird (*Cracticus torquatus*) in Murray-Sunset National Park, Australia.

conserve energy by remaining inactive on many days, regardless of food availability or temperature and thereby may decrease their risk of predation. Henle (1989. *Acta Oecologica Oecologia Generalis* 10:19–35) considered that it is likely that predation generally plays an important role in segregating lizard communities, including those containing *C. regius*, but does not describe the types of predators.

The apparent preference for more open woodlands by *C. regius* in northwest Victoria (Coventry 1996. *Victorian Nat.* 113:289–299) and their habit of actively foraging around ground vegetation (Swan and Watharow 2005, *op. cit.*) may make this species more susceptible to predation by birds than others in the genus.

Thanks to Andrew Bennett and Dale Nimmo for identification of the skink.

Submitted by **JAMES A. FITZSIMONS**, School of Life and Environmental Sciences, Deakin University, 221 Burwood Highway, Burwood, Victoria 3125, Australia & The Nature Conservancy, Suite 3-04, 60 Leicester Street, Carlton, Victoria 3053, Australia (e-mail: james.fitzsimons@deakin.edu.au); and **JANELLE L. THOMAS**, Birds Australia, Suite 2-05, 60 Leicester Street, Carlton, Victoria 3053, Australia (e-mail: j.thomas@birdsaustralia.com.au).

CYCLURA CYCHLURA INORNATA (Allen Cays Rock Iguana). **PARAPHIMOSIS AND PROLAPSED CLOACA.** In reptiles, several problems can arise involving the cloaca and the prolapse of different organs (e.g., colon, oviducts, hemipenes, etc.; see Bennett and Mader 2006. *In* Mader [ed.], *Reptile Medicine and Surgery*, pp.

751–755. Elsevier/Saunders, St. Louis, Missouri; Barten 2006. *In* Mader [ed.], *op. cit.*, pp. 862–864; DeNardo 2006. *In* Mader [ed.], *op. cit.*, pp. 376–390). Published observations of cloacal prolapse in natural populations of reptiles are relatively rare (see Pernetta and Reading 2009. *Herpetol. Rev.* 40:95). Here we report two observations of prolapse from the cloaca in the Allen Cays Rock Iguana (*Cyclura cyclura inornata*) from Leaf Cay and Southwest Allen Cay in the Bahamas (24.75°N, 76.83°W; see Iverson et al., 2004: *Herpetol. Monogr.* 18:1–36 for a detailed description of the study area).

On 9 May 2001, we observed an adult male (snout–vent length, SVL = 35.0 cm, SVL) on Leaf Cay with a prolapsed right hemipenis that was hard and shriveled. This male was subsequently captured in 2002, 2003, and 2004 with no obvious health problems, and no evidence of the prolapsed hemipenis. He was not subsequently captured between 2005 and 2009, but may have been poached or died of other causes. Prolapsed hemipenes typically arise from damage to the hemipenis during copulation (Barten 2006, *op. cit.*; DeNardo 2006, *op. cit.*).

On 29 March 2008 we observed a large female (SVL = 32.0 cm, SVL) with a prolapsed cloaca on Southwest Allen Cay (Fig. 1). This female was found to have an elevated corticosteroid level (30.6 ng mL⁻¹) compared to others in the population (mean = 5.9 ng mL⁻¹) as determined by blood tests conducted on samples collected within three minutes of capture to avoid increased glucocorticoid concentrations (see Romero and Wikelski 2002. *Biol. Conserv.* 108:371–374). She was subsequently found dead less than two months later on 14 May 2008. Cloacal prolapse can occur due to straining during oviposition or straining during defecation due to constipation or other causes (Bennett and Mader 2006, *op. cit.*). Of particular concern for the Allen Cays Rock Iguana is the potential increase in strained defecation due to the feeding of iguanas by tourists. Diets high in grapes, the most commonly provided food item, result in sand and liquid-filled scat that dries to a cement-like consistency (Fig. 2; see also Hines 2007. *Iguana* 14:243). The density of these cement-like scats is greater than those formed from a natural diet of leaves and fruits, potentially increasing the incidence of constipation and tenesmus, and thereby cloacal prolapse. The death of this female suggests that cloacal prolapse may result in



FIG. 1. Prolapsed cloaca of a female Allen Cays Rock Iguana found on Southwest Allen Cay, Exumas, Bahamas in March 2008.

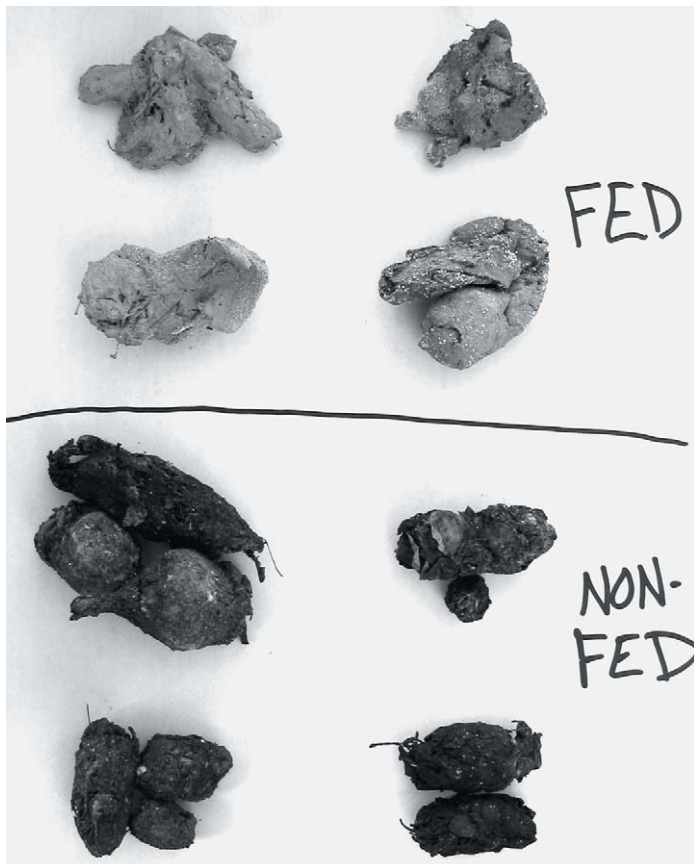


FIG. 2. Comparison of scat samples from the tourist feeding beach (top) versus non-visited areas (bottom) of Leaf Cay, Exumas, Bahamas.

death, or alternatively, may be a sign of another health issue that may result in death.

Submitted by **KIRSTEN N. HINES**, The Institute for Regional Conservation, 22601 SW 152 Ave, Miami, Florida 33170, USA (e-mail: kirsten.n.hines@gmail.com); **CHARLES R. KNAPP**, Conservation Department, John G. Shedd Aquarium, Chicago, Illinois 60605, USA (e-mail: cknapp@ufl.edu); **TREVOR T. ZACHARIAH**, Chicago Zoological and Aquatic Animal Residency Program, College of Veterinary Medicine, University of Illinois, Urbana, Illinois 61802, USA (e-mail: zachariahdv@ufl.edu); **JOHN B. IVERSON**, Department of Biology, Earlham College, Richmond, Indiana 47374, USA (e-mail: johni@earlham.edu); **GEOFFREY R. SMITH**, Department of Biology, Denison University, Granville, Ohio 43023, USA (e-mail: smithg@denison.edu).

DELMA IMPAR (Striped Legless Lizard) **REPEATED USE OF COMMUNAL NESTING SITE**. Communal nesting is a reproductive trait commonly observed in some groups of reptiles (Graves and Duvall 1995. *Herpetol. Monogr.* 9:102–119). The benefits of communal nesting may include a response to the limited availability of suitable nest sites in the environment due to thermal, hydric and anti-predator constraints, or fitness benefits for offspring born in a cluster of eggs (Radder and Shine 2007. *J. Anim. Ecol.* 76:881–887). The trait has been identified in some species of pygopodids, a family of flap-footed snake and worm-like lizards confined to

the Australian region (Greer 1989. *The Biology and Evolution of Australian Lizards*. Surrey Beatty & Sons Pty Limited, Chipping Norton, N.S.W. 264 pp.). This family includes the Striped Legless Lizard, *Delma impar*, with females known to lay a single clutch of up to two eggs annually in early summer. Communal nesting has so far been reported three times in this species; once with four eggs and twice with six eggs clumped together in substrate cavities or under rocks, inferring the joint use of a nesting site by at least two and three female *D. impar*, respectively (Banks et al. 1999. *Herpetofauna* 29:18–30; Coulson 1995. *Management Directions for the Striped Legless Lizard (Delma impar) in the Australian National Territory*. ACT Parks & Conservation Service, Canberra, ACT; Mills 1992. *Report of Delma impar trapping survey conducted at Werribee, Jan–Feb 1992*. Unpubl. report to the Striped Legless Lizard Working Group, Victoria). Further information on this aspect of the species' reproductive biology is important for its management and conservation, as *D. impar* is listed as threatened under state, national, and international legislations (Smith and Robertson 1999. *National Recovery Plan for the Striped Legless Lizard (Delma impar): 1999–2003*. Environment Australia, Canberra) and general knowledge of its biology is sparse.

As part of an intensive survey program for this species in Western Victoria, southeastern Australia, we report the repeated use of an artificial, communal nesting site exceeding the aggregations reported previously and discuss environmental parameters associated with the site. In 2000, four survey grids were established in native grassland on a private property near Hamilton in Western Victoria with the aim of determining the presence of *D. impar*. Each survey grid consisted of fifty roof tiles arranged in a 20 × 45m grid formation. Grids were monitored first annually, and since 2005, quarterly, with the presence of all terrestrial vertebrate fauna within the grids recorded. On 9 December 2007 we captured two female *D. impar* (90 and 93 mm SVL) that appeared to be gravid and also noted the presence of six *D. impar* eggs deposited in a prominent soil crack underneath a single tile on grid #1 (37.5016°S, 142.3314°E). We released the gravid females within an hour underneath the same tile and returned on 20 April 2008 and retrieved, with minimum disturbance to the crack, a total of 32 egg shells. This finding infers a communal nesting site with contribution of at least 16 female *D. impar*. On 30 November 2008 we attached a temperature data logger (Thermochron iButton®, Dallas Semiconductor) programmed to collect temperature ($\pm 0.5^\circ\text{C}$) every hour until 31 January 2009 beneath the above roof tile with the data logger situated just above the soil crack. On 5 January we returned and briefly lifted the tile and confirmed the presence of at least six *D. impar* eggs. On 27 March 2009 we collected a total of 16 egg shells from the soil crack, again with minimal disturbance. This inferred that the same nesting site had been used again by at least eight females. Data logger records showed that temperatures underneath the roof tile between 1 December 2008 and 31 January 2009 had ranged from 3°C to 72°C (mean = 23.6°C, SD = 15.52).

The site on which the four grids were established is one of a few remaining large, high-value natural temperate grassland remnants on the Victorian Volcanic Plain. The site consists of mostly intact native grassland vegetation and soil crust with submerged volcanic rocks along the slopes of a creek gully. The conservation status of *D. impar* is increasingly being linked to the survival of such remnant habitats so that the presence of a large number of gravid *D.*

impar at this site may not be surprising and treated as an indication of the ecological value of the habitat. In the greater context of the project, this is the only communal nesting site discovered so far underneath roof tiles across 73 survey grids where *D. impar* has been detected (3650 roof tiles lifted approximately 43,800 times). The low success rate in finding such sites and the repeated use of a single communal nesting site by a large number of gravid females suggest that the species is very selective in choosing oviposition sites. It may be possible that aggregating eggs may protect them from desiccation in extreme weather conditions, like the temperature extremes displayed by our thermal data, or provide a selective fitness advantage to the offspring. More than 90% of egg shells recovered indicated successful hatching so the former may be plausible. Alternatively, suitable soil cracks or cavities with protection from predators and environmental extremes may be a limited resource (and the roof tile may have added a favorable element to produce a suitable oviposition site). Grid #1 was located on a small flood plain at the bottom of the gully with a deep layer of clay soil that cracked in summer, as opposed to shallow sandy clay horizon on the slopes. Further work to identify the oviposition preferences of the species will aid in the preparation of informed management and conservation strategies for *D. impar* in the wild.

This research was funded by the Australian Commonwealth Government via the Corangamite, Glenelg Hopkins and Wimmera Catchment Management Authorities and conducted under the Victorian Department of Sustainability and Environment (Australia) Research Permits 10002996, 10003505, and 10004675.

Submitted by **GARRY N.L. PETERSON**, Department of Sustainability and Environment, 78 Henna Street, Warrnambool 3280, Victoria, Australia (e-mail: Gary.Peterson@dse.vic.gov.au); and **DETLEF H. ROHR**, Applied Ecological Research P/L, PO Box 350, Doncaster East 3109, Victoria, Australia (e-mail: ted.rohr@aerresearch.com.au).

GERRHONOTUS PARVUS (Pygmy Alligator Lizard). **JUVENILE SIZE.** *Gerrhonotus parvus*, an anguid endemic to Nuevo León, Mexico, is known from only adult specimens (Knight and Scudday 1985. *Southwest. Nat.* 30:89–94; Banda-Leal et al. 2002. *Southwest. Nat.* 47:614–615; Banda et al. 2005. *Herpetol. Rev.* 36:449). Although one adult female maintained in captivity reportedly laid four eggs (Knight and Scudday, *op. cit.*), nothing has been reported on the size of the young of this species. Here, we report on the size of a juvenile *G. parvus* found in the wild.

On 1 October 2005, we found a juvenile *G. parvus* under a small rock in a canyon bottom near San Isidro, Municipio Santiago, Nuevo León. The canyon (ca. 1600 m elev.) runs east to west and is characterized by steep limestone walls covered with various agaves (*Agave* spp.), sotol (*Dasyllirion* sp.), and scrub oak (*Quercus* sp.), and has intermittent pools of water, piles of leaf litter, and large rocks scattered throughout. The *G. parvus* measured 25.1 mm SVL, had an unbroken tail 28.5 mm in length, and a mass of 0.4 g. Previous reports of juvenile size in the small-bodied and closely related alligator lizard *Gerrhonotus lugoi* ranged from 37–55 mm SVL (Lazcano et al. 1993. *Bull. Chicago Herpetol. Soc.* 28:263–265), making the specimen of *G. parvus* reported herein one of the smallest known gerrhonotine lizards in North America.

The specimen was deposited in the Universidad Autónoma de Nuevo León Herpetological Collection (UANL 6785). Research and collecting were conducted under the authority of SEMARNAT scientific research permits OFICIO NÚM/SGPA/DGVS/01612 and 01454 issued to DL.

Submitted by **DAVID LAZCANO**, Universidad Autónoma de Nuevo León, Facultad de Ciencias Biológicas, Laboratorio de Herpetología, Apartado Postal - 513, San Nicolás de los Garza, Nuevo León, C.P. 66450, México (e-mail: dlazcanov@hotmail.com); and **ROBERT W. BRYSON, JR.**, School of Life Sciences, University of Nevada, Las Vegas, 4505 Maryland Parkway, Las Vegas, Nevada 89154-4004, USA (e-mail: brysonjr@unlv.nevada.edu).

IGUANA DELICATISSIMA (Lesser Antillean Iguana). **DISPLAY BEHAVIOR.** Iguanine lizards typically use headbob displays consisting of ritualized up-and-down motions. Forms of these displays often are referred to as “signature” displays because the number and timing of motions carry information about the individual, sex, and species identity of the displaying animal. Headbob displays serve primarily in territorial maintenance, frequently are directed toward individuals at a distance, often are used in aggressive displays (most commonly by males), and occasionally by males during courtship (Martins and Lacy 2004. *In* Alberts et al. [eds.], *Iguanas: Biology and Conservation*, pp. 101–108. Univ. California Press, Berkeley, and references therein). Although signature displays have been described for many iguane lizards, we present here observations of such displays in *Iguana delicatissima*.

From 5–25 June 2008, in the course of a study examining movements and allocations of time and space in a community of *I. delicatissima* at the Sunset Bay Club on Dominica, Lesser Antilles (15.4514°N, 61.4465°W; elev. ~5 m), we observed dozens of displays and videotaped six displays by males and two by females with a Sony digital video camera recorder (model DCR-TRV120).

Headbob displays were used by both males and females. Those of males were of slightly higher amplitudes than those of females and were more likely to be repeated (especially when directed toward other males). Each display consisted of two to five headbobs of decreasing amplitude, with most (six of eight videotaped displays, five by males; 16 of 18, 12 by males; and two by individuals of unknown sex, for which data were recorded) involving four sequential bobs.

The first bob was inevitably of highest amplitude (position 2 in Fig. 1), after which the head returned to the initial position (1). Headbobs 2 and 3 (positions 3 and 5, respectively) were of lower amplitude and were followed by the head dropping to below the starting point (positions 4 and 6). The final headbob was little more than a “jiggle,” after which the head returned to the initial position.

Marcella & Roger Dutrieux Cools, owners of the Sunset Bay Club, work diligently to coexist with Dominica’s wildlife and were very tolerant of our antics. Mr. Arlington James, Forest Officer, Forestry, Wildlife, and Parks Division, Ministry of Agriculture & the Environment, Commonwealth of Dominica, was instrumental in issuing permits to conduct research in Dominica. Protocols were approved by the Avila University Animal Care and Use Committee. Fieldwork was funded by a grant from the National Science Foundation (USA) to RP (DBI-0242589).

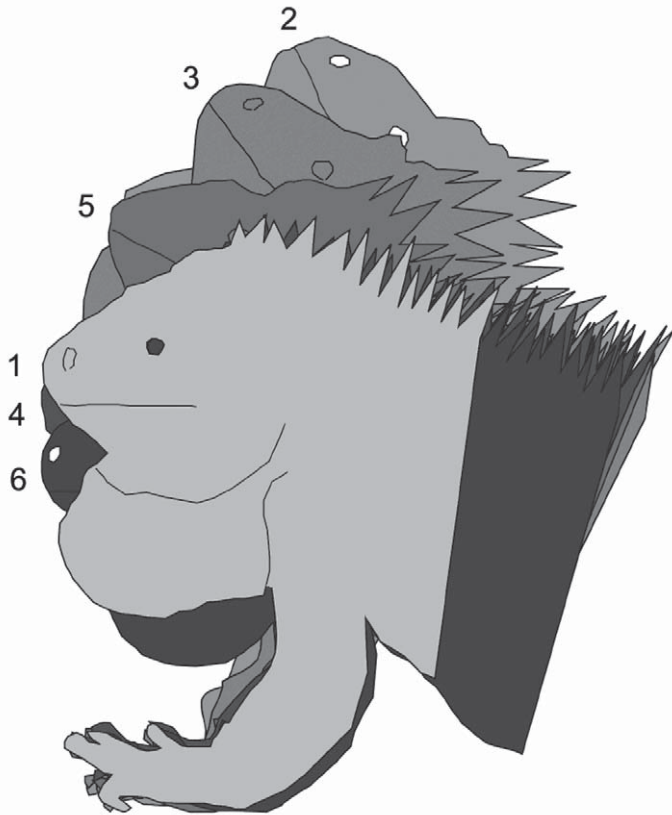


FIG. 1. Signature display in *Iguana delicatissima* drawn by PAT from a videotaped display by an adult male. See text for description of the display.

Submitted by **PATRICK A. TURK**, Department of Biology, Avila University, Kansas City, Missouri 64145, USA (e-mail: turk95917@avila.edu); **NATALIE N. WYSZYNSKI**, Department of Psychology, University of Tennessee, Knoxville, Tennessee 37996, USA (e-mail: nwyszyns@utk.edu); and **ROBERT POWELL**, Department of Biology, Avila University, Kansas City, Missouri 64145, USA (e-mail: robert.powell@avila.edu).

LEPIDOBLEPHARIS XANTHOSTIGMA (Orange-tailed Gecko). **PREDATION.** Many species of gekkonid lizards have been reported as prey of various vertebrates, such as mammals (Daugherty et al. 1994. *New Zealand J. Zool.* 21:317–323; Gardner 1977. *In* Baker et al. [eds.], *Biology of Bats of the New World Family Phyllostomatidae, Part II. Spec. Pub., Mus. Texas Tech Univ.*), birds (McKeown 1983. *In* 6th Annual Reptile Symposium on Captive Propagation and Husbandry. Zoological Consortium, Thurmont, Maryland), snakes (Bernarde et al. 2000. *Rev. Brasil. Biol.* 60:695–699; Downes and Shine 1997. *Anim. Behav.* 55:1373–1385), and lizards, including large geckos (Bauer 1990. *Herpetol. Rev.* 21:83–87). Invertebrate predators of geckos have also been reported, including arachnids, centipedes, mantids and ants (Bauer 1990, *op. cit.*; Henle 1990. *Herpetol. Monog.* 4:30–60; Henle 1993. *J. Arachnol.* 21:153–155; Punzo 1993. *Psyche* 100:151–162). Vitt et al. (2005. *Herpetol. Monog.* 19:137–152) reported a high rate of tail-loss in *Lepidoblepharis xanthostigma* and commented on the interest in obtaining information on their

interactions with invertebrate predators; however, no predators have previously been reported for the species.

This note reports a single observation of an arthropod attack on *L. xanthostigma* on Isla Palma, Department of Valle del Cauca, approx. 1.5 km off the Pacific coast of Colombia (3.90019°N, 77.35597°W, WGS84). The island is in the tropical rain forest life zone (Holdridge 1987. *Life Zone Ecology*. Tropical Science Center, San Jose, Costa Rica) and has average annual precipitation of 6000 mm and 90% relative humidity—the predominant height of forest trees is between 10 and 50 m, with many shrubs and ferns in the understory (Castellanos 2003. *Interacciones Tróficas y Espaciales de un Ensamblaje de Peces de Charcos Intermareales en un Acanalado Rocoso Tropical, Bahía Malaga-Pacífico Colombiano*. Universidad del Valle, undergraduate thesis. Cali, Colombia, 88 pp.; Montoya 2003. *Estructura de la Comunidad de Gasterópodos: Diversidad, Distribución y Abundancia con Relación a la Heterogeneidad Espacial en dos Acanalados Rocosos Intermareales de Isla Palma, Pacífico Colombiano*. Universidad del Valle, undergraduate thesis. Cali, Colombia, 82 pp.). We made the observations during a light rain along the crude trail to Punta Brava near the southeastern corner of the island on 29 June 2007 at 2045 h. A spider was captured on the ground in the leaf litter with a *Lepidoblepharis xanthostigma* in the grasp of its chelicerae. Injuries on the gecko's body indicate the spider had likely attacked the gecko in at least two places. One pair of wounds involved the dorsal, occipital region of the head and dorsum of the torso behind the forelimb on the left side of the body, and a separate area with broken skin at the base of the tail, which was missing. As the spider was lifted from the ground it released the gecko, the spider was then dropped, and both ran into the leaf litter where they were recaptured. The gecko was an adult male (SVL 24.1 mm) and the spider was an unidentified species of brushed trapdoor spider (Barychelidae) of the genus *Trichopelma* (cephalothorax length 29 mm), locally known as “chicken-eating tarantula.” The gecko specimen was deposited in the collections of the Museo de Ciencias Naturales “Federico Lehman” in Cali, Colombia (IMCN-Rep 197).

We are indebted to the Dirección General Marítima (DIMAR) for allowing us access to the island, to the Grupo de Ecología Animal of the Universidad del Valle for its assistance in the fieldwork, Carlos Valderrama for help with identification of the spider, and Eli Greenbaum for comments on the manuscript.

Submitted by **ANDRÉS QUINTERO-ANGEL**, Grupo de Investigación en Ecología Animal, Departamento de Biología, Universidad del Valle, Cali, Colombia (e-mail: aquinteroa@gmail.com); and **JOHN L. CARR**, Department of Biology and Museum of Natural History, University of Louisiana at Monroe, Monroe, Louisiana 71209-0520, USA (e-mail: carr@ulm.edu).

LIOLAEMUS GRACILIS (Striped Slender Lizard). **PREDATION.** *Liolaemus gracilis* occurs from northern Chubut to southern La Rioja provinces, in western Argentina (Ceï 1986. *Reptiles del Centro, Centro-Oeste y Sur de la Argentina*, Mus. Reg. Sci. Nat. Torino, Mon. 4:1–527). Only a few data are available on its biology (e.g., Vega and Bellagamba 2005. *Cuad. Herpetol.* 18:3–13) and no data regarding its predators have been published. Hence, here we report an observation of *Philodryas psammophidea* predation on *L. gracilis*.

Philodryas psammophidea is a common snake in the Monte and Chaco arid and semiarid regions of western and northwestern Argentina and has been reported as a lizard-eater in general citations (Ceï 1993. Reptiles del Noroeste, Nordeste y Este de la Argentina. Mus. Reg. Sci. Nat. Torino, Mon. 14:1–949). At 1030 h on 19 October 2008 during a collecting trip through western San Luis province a DOR juvenile *P. psammophidea* (sex undetermined, 490 mm SVL, 555.0 mm TL, 28 g) was found on Provincial Road 3, 43.7 km S of San Luis City, La Capital Department, San Luis province (33.6171°S, 66.4139°W, datum = WGS 84, 515 m elev.). As we were preserving the specimen, we extracted from its stomach an adult *Liolaemus gracilis* (47.0 mm SVL, 134.0 mm TL, 1.8 g). The lizard's body was nearly completely intact, with only its tail autotomized near the base and its head possessing a severe wound, probably inflicted when the snake caught it. The specimens of *L. gracilis* (LJAMM 10937) and *P. psammophidea* (LJAMM 10935) were deposited in the herpetological collection at Luciano Javier Avila Mariana Morando (LJAMM) of the Centro Nacional Patagónico – CONICET, Puerto Madryn, Argentina.

Submitted by **MONICALILIAN KOZYKARISKI, NATALIA FELTRIN**, and **LUCIANO JAVIER AVILA**, CENPAT-CONICET, Boulevard Almirante Brown 2915, U9120ACF, Puerto Madryn, Chubut, Argentina (e-mail: avila@cenpat.edu.ar).

LIOLAEMUS HATCHERI (NCN). MULTIPLE MORTALITY.

Liolaemus hatcheri is a small liolaemid lizard endemic to a small region in northwestern Santa Cruz Province, northern Patagonian, Argentina (Etheridge 1998. Cuad. Herpetol. 12:31–36). Only anecdotal data are known about its biology and natural history (Ceï 1986. Reptiles del Centro, Centro-oeste y Sur de la Argentina. Mus. Sci. Nat. Torino Mon. 4:1–427). During field work carried out on 18 January, 2008 in Estancia Cerro Beltza (47.9937°S, 71.6804°W; datum: WGS84; elev. 912 m), Rio Chico Department, Santa Cruz Province, we found a population of *L. hatcheri* inhabiting a gently sloping area with highly degraded vegetation overgrazed by sheep. Lizards were found basking on medium-sized rocks scattered in the area and typically retreated to nearby rock crevices or burrows upon disturbance. Upon lifting a roughly oval-shaped, medium-sized rock (70 × 25 × 40 cm; ~30 kg) that overlaid a larger, imbedded rock, and thus provided a crevice between the two, we found three lizard carcasses that we identified by comparison with live individuals as adult specimens of *Liolaemus hatcheri* (~75 mm, SVL) (Fig. 1). This finding revealed that *L. hatcheri* use small crevices as communal shelters, but the cause of death is unclear. We hypothesize two potential causes: lizards use this refugia for temporary shelter during the normal season of activity and unusually low temperatures caused their demise inside the crevice, or the rock was moved by human or domestic livestock activity in the area and the lizards were crushed underneath. Findings on multiple deaths of *Liolaemus* in Patagonia are uncommon and formal reports are non-existent to our knowledge. Voucher specimens (LJAMM 7615–7617) are deposited in the Luciano Javier Avila Mariana Morando (LJAMM) collection housed in CENPAT-CONICET.

Submitted by **NATALIA FELTRIN, CRISTIAN HERNAN FULVIO PEREZ, MARIA FLORENCIA BREITMAN**, and **LUCIANO JAVIER AVILA**, CENPAT-CONICET, Boulevard



FIG. 1. Upper: general view of the site where the three lizards were found dead in the rock. Below: Detail of the three carcasses.

Almirante Brown 2825, U9120ACF, Puerto Madryn (Chubut), Argentina (e-mail: avila@cenpat.edu.ar)

LIOLAEMUS OLONGASTA (NCN). PREDATION.

Liolaemus olongasta is an oviparous and insectivorous, small-sized lizard inhabiting the arid landscape of Monte desert in western Argentina. Its geographic distribution ranges through central-west La Rioja to northern Mendoza provinces (Etheridge 1993. Boll. Mus. Reg. Sci. Nat. Torino 11:1–99; Sanabria et al. 2005. Herpetol. Rev. 36: 337). Only a few data are available on its biology (e.g., Canovas et al. 2006. Herpetol. Rev. 37:87–88) and no data about its predators have been published. Hence, here we report an observation of *Pseudotomodon trigonatus* predation on *L. olongasta*.

Pseudotomodon trigonatus is a rare snake, endemic to western Argentina, inhabiting mainly the Monte and southern Chaco regions and has been reported as a lizard-eater in general citations (Etheridge, *op. cit.*). At 1000 h on 19 October 2008 during a collecting trip through northern San Juan province we observed a juvenile female *L. olongasta* basking in an open area between bushes outside National Road 40, 6.5 km E Huaco River Bridge, in the road to Huaco, Jachal Department, San Juan province (30.3323°S, 68.6537°W, datum = WGS 84, 1096 m elev.). As we approached, the lizard ran away looking for refuge between the branches of a *Larrea cuneifolia* bush. When it reached the proximity of a small burrow between the branches, we observed the lizard's body writhing, as something appeared to be grabbing it from inside the burrow. We continued to observe this activity until only a hind limb and the tail remained outside the burrow. When we grabbed

the lizard something was still trying to pull it back into the burrow but finally we were able to pull the complete animal out with a large wound across its chest and belly. We dug into the burrow and found a *P. trigonatus* (SVL 240 mm, TL 278 mm, weigh 70 g) coiled within, which we collected after the snake attempted to flee. The specimens of *L. olongasta* (LJAMM 10699) and *P. trigonatus* (LJAMM 11087) were deposited in the herpetological collection Luciano Javier Avila Mariana Morando of the Centro Nacional Patagónico-CONICET, Puerto Madryn, Argentina.

Submitted by **MONICA LILIAN KOZYKARISKI NATALIA FELTRIN**, CENPAT-CONICET, Boulevard Almirante Brown 2915, U9120ACF, Puerto Madryn, Chubut, Argentina; **ARLEY CAMARGO**, Department of Biology, Brigham Young University, WIDB 177, Provo, Utah 84602, USA; and **LUCIANO JAVIER AVILA**, CENPAT-CONICET, Boulevard Almirante Brown 2825, U9120ACF, Puerto Madryn, Chubut, Argentina (e-mail: avila@cenpat.edu.ar).

LIOLAEMUS PETROPHILUS (NCN). **PREDATION.** Although birds are often acknowledged as feeding on lizards, direct observations of predation are relatively rare under natural conditions. *Liolaemus petrophilus* is a medium-sized lizard inhabiting the Patagonian steppe in association with rocky outcrop habitats in central Rio Negro and Chubut provinces, Argentina (Avila et al. 2006. Check List 2:66–69). Despite its abundance in its natural habitats, only recent information regarding its avian predators is available (Perez and Avila 2005. Herpetol. Rev. 36:451–452). On 13 January 2009 at ca. 1900 h, in the course of a herpetological survey carried out on the edge of a volcanic plateau, within a small valley known as Cañada La Leona (42.4084°S, 68.2615°W; datum: WGS84; elev. 1062 m), north of the town known as Gan Gan, Telsen Department, Chubut Province, CHFP observed the remains (tail with spinal axis) of a lizard *Liolaemus petrophilus* (SVL was estimated in 84 mm and a TL of 226 mm) below an American Kestrel (*Falco sparverius*) nest. The nest was on a small cliff and contained fledglings, with an adult also present. A few minutes following the initial observation, another adult kestrel arrived with an adult *L. petrophilus* in its talons. The lizard was approximately of the same size as the former dead specimen, suggesting that during summer the kestrel is an active predator of this lizard. *Falco sparverius* is widely distributed in Patagonia and is an active diurnal predator (Narosky and Yzurieta 2003. Guía para la Identificación de las Aves de Argentina y Uruguay. A.O. P., Vázquez Mazzini, Buenos Aires, Argentina. 346 pp.). It is a generalist predator known to eat lizards in summer (Figueroa Rojas and Corales Stappung 2004. Hornero 19:53–60). This is the first record of predation on *L. petrophilus* by *F. sparverius*.

Submitted by **CRISTIAN HERNAN FULVIO PEREZ, MONICA KOZYKARISKI**, and **LUCIANO JAVIER AVILA**, CENPAT-CONICET, Boulevard Almirante Brown 2915, U9120ACF, Puerto Madryn, Chubut, Argentina (e-mail: avila@cenpat.edu.ar).

MABUYA NIGROPUNCTATA (NCN). **PREDATION.** *Mabuya nigropunctata* occurs throughout Amazonian rain forest, living

along forest edges, open patches and on the margins of terra firme forest (Avila-Pires 1995. Lizards of Brazilian Amazonia. Zool. Verh. Leiden 299; Vitt et al. 1996. J. Trop. Ecol. 13:199–220). The species is heliothermic and is often observed basking (Avila-Pires 1995, *op. cit.*). Hoogmoed (1973. Biogeographica 4:1–419) reported a *M. nigropunctata* preyed upon by a pygmy-owl (*Glaucidium* sp.), and Cunha and Nascimento (1994. Bol. Mus. Paraense E. Goeldi 9:1–191) also encountered an individual in the stomach of the snake *Siphlophis cervinus*. Herein, we report an observation of Pearl Kite (*Gampsonyx swainsonii*) predation on *M. nigropunctata*.

On 27 April 2008 at ca. 1200 h, while conducting an ornithological survey as a part of the Environmental Impact Study of the Foz do Apicás Hydroelectric Power Plant in Mato Grosso State, Brazil, we collected an adult *G. swainsonii* with a pressure gun from a grassland area of Paranaíta, Mato Grosso (57.1092°W, 9.4155°S, datum: SAD69; elev. 701 m); dissection revealed a tail of one adult *M. nigropunctata* in the stomach. The grasslands are surrounded by rain forest dominated by Babaçu Palms (*Orbignya oleifera*).

Gampsonyx swainsonii, the smallest raptor in Brazil, inhabits open areas and forest edges (Antas 2005. Pantanal Guia de Aves: Espécies da Reserva Particular do Patrimônio Natural do SESC - Pantanal. Editora Serviço Social do Comércio, Rio de Janeiro-RJ, Brazil. 225 pp.). Previous studies of *G. swainsonii* diet report insects, birds, and unidentified lizards (Sick 2001. Ornitologia Brasileira. Editora Nova Fronteira. Rio de Janeiro, Brazil. 862 pp.).

The *G. swainsonii* specimen (JB 396 - collection license 10698-1/IBAMA) (length: 24.1 cm) and its stomach contents were deposited in Laboratório de Ornitologia, Campus of Cuiabá, Universidade Federal de Mato Grosso (UFMT).

We thank M. Hayes for valuable suggestions on the manuscript and we are grateful to Biodinâmica Engenharia e Meio Ambiente for logistical support.

Submitted by **JOÃO BATISTA DE PINHO** (pinho@cpd.ufmt.br), **MILENE GARBIM GAIOTTI** (enelim@gmail.com), **PAULA FERNANDA ALBONETTE DE NÓBREGA** (pnbio@yahoo.com.br), Laboratório de Ornitologia, Núcleo de Estudos Ecológicos do Pantanal, IB, Universidade Federal de Mato Grosso, Avenida Fernando Corrêa, s/n° Coxipó CEP 78060-900, Cuiabá, MT, Brazil.

MICRABLEPHARUS MAXIMILIANI (Blue-tailed Lizard). **PREDATION.** *Micrablepharus maximiliani* is a widely distributed heliothermic lizard, occurring from Brazilian Amazonia to Paraguay (Ávila - Pires 1995. Zool. Verh. Leid. 299:1–706; Peters and Donoso-Barros 1986. Bull. Uni. Stat. Nat. Mus. 297 pp.; Rodrigues 1990. Simp. Ecos. Cost. Sud. Bras. pp. 404–410; Vanzolini 1988. Proc. Work. Neotropical Distribution Patterns, pp. 317–342; Vanzolini et al. 1980. Acad. Bras. Ciên. 161 pp.). It occurs in coastal areas and the edges of forested areas where it can also be found in the isolated forest range (known locally as ‘Brejos de Altitude’) in the semi-arid Caatingas (Vanzolini 1974. Pap. Avul. Zool. 28[4]:61–90; Freire 1996. Rev. Bras. Zool. 13[4]:903–921; Rodrigues, *op. cit.*; Borges-Nojosa and Caramaschi 2003. Ecol. Cons. Caat. V. 01, pp. 489–540). It is commonly observed in leaf

litter, herbaceous vegetation and can be found in association with eusocial insects like termites and ants (Vitt 1991. *J. Herpetol.* 25:79–90; Mesquita et al. 2006. *Copeia* 2006(3):460–471; Sousa and Freire, *in press*, *S. Amer. J. Herpetol.*). Theraphosid spiders are part of the infraorder Mygalomorphae which includes a great diversity of spiders that occupy a variety of habitats and are common in Brazil, where they are known as “aranhas caranguejeiras” (‘crab spiders’) because of their large size (Brescovit et al. 2002. *In Adis* (org.), *Amazonian Arachnida and Myriapoda*, pp. 303–343). The large size of these spiders allow them to consume large invertebrates and small vertebrates (Vitt 2000. *Herpetol. Monogr.* 14:388–400; Brescovit et al., *op. cit.*).

Few studies are available regarding prey-predator relationship of these spiders within Brazilian communities, especially involving reptiles, due to the time required for sampling and the elusive habits of many reptiles species (Rocha and Vrcibradic 1998. *Ciência e Cultura* 50[5]:364–368). Here, we report on an observation of predation on *M. maximiliani* by a theraphosid spider.

At 0930 h on 1 July 2009, in the Parque Estadual Mata da Pipa (PEMP), municipality of Tibau do Sul, State of Rio Grande do Norte, Brazil (6.24861°S, 35.05750°W, datum: WGS84; elev. 63 m), PAGES saw a medium-sized spider (~6 cm from the anterior tip of the head to the posterior end of the abdomen) in bare sand of open forest with a specimen of *M. maximiliani* grasped in its chelicerae. The lizard had no head, no front legs and no chest, but its color pattern and the absence of records of other species of this genus in the State served for a positive identification. The specimen of *M. maximiliani* could not be used for scientific collection, due to its high degree of deterioration caused by spider’s digestive enzymes.

We thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the research scholarship granted to PAGES (process 127543/2008-2) and EMXF (process 304077/2008-9), Jackson D. Shedd for helpful comments on this note and Roberto Lima Santos for identifying the spider.

Submitted by **PABLO AUGUSTO GURGEL DE SOUSA** (e-mail: pabloguitar2@hotmail.com), and **ELIZA MARIA XAVIER FREIRE** (e-mail: elizajuju@ufrnet.br), Laboratório de Herpetologia, Departamento de Botânica, Ecologia e Zoologia, Centro de Biociências, Universidade Federal do Rio Grande do Norte, Campus Universitário Lagoa Nova, CEP 59072-970, Natal, RN, Brazil.

NOROPS CARPENTERI (NCN). **ENDOPARASITES.** Nematodes are known as endoparasites of several species of anoles (e.g., Bursley et al. 2003. *J. Parasitol.* 89:118–123; Dobson et al. 1992. *Oecologia* 91:110–117; Goldberg and Bursley 2004. *Herpetol. Rev.* 35:269). Herein, I report a case of nematode infestation in *Norops carpenteri*. In the Reserva Biológica Hitoy Cerere (Costa Rica, Limón Province, 9.667°N, 83.033°W, ca. 250 m elev.) on 25 August 2005, I encountered a male *N. carpenteri* on the forest floor. The anole was hardly moving and at closer examination I noticed that it was heavily infested with nematodes, apparently ascaridids. The body loop of one nematode protruded from the anole’s cloaca and while I carefully handled the anole, several nematodes emerged (Fig. 1). This is the first report on endoparasites in *Norops carpenteri*.



FIG. 1. Nematodes protruding from the cloaca of *Norops carpenteri*.

Submitted by **DAVID MATTHIAS DEHLING**, Department of Ecology, Animal Ecology, Faculty of Biology, Philipps-University Marburg, Karl-von-Frisch-Straße 8, D-35032 Marburg, Germany; e-mail: Dehling@students.uni-marburg.de.

PHRYNOSOMA CORNUTUM (Texas Horned Lizard). **NESTING BEHAVIOR.** Few detailed accounts of nesting activities of the Texas Horned Lizard (*Phrynosoma cornutum*) have been published that span the early digging of a nest through oviposition and subsequent completion of an undetectable nest site. Nesting behaviors have been reported by Sherbrooke (2002. *Herpetol. Rev.* 33:206–208) and Allison and Cepeda (2009. *Southwest. Nat.* 54[2]:211–213). This note describes previously unreported behaviors during a nesting event.

At 1020 h on 25 May 2008, we observed a female (87 mm SVL; 52 g on 22 May) Texas Horned Lizard (*Phrynosoma cornutum*) excavating a nest under extremely hot, dry, windy conditions in Randall County, Texas, USA (ca. 34.98°N, 101.93°W, datum: NAD27; elev. 1080 m). Temperatures recorded for 25 and 26 May reached 32 and 33°C, respectively. At 1655 h the lizard (now 31.4 g) had laid eggs and was 10 m upslope from the site of excavation, resting in the shade of a nearby fence, but in clear view of, and intently watching, the nest site. This is the only observation we have made of a nesting female leaving the immediate area of the nest after ovipositing and before backfilling the nest, leaving the eggs exposed, and attribute it to the need for thermoregulation (lowering her body temperature). The lizard returned to, and resumed work at, the nest ca. 1855 h.

At ca. 2100 h, the lizard was working inside the nest with a large mound of loose soil outside the cavity when a violent thunderstorm approached. The storm, with 80 km/h winds (gusting to 112 km/h), hail, and driving rain, passed quickly and resulted in pea to marble sized hail, but minimal precipitation. When we checked the nest immediately after the worst of the storm had passed, the lizard and eggs were concealed within the excavation by a mound of loose soil (with the mounded soil having the appearance of a pocket gopher [Geomyidae] mound). The mound was 4–5 cm in height and 10–12 cm in diameter. However, at 0700 h the next morning, the entrance tunnel was exposed with the lizard asleep inside the

now-open tunnel, facing outward. This behavior is consistent with two other nesting events we observed in which the nest cavity and entrance tunnel remained open overnight.

Of three other nesting events we have observed, two nests were oviposited and backfilled during the night before the lizard rested (see also Sherbrooke 2002, *op. cit.*), and one nest was backfilled in late evening (second nest in Allison and Cepeda 2009, *op. cit.*).

At 0839 h the lizard was awake but not yet moving, and became active by 0915 h. By 1140 h the nest had been backfilled, and the lizard was resting in the shade of the nearby fence upslope in view of the nest.

At 1140 h, the lizard proceeded to camouflage the nest surface by walking back and forth across, out of and into, the nest site while shuffling feet at each step (noted also in Sherbrooke 2002, *op. cit.*). Camouflaging was complete at 1224 h. At that time, the lizard traveled 1 m upslope from the nest-site, and assumed a standing, upright pose on hind legs until after 1314 h. The posture included two firmly planted hind feet, one somewhat in front of the other, and forelimbs resting on small, herbaceous plants. The posture was striking in both its erectness and its prolonged duration. During this time period, the lizard maintained her two-legged stance without pause. The lizard closed her eyes while an ant (*Pogonomyrmex rugosus*) climbed over her head. The only other movements we observed were periodic head-bobbing and three rapid upper-body twists to look in the direction of sounds from nearby.

We have observed similar postures by two other lizards following nesting events, although neither was as erect, and durations were unrecorded. Sherbrooke (2002, *op. cit.*) reported a lizard “standing high on stretched legs” following the backfilling of a nest cavity and prior to camouflaging activities, but we interpret his account to have been a four-legged stance.

Lizards were weighed, measured, and immediately released in accordance with permit SPR-0294-659 issued by the Texas Parks and Wildlife Department. The Texas Horned Lizard (*P. cornutum*) is designated as a Threatened species in the State of Texas.

Submitted by **PAMELAS ALLISON**, P.O. Box 60812, Canyon, Texas 79016, USA (e-mail psallison@earthlink.net); and **JOSEPH C. CEPEDA**, West Texas A&M University, Department of Life, Earth, and Environmental Science, P.O. Box 60938, Canyon, Texas 79016, USA (e-mail: jcepeda@mail.wtamu.edu).

PHYLLODACTYLUS UNCTUS (San Lucan Gecko). **REPRODUCTION.** *Phyllodactylus unctus* is restricted to the Cape Region of Baja California and several nearby islands (Grismer 2002. Amphibians and Reptiles of Baja California, Including its Pacific Islands and the Islands in the Sea of Cortés. University of California Press, Berkeley. 399 pp.). Anecdotal information on its reproduction is given in Asplund (1967. Amer. Midl. Nat. 77:462–475) and Grismer (*op. cit.*). The purpose of this note is to report additional information on the reproduction of *P. unctus* from a histological examination of gonadal material from museum specimens.

A sample of 26 *P. unctus*, consisting of 12 adult males (mean snout vent length, SVL = 46.0 mm ± 6.1 SD, range: 39–60 mm), 11 adult females (mean SVL = 45.4 mm ± 3.2 SD, range: 39–48 mm) and 3 presumed neonates (mean SVL = 22.0 mm ± 1.0 SD, range: 21–23 mm) collected 1947, 1959, 1961, 1964, 1975, 1978, were examined from the herpetology collection of the Natural History

Museum of Los Angeles County (LACM), Los Angeles, California. The left testis was removed from males and the left ovary was removed from females for histological examination. Tissues were embedded in paraffin and cut into sections of 5 μm. Slides were stained with Harris hematoxylin followed by eosin counterstain. Slides of testes were examined to determine the stage of the spermatogenic cycle. Slides of ovaries were examined for the presence of yolk deposition. Histology slides were deposited in LACM. The following specimens of *P. unctus* were examined from LACM: 3263, 9811, 13971, 13973, 13974, 13976, 13977, 13979–13984, 13987, 13988, 51832, 51833, 122508, 127882–127889.

Testes were classified (sample size in parentheses) as to their spermatogenic state: spermiogenesis, the seminiferous tubules are lined with sperm and/or groups of metamorphosing spermatids: March (1), April (7), June (1); regressed, the seminiferous tubules are reduced in size and mainly contain spermatogonia and Sertoli cells: August (3). The smallest reproductively active males (spermiogenesis) each measured 39 mm SVL (LACM 9811, 127883). Ovaries were classified (sample size in parentheses) as to their reproductive state: quiescent: no yolk deposition March (2), August (8), December (1); early yolk deposition: yolk granules in the cytoplasm: April (1). The smallest reproductively active female (yolk deposition) measured 41 mm SVL (LACM 127886). Three presumed neonates were collected in August.

My findings indicate breeding occurs in spring to early summer with a late summer hatching period. This concurs with Asplund (*op. cit.*) who observed *P. unctus* ovaries (N = 6) were quiescent during August and neonates were present in that month. Examination of additional females are needed to elucidate Grismer’s (*op. cit.*) observation of gravid August *P. unctus* females. Timing of events in the *P. unctus* reproductive cycle appear similar to those of the congener *P. nocticolus* (formerly *P. xanti*) from southern California (Goldberg 1997. Herpetol. Rev. 28:152–153).

I thank Christine Thacker (LACM) for permission to examine *P. unctus*.

Submitted by **STEPHEN R. GOLDBERG**, Department of Biology, Whittier College, Whittier, California 90608, USA; e-mail: sgoldberg@whittier.edu.

PHYLLODACTYLUS UNCTUS (San Lucan Gecko). **ENDOPARASITES.** *Phyllodactylus unctus* is restricted to the Cape Region of Baja California and several nearby islands (Grismer 2002. Amphibians and Reptiles of Baja California, Including its Pacific Islands and the Islands in the Sea of Cortés. University of California Press, Berkeley. 399 pp.). To our knowledge, there are no reports of helminths from *P. unctus*. The purpose of this note is to establish the initial helminth list for *P. unctus*.

Five individuals of *P. unctus* (mean SVL = 49.8 mm ± 6.9 SD, range = 41–60 mm) from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California (LACM 127884–127888) collected in 1978 were examined for endoparasites. The lizards were opened by a mid-ventral incision and the gastrointestinal tract removed and opened longitudinally. The esophagus, stomach, small and large intestines as well as the body cavity were searched for endoparasites using a dissecting microscope. Eight juvenile (11–15 proglottids) cestodes (small intestine, LACM 127885; prevalence, number infected

lizards/number lizards examined $\times 100 = 20\%$) were stained in hematoxylin, mounted on slides in Canada balsam and identified as *Oochoristica* sp. Nematodes were cleared in a drop of glycerol, cover-slipped, studied as wet mounts and identified as one female *Thubunaea iguanae* (stomach, LACM 127884; prevalence = 20%) and seven female *Spauligodon oxkutzcabiensis* (large intestine, LACM 127884, 127886, 127887; prevalence = 60%, mean intensity, mean number infected lizards = 2.33 ± 1.5 , range = 1–4). Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as: *Oochoristica* sp. (USNPC 102324), *Spauligodon oxkutzcabiensis* (USNPC 102325), *Thubunaea iguanae* (USNPC 102326).

Species of *Oochoristica* are often identified by number of testes, structure of scolex and ovary as well as sucker size and shape. While structure of the scolex and ovary allow assignment to the genus *Oochoristica*, we were unable to assign the juvenile cestodes to a species. *Spauligodon oxkutzcabiensis* has been reported from lizards in Mexico, Central and South America (see Goldberg and Bursey 2009. Herpetol. Rev. 40:224). *Phyllodactylus unctus* is the fourth species of gecko reported to harbor *Spauligodon oxkutzcabiensis* and represents a new host record for this nematode. Baja California Sur is a new locality record. *Thubunaea iguanae* has been reported in a variety of lizards from the southwestern United States and Mexico (Telford 1965. Jpn. J. Exp. Med. 35:111–114; Goldberg et al. 2009. Herpetol. Rev. 40:85) as well as colubrid snakes (Goldberg and Bursey 2001. Bull. South. California Acad. Sci. 100:109–116). *Phyllodactylus unctus* represents a new host record for *Thubunaea iguanae*.

We thank Christine Thacker (LACM) for permission to examine *P. unctus* and Cecilia Nava (Whittier College) for assistance with dissections.

Submitted by **STEPHEN R. GOLDBERG**, Department of Biology, Whittier College, Whittier, California 90608, USA (e-mail: sgoldberg@whittier.edu); and **CHARLES R. BURSEY**, Pennsylvania State University, Shenango Campus, Department of Biology, Sharon, Pennsylvania 16146, USA (e-mail: cxb13@psu.edu).

PHYMATURUS FLAGELLIFER (Matuasto). **BRUMATION BEHAVIOR.** *Phymaturus flagellifer* is an endemic lizard of the Andes Mountains, ranging from 32° to 37°S latitude (Lambrot and Navarro 1984. Herpetologica 40:258–264). During the breeding season (October to March), hierarchy reproductive systems have been described with one male congregating numerous females on large stones, while in sites with smaller stones, only lone couples or solitary individuals are observed (Habit and Ortiz 1994. Bol. Soc. Biol. Concepción, Chile 65:149–152; Habit and Ortiz 1996. In Pefáur [ed.], Herpetología Neotropical, pp. 141–154). There is almost no information regarding brumation behavior in this species within its extreme environment (areas covered with snow for six to seven months).

From 19 to 23 May 2008, while performing fieldwork in the Andes Mountains (Laguna del Maule (35.984074°S, 70.532293°W; WGS84; 2184 m elev., Maule Administrative Region, Chile), we found a group of 37 *P. flagellifer* in brumation underneath a stone (1 m \times 40 cm; 40 cm depth) resting on a substrate of volcanic sand. The group was composed of 4 males, 18 females, 11 juveniles, and

5 neonates.

Our observation suggests that aggregation behavior in *P. flagellifer* is likely important in enabling this species to survive harsh winter conditions. Brumation behavior of reptiles at high elevations of the Andes is poorly known and this report contributes to the limited knowledge concerning the life history of *P. flagellifer*.

Submitted by **ALEJANDRA ALZAMORA** (e-mail: alealzamora@yahoo.com), **CAROLINA GALLARDO**, Lab. Ecología, Facultad de Ciencias Veterinarias y Pecuarias, Universidad de Chile, Casilla 2 Correo 15, Santiago de Chile; **M. ANGELICA VUKASOVIC**, **ROBERTO THOMSON S.**, Lab. Ecología de Vida Silvestre, Facultad de Ciencias Forestales, Universidad de Chile, Casilla 9206, Santiago de Chile; **BERNARDINO CAMOUSSEIGT**, INGENDESA, Casilla 1392, Santiago de Chile; **ANDRES CHARRIER**, **CARLOS GARIN** and **GABRIEL LOBOS**, CASEB, Pontificia Universidad Católica de Chile, Casilla 114 D, Santiago de Chile.

PODARCIS SICULUS (Italian Wall Lizard). **PREDATION.** *Podarcis siculus campestris* is a medium-sized Italian lacertid lizard that has been introduced into at least four U.S. states (New York, Pennsylvania, and Kansas—Burke and Deichsel 2008. In Mitchell et al. [eds.], Urban Herpetology, pp. 347–353. SSAR Herpetol. Conserv. 3, Salt Lake City, Utah; New Jersey—Burke, unpubl. data). Here we report on the predation of this introduced species by a native species.

At least three different American Kestrels (*Falco sparverius*) were observed feeding on Italian Wall Lizards (*P. siculus campestris*) in New York City. One *F. sparverius* was an adult (sex undetermined) at a nest on Broadway between 68th and 69th streets, Manhattan, observed clutching a lizard in the summer of 2006. Two male *F. sparverius*, one at East 75th Street, Manhattan and another in Sunnyside, Queens, were observed bringing *P. siculus campestris* to their mates and young. Although observations were not systematic in any of these cases, the East 75th Street male was observed with at least six different lizards between 8 June and 6 July, 2009 and the Queens male was observed with at least five different lizards during the spring of 2009, and five lizards in spring of 2008. A photograph, (Fig. 1) taken 4 July 2009 at the East 75th Street nest, is clearly that of a gravid female *P. siculus campestris* being passed from an adult male *F. sparverius* to a juvenile. Male-biased foraging is not surprising because female *F. sparverius* are largely dependent on their mates for provisioning during the last few weeks of incubation and until hatchlings are about ten days old (Smallwood and Bird 2002. Birds of North America Online <http://bna.birds.cornell.edu/bna/species/602>).

Although there may be others, we are aware of only five *Podarcis siculus* populations in the area: Queens College (Queens), Bronx Botanical Gardens and Pelham Bay Park (Bronx), Washington Cemetery (Brooklyn), and Baker Field (Manhattan). These populations are a minimum of 13 km from any of these nests, thus we suspect that there may be other *Podarcis* populations closer to the nests.

Falco sparverius are common inhabitants of urban, suburban, and rural habitats of North America and South America and feed on a wide variety of small vertebrates and invertebrates (Smallwood and Bird, *op. cit.*). *Falco sparverius* have not been previously



FIG. 1. Male kestrel passes *Podarcis* lizard to young. Photograph by Deborah Allen.

reported to predate *Podarcis*, but they have been reported to consume *Anolis* lizards (Adolph and Roughgarden 1983 *Oecologia* 56: 313–317) and *Sceloporus occidentalis*, *S. graciosus*, and *Elgaria coerulea* (Balgooyen 1976 *Univ. California Publ. Zool.* 103:1–87). The natural range of *P. siculus* is restricted almost entirely to Italy. There *Podarcis* spp. are predated by *Falco tinnunculus* (Eurasian Kestrel) (Martín and López 1990. *Smithson. Herpetol. Info. Serv.* No. 82, pp. 1–43; Costantini et al. 2005. *Behaviour* 142:1409–1421), but *P. siculus* has not specifically been positively identified as *Falco* prey.

This is the second report of predation by a native predator on *Podarcis* in New York (see Mendyk 2007 *Herpetol. Rev.* 38:82); introduced *Podarcis* in Kansas are predated by Great Plains Skinks (*Eumeces obsoletus*) and Blue Jays (*Cyanocitta cristata*) (Burke and Deichsel, *op. cit.*). Should populations of *Podarcis siculus* expand, it is likely the list of species that prey on this non-native lizard will increase.

Submitted by **RUSSELL L. BURKE**, Department of Biology, Hofstra University, Hempstead, New York 11549, USA (e-mail: biorlb@hofstra.edu); **DEBORAH ALLEN**, P.O. Box 1452 Peter Stuyvesant Station, New York 10009, USA (e-mail: DAllenyc@earthlink.net); **BEN CACACE**, 425 E. 74th St. Apt. 6E, New York, New York 10021, USA (e-mail: bcacace@gmail.com); **ROB CICCCHETTI**, 155W 68th St., Manhattan, New York 10023, USA (e-mail: rob.cicchetti@yahoo.com); **ERIC COHEN**, 4209 47th Avenue, Apartment 6A, Sunnyside, New York 11104, USA (e-mail: ericmarccohen@gmail.com); and **ROBERT DECANDIDO**, 1831 Fowler Avenue, The Bronx, New York 10462, USA (e-mail: rdcny@earthlink.net).

***SCELOPORUS CLARKII* (Clark's Spiny Lizard). AQUATIC BEHAVIOR.** Several terrestrial lizard species have been observed attempting to escape potential predators by submerging their bodies underwater, including *Cnemidophorus sexlineatus* (Dillon and Baldauf 1945. *Copeia* 1945:174; Trauth et al. 1996. *Herpetol. Rev.* 27:20), *Crotaphytus collaris* (Burt and Hoyle 1934. *Trans. Kansas Acad. Sci.* 37:193–216), and *Scincella lateralis* (Akin and Townsend 1998. *Herpetol. Rev.* 19:43). Herein, we report an observation of similar behavior in *Sceloporus clarkii*, a non-aquatic, typically arboreal, lizard.

On 30 June 2008 at 0823 h, we observed an adult *S. clarkii* sprinting across bedrock in the bottom of a deeply-incised canyon in the Rincon Mountains east of Tucson, Arizona (32.16271°N, 110.69902°W, WGS84). The lizard disappeared under a rock ledge below us, and moments later we heard a splash. We found the lizard completely submerged in a shallow pool of water with a gravel-lined bottom (ca. 60 mm deep) under the rock ledge. The lizard remained underwater for approximately three minutes, lifted its head out of the water and took a breath, and then submerged its head and body completely for several more minutes. The lizard then lifted its snout and eyes above the surface of the water and remained in this position for more than 10 minutes, after which we stopped observing to avoid disturbing the lizard any more than necessary. The use of water as a refuge from predators has not been widely reported for terrestrial lizards, probably due to the thermodynamic costs associated with submergence. In this case, however, the lizard may have tolerated prolonged submergence because the water temperature was relatively high due to elevated ambient temperatures (>32°C) and the shallow depth of the pool.



FIG. 1. Adult *Sceloporus clarkii* partially submerged in shallow canyon pool in southern Arizona, USA.

Submitted by **ERIN R. ZYLSTRA**, School of Natural Resources, University of Arizona, 325 Biological Sciences East, Tucson, Arizona, USA (email: erinzylstra@gmail.com); and **BRUCE D. WEISE**, 6251 E. 35th St., Tucson, Arizona 85711, USA.

***STENOCERCUS DOELLOJURADOI* (NCN). CLUTCH SIZE.** *Stenocercus doellojuradoi* (Tropiduridae) is a Chaco endemic species of Argentina, and regarded as a vulnerable species associated with Chaco forests (Pelegrin et al. 2006. *Herpetozoa* 19(1/2):85–

86). The Chaco ecoregion is a vast woodland that covers more than 1.2 million km², including portions of Argentina, Bolivia, and Paraguay, ranging from tropical (18°S) to subtropical (31°S) latitudes. The southernmost portion of the Chaco (Dry Chaco) is characterized by having lower temperatures and rainfall (Bucher 1982. *Ecological Studies* 42:48–79). Although *S. doellojuradoi* is a common species within its limited distribution, its natural history has been poorly studied, and there is no available information on its reproductive biology. In the context of an ecological study on lizard assemblages in the Dry Chaco of Córdoba, Argentina (30.37°S, 65.43°W), we recorded females with oviductal eggs in November, January, and February; one female (SVL = 77 mm, 18 g) from November was found to be carrying six eggs (mean length \pm SD = 13.33 \pm 1.37 mm). This is the first report of reproductive data for this species.

Submitted by **NICOLÁS PELEGRIN** (e-mail: npelegrin@efn.uncor.edu) and **ENRIQUE H. BUCHER**, Centro de Zoología Aplicada, FCEfyN, Universidad Nacional de Córdoba, Casilla de Correos 122 - X5000AVP Córdoba, Argentina.

TROPIDURUS HISPIDUS (Calango). **PREY**. Lizard species of the widely distributed South American genus *Tropidurus* (Rodrigues 1987. *Arq. Zool.*, São Paulo 31:105–230) are sit-and-wait ambush predators that feed predominantly on arthropods (Fialho et al. 2000. *J. Herpetol.* 34:325–330; Van Sluys 1993. *J. Herpetol.* 27:347–351; Vitt 1991. *J. Herpetol.* 25:79–90). Some species also are known to prey on vertebrates such as mammals, lizards, and frogs (Gasparini and Peloso 2007. *Herpetol. Rev.* 38:464). Sauriphagy is already recorded for species of *Tropidurus*, be these conspecifics (Araújo 1987. *Rev. Brasil. Biol.* 51:857–865; Dias and Rocha 2004. *Herpetol. Rev.* 35:398–399; Kiefer and Sazima 2002. *Herpetol. Rev.* 33:136; Kohlsdorf et al. 2004. *Herpetol. Rev.* 35:398) or other lizard species (Galdino and Van Sluys 2004. *Herpetol. Rev.* 35:173; Kiefer 1998. *Herpetol. Rev.* 29:41; Kiefer et al. 2006. *Herpetol. Rev.* 37:475–476; Teixeira and Giovanelli 1999. *Rev. Brasil. Biol.* 59:11–18). *Tropidurus hispidus* has a wide distribution and is locally abundant (Rodrigues, *op. cit.*). This species is considered a generalist, its diet consisting primarily of arthropods (Vitt and Carvalho 1995. *Copeia* 1995:305–329), although there are records of predation on frogs (Vitt et al. 1996. *J. Trop. Ecol.* 12:81–101) and an attempt of predation on the gekkonid lizard *Hemidactylus palaichthus* (Rojas-Runjaic et al. 2006. *Herpetol. Rev.* 37:474). Here we present two instances of sauriphagy and one of anurophagy in a coastal population of *T. hispidus*. Several individuals of this species were caught in April and May 2006, during a study carried out in a restinga habitat (characterized by sand dunes and sparse vegetation) on the beach of Panaquatira (2.561944°S, 44.054167°W), São José de Ribamar municipality, State of Maranhão, Brazil. One hundred and eleven specimens were dissected for gut content investigation; these specimens and their prey are in the Museu de Zoologia “Prof. Dr. Adão José Cardoso” (ZUEC), Universidade Estadual de Campinas. An adult male (ZUEC REP 03193; 85.3 mm SVL; 25 g) contained a partially digested juvenile (ca. 50.66 mm SVL) teiid lizard *Cnemidophorus ocellifer*; another adult male (ZUEC REP 03194; 83.9 mm SVL; 19 g) contained one adult (ca. 48 mm SVL) of the gymnophthalmid lizard *Colobosaura modesta*, and a female (ZUEC REP 03195; 80.4 mm SVL; 15.5 g)

contained a skull bone (12.14 mm) of an unidentified frog. The two lizard prey items were partly digested, however, the head to the anterior part of the tail remained nearly intact. Further, the heads of each lizard were positioned in the anterior part of the stomach, thus indicating that both lizards were probably swallowed tail-first. *Cnemidophorus ocellifer* and *Colobosaura modesta* are active foragers (Bergallo and Rocha 1994. *Austral. J. Ecol.* 19:72–75; Rocha 1994. *In* Nascimento et al. [eds.], *Herpetologia no Brasil* 1, pp. 39–57. PUC-MG: Fundação Biodiversitas: Fundação Ezequiel, Belo Horizonte), whereas *T. hispidus* is a territorial sit-and-wait predator (Van Sluys et al. 2004. *J. Herpetol.* 38:606–611; Vitt and Carvalho, *op. cit.*). Active foragers are on the move and thus are exposed to risk of predation by sit-and-wait predators (Pianka 1986. *Ecology and Natural History of Desert Lizards*. Princeton University Press, Princeton, New Jersey. 208 pp.). Our observations on the positions of the two lizards in the stomachs of each *T. hispidus*, in addition to a record of a *C. ocellifer* also ingested tail-first by the conspecific *T. torquatus* (Kokubum and Lemos 2004. *Herpetol. Rev.* 35: 270–271) indicate that all three lizard prey were chased down by the predator and swallowed as they were caught. The occurrence of lizards among the prey items sampled was of low frequency (1.8%), which suggests that sauriphagy in *T. hispidus* is opportunistic. Predation on frogs by *T. hispidus* (0.9%) is even lower in our sample and also seems to be opportunistic as recorded for other populations of the same species (Vitt et al., *op. cit.*). Predation on *C. ocellifer* and *C. modesta* presented here are the first records of sauriphagy for *T. hispidus*.

We thank I. Sazima for critically reading this manuscript and Jerriane O. Gomes for confirming the identification of the prey items. The permit for collecting lizards was given by IBAMA (process 02010000071/07-01).

Submitted by **JOÃO C. L. COSTA**, Departamento de Parasitologia, Instituto de Biologia, Universidade Estadual de Campinas, 13083-970, Campinas, São Paulo, Brazil (e-mail: joaoclcosta@yahoo.com.br); **PAULO R. MANZANI**, Departamento de Zoologia, Instituto de Biologia, Universidade Estadual de Campinas, 13083-970, Campinas, São Paulo, Brazil (e-mail: manzani@unicamp.br); **MARIA P. DE L. BRITO** (e-mail: mplbrito@hotmail.com), and **ADRIANO O. MACIEL**, Museu Paraense Emílio Goeldi, 66077-830, Belém, Pará, Brazil (e-mail: aombiologo@yahoo.com.br).

TUPINAMBIS LONGILINEUS (NCN). **ENDOPARASITES**. *Tupinambis longilineus* is the smallest and least known species of its genus, with distribution records for only four localities documented from the Brazilian states of Amazonas, Pará, Rondônia and Mato Grosso (Costa et al. 2008. *Check List* 4[3]:267–268). No records of parasites are published for this species. Here, we report the nematode *Physaloptera retusa* infecting the stomach of an adult male *T. longilineus* (MZUFV 564; 230 mm SVL) from Aripuanã, Mato Grosso State, Brazil (10.16°S, 59.47°W; datum: WGS84) housed in the herpetological collection of Museu de Zoologia João Moojen, Universidade Federal de Viçosa, municipality of Viçosa, Minas Gerais State, Brazil. Six adult *P. retusa* were recovered while we conducted a dietary study. The nematodes were deposited at Coleção Helminológica de Referência do Instituto de Biociências da UNESP-Botucatu (CHIBB 4006).

Phrynosoma marmoratum is one of the most common parasites of Neotropical herpetofauna, known to infect more than 60 hosts, including *Tupinambis teguixin* and *T. rufescens* (Burse et al. 2007. *Comp. Parasitol.* 74:108–140). *T. longilineus* is a new host record for *P. retusa* and the state of Mato Grosso represents a new locality record for this parasite.

We thank Energética Águas da Pedra S.A. for financial support of the fieldwork in Aripuanã and IBAMA for granting collection permits (029/2006-COFAN and 50/2007-SUPES/MT, process # 02001.003069/2004-42). The parasitological study had financial support by FAPESP (processes 04/03628-1, 06/59692-5 and 08/05417-7) and RWA thanks CAPES for a grant.

Submitted by **ROBSON W. ÁVILA** (e-mail: robsonavila@gmail.com); **LUCIANO A. DOS ANJOS, REINALDO J. SILVA**, Departamento de Parasitologia, Instituto de Biociências, UNESP, Distrito de Rubião Jr., CEP 18618-000, Botucatu, SP, Brazil; **HENRIQUE CALDEIRA COSTA, VINÍCIUS DE AVELAR SÃO PEDRO**, and **RENATO NEVES FEIO**, Museu de Zoologia João Moojen, Universidade Federal de Viçosa, Vila Giannett 32, CEP 36571-000, Viçosa, MG, Brazil.

TYMPANOCRYPTIS LINEATA (Lined Earless Dragon). **ENDOPARASITES.** *Tympanocryptis lineata* is known from eastern and southeastern Western Australia to the western slopes of New South Wales and southern Victoria where it occurs in a wide variety of terrestrial habitats (Cogger 2000. *Reptiles and Amphibians of Australia*, 6th ed. Ralph Curtis Books, Sanibel Island, Florida. 808 pp.). We know of no reports of endoparasites from this species. The purpose of this paper is to establish the initial helminth list for *T. lineata*.

Seven individuals of *T. lineata* (mean SVL = 53.3 mm ± 4.0 SD, range = 48–61 mm) were borrowed from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California and examined for helminths. Three were collected between 28.9500°S to 32.5500°S and 134.3167°E to 137.2167°E; WGS 84, elev. ca 200 m, in South Australia during 1966 and 1968 (LACM 55380–55381, 57944) and four were collected between 18.3833°S to 31.9833°S and 125.7333°E to 125.8500°E; WGS 84, elev. 125–400 m, in Western Australia during 1966–1967 (LACM 55382–55383, 55385–55386). The body cavity was opened by a longitudinal incision and the large and small intestines were removed and examined using a dissecting microscope. Stomachs were not available for examination. Only cestodes were present, which were regressively stained in hematoxylin, mounted in Canada balsam, studied under a compound microscope and identified as *Oochoristica piankai*.

One, one, and two individuals of *O. piankai* were found in the small intestines of LACM 55381, 55382, and 55385, respectively. Prevalence (number infected lizards/number examined lizards × 100) was 43%. Mean intensity (mean number parasites) was 1.3 ± 0.57 SD, range = 1–2.

Voucher endoparasites were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as *Oochoristica piankai* (USNPC 102139, 102140).

Oochoristica piankai was originally described from the small intestines of *Moloch horridus* by Bursey et al. (1996. *J. Helminthol. Soc. Washington* 63:215–221). It has subsequently been reported

in *Ctenophorus fordii*, *C. isolepis*, and *C. reticulatus* (Goldberg et al. 2000. *Comp. Parasitol.* 67:109–114) and *Nephrurus laevissimus* (Burse et al. 1999. *J. Helminthol. Soc. Washington* 66:175–179). The life cycle of *O. piankai* has not been studied, but Conn (1985. *J. Parasitol.* 71:10–16) reported beetles (*Tribolium*) acted as intermediate hosts for the congener *Oochoristica anolis*. *Tympanocryptis lineata* represents a new host record for *Oochoristica piankai*.

We thank C. Thacker (LACM) for permission to examine specimens and C. Nava (Whittier College) for assistance with dissections.

Submitted by **STEPHEN R. GOLDBERG**, Department of Biology, Whittier College, Whittier, California 90608, USA (e-mail: sgoldberg@whittier.edu); and **CHARLES R. BURSEY**, Department of Biology, Pennsylvania State University, Shenango Campus, Sharon, Pennsylvania 16146 (e-mail: cxb@psu.edu).

SQUAMATA — SNAKES

AGKISTRODON PISCIVORUS (Cottonmouth). **ECTOPARASITE.** Many internal parasites have been reported for *Agkistrodon piscivorus* (Gloyd and Conant 1990. *Snakes of the Agkistrodon Complex: A Monographic Review*. Society for the Study of Amphibians and Reptiles, Oxford, Ohio. 614 pp.). However, no data on ectoparasites from wild-caught individuals are available, with the exception of reports of blood feeding by mosquitoes (Burkett-Cadena et al. 2008. *Am. J. Trop. Med. Hyg.* 79:809–815). On 31 July 2008, 2020 h CST, we captured a large adult male *A. piscivorus* (SVL = 83.8 cm; 595 g) in a small creek at Tuskegee National Forest, Macon County, Alabama, USA (32.434486°N, 85.643901°W; WGS 84). While restraining (tubing) the snake for processing, we noticed a leech attached to the posterior one-third of the snake's dorsum. The leech was placed in water in a plastic vial and was later keyed (by EB) as *Placobdella ornata*, a leech that commonly parasitizes turtles (Siddal and Gaffney 2004. *J. Parasitol.* 90:1186–1188). We could not confirm that this leech had obtained a blood meal from the snake, so the attachment may have been only phoretic (e.g., for dispersal).

This observation was made while conducting research funded by NIH grant # R01-A149724 to T. Unnasch under ADCNR Permit # 4268, and NSF Minority Postdoctoral Fellowship (DBI# 0706856) to EB.

Submitted by **SEAN P. GRAHAM** (e-mail: grahasp@auburn.edu), **ELIZABETH BORDA**, and **MATT R. CONNELL**, Department of Biological Sciences, 331 Funchess Hall, Auburn University, Alabama 36849, USA.

AGKISTRODON PISCIVORUS (Cottonmouth). **DIET.** On 19 April 2008, at 1647 h at an oxbow pond in Tuskegee National Forest, Macon County, Alabama, USA (32.43875203°N, 85.63422342°W, datum: WGS 84), we captured an adult male *Agkistrodon piscivorus* (SVL = 75.7 cm) with a pronounced bulge in its posterior half. We palpated the snake and discovered the bulge to be a partially digested subadult *Agkistrodon contortrix* (Copperhead). *Agkistrodon piscivorus* has one of the broadest diets of any known snake, with >100 species of invertebrates, fish, amphib-

ians, reptiles, mammals, and birds listed as prey (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Press, Washington, D.C., 668 pp.). However, this is the first record of an *A. contortrix* being consumed by an *A. piscivorus*. A photograph of both snakes was deposited in the AUM digital database (AHAP-D 42). The *A. piscivorus* was released at its point of capture and the palpated copperhead was left next to the cottonmouth.

We thank the C. Guyer for comments on this note. This observation was made while conducting research funded by NIH grant R01-A149724 to T. Unnasch under ADCNR Permit 4268.

Submitted by **SEAN P. GRAHAM** (e-mail: grahasp@auburn.edu), **MATT R. CONNELL**, and **KATHERINE M. GRAY**, Auburn University, Department of Biological Sciences, 331 Funchess Hall, Auburn, Alabama 36849, USA.

BOTHROPS INSULARIS (Golden Lancehead). **MAXIMUM LENGTH.** *Bothrops insularis* is a viperid endemic to Queimada Grande Island (0.43 km²), approximately 35 km from the coast of São Paulo State, Brazil (Amaral 1922. Mem. Inst. Butantan 1:39–44). *Bothrops insularis* is considered critically endangered (IUCN 2007. Red List of Threatened Species; Machado et al. 2005. Lista da Fauna Brasileira Ameaçada de Extinção. Fundação Biodiversitas. Belo Horizonte. 157 pp.) and may be declining (Martins et al. 2008. South Am. J. Herpetol. 3:168–174). In December 1995, one of us (OAVM) found a female *B. insularis* that weighed 391 g and measured 1093 mm total length (SVL = 950 mm; tail length = 143 mm). In December 2007 we found a male that weighed 185 g and measured 912 mm total length (SVL = 775 mm; tail length = 137 mm). Of the 520 individuals observed over 15 years of fieldwork on the island, the specimens above represent the largest individuals of each sex. The size of these snakes also exceeds the length of all preserved specimens (250 males and 400 females) from the herpetological collection of the Instituto Butantan.

In 1920, Amaral (1922) collected a female *B. insularis* (IB 1900) that reportedly measured 1180 mm in total length. The current total length of this specimen is 992 mm (SVL = 882 mm; tail length = 110 mm). When re-measured, we found other specimens cited by Amaral (1922) to be smaller than originally reported. This incongruence in lengths suggests that the specimens either shrunk substantially over time or were measured incorrectly at the time of collection. Regardless of the status of specimens collected by Amaral (1922), the lengths reported here likely represent the maximum sizes currently attained by male and female *B. insularis* in the field.

We thank Valdir Germano from Herpetological Collection of Instituto Butantan, and J. D. Willson for suggestions on the manuscript. Conselho Nacional de Pesquisa e Desenvolvimento (CNPq) and Fundação de Amparo a Pesquisa do Estado de São Paulo (Fapesp) provide financial support.

Submitted by **MURILO R. GUIMARÃES**, **RAFAEL P. BOVO**, **KARINA N. KASPEROVICZUS**, and **OTAVIO A. V. MARQUES**, Laboratório de Ecologia e Evolução, Instituto Butantan, Avenida Vital Brazil, 1500, São Paulo, 05503900 Brazil.

CONOPSIS LINEATA (Large-nosed Earthsnake). **LITTER SIZE.** Little is known about reproduction of *Conopsis lineata*

(Fitch 1970. Univ. Kansas Mus. Nat. Hist. Misc. Publ. 52:1–214). Anecdotal information indicates that litter size ranges from 2–3 for individuals from Hidalgo, Mexico (Goyenechea 2003. Herpetol. Rev. 34:63), 3–5 for individuals from Veracruz, Mexico (Greer 1966. Copeia 1966:371–373), and 2–6 for individuals from Mexico City (Uribe-Peña et al. 1999. Anfíbios y Reptiles de Las Serranías del Distrito Federal. Universidad Nacional Autónoma de México. 118 pp.). On 14 June 2008 we found a dead gravid female *C. lineata* on the road from Municipality of Mineral de la Reforma, Mexico (20.09011°N, 98.71064°W, datum: WGS84; elev. 2431 m; xerophytic vegetation). The female measured 225 mm SVL, weighed 17.5 g, had a litter size of seven well-developed embryos (stage 40). Measurements of embryos (mean ± SE, range) are as follows— mass: 0.78 ± 0.02 g, 0.70–0.84; SVL: 64.5 ± 7.5 mm, 34.6–77.6; total length: 82.4 ± 7.9 mm, 51.4–101.1.

We thank A. Leyte-Manrique for his logistic help. This study was supported by the projects SEP-PROMEP-1103.5/03/1130, CONACYT-S 52552-Q, and FOMIX-CONACYT-43761

Submitted by **RACIEL CRUZ-ELIZALDE** (e-mail: rabunbury@hotmail.com), **URIEL HERNÁNDEZ-SALINAS**, and **AURELIO RAMÍREZ-BAUTISTA**, Centro de Investigaciones Biológicas (CIB), A.P. 1-69 Plaza Juárez, C.P. 42001, Pachuca, Hidalgo, México.

CORALLUS HORTULANUS (Amazon Tree Boa). **TIMING OF REPRODUCTION.** Observations of snakes giving birth in nature are rarely published and little is known about timing of reproduction in most tropical snake species (Greene 1997. Snakes the Evolution of Mystery in Nature. Univ. California Press, Los Angeles. 351 pp.). *Corallus hortulanus* are known to give birth to 3–24 newborns (total length: 282–455 mm) from January to June and litter size is positively related to female SVL (Pizzatto and Marques 2007. S. Am. J. Herpetol. 2:107–122).

On 17 November 2008, at 2040 h, in Parque Nacional dos Campos Amazônicos, Amazonas state, Brazil (8.05°S, 61.58°W; datum WGS84; elev. ca. 100 m), we observed a female *C. hortulanus* (SVL = 1040 mm; tail length = 290 mm) on the ground and four newborns (SVL: 462, 465, 460, 467 mm; tail lengths: 121, 122, 119, and 126 mm) on vegetation (40–250 cm high) nearby. The specimens were photographed, measured, and immediately released. This observation extends the known birthing season for the species and possibly suggests year-round reproduction or geographic variation in timing of reproduction for *C. hortulanus* in Brazil.

Submitted by **PAULO SÉRGIO BERNARDE** (e-mail: SnakeBernarde@hotmail.com), and **REGINALDO ASSÊNCIO MACHADO**, Universidade Federal do Acre – UFAC, Campus Floresta, Centro Multidisciplinar, Laboratório de Herpetologia, Cruzeiro do Sul, AC, 69980-000, Brazil.

CROTALUS DURISSUS (South American Rattlesnake). **ARBOREAL HABITAT USE.** *Crotalus durissus* is the most widespread rattlesnake species and is the only one to reach South America. It occurs in all mainland countries except Ecuador and Chile, with a discontinuous distribution from Colombia to Argentina (Campbell and Lamar 2004. Venomous Reptiles of the Western Hemisphere.



FIG. 1. An adult *Crotalus durissus* using an arboreal resting site in small trees at the edge of Cerrado canopy woodland (*cerradão*) in Volta Grande Environmental Station, southeastern Brazil.

Cornell Univ. Press, Ithaca, New York. 870 pp.). *Crotalus durissus* inhabits open habitats (Campbell and Lamar, *op. cit.*; Wüster et al. 2005. *Mol. Ecol.* 14:1095–1108), and also colonizes anthropogenically deforested areas (Bastos et al. 2005. *Rev. Bras. Zool.* 22:812–815; Sazima and Haddad 1992. *In* Morellato [ed.], *História Natural da Serra do Japi*, pp. 212–236. Editora da UNICAMP e FAPESP, Campinas). It is primarily crepuscular or nocturnal and terrestrial, using holes on the ground as diurnal shelters (Sazima and Haddad, *op. cit.*).

At 1500 h on 11 January 2006, we observed arboreal habitat use by an adult *C. durissus* at Volta Grande Environmental Station (20.024917°S, 48.235750°W, datum: SAD69), municipality of Conceição das Alagoas, state of Minas Gerais, southeastern Brazil. The rattlesnake was found coiled and stationary on branches of a small tree, at the edge of a Cerrado canopy woodland (*cerradão*), about 2 m above ground (Fig. 1).

Campbell and Lamar (*op. cit.*) reviewed published reports of *Crotalus* species resting, foraging, or feeding above ground. They reported arboreal habitat use in several species, including *C. adamanteus*, *C. catalinensis*, *C. enyo cerralvensis*, *C. horridus*, *C. lepidus klauberi*, *C. molossus*, *C. oreganus helleri*, *C. ruber lorenzoensis*, and *C. willardi willardi*, sometimes up to 9 m high. By resting above the ground, a snake may be less vulnerable to terrestrial predators (Martins 1993. *Herpetol. Rev.* 24:83–84). Another hypothesis for the behavior is that the snake was thermoregulating in the sun-shade mosaic formed by vegetation, a behavior commonly observed in the sympatric pitviper *Bothrops jararaca* (Sazima 1988. *Mem. Inst. But.* 50:83–99).

We thank Companhia Energética de Minas Gerais (CEMIG) for the financial support to JSD and John D. Willson for valuable suggestions.

Submitted by **JUSSARA SANTOS DAYRELL** (e-mail: jussadayrell@yahoo.com.br), **HENRIQUE CALDEIRA COSTA** (e-mail: ccostah@yahoo.com.br), **RENATO NEVES FEIO** (e-mail: rfeio@ufv.br), Universidade Federal de Viçosa, Museu de Zoologia João Moojen, 36570-000 Viçosa, MG, Brazil; and **LE-ANDRO OLIVEIRA DRUMMOND**, Universidade Federal de

Ouro Preto, Instituto de Ciências Exatas e Biológicas, Laboratório de Zoologia dos Vertebrados, 35400-000, Ouro Preto, MG, Brazil (e-mail: barrocolod@hotmail.com).

CROTALUS OREGANUS LUTOSUS (Great Basin Rattlesnake).

ELEVATION. On 18 June 2007 we observed a *Crotalus oreganus lutosus* at an elevation of 3962 m near the summit of Wheeler Peak, Great Basin National Park, White Pine County, Nevada, USA (38.986°N, 114.314°W, datum: WGS1984). A color slide of the snake was cataloged as a photo voucher (BYU 49442; verified by Jack Sites) (Fig. 1). The snake was found well above the treeline, in rocky, talus, fell-field habitat. It rattled upon approach and crawled over a snowfield. In July 2000 we observed three *C. o. lutosus* at 3090 m in south-facing, rocky, low sagebrush (*Artemisia arbuscula*) steppe habitat, in Great Basin National Park. *Crotalus o. lutosus* was previously reported at a maximum elevation of 3063 m (Klauber 1972. *Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind*. Volume I. 2nd ed. Univ. California Press, Berkeley, 740 pp.). To our knowledge, these observations represent the maximum elevations reported for *C. o. lutosus*. Wheeler Peak is the second highest point in the Great Basin, at 3982 m, suggesting that *C. o. lutosus* may occur at all elevations within its range.



FIG. 1. *Crotalus oreganus lutosus* (BYU 49442) crawling through talus and snowfields at 3962 m in Great Basin National Park, White Pine County, Nevada, USA.

Submitted by **BRYAN HAMILTON**, Great Basin National Park, Baker, Nevada 89311, USA (e-mail: bryan_hamilton@nps.gov); and **DALE RICHARD**, Box 17, Heffley Creek, British Columbia, Canada.

DIADOPHIS PUNCTATUS PUNCTATUS (Southern Ring-necked Snake).

DIET. *Diadophis punctatus* eats a variety of small animals, including insects, slugs, earthworms, snakes, lizards, anurans and salamanders (Ernst and Ernst 2003. *Snakes of the United States and Canada*. Smithsonian Institution Press, Washington D.C. 668 pp.). In addition to the salamandrid *Taricha torosa*, plethodontid salamanders in the genera *Aneides*, *Batrachoseps*, *Desmognathus*,

Eurycea, and *Plethodon* have been reported as prey of *Diadophis*, as well as salamander eggs. Specifically, *Eurycea bislineata*, *E. cirrigera*, *E. longicauda*, and *E. quadridigitata* are known to be constituents of the diet of *D. punctatus*. Uhler et al. (1939. Trans. N. Am. Wildl. Conf. 4:605–622) reported that salamanders made up 80% by volume of the diet of Virginia *D. punctatus*. We report a novel species of *Eurycea*, *E. lucifuga* (Cave Salamander), in the diet of *D. punctatus*.

At 1545 h on 25 April 2009, one of us (KTN) found an adult ring-neck snake crawling ~2 m inside the entrance to Pettijohn's Cave on Pigeon Mountain, Walker Co., Georgia, USA (34.663947°N, 85.363547°W; WGS 84). At 1610 h, the snake regurgitated an adult *E. lucifuga* weighing 3.37 g and measuring 67 mm SVL (total length = 157 mm), swallowed headfirst. At least 15 live *E. lucifuga* had been observed in crevices and on rock faces immediately surrounding the cave entrance, as well as at least two *Plethodon petraeus*, so presumably these salamanders represent a fairly abundant and predictable source of food.

D. punctatus are known to occasionally enter moist caves (Ernst and Ernst, *op. cit.*) and locate their prey by scent (Lancaster and Wise 1996. *Herpetologica* 52:98–108). Venom (Taub 1967. *Bull. Am. Mus. Nat. Hist.* 138:1–50; O'Donnell et al. 2007. *Toxicon*. 50:810–815) may enable *D. punctatus* to overcome salamander defensive behaviors (Brodie Jr 1977. *Copeia*. 1977:523–535). Cave salamanders have been suggested to be top predators in many cave communities (Petranka 1998. *Salamanders of the United States and Canada*. Smithsonian Institution Press, Washington, D.C. 587 pp.), so the addition of a higher trophic level is significant, especially since *E. lucifuga* are reported to depredate *Plethodon glutinosus*, another predator (Peck and Richardson 1976. *Annales de Spéleologie* 31:175–182).

Submitted by **KERRY T. NELSON**, **ANDREW M. DURSO** (e-mail: amdurso@gmail.com), and **ROBERT V. HORAN**, University of Georgia, Athens, Georgia 30602, USA.

DINODON RUFOZONATUM RUFOZONATUM (Asian King-snake). **DIET, OVOPHAGY**. Recorded prey items of *Dinodon rufozonatum rufozonatum* include a nestling bird (species unknown), anurans (*Bufo bankorensis*, *B. melanostictus*, *Rana adenopleura*), skinks, snakes (including *Sinonatrix percarinata*), and a beetle (Lee and Lue 1996. *Biol. Bull. Natl. Taiwan Normal Univ.* 31:119–124; Lee and Lue 1996. *J. Taiwan Mus.* 49:137–138; Lin et al. 1995. *Newsletter of Wildlifers* 3:19–21; Norval and Mao 2004. *Herpetol. Rev.* 35:65; Mao, unpubl. data).

On 20 April 2008, at 2010 h, a juvenile female *D. r. rufozonatum* (SVL = 462 mm; tail length = 122 mm; 33.8 g) was found at the edge of a field that had been tilled and left to lay fallow in Santzepu, Sheishan District, Chiayi County, Taiwan (23.4308667°N, 120.4845333°E, datum: WGS84; elev. 64 m). Palpation revealed an object in the stomach and the snake was induced to regurgitate the object; a reptilian egg (length = 9.3 mm; width = 5.3 mm; 0.1 g). Two days later, the remains of four additional eggs were found in the excrement of the snake. *Plestiodon* (= *Eumeces*) *elegans* and *Takydromus kuhnei* are very common lizards in this area. Eggs of *P. elegans* are larger (mean length \pm SD = 15.25 \pm 1.89 mm; width = 10 \pm 0.82 mm; 1.25 g; Mao et al. 2008. *Sauria* 30:51–54) than those of *T. kuhnei* (mean length = 10.25 \pm 0.69 mm; width = 5.93

\pm 0.23 mm; 0.23 \pm 0.05 g). Thus, based on the size, we believe that the eggs retrieved from the *D. r. rufozonatum* were those of *T. kuhnei*. The fact that no other prey remains were found leads us to believe the snake preyed only on the eggs. To our knowledge this is the first report of *D. r. rufozonatum* predation on reptilian eggs.

Submitted by **GERRUT NORVAL**, Applied Behavioural Ecology & Ecosystem Research Unit, Department of Environmental Sciences, University of South Africa, Private Bag X6, Florida, 1710, Republic of South Africa (e-mail: a_sagrei@hotmail.com); and **JEAN-JAY MAO**, Department of Forestry and Natural Resources, National Ilan University. No. 1, Sec. 1, Shen-Lung Rd., Ilan, 260, Taiwan, R.O.C.

DRYMARCHON COUPERI (Eastern Indigo Snake). **LONG-DISTANCE INTERPOPULATION MOVEMENT**. *Drymarchon couperi* was listed by the U.S. Fish and Wildlife Service (USFWS) as threatened in 1978 due to population declines caused primarily by habitat loss and habitat degradation (USFWS 1982. Eastern Indigo Snake Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 23 pp.). In the northern part of their range (northern Florida and the Coastal Plain of southern Georgia, USA), adult *D. couperi* rely on Gopher Tortoise (*Gopherus polyphemus*) burrows for winter dens (Diemer and Speake 1983. *J. Herpetol.* 17:256–264; Stevenson et al. 2009. *Herpetol. Cons. Biol.* 4:30–42). In southeastern Georgia, *D. couperi* populations are typically restricted to sites where intact xeric sandhill habitats supporting *G. polyphemus* occur contiguous with extensive areas of poorly-drained or mesic upland habitats (pine flatwoods, mixed pine-oak forests, slope forests) and wetlands (Diemer and Speake 1981. *In* Odum and Guthrie [eds.], *Proc. Nongame and Endangered Wildlife Symposium*, pp. 52–61. Georgia Dept. Nat. Resources, Game and Fish Div. Tech. Bull. WL-5; Diemer and Speake 1983, *op. cit.*). Although *D. couperi* may use sandhill habitats throughout the year, during their period of greatest surface activity and movements (April–October) mesic habitats and wetlands are used frequently, particularly by foraging snakes (Hyslop 2007. *Movements, Habitat Use, and Survival of the Threatened Eastern Indigo Snake [Drymarchon couperi]* in Georgia. Unpubl. dissertation, University of Georgia, Athens). Adult *D. couperi* may range 2–6 km from their overwintering sites and typically exhibit overwintering site fidelity by returning to the same sandhills, commonly using some of the same tortoise burrows in successive years (Hyslop et al. 2009. *Copeia* 2009:460–466; Stevenson et al., *op. cit.*).

From 1998–2006, we monitored four *D. couperi* populations at Fort Stewart Military Installation in the lower Coastal Plain of southeastern Georgia. For the purposes of this note, we define a *D. couperi* population as overwintering adult *D. couperi* occupying a discrete sandhill area known to support *G. polyphemus* that is separated > 6.0 km from a similar sandhill area. Distances between populations in this study ranged from 6.5–27 km. We monitored these populations by surveying for snakes from mid-November through mid-March (see Stevenson et al., *op. cit.* for additional details). During the seven-year period we captured and marked 77 individual *D. couperi* (51 males, 26 females). We recaptured 33 of these snakes (20 males, 13 females) in at least one additional survey year, and we recaptured 17 individuals (12 males, 5 females)

in 3–5 different survey years. Of these multi-year captures, we documented only a single instance of a snake moving between populations.

On 8 November 2002, we captured an adult male *D. couperi* (SVL = 140 cm; 1.86 kg) in sandhill habitat along Beards Creek, Long Co., Georgia, USA. The snake was marked with a passive integrated transponder (PIT) implanted subcutaneously and was released at the site of capture. On 23 December 2004, the snake was recaptured 22.2 km linear distance NE of its initial capture site in sandhill habitat N of the Canoochee River, Bryan Co., Georgia, USA. The snake was twice recaptured (at different tortoise burrows) the following fall/winter at the same sandhill site in Bryan Co.

The snake may have moved in search of mating opportunities; the Long County site where it was originally captured seems to support a very small *D. couperi* population, with only four males and no females found during our eight-year survey, while the site it moved to supports a larger population (9 adult females captured). If this snake moved between sites in a direct route (ca. 22 km), it would have traversed extensive areas of mesic pine flatwoods dotted with depression wetlands and would have crossed numerous blackwater creek swamps. Because of poorly-drained soils, *G. polyphemus* are very uncommon and locally distributed on this part of Fort Stewart. Alternatively, a less direct route (ca. 27 km) would have the snake traveling north along a north-south trending upland terrace, and then traveling east (parallel to the Canoochee River), often through sandy uplands populated by *G. polyphemus*.

Interpopulation dispersal in snakes is generally thought to be low (Parker and Plummer 1987. In Seigel et al. [eds.], *Snakes: Ecology and Evolutionary Biology*, pp. 253–301. McGraw Hill, New York, New York), and even short distances (e.g., 1.6 km) of unsuitable habitat can potentially restrict gene flow (Prior et al. 1997. *Conserv. Biol.* 11:1147–1158). This type of long-distance movement by an imperiled species underscores the importance of conserving large tracts of land and the value of maintaining habitat connectivity and dispersal corridors between populations.

We thank David C. Rostal for first capturing the snake, and M. Rebecca Bolt, Kevin M. Enge, and John G. Palis for helpful comments on the manuscript.

Submitted by **DIRK J. STEVENSON**, Project Orianne, Indigo Snake Initiative, 414 Club Drive, Hinesville, Georgia 31313, USA (e-mail: dstevenson@projectorianne.org); and **NATALIE L. HYSLOP**, Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida 32611, USA (e-mail: hyslopn@warnell.ufl.edu).

DRYMARCHON COUPERI (Eastern Indigo Snake). **DEATH FEIGNING.** At 1100 h on 5 November 2008, I captured an adult female *Drymarchon couperi* (SVL = 1080 mm) ca. 10 km SW of Townsend, McIntosh Co., Georgia, USA. When found, the snake was on the ground, moving through open-canopied sandhill habitat, vegetated with scattered clumps of Saw Palmetto (*Serenoa repens*); numerous Gopher Tortoise (*Gopherus polyphemus*) burrows were located within 100 m of the capture site. Upon capture, the snake actively struggled in my hands, rattled its tail, flattened its neck vertically, and released musk—characteristic defensive behaviors

for wild *D. couperi* when threatened (Stevenson et al. 2008. In Jensen et al. [eds.], *Amphibians and Reptiles of Georgia*, pp. 339–341. University of Georgia Press, Athens). Ambient temperature at the time of capture was 18°C, following an overnight low of 12°C; skies were cloudy and a very light, misty rain was falling. The snake had recently shed its skin, and appeared in good health.

When I attempted to pose the snake for photographs, it became motionless, rolled its head and neck to one side, and gaped (Fig. 1). It lay on the ground stationary and immobile, its mouth continuously open in the same position, for ca. 5 minutes. Occasionally, its tail would slowly and weakly twitch back and forth. Similar to Gehlbach's (1970. *Herpetologica* 26:24–34) description of death-feigning in the Western Coachwhip (*Masticophis flagellum testaceus*), the head and neck of the *D. couperi* were rigid while the posterior part of the snake was limp, and a bend in the neck caused the snake's head to face downward. When I moved to a distance of 5 m, within 45 seconds the *D. couperi* closed its mouth, fully righted itself, and crawled off normally. Twice, I captured the snake and elicited the behavior described above—both times followed by the snake again closing its mouth, righting itself, and crawling away within ca. 45 seconds when I retreated. It never struck or made any attempt to bite during the entire time it was being handled.

On 3 December 2008, I observed a second adult female *D. couperi* (SVL = 1295 mm; Wheeler Co., Georgia, USA) exhibit the same behavior. This snake, eyes opaque and nearing a shed event, was captured as it emerged from a tortoise burrow at 1210 h on a clear, sunny day (temperature at time of collection = 10°C) following a cold night (2.2°C) and frost event. The snake displayed the behavior for ca. 1 minute during my processing and marking; it moved slowly, albeit normally, when released at its capture burrow.

I interpret this behavior as death-feigning (thanatosis), a defensive strategy that has not previously been reported for *D. couperi*. Over a 15-year period (1992–2008), I have captured and handled over 150 *D. couperi* in southern Georgia as part of population moni-



FIG. 1. An adult female Eastern Indigo Snake (*Drymarchon couperi*) exhibiting death-feigning behavior (McIntosh Co., Georgia, USA).

toring studies (Stevenson et al. 2003. Southeast. Nat. 2:393–408), and had never observed this behavior. Similar death-feigning behavior has been observed in Eastern Coachwhips (*M.f. flagellum*) in North Carolina (Palmer and Braswell 1995. Reptiles of North Carolina. Univ. of North Carolina Press, Chapel Hill. 412 pp.) and in the Coastal Plain region of southeastern Georgia, including the Wheeler Co., Georgia site mentioned above (D. Stevenson, unpubl. data).

I thank Jeff Beane for reviewing the manuscript. Eastern Indigo Snake studies in Georgia are supported by Georgia Department of Natural Resources Scientific Collecting Permit 29-WBH-08-206, issued to Christopher L. Jenkins.

Submitted by **DIRK J. STEVENSON**, Project Orienne, Indigo Snake Initiative, 414 Club Drive, Hinesville, Georgia 31313, USA; e-mail: dstevenson@projectorianne.org.

FARANCIA ABACURA REINWARDTII (Western Mudsnake). **FEEDING BEHAVIOR.** Rossman (*in* Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana State Univ. Press, Baton Rouge. 300 pp.) recounts witnessing a captive Western Mudsnake chewing “vigorously back and forth along the trunk” of a Western Lesser Siren (*Siren intermedia nettingi*) “– inflicting deep gashes – before swallowing it headfirst.” During mid-morning on 28 June 1995, in a riparian area near the town of Kisatchie, Natchitoches Parish, Louisiana, USA, a repeated faint “yelp” drew my attention to a shallow puddle measuring about 0.3 m². Protruding out of the water, near the middle of the puddle, I saw the anterior 15–18 cm of an *F. abacura* that I judged to be about 75 cm total length. The snake had an *S. intermedia* ca. 18–20 cm total length, which was the source of the yelps, grasped by the midsection in its jaws. Most of the snake was completely concealed by the thick layer of dead hardwood leaves covering the bottom of the puddle. As I watched, the *F. abacura* proceeded to chew methodically back and forth along the trunk of the siren before finally swallowing it headfirst. Shortly after swallowing its prey, the snake withdrew the exposed portion of its body straight back into the opening in the submerged leaf litter, completely disappearing from view. This observation confirms that the captive behavior witnessed by Rossman was not unique, and may represent a typical feeding behavior in *Farancia abacura*.

Submitted by **STEPHEN H. SHIVELY**, 350 Castor Plunge Road, Woodworth, Louisiana 71485, USA.

HELICOPS ANGULATUS (Watersnake). **DIET AND REPRODUCTION.** The primarily nocturnal snake *Helicops angulatus* is a large colubrid that occurs in ponds, streams, and rivers of northern South America (Duellman 1978. Univ. Kans. Mus. Nat. Hist. Misc. Publ. 65:1–352; Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150). On 15 September 2007 we collected an adult female *H. angulatus* (SVL = 720 mm) in herbaceous vegetation next to a waterfall in a fragment of Atlantic Forest (12.950°S, 38.375°W; datum WGS84) in the Municipality of Salvador, Bahia State, Brazil. The snake was collected with official authorization (IBAMA-RAN 02010.000230/07-60) and deposited at the Zoologic Museum of Universidade Federal da Bahia

(MZUFBA 1921). The specimen was dissected, and food items identified and counted. Except for a small quantity of arthropods (Acarina, Hymenoptera, and Isoptera) that could have been secondarily ingested, stomach contents were composed entirely of four toads—*Rhinella margaritifera* (mean ± SE SVL = 120 ± 4 mm). Anurans and fishes are common prey of *Helicops* spp. (e.g., *H. leopardinus*, *H. caricaudus*; Marques et al. 2001. Serpentes da Mata Atlântica: Guia Ilustrado para a Serra do Mar. Editora Holos, Ribeirão Preto, São Paulo, 184 pp.; *H. angulatus* in Trinidad—Ford and Ford 2002. Carib. J. Sci. 38:129–132).

The *H. angulatus* was gravid with 17 vitellogenic follicles (mean length = 11.6 mm) and 37 previtellogenic follicles. The reproductive cycle for this species has been reported to last from February to November (Martins and Oliveira, *op. cit.*) with clutch sizes ranging from 11 to 18 (Ford and Ford, *op. cit.*). The observation of anuran predation in a vitellogenic female is further indication of the opportunistic foraging behavior of *H. angulatus*.

We thank the 19o Batalhão de Caçadores, for the permits to work at federal property. The Instituto Brasileiro do Meio Ambiente e Recursos Naturais Renováveis – IBAMA issued permits for the collection of snakes for our study.

Submitted by **JORGE AUGUSTO REIS GUIMARÃES**, **EDUARDO JOSÉ DOS REIS DIAS** (e-mail: ejrdias@hotmail.com), **LISE CUNHA VILELA**, and **ANDRÉA ROCHA OLIVEIRA**, Faculdades Jorge Amado, Avenida Luis Viana Filho, 6775, Paralela, 41745-130, Salvador, Bahia, Brazil.

HELICOPS POLYLEPIS (Norman’s Keelback). **DIET AND INTRASPECIFIC COMPETITION.** The genus *Helicops* is widespread throughout most of South America, from Colombia to Argentina (Rossman 1970. *In* Peters and Orejas-Miranda (eds.), Catalogue of the Neotropical Squamata Part 1. Snakes. U.S. Nat. Mus. Bull. (297):122–125). *Helicops polylepis* is little known and no diet information for the species has been published (Duellman 2005. Cusco Amazónico. Cornell University Press, Ithaca, New York. 433 pp.). Additionally, intra- and interspecific competition has been observed among North American watersnakes and on several occasions a single prey item (i.e., fish or frog) has been attacked by multiple individuals (Himes 2003. J. Herpetol. 37:126–131). Here we identify the first diet item for *H. polylepis* and report an observation of intraspecific competition in this species.

On 28 September 2006 (1056 h) two adult (total length of each ca. 70 cm) *H. polylepis* were observed consuming opposite ends of a freshwater eel, likely *Synbranchus marmoratus* (Fig. 1). A photograph was taken of the event (UTADC 1927), which occurred in a small stream 50 m N of the port at Lake Sandoval (approx. 12.6041667°N, 69.0472222°W, datum: WGS 84; 190 m elev.). Lake Sandoval is located in the Provincia Tambopata, ca. 3 km E of the Rio Madre de Dios in southeastern Peru. Both the snakes and their prey were identified from the photo and *H. polylepis* was distinguished from other *Helicops* by having paravertebral spots less than 3 scales long (Rossman, *op. cit.*). Duellman (2005, *op. cit.*) conjectured that this species likely feeds on fish and/or tadpoles and *Synbranchus marmoratus* has been found to be eaten by *H. infrataeniatus* and *H. leopardinus* (Aguiar and Di-Bernardo 2004. Stud. Neotrop. Fauna Environ. 39:7–14; Ávila et al. 2006. J. Herpetol. 40:274–79).



FIG. 1. Photograph of two adult *Helicops polylepis* consuming a freshwater eel, likely *Synbranchus marmoratus* (UTADC 1927). Photograph by E. Flores.

We thank J. A. Campbell for cataloguing the photograph and Jose Koechlin and Inkaterra for logistical support.

Submitted by **EFRAIN FLORES**, Reserva Amazónica, Inkaterra, Peru; **ROBERT C. JADIN**, Amphibian and Reptile Diversity Research Center and Department of Biology, University of Texas at Arlington, Arlington, Texas 76019, USA (e-mail: snakeman1982@hotmail.com); and **SARAH A. ORLOFSKE**, Department of Ecology and Evolutionary Biology, University of Colorado at Boulder, Boulder, Colorado 80309, USA.

LAMPROPELTIS GETULA GETULA (Eastern Kingsnake). **SCAVENGING AND DIET.** *Lampropeltis getula* is an ophiophagous colubrid known to consume other colubrid, viperid and elapid snakes (Ernst and Ernst 2002. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 661 pp.). Here we report evidence that *L. getula* may venture out onto roads to scavenge dead snakes that have been killed by vehicles, in turn exposing themselves to road mortality. Additionally, we report a novel diet record for *L. getula*, *Pantherophis guttatus* (Red Cornsnake).

Historically, carrion feeding by snakes has been largely downplayed or ignored, despite recent work suggesting that scavenging is a common component of snake behavior (Sazima and Strüssmann 1990. Rev. Brasil. Biol. 50:463–468; Shivik and Clark 1997. J. Exp. Zool. 279:549–553) and the observation that nearly all snake species will readily accept pre-killed prey in captivity (e.g., Rossi 1992. Special Issue: 7th Annual Conference, Assoc. of Rept. and Amph. Vets. 107–108). At least 26 snake species from five families have been observed scavenging carrion from at least 35 species of vertebrate taxa (reviewed in DeVault and Krochmal 2002. Herpetologica 58[4]:429–436). However, because scavenged carcasses are difficult to differentiate from live prey through stomach content or fecal surveys, the majority of scavenging events that take place in the field are likely overlooked. The costs associated with exploiting carrion as a food source are generally low compared to other costs incurred through foraging on live prey (e.g., stalking, production of venom, and potential injury during prey



FIG. 1. Road-killed *Lampropeltis getula* (left) with *P. alleghaniensis* protruding from mouth (upper right) and *P. guttatus* protruding from burst body cavity (lower right, partially obscured by *P. alleghaniensis*).

capture). However, the risk of scavenging carcasses from roads is relatively high, especially considering the lengthy amount of time snakes take to consume large food items. Additionally, while the use of carrion as a major food source may be unrealistic for many endothermic scavengers due to its ephemeral and unpredictable availability, snakes' exceptionally low metabolic demands make it possible for them to capitalize on these irregular, energy-rich meals (DeVault and Krochmal, *op. cit.*).

At 1130 h on 2 April 2006, we found a road-killed female *L. getula* (SVL = 575 mm SVL; total length = 675 mm) on Turney Anderson Road, 0.15 road mi. E of the junction with Arline Road in Jefferson County, Florida, USA (30.581152°N, 83.844966°W, WGS84; elev. 56.4 m). Protruding from the mouth of the *L. getula* was a dead female *Pantherophis alleghaniensis* (Eastern Ratsnake; SVL = 365 mm; total length = 455 mm), ca. 70 mm of which had been ingested by the *L. getula*. Additionally, protruding from the stomach through the body wall of the *L. getula* was a partially digested segment of a *Pantherophis guttatus* (Red Cornsnake) of indeterminable sex, measuring at least 240 mm SVL (Fig. 1). Surprisingly, *P. guttatus* has not been documented in the literature as a food item for *L. getula*, although at least nine other colubrid species including conspecifics and *P. alleghaniensis* have been recorded (Ernst and Ernst, *op. cit.*).

Our findings suggest potential direct costs (mortality) for snakes scavenging roadkill or foraging on roads and reports a new aspect of the feeding ecology of *L. getula*.

Submitted by **ANDREW M. DURSO**, Odum School of Ecology, University of Georgia, 140 E. Green St., Athens, Georgia 30602, USA (e-mail: amdurso@uga.edu); **E. PIERSON HILL**, Florida State University, Department of Biological Science, Tallahassee, Florida 32306, USA (e-mail: phill@bio.fsu.edu); and **KIMBERLY J. SASH**, Florida Fish and Wildlife Conservation Commission, 620 S. Meridian St., Tallahassee, Florida 32399, USA (e-mail: kjsash@gmail.com).

LIOPHIS ALMADENSIS (NCN). **PREDATION.** *Liophis almadensis* is a small terrestrial xenodontine snake that occurs from the southern side of the Rio Amazonas (Marajó Island) to the Rio

Grande do Sul in Brazil, south of the Paraguayan Chaco (Dixon 1991. *Texas J. Sci.* 43:225–236). This species feeds on anurans and possesses red ventral coloration contrasting with a predominantly gray dorsum (Marques et al. 2005. *Serpentes do Pantanal*. Holos Editora, Ribeirão Preto, SP. 179 pp.). There are no published records of predation on *L. almadensis*. At 1700 h on 29 July 2008, I observed a *Furnarius rufus*, a large ovenbird (Rufous Hornero, Furnariidae), handling a *L. almadensis* along an unpaved road that crosses a pasture (30.2042°S, 50.8700°W; datum Córrego Alegre; elev. 50 m) in a rural area in municipality of Viamão, State of Rio Grande do Sul, south Brazil. On my approach, the bird flew off, leaving the snake (juvenile male; SVL = 190 mm; total length = 204 mm) on the ground. Examination of the snake revealed that the top of its head, between the eyes, was deeply perforated by bird's beak. Five more perforations and additional peck marks were present on the snake's dorsum and part of the digestive tract was exposed. The snake was still showing motor reflexes, indicating that it had been recently attacked.

This observation reports a novel predator for *L. almadensis*. The record is even more interesting because *F. rufus* is known to eat only invertebrates (arthropods and earthworms) and seeds (Sick 1988. *Ornitologia Brasileira: uma Introdução*. Universidade de Brasília, Brasília, DF. 828 pp.) and the red ventral coloration of *L. almadensis* may mimic a sympatric coral snake (*Micrurus altirostris*). The *L. almadensis* voucher (MCP 18412) was deposited in the Coleção Herpetológica do Museu de Ciência e Tecnologia da PUCRS.

I thank Gláucia M. F. Pontes for snake identification, Marcio Borges Martins and Carlos Roberto R. Oliveira for suggestions on the manuscript.

Submitted by **ALEXANDRO M. TOZETTI**, Laboratório de Ecologia de Vertebrados Terrestres. Instituto de Ciências Biológicas, Universidade Federal do Rio Grande. Av. Itália, km 8, Rio Grande, RS, Brazil; e-mail: alexandrotozetti@furg.br.

NERODIA ERYTHROGASTER (Plain-bellied Watersnake). **FORAGING BEHAVIOR.** Published observations of watersnake foraging behavior in nature are few (Gibbons and Dorcas 2004. *North American Watersnakes: A Natural History*. Univ. Oklahoma Press, Norman. 438 pp.). On 3 June 2006, I observed a *Nerodia erythrogaster* (total length = 76 cm) in a shallow (< 3 cm), 1.5 m × 3 m, muddy-water pool in a floodplain forest, Union County, Illinois, USA. As I entered the pool, the snake began to make a series of circular loops, first in one direction, then in the other. Initially, I assumed the snake was making an ineffectual attempt to escape. As I watched, however, I realized it was foraging for prey.

The snake foraged as follows: with head and body just under the water's surface, the snake rapidly coiled in one direction one or more times, ducked its head beneath its coiled body, repeated the coiling motion in the opposite direction, ducked its head beneath its coiled body, repeated the coiling motion in the opposite direction, etc. (Fig. 1). Forward movement, including change of direction, was continuous. The overall pattern created by the snake was that of a series of figure eights. However, because the loops did not follow the same path each time, the snake foraged over a different area with each change in direction. Foraging behavior was confirmed when, after performing a series of figure eights,

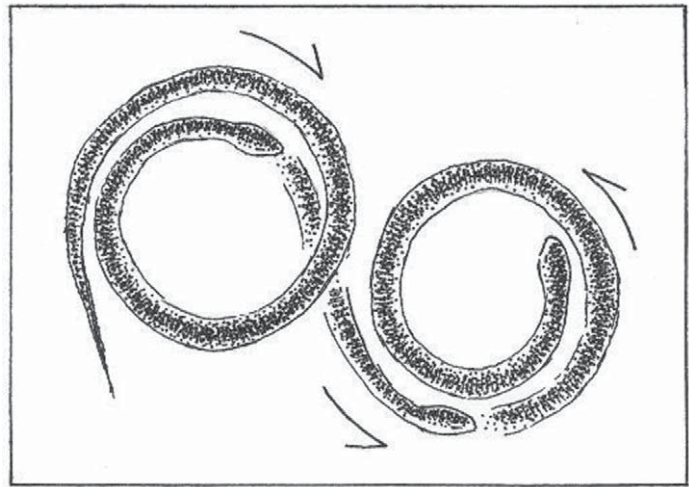


FIG. 1. Movement path of foraging *Nerodia erythrogaster*.

the snake raised its head above water holding a small fish in its mouth. Four species of fishes (*Ameiurus natalis*, *Aphredoderus sayanus*, *Esox americanus*, and *Notemigonus crysoleucus*; all ≤ 75 mm total length) and *Rana clamitans* tadpoles (≤ 25 mm total length) inhabited in the pool.

Evans (1942. *Chicago Nat.* 5:53–55) described watersnakes (*Nerodia* spp.) moving, open-mouthed, “through the water...in a series of figure eights, the entire body following the path of the head.” Although Evans assumed the snakes were foraging, he never saw snakes actually capture prey while engaging in the behavior. Although I could not see if the snake foraged open-mouthed due to the turbidity of the water, it is likely that the foraging behavior I observed is that described by Evans. My observation of prey capture supports Evans’ contention that he observed watersnakes foraging.

I thank J. W. Gibbons for providing a copy of the Evans reference, and E. L. Palmer for rendering the figure.

Submitted by **JOHN G. PALIS**, P.O. Box 387, Jonesboro, Illinois 62952, USA; e-mail: jpalis@yahoo.com.

OPHEODRYS AESTIVUS (Rough Greensnake). **FORAGING.** *Ophedryus aestivus* is an entomophagous colubrid known to consume spiders, harvestmen, millipedes, isopods, land snails, small hylid frogs and insects from several orders (Coleoptera, Ephemeroptera, Lepidoptera, Odonata, Orthoptera; Ernst and Ernst 2002. *Snakes of the United States and Canada*. Smithsonian Institution Press, Washington D.C. 661 pp.). Captive feeding trials on orthopterans have suggested that vision is the sole sense used to detect moving prey; motionless insects were overlooked despite tongue flicking (Goldsmith 1986. *Southwest. Nat.* 31:246–249). Here, we report evidence that *O. aestivus* will forage on visually concealed, gall-living insects (Price et al. 1987. *Environ. Entomol.* 16:15–24).

At 1445 h on 26 July 2007, one of us (KPD) spotted an adult *O. aestivus* in a Water Tupelo (*Nyssa aquatica*) along a boardwalk trail at the Virginia Marine Science Center, Virginia Beach, Virginia, USA (36.816144°N, 75.987989°W, WGS84; elev. <1 m). The trail is adjacent to the southern shore of Lake Rudee, a brackish water estuary that empties into the Atlantic Ocean via Rudee Inlet. The



FIG. 1. *Ophedrys aestivus* probing the surface of a crown gall in search of concealed insects.

snake was probing the surface of a large (>30 cm diameter) decayed woody “crown gall” identified as being caused by a bacterium, *Agrobacterium tumefaciens* (Smith and Townsend 1907. *Science* 25:671–673; Stafford 2000. *Bot. Rev.* 66:99–118). After several minutes, the snake inserted the anterior third of its body through a concealed hole in the gall and withdrew a minute later with a live insect, which it immediately swallowed. We watched and photographed the snake for 15 minutes as it repeated this behavior (Fig. 1) before it departed.

We thank S. Covert (University of Georgia) and S. Fraedrich (U.S. Forest Service) for their assistance in identifying the gall.

Submitted by **ANDREW M. DURSO**, Odum School of Ecology, University of Georgia, Athens, Georgia 30602, USA (e-mail: amdurso@gmail.com); and **KEVIN P. DURSO**, College of Natural Resources, North Carolina State University, Raleigh, North Carolina 27695, USA (e-mail: kpdurso@ncsu.edu).

OVOPHIS MONTICOLA MAKAZAYAZAYA (Taiwan Mountain Pitviper). **DIET.** *Ovophis monticola* feeds primarily on small rodents and insectivorous mammals (Zhao et al. 1998. *Fauna Sinica-Reptilia* Vol. 3. Science Press, Beijing. 522 pp.). However, little natural history or dietary information has been published regarding *O. monticola makazayazaya*, a subspecies inhabiting Taiwan. This is likely a consequence of nocturnal and secretive behavior, activity during periods of light rain or fog, and occurrence in montane forests (Mao, pers. obs.).

On 24 November 2007, a female *O. m. makazayazaya* (SVL = 498 mm; tail length = 72 mm) was found in a funnel trap along a drift fence in Minchi, Yilan County, Taiwan (24.6442°N, 121.4631°E; datum WGS84; elev. 1130 m). The snake had an obvious bulge at mid-body, which slightly reduced its mobility. We palpated a partially digested *Niviventer coxingi* (Spinous Country Rat; 15.4 g), which had been ingested head-first. Based on a comparison with specimens in the National Museum of Natural Science (NMNS), Taiwan, we believe the rat had a body length ca. 95–130 mm. The snake was released.

Niviventer coxingi is endemic to Taiwan and occurs throughout the country in mountainous forests below 2200 m elevation (Pei 1995. *Zool. Stud.* 34:55–58) and appears to decrease activity in

response to strong moonlight (Lin et al. 1995. *Notes and Newsletter of Wildlifers* 3:11–13). Although the moon was nearly full at the time of these observations, dense fog may have reduced the lunar effect on the rat’s activity pattern.

We thank Y.-J. Chen (NMNS) for assistance.

Submitted by **JEAN-JAY MAO** (e-mail: jjmao@niu.edu.tw), **CHIN-LIANG HSU**, **WEI-HAN CHEN**, and **TIEN-SHIU HSIEH**, Department of Forestry and Natural Resources, National Ilan University, No. 1, Sec. 1, Shen-Lung Rd., Ilan, Taiwan 260; and **GERRUT NORVAL**, Applied Behavioural Ecology & Ecosystem Research Unit, Department of Nature Conservation, UNISA, Private Bag X6, Florida, 1710, Republic of South Africa.

PHILODRYAS NATTERERI (Paraguay Green Racer). **DIET.**

The diet of the medium-sized colubrid snake *Philodryas nattereri* is relatively well studied and includes lizards and mammals (Vitt 1980. *Pap. Avul. Zool.* 34:87–98.). On 24 November 2008, at 1400 h, we found an adult female *P. nattereri* (SVL = 879 mm; 175 g after dissection) that had been killed by local farmers, in a fish farm near Pentecoste, Ceará, Brazil (3.82145°S, 39.33824°W; datum WGS 84). Upon dissection, we found a *Myotis nigricans* (Little Brown Bat), a small bat of the family Vespertilionidae, that had been eaten head first by the snake. The prey was nearly intact and weighed 7 g. This insectivorous bat species is widespread in Central and South America and inhabits open habitats, including urban areas (Emmons and Feer 1999. *Neotropical Rainforest Mammals, a Field Guide*. Univ. Chicago Press, Chicago, Illinois. 307 pp.). The ingestion of bats by snakes is seldom reported in the literature, but may not be infrequent because bat colonies can represent a potential concentration of food that is constantly available (Esberárd and Vrcibradic 2007. *Rev. Bras. Zool.* 24:848–853). There is a report of bat predation by *Philodryas viridissimus*, which is primarily arboreal (Otto and Miller 2004. *Herpetol. Rev.* 35:277). To our knowledge, this is the first record of bat predation by the mainly terrestrial *P. nattereri*. The snake and the bat are deposited together in the herpetological collection of Universidade Federal do Ceará (CHUFC 3087).

We thank the Fundação Cearense de Amparo a Pesquisa (FUNCAP) for financial support, the Instituto Brasileiro do Meio Ambiente e Recursos Naturais (IBAMA) for the license (License number: 18596-1) to collect snake samples in the studied area.

Submitted by **PAULO CESAR MATTOS DOURADO DE MESQUITA** (e-mail: paulocmdm@gmail.com), **DIVA MARIA BORGES-NOJOSA** (e-mail: dmbnojosa@yahoo.com.br), and **FELIPE AUGUSTO CORREIA MONTEIRO** (e-mail: felipebioufc@gmail.com), Núcleo Regional de Ofiologia of the Universidade Federal do Ceará (NUROF-UFC), Campus do Pici, Depto. Biologia, Bl. 905, CEP 60.455-760, Fortaleza, CE – Brazil.

PSOMOPHIS JOBERTI (Sand Snake). **DEFENSIVE BEHAVIOR.** The genus *Psomophis* is composed of small, poorly-understood colubrid snakes with short tails that terminate in a spine (Myers and Cadle 1994. *Am. Mus. Novitates* 3101:1–33).

Psomophis spp. are restricted to South America and *P. joberti* is the only species that occurs in northeastern Brazil, which is dominated by caatinga vegetation (França et al. 2006. Occas. Pap. Oklahoma Mus. Nat. Hist. 17:1–13). On 3 July 2008, we collected a *P. joberti* (Co-0826) in São Gonçalo do Amarante Municipality (3.5741667°S, 38.8886111°W; datum WGS84), state of Ceará, Brazil, that displayed a defensive behavior after being collected—bending its body and pressing the tail spine against the collector’s hands, causing slight pain, but not inflicting any damage to the skin. The same behavior was observed in another specimen (Co-0829) collected on 12 September 2008 from Itapipoca Municipality, Brazil (3.4175°S, 39.6919444°W; datum WGS84). *Psomophis* are said to not bite defensively when touched (Carvalho and Nogueira 1998. Cad. Saúde Pública. 14:753–763). Lima-Verde (1991. Unpublished thesis, Universidade Federal do Ceará, Fortaleza, Brazil) collected 57 specimens of *P. joberti* in northeastern Brazil and described the species as diurnal, oviparous, and gentle. Although the defensive behavior reported here has not been noted previously, all works mention the presence of the tail spine. Tail spines and spine-pressing behavior have been reported in snakes of the genera *Typhlops* (Richmond 1955. Am. Mus. Novitates 1734:1–7), *Farancia* (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington DC. 668 pp.), and *Carphophis* (Ernst and Ernst, *op. cit.*).

Submitted by **DANIEL CASSIANO LIMA**, Universidade Estadual do Ceará – UECE/FACEDI, Av. Mons. Tabosa s/n, Itapipoca, Ceará, Brazil, 62500-000 (e-mail: dancassiano@yahoo.com.br); **DIVAMARIA BORGES-NOJOSA**, **MARIA JULIANA BORGES-LEITE**, and **DANIEL CUNHA PASSOS**, Núcleo Regional de Ofiologia, Universidade Federal do Ceará – NUROF/UFC. Campus do Pici, Bl. 905, Fortaleza, Ceará, Brazil, 60455-760.

PYTHON MOLURUS BIVITTATUS (Burmese Python). **CLUTCH SIZE.** Through instances of pet release or escape, a reproducing population of *Python molurus bivittatus*, native to Southeast Asia, has recently become established in and around Everglades National Park, Florida, USA (Snow et al. 2007. In Henderson and Powell [eds.], Biology of the Boas and Pythons, pp. 416–438. Eagle Mountain Publishing, Utah). On 2 March 2007, an adult female *P. m. bivittatus* (EVER 055842; SVL = 4240 mm; total length = 4710 mm; 56.69 kg) was captured near Ficus Pond (25.3749°W, 80.8274°W; datum WGS 1984) in Everglades National Park, Florida, USA. This specimen contained 85 large vitellogenic follicles (44.4 to 53.5 mm diameter) and 7.18 kg of fat bodies. Of these follicles, 48 were located in the right ovary (weight 2.49 kg) and 37 in the left ovary (weight 1.90 kg). A previous study reports a mean clutch size for *P. m. bivittatus* in Florida of 35.75 ± 3.35 (N = 8; range 19–46; Brien et al. 2007. Herpetol. Rev. 38:342). This finding of 85 follicles marks the largest recorded clutch size for *P. m. bivittatus* found in Florida.

Submitted by **MIKE ROCHFORD** (e-mail: mikerochford@hotmail.com), **MATTHEW L. BRIEN** (e-mail: mbrien@ufl.edu), and **JEMEEMA CARRIGAN** (e-mail: jjc2710@hotmail.com), University of Florida, Fort Lauderdale Research and Education Center, 3205 College Avenue, Fort Lauderdale, Florida, 33314-7719, USA; **RAY W. SNOW**, South

Florida Natural Resources Center, Everglades National Park, 40001 State Road 9336, Homestead, Florida 33034, USA (e-mail: skip_snow@nps.gov); and **FRANK J. MAZZOTTI**, University of Florida, Fort Lauderdale Research and Education Center, 3205 College Avenue, Fort Lauderdale, Florida 33314-7719, USA (e-mail: fjma@ufl.edu).

PYTHON MOLURUS BIVITTATUS (Burmese Python). **DIET.** Although Burmese pythons are native to southeastern Asia, both juvenile and adult specimens have been collected in Everglades National Park and surrounding areas in Florida since the mid 1990s (Snow et al. 2007. In Henderson and Powell [eds.], Biology of the Boas and Pythons, pp. 416–438. Eagle Mountain Publishing, Utah). On 20 March 2006, an adult female *P. m. bivittatus* (SVL = 4320 mm; total length = 4870 mm; 69 kg) was captured near Ficus Pond (25.3739°N, 80.8241°W, datum: WGS 1984; elev. <1 m) in Everglades National Park, Florida, USA. This specimen was deposited in the Florida Museum of Natural History, University of Florida (UF 146019). While examining gut contents, we found hair and four hooves of a fawn White-tailed Deer (*Odocoileus virginianus*). *Python m. bivittatus* is a dietary generalist known to eat a wide variety of mammalian, avian, and crocodylian prey (Snow et al., *op. cit.*). This observation constitutes the first record of White-tailed Deer predation by *P. m. bivittatus*.

Submitted by **MIKE ROCHFORD**, University of Florida, Fort Lauderdale Research and Education Center, 3205 College Avenue, Fort Lauderdale, Florida, 33314-7719, USA (e-mail: mikerochford@hotmail.com); **KENNETH L. KRYSKO** (e-mail: kenneyk@flmnh.ufl.edu), **JAMES NIFONG** (e-mail: nifong420@yahoo.com), and **LURIE WILKINS** (e-mail: lauriew@flmnh.ufl.edu), Florida Museum of Natural History, Dickinson Hall, P.O. 117800, University of Florida, Gainesville, Florida 32611, USA; **RAY W. SNOW**, South Florida Natural Resources Center, Everglades National Park, 40001 State Road 9336, Homestead, Florida 33034, USA (e-mail: skip_snow@nps.gov); and **MICHAEL S. CHERKISS**, University of Florida, Fort Lauderdale Research and Education Center, 3205 College Avenue, Fort Lauderdale, Florida, 33314-7719, USA (e-mail: mcherkis@ufl.edu).

RHINOBOOTHRYUM LENTIGINOSUM (Ringed Tree Snake). **DIET AND MAXIMUM SIZE.** The *Rhinobothryum* are poorly known (Greene 1997. Snakes: the Evolution of Mystery in Nature. Univ California Press, Berkeley. 351 pp.). *Rhinobothryum lentiginosum* is a nocturnal lizard specialist that seems to prefer riparian forest or edges of creeks or streams, as has been noted for *R. bovalli* (Solórzano 2004. Snakes of Costa Rica: Distribution, Taxonomy, and Natural History. Inbio, San José, Costa Rica 791 pp.). Here I report a *R. lentiginosum* that had consumed a juvenile green iguana (*Iguana iguana*) at Vitória do Xingu, Pará State, Brazil. At 2100 h on 11 July 2007, a large *R. lentiginosum* was found moving close to a fishing camp on the banks of the Xingu River and was killed. A visitor of the camp, Ian-Arthur Sulocki (IAS), took several photographs of the snake and the juvenile green iguana contained in the snake’s gut (Fig. 1). Based on the description and photographs by IAS, the snake was at least 1800 mm total length, substantially



FIG.1. *Rhinobothryum lentiginosum* (decapitated) with juvenile *Iguana iguana* that it had consumed.

larger than the largest (total length = 1498 mm) reported by Cunha and Nascimento (*op. cit.*). Thus, this event is noteworthy not only because it reports a new prey species and additional case of saurophagy in *R. lentiginosum*, but also because the snake likely represents the maximum size for this species. Additionally, this note documents a novel predator for juvenile *Iguana iguana* (Greene et al. 1978. *J. Herpetol.* 12:169–176).

I thank Ian-Arthur Sulocki for reporting the event and contributing photographs.

Submitted by **MARCELO RIBEIRO DUARTE**, Laboratório de Herpetologia, Instituto Butantan, Av. Vital Brazil, 1500, São Paulo, SP, Brazil, CEP 05503-900; e-mail: mrduarte@butantan.gov.br.

SIBON ANNULATUS (Ringed Snail-eater). **MAXIMUM SIZE.** *Sibon annulatus* is a small snake for its genus and has previously been recorded to a maximum total length of 557 mm (Savage 2002. *Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas.* Univ. Chicago Press, Chicago, Illinois. 934 pp.). At 2230 h on the 31 December 2004, during a nocturnal visual encounter transect for amphibians, we found an adult female *S. annulatus* in *Manicaria* swamp forest at Caño Palma Biological Station (8 km N of Tortuguero, Limón Province, Costa Rica). The snake was found at a perch height of 4.5 m in a *Loreya* sp. (Melastomataceae) tree. The live snake measured 362 mm SVL, 214 mm tail length, and weighed 8.8 g. At 576 mm total length, this specimen is the longest known *S. annulatus*. The specimen was collected under permit (Resolución No. 171-2004-OFAU) and deposited in the herpetological collections at Universidad de Costa Rica.

We thank the Canadian Organization for Tropical Education and Rainforest Conservation (COTERC) for permission to study at Caño Palma Biological Station, Xavier Guevara at the Ministerio de Recursos Naturales Energía y Minas (MINAE) for permits, Federico Bolaños of Universidad de Costa Rica for access to collections, and Farnborough College of Science and Technology for assistance with literature.

Submitted by **TODD R. LEWIS**, Westfield, 4 Worgret Road, Wareham, Dorset, BH20 4PJ, United Kingdom (e-mail: lewistr@hotmail.com); **GABRIEL DAVID**, 3819 Shelbourne St. Apt. 401, Victoria, British Columbia, V8P 5N3, Canada; **PAUL B. C. GRANT**, 4901 Cherry Tree Bend, Victoria, British Columbia, V8Y 1S1, Canada; **THOMAS C. LADUKE**, East Stroudsburg University, 200 Prospect Street, East Stroudsburg, Pennsylvania 18301-2999, USA; and **COLIN RYALL**, Kingston University, Penrhyn Road, Kingston upon Thames, Surrey, KU1 2EE, United Kingdom.

SISTRURUS CATENATUS EDWARDSII (Desert Massasauga). **DIET, PREY SIZE, AND FEEDING-RELATED MORTALITY.** *Sistrurus catenatus edwardsii* feeds on lizards, small mammals, small snakes, centipedes, and anurans (Holycross and Mackessy 2002. *J. Herpetol.* 36:454–464). Whiptails of the genus *Aspidoscelis* have been reported to be in the diet of *S. c. edwardsii*, however *A. marmorata* (Marbled Whiptail) has not yet been identified as prey (Holycross and Mackessy, *op. cit.*). This is rather intriguing, given the overlap that exists for both species' known geographic ranges (Degenhardt et al. 1996. *Amphibians and Reptiles of New Mexico.* Univ. New Mexico Press, Albuquerque. 431 pp.). Furthermore, little published information exists regarding prey size for *S. c. edwardsii*. Here, I report feeding-related mortality of an *S. c. edwardsii* following consumption of an adult *A. marmorata*.

At 1018 h on 7 August 2008, I discovered a deceased female *S. c. edwardsii* (TCWC 93556) lying in the bottom of a large sand dune blowout in Lea County, New Mexico, USA (32.7847°N, 103.8089°W; datum WGS 84; elev. 1173 m). The individual was lying dorsum up, appeared bloated, and had recently deceased. Both lizard and snake tracks were observed near the dead snake. The individual was collected and dissected to determine what was causing the large bulge in the snake's mid-section. Upon dissection, I discovered that the snake had consumed a female *A. marmorata* (TCWC 93557). The lizard's girth had caused a 35 mm long rupture in the snake's stomach which was likely the ultimate cause of death for the snake.

The *S. c. edwardsii* measured 310 mm SVL and 18 g mass post mortem and the *A. marmorata* measured 100 mm SVL and 21 g mass post mortem. This indicates that the snake attempted to ingest a prey item 1.17 times its own mass. This measurement is slight in comparison to the record for snakes (relative prey mass = 1.72; Mulcahy et al. 2003. *Herpetol. Rev.* 34:64); however, perhaps it illustrates a differential consumption/mortality threshold exists among species or individuals.

This observation is noteworthy for two reasons. First, although *S. c. edwardsii* and *A. marmorata* overlap in geographic range, their trophic relationship had not yet been clarified. Second, it indicates the consumption of large prey items may result in increased energy stores for *S. c. edwardsii*, but the potential threat of death due to a ruptured stomach exists.

Submitted by **DANIEL J. LEAVITT**, Texas Cooperative Wildlife Collection, Department of Wildlife and Fisheries Science, Texas A&M University, College Station, Texas 77843-2258, USA; e-mail: dlea886@neo.tamu.edu.

TANTILLA GRACILIS (Flat-headed Snake). **ARACHNID PREDATION.** *Tantilla gracilis* is found in the south-central region of the United States and is known to have 20 species of mammalian, avian, and snake predators (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 668 pp.). Because of the highly fossorial nature of this species, much of its life history remains unknown (Cobb 2004. Copeia 2004:397–402) and spider predators have not been reported. Here we report the first arachnid predation documented for *T. gracilis*.

On 27 September 2007, at ca. 1000 h, a juvenile (SVL = 74 mm; tail length = 22 mm; 0.095 g) *T. gracilis* (UTA R-55476) was observed in the web of a spider (0.034 g) of the genus *Steatoda* (Theridiidae); the snake was being consumed from behind the neck by its captor. At its lowest point, the juvenile *T. gracilis* was ca. 23 cm from the floor. It is highly unlikely that the snake fell or climbed into the web and therefore it is probable that the spider hoisted the snake to this position. While in the web, the snake's tail was tethered to its neck with webbing. Photographs were taken of the event, which occurred in the shower room of a large outdoor restroom at Camp Tyler, Smith County, northeastern Texas, USA (32.2566722°N, 95.1847778°W; datum WGS 84; elev. 129 m). This restroom hosts a group of >50 adult spiders of the family Theridiidae.

We thank J. A. Campbell and C. J. Franklin for cataloguing the photograph and specimen, D. Formanowicz for identifying the spider to genus, and V. A. Cobb for reviewing this manuscript. We also thank Alan and Jenny Byboth, Jim Connally, and the Camp Tyler Foundation for giving us a welcome place to live at Camp Tyler during much of our stay at Tyler. The specimen was collected under Texas Parks and Wildlife scientific permit no. SPR-0691-418.

Submitted by **JAKE A. PRUETT**, Department of Biology, University of Texas at Tyler, Tyler, Texas 75799, USA (e-mail: jpruett2@patriots.uttyler.edu); and **ROBERT C. JADIN**, Amphibian and Reptile Diversity Research Center and Department of Biology, University of Texas at Arlington, Arlington, Texas 76019, USA.

TANTILLA OOLITICA (Rim Rock Crowned Snake). **DEFENSIVE BEHAVIOR.** At 0950 h on 25 May 2007 we captured a *Tantilla oolitica* (total length = 199 mm; 1.65 g) resting in an elongate coil under a rotting board in Dove Creek Hammock, Key Largo, Florida, USA, during a study by The Institute of Regional Conservation to determine the conservation status of this species. The ambient temperature was 25.2°C and the relative humidity was 80%. Upon capture, the snake began to feign death by remaining limp in our hands with its mouth open and tongue slightly extended. It continued to behave this way for about 10 minutes as we measured and weighed the snake. The act was very convincing and the three of us present at the time believed it to be dead or dying. We were particularly convinced of this when it continued the act even when placed upon a rock. It remained as posed for several minutes before slowly starting to crawl away. When we started to handle the snake again, it repeated the process of feigning its death. This cycle continued for 30 minutes until the snake was deemed healthy and was released. The ecology of this species is poorly-understood

and whether this behavior represents a common defensive response or an isolated instance remains unknown.

Submitted by **MIKE ROCHFORD**, University of Florida, Fort Lauderdale Research and Education Center, 3205 College Avenue, Fort Lauderdale, Florida, 33314-7719, USA (e-mail: mikerochford@hotmail.com); **KIRSTEN HINES**, The Institute for Regional Conservation, 22601 SW 152 Avenue, Miami, Florida 33170 USA (e-mail: hines@regionalconservation.org); and **FRANK J. MAZZOTTI**, University of Florida, Fort Lauderdale Research and Education Center, 3205 College Avenue, Fort Lauderdale, Florida, 33314-7719, USA (e-mail: fjma@ufl.edu).

THAMNOPHIS SIRTALIS (Common Gartersnake). **SCAVENGING.** Although snakes often accept dead food items in captivity, observations of scavenging by wild snakes are relatively rare. In a recent review, DeVault and Krochmal (2002. Herpetologica 58:429–436) suggested that scavenging may be a deliberate feeding strategy in some snake species rather than just an opportunistic event.

Thamnophis sirtalis is considered to be a dietary generalist and studies have indicated that it preys upon invertebrates, fishes, amphibians, mammals, and birds (Rossman et al. 1996. The Garter Snakes, Evolution and Ecology. Animal Nat. Hist. Series, vol. 2. Univ. of Oklahoma Press, Norman. 332 pp.). Published records of scavenging by wild *T. sirtalis*, however, are rare, and to date only six reports exist, all involving birds and anurans as prey. Gray (2002. Herpetol. Rev. 33:142–143) suggested that scavenging of dead anurans by *T. sirtalis* may be common but scavenging of birds is rare. However, there are four reports of this species scavenging birds (Ruthven 1908. Bull. U.S. Natl. Mus. 61:1–201; Feldman and Wilkerson 2000. Herpetol. Rev. 31:248; Gray, *op. cit.*; Sajdak and Sajdak 2007. Herpetol. Rev. 30:229–230) and only two on frogs (Ruthven, *op. cit.*; Brown 1979. Brimleyana 1:113–124). The latter two reports lack detail and only Ruthven (*op. cit.*) specified the scavenged anuran species (*Rana clamitans*; Green Frog). Given the abundance of *T. sirtalis* in many areas and high levels of road mortality often suffered by frogs and other prey items, frequent opportunities for scavenging should occur. Thus, the scarcity of reports suggests that scavenging by *T. sirtalis* is either rare in nature or frequently goes unreported. Here, I report two additional instances of scavenging of anurans by *T. sirtalis*.

At 1815 h on August 8 2008, I observed a *T. sirtalis* (total length ca. 30 cm) consuming a small (SVL ca. 3.0 cm), recently road-killed *Anaxyrus terrestris* (Southern Toad) on Road 161 (gravel) in Francis Marion National Forest, Berkeley County, South Carolina, USA (33.1853°N, 79.6946°W; datum WGS84). The incident occurred on the road surface approximately one meter from the heavily vegetated road shoulder. When discovered, the snake had already ingested the anterior one-third of the toad and continued to ingest it in my presence; complete ingestion took an additional six minutes.

At 1515 h on 17 September 2008, I observed another adult *T. sirtalis* (total length ca. 60 cm) attempting to engulf a road-killed *Lithobates pipiens* (Northern Leopard Frog; SVL ca. 7.5 cm) on Lyman Rd. (blacktop) bordering the southern edge of Big Bend State Fish and Wildlife Area, Whiteside County, Illinois, USA (41.6332°N, 90.0417°W; datum WGS84). The incident occurred

on the blacktop about 50 cm from the road shoulder, which was heavily vegetated. In this case, the frog was not freshly killed and desiccation of the skin indicated that it was killed about an hour before the observation. The anterior portion of the frog was stuck to the road surface and the snake was rather awkwardly attempting to ingest the left rear leg. The snake released it upon my approach. Following this observation, three more adult *T. sirtalis* and four more road-killed adult *L. pipiens* were observed on the road near the shoulder within 20 m of the location where the scavenging incident occurred. Despite observing the road for about 30 minutes, no other incidents of scavenging were noted.

Submitted by **ALLAN L. MARKEZICH**, Department of Natural Sciences and Engineering, Black Hawk College, Moline, Illinois 61265, USA; e-mail: markezicha@bhc.edu.

TOXICOCALAMUS STANLEYANUS (Stanley's Forest Snake).

DIET. Snakes of the genus *Toxicocalamus* are widespread in New Guinea, with published reports suggesting that the species *T. stanleyanus* is relatively common in the Purari basin region of Papua New Guinea (PNG; O'Shea 1996. A Guide to the Snakes of Papua New Guinea. Independent Publishing, Port Moresby, PNG. xii + 239 pp.). There is some evidence that *Toxicocalamus* spp. prey on earthworms (O'Shea, *op. cit.*). However, because of the secretive nature of these snakes, little is known of the ecology of many of the species and no data are available on the size of earthworms typically consumed for any species. While conducting herpetological censuses on 1 December 2008, at 1216 h (Australian EST), I captured a *T. stanleyanus* (total length ca. 670 mm) active in a disturbed area of lowland rainforest in the Purari basin of PNG (7.495556°S, 145.359444°E; datum WGS84; elev. 110 m). Immediately following capture, the snake was placed in a bag in a cooler maintained at 24°C. On checking the snake five hours later, it was revealed that the specimen had regurgitated a large, partly digested earthworm (Class Oligochaeta) measuring 150 mm in total length and 17 mm in width at mid-body. Following proper identification, the snake was released.

Submitted by **BRETT A. GOODMAN**, School of Marine & Tropical Biology, James Cook University, Townsville, Queensland, 4811, Australia. Current address: Ecology and Evolutionary Biology, University of Colorado, Ramaley N122, Campus Box 334, Boulder, Colorado 80309, USA; e-mail: Brett.Goodman@colorado.edu.

TYPHLOPS ANOUSIUS (NCN). **MAXIMUM SIZE.** On 8 March 1978, N. Drosdov collected a male *Typhlops anousius* (CZACC 4.5530; Colecciones Zoológicas del Instituto de Ecología y Sistemática, Cuba) from Tortuguilla, San Antonio del Sur municipality, Guantánamo province, Cuba. The specimen measured 273 mm SVL and 5 mm tail length. It had 24 scale rows anteriorly, reducing to 22 posteriorly at 7.6% TL or 49th middorsal scales row, 460 middorsal scale counts, 13 dorsal and 14 ventral caudal counts, snout sharp-pointed, rostral broad in dorsal aspect, 0.82 widest part of the posterior rostral to the internasal sutures in dorsal view / standard length of the rostral from the internasal sutures to the posterior tip in dorsal aspect (RWD/RLD). The body was straight-

sided and very acuminate posteriorly, and lacked pigmentation. The specimen was previously identified as *T. biminiensis* (by the collector and also by Orlando H. Garrido). I have re-identified the specimen as *T. anousius*. The specimen is a topotype and the first specimen of *T. anousius* reported since the species was described by Thomas and Hedges (2007. Zootaxa 1400:1–26). The previously-reported maximum length for this species is 193 mm SVL. Thus, this record represents a substantial increase in maximum size for the species and extends the range of variation in middorsal scale counts from 465–513 to 460–513 and RWD/RLD from 0.74–0.77 to 0.74–0.82 (Thomas and Hedges, *op. cit.*).

Submitted by **MICHEL DOMÍNGUEZ**, Ave. de Niza 3, 6°A, Alicante, 03540, Spain; e-mail: micheldd@hotmail.es.

TYPHLOPS BRONGERSMIANUS (Brongersma's Threadsnake).

REPRODUCTION. The genus *Typhlops* contains 121 species of pantropical snakes and is the largest of six genera within the Typhlopidae (Kley 2003. In M. Hutchins et al. [eds.], Grzimek's Animal Life Encyclopedia, 2nd ed. Vol. 7, Reptiles, pp. 379–385. Gale Group, Farmington Hills, Michigan). Six species of *Typhlops* have been reported for Brazil (Rodrigues and Juncá 2002. Pap. Avul. Zool., São Paulo 42:325–333). The biology of the Typhlopidae is still poorly known and the few available data refer to African species. For Brazil, biological information is scarce and restricted to anecdotal data (Ávila et al. 2006. J. Herpetol. 16:403–405). *Typhlops brongersmianus* is widely distributed through South America (Vanzolini 1972. Zool. Mededel. 47:27–29).

A gravid female *T. brongersmianus* (MZUESC 6531; SVL = 350 mm), captured on 21 December 2007 in a pit-fall trap in a cocoa (*Teobroma cacao*) plantation on the campus of Universidade Estadual de Santa Cruz, Ilhéus, southern Bahia, Brazil, was held in captivity until it began ovipositing eggs twelve days later. Fifteen eggs measuring (mean ± SD) 22.5 ± 2.2 mm in length and 13.0 ± 0.3 mm in width were laid. Four of the 15 eggs hatched after 34 days, while the others failed to hatch. The four hatchlings (MZUESC 6532) averaged 91.0 mm SVL and weighed 1.2 g. The hatchlings were light blue in color at birth but changed into the characteristic brown coloration of adults after 12 days. One of the hatchlings shed its skin in a continuous slough and not in pieces as reported by Kley (*op. cit.*).

Ávila et al. (*op. cit.*) reported four clutches from female *T. brongersmianus* originating from the Pantanal of Mato Grosso, Brazil. Clutch size averaged 4.67 eggs (range 4–5) and averaged 4.11 mm in length and 8.27 mm in width. The eggs reported here are 172% larger and 215% broader than those reported by Ávila et al. (*op. cit.*), perhaps reflecting geographic variation in reproductive strategy and/or local environmental conditions.

We thank G. E. Iack-Ximenes, A. Argôlo, and I. R. Dias for assistance. IBAMA issued the collecting permit (003/07 – IBAMA/RAN).

Submitted by **EUVALDO MARCIANO JUNIOR, JULIANA ALVES DE JESUS**, and **MIRCO SOLÉ** (e-mail: mksole@uesc.br), Universidade Estadual de Santa Cruz (UESC), Departamento de Ciências Biológicas, Rodovia Ilhéus-Itabuna, km 16, Salobrinho, CEP 45662-000, Ilhéus, BA, Brazil.

VIRGINIA VALERIAE VALERIAE (Eastern Smooth Earthsnake). **PREDATION.** Although many North American raptors include reptiles in their diets, reports of predation on snakes by passerine birds other than shrikes (Laniidae) and corvids are relatively uncommon (Ross 1989. Amphibians and Reptiles in the Diets of North American Raptors. Wisconsin Endangered Species Report No. 59). Most such incidents involve relatively large or mid-sized ground foragers such as thrashers (Browning 1973. Chat 37:107) and thrushes (Davis 1969. Wilson Bull. 81:471; Erickson 1978. Murrelet 59:26; Palmer and Braswell 1995. Reptiles of North Carolina. Univ. North Carolina Press, Chapel Hill. 412 pp.).

At ca. 1700 h on 31 January 2009, at Howell Woods, ca. 14 km ESE of Four Oaks, Johnston Co., North Carolina, USA (35.371°N, 78.307°W; datum WGS84), CEM heard rustling in the leaf litter 10 m away from and below his elevated position 5 m off the ground. The air temperature was ca. 6°C with a light wind (5–10 mph). Approximately 20 sec later, a Tufted Titmouse (*Baeolophus bicolor*) perched at the spot of the rustling in a small plant just above the ground surface. The bird then flew straight up to a tree branch ca. 5 m above the ground, carrying what later was identified as a *Virginia v. valeriae*. The titmouse immediately began pecking the snake and continued for 60 sec. The bird then flew to a branch 25 m above the ground while still carrying the snake, and resumed the pecking behavior. Between 5 and 10 min later, the bird was observed perched at the same spot, but without the snake. It swiped its bill as birds often do following predation. At ca. 1820 h, CEM scanned the area beneath the perch and located the remains of the snake. The head had been completely removed and punctures, likely from the bird's bill and claws, were scattered over the snake's body. The remains of the snake measured 19.69 cm in total length and weighed 2.1g.

This observation is particularly interesting because the Tufted Titmouse is such a small bird—averaging 17 cm long, 20 g in weight (Grubb and Pravosudov 1994. In A. Poole [ed.], The Birds of North America Online. Cornell Lab of Ornithology, Ithaca, New York; <http://bna.birds.cornell.edu/www.lib.ncsu.edu:2048/bna/species/086>). It eats primarily arthropod (e.g., caterpillars, beetles, ants, wasps, spiders, and scale insects) and vegetable foods, and typically forages by gleaning foliage and probing bark crevices (Grubb and Pravosudov, *op. cit.*). Although titmice generally forage in high vegetation, they may also spend considerable time feeding on or near the ground, especially on cold, windy days (Grubb and Pravosudov, *op. cit.*). To our knowledge, this represents the first report of a titmouse, or any similarly-sized passerine, as a predator of *V. valeriae*. The specimen is deposited in the North Carolina State Museum of Natural Sciences (NCSM 75790). It also represents a new county record and an early date of activity for the species in North Carolina (Palmer and Braswell, *op. cit.*).

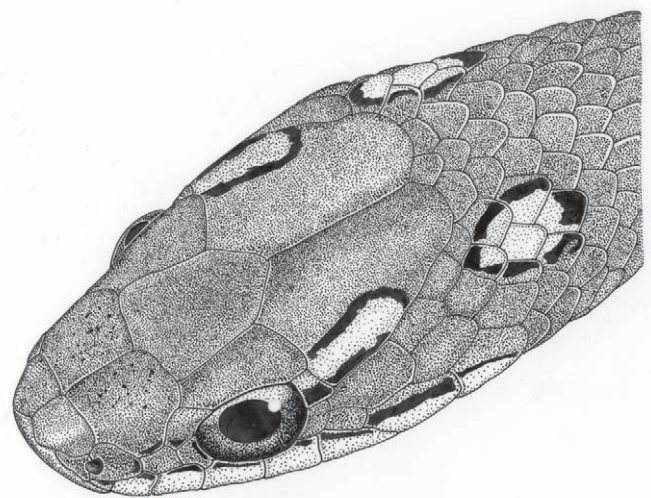
Submitted by **CHRISTOPHER E. MOORMAN**, Fisheries and Wildlife Sciences Program, Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, North Carolina 27695, USA (e-mail: chris_moorman@ncsu.edu); and **JEFFREY C. BEANE**, North Carolina State Museum of Natural Sciences, Research Laboratory, MSC # 1626, Raleigh, North Carolina 27699-1626, USA (e-mail: jeff.beane@ncdenr.gov).

XENOPHOLIS SCALARIS (Wucherer's Ground Snake). **DIET.** *Xenopholis scalaris* is believed to be a predatory specialist of frogs and its diet is known to be composed of *Adenomira andreae*, *Eleutherodactylus* species, *Hamptophryne boliviana*, and *Ischnocnema quixensis* (Duellman 1978. Univ. Kansas Nat. Hist. Mus. Misc. Publ. No. 65; Duellman 2005. Cusco Amazónico. Cornell University Press, Ithaca, New York. 433 pp.; Martins and Oliveira 1998. Herpetol. Nat. Hist. 6:78–150). Here we report an additional anuran food item for the species.

On 26 December 2007 an adult *X. scalaris* was observed and photographed consuming a subadult *Leptodactylus didymus* at Reserva Amazónica, Peru (UTADC 1954–55). The snake was found with the left leg of the anuran in its mouth. Over the next few minutes the snake engulfed the frog with its mouth, however the final ingestion of the prey item was not observed. The *L. didymus* was distinguished from *L. bolivianus*, also found at Reserva Amazónica, by having a creamy white longitudinal stripe across the thighs (Duellman 2005, *op. cit.*). Reserva Amazónica occurs in the Provincia Tambopata, ca. 12 km E of Puerto Maldonado on the north shore of the Rio Madre de Dios in southeastern Peru (ca. 12.5416667°N, 69.0527778°W; datum WGS 84; elev. 195 m). During our surveys from 18 December 2007 to 9 January 2008 we found *L. didymus* to be the most common anuran encountered. In addition, three *X. scalaris* were observed during surveys and the abundance of *L. didymus* may represent a large part of the prey base for *X. scalaris* in the area.

We thank J. A. Campbell for cataloguing the photograph and Jose Koechlin and Inkatererra for logistical support.

Submitted by **ROBERT C. JADIN**, Amphibian and Reptile Diversity Research Center and Department of Biology, University of Texas at Arlington, Arlington, Texas 76019, USA (e-mail: snakeman1982@hotmail.com); and **SARAH A. ORLOFSKE**, Department of Ecology and Evolutionary Biology, University of Colorado at Boulder, Boulder, Colorado 80309, USA.



Rhadinaea decorata (UMMZ 126432; 225 mm SVL). Guatemala: El Petén, Tikal. Illustration by Julian C. Lee.

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.

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 crocodylians). 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.**

Please submit any geographic distribution records in the **standard format only** to one of the Section Co-editors: **Alan M. Richmond** (USA & Canada records only); **Jerry D. Johnson** (Mexico and Central America, including the Caribbean Basin); **Indraneil Das** (all Old World records); or **Gustavo J. Scrocchi** (South American records). Short manuscripts are discouraged, and are only acceptable when data cannot be presented adequately in the standard format. **Electronic submission of manuscripts is required** (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments). Refer to inside front cover for e-mail addresses of section editors.

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.

NOTOPHTHALMUS VIRIDESCENS VIRIDESCENS (Red-spotted Newt). USA: OHIO: BELMONT Co.: Wayne Township, Raven Rock (39.88036°N, 81.04077°W; WGS 84). 04 April 2006. Cincinnati Museum Center (CMC 8957–8958). Vouchers for a second Belmont Co. location were also obtained (CMC 8998–8999). SHELBY Co.: Washington Township, Lockington Preserve (40.21596°N, 84.25667°W; WGS 84). 12 August 2008. CMC 11283. All material collected by Jeffrey G. Davis and Greg Lipps Jr. and verified by John W. Ferner. First county records (Pfungsten and Matson 2003. Ohio Salamander Atlas, Ohio Biological Survey Misc. Contrib. No. 9, Columbus).

Submitted by **JEFFREY G. DAVIS**, Cincinnati Museum Center – Fredrick and Amye Geier Research and Collections Center, 1301 Western Avenue, Cincinnati, Ohio 45203-1130, USA (e-mail: anura@fuse.net); and **GREG LIPPS JR.**, 1473 County Road 5-2, Delta, Ohio 43515, USA (e-mail: GregLipps@aol.com).

SALAMANDRA SALAMANDRA (Fire Salamander). HUNGARY: BUDAPEST: Pesthidegkút (47.34°N, 18.56°E; elev. 260 m). 01 June 2009. Gábor Szelényi. Verified by Judit Vörös, Hungarian Natural History Museum (HNHM 2009.2.1). First county record. Species previously known from Budapest Hills (Méhely 1918. Fauna Regni Hungariae [Reptilia et Amphibia]. Királyi Magyar Természettudományi Társulat 13 pp.), but report did not specify locality. No specimens had been observed in the area since 1918. Adult specimen collected close to stream in forested valley surrounded by buildings and roads.

Submitted by **GÁBOR SZELÉNYI**, Middle-Danube-Valley Inspectorate for Environmental Protection, Nature Conservation and Water Management, 1072 Budapest, Nagydiófa u. 10–12, Hungary; **ISTVÁN KISS**, Szent István University, Department of Zoology and Animal Ecology, 2100 Gödöllő, Páter K. u. 1, Hungary (e-mail: kiss.istvan@mkk.szie.hu); and **JUDIT VÖRÖS**, Hungarian Natural History Museum, 1088 Budapest, Baross u. 13, Hungary.

ANURA – FROGS

ACRIS CREPITANS (Northern Cricket Frog). USA: ARKANSAS: WOODRUFF Co.: near Brushy Lake Road on Cache River National Wildlife Refuge, 0.2 mi. S of AR 260 W (35.22372°N, 91.25617°W; WGS84; elev. 60 m). 25 Oct 2009. Thomas J. Belford. University of Kansas Natural History Museum photo voucher (KUDA 9109). Verified by William E. Duellman. Four specimens were found in a grassy flooded ditch. First county record. Extends range ca. 29 km from nearest known record in White Co., Arkansas. (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press. Fayetteville. 421 pp.)

Submitted by **THOMAS J. BELFORD**, 701 West Academy Avenue, Searcy, Arkansas 72143, USA; e-mail: thomasbelfordini@yahoo.com.

ACRIS CREPITANS (Northern Cricket Frog). USA: TENNESSEE: LAWRENCE Co.: Tennessee Amphibian Monitoring Program (TAMP) Route 820513, Stop 10, Dry Creek Rd. 0.39 km S of intersection with County Line Rd (35.43605°N, 087.22462°W;

WGS84). 15 May 2007. Brian Stewart. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU audio). New county record (Redmond and Scott 1996. Austin Peay St. Univ. Center Field Biol. Misc. Publ. 12:1–94).

Submitted by **BRIAN STEWART**, 850 Lion Parkway, Columbia, Tennessee 38401, USA.

ANAXYRUS WOODHOUSII (Woodhouse's Toad). USA: COLORADO: CHAFFEE Co.: Ute Creek drainage north of Salida (38.54967°N, 106.00728°W; NAD 83; elev. 2150 m), 14 September 2009. Raquel Stotler and Heather Adams. Verified by Lauren J. Livo. Photograph deposited in the Ancillary Collection of the University of Colorado Museum, Boulder, Colorado (UCM-AC 171). First county record. Extends range along Arkansas River northwest ca. 11 km from Wellsville record in Fremont Co. (Hammerson 1999. *Amphibians and Reptiles in Colorado*, 2nd ed. University Press of Colorado, Niwot. xxvii +484 pp.).

Submitted by **RAQUEL STOTLER**, Colorado Division of Wildlife, 7405 U.S. Highway 50, Salida, Colorado 81201, USA; e-mail: Raquel.Stotler@state.co.us.

CHIASMOCLEIS ALAGOANUS (NCN). BRAZIL: PERNAMBUCO: Municipality of São Lourenço da Mata: Engenho Tapacurá (08.014522°S, 35.087728°W; WGS 84; elev. 153 m). 27 September 2006. E. M. dos Santos and F. O. de Amorim. *Coleção Herpetológica da Universidade Federal Rural de Pernambuco, Unidade Acadêmica de Serra Talhada, Serra Talhada, Pernambuco, Brazil* (CHUFPRPE 972, adult specimen SVL 26.4 mm). Verified by M. A. Freitas. First state record. Previously known from the type locality: Mata do Catolê, Municipality of Maceió, state of Alagoas (Cruz et al. 1999. *J. Zool.*, London 249:123); and Mata do Buraquinho, municipality João Pessoa, state of Paraíba (Vieira et al. 2008. *Biotemas* 21[1]:75–84). Extends the known distribution 195 km N from type locality and 100 km S from municipality of João Pessoa.

Submitted by **EDNILZA MARANHÃO DOS SANTOS**, Unidade Acadêmica de Serra Talhada, Universidade Federal Rural de Pernambuco, 56900-000, Serra Talhada, PE, Brazil; and **FABIANA OLIVEIRA DE AMORIM**, Rua Eng. Gercino de Pontes, n.129, apto.101, Iputinga, 50800-110, Recife-PE, Brazil.

CHIROMANTIS DORIAE (Doria's Bush Frog). BANGLADESH: SYLHET DIVISION: Maulvibazar District, Sreemangal, Lawachara National Park (24.3306333°N, 91.793°E). 12–13 June 2008. M. K. Hasan. Jahangirnagar University Herpetological Group, Department of Zoology, Jahangirnagar University, Savar, Dhaka, Bangladesh (JUHG 0292–0296). Verified by S. D. Biju. First country record for Bangladesh. Nearest locality record, from Namdapha Tiger Reserve, Arunachal Pradesh, NE India, is ca. 630 km NE of this locality (Pawar and Birand. 2001. *CERC Tech. Rep.* [6]:1–118). Males observed calling between 1950–2015 h from foliage of climbing plants, on wall bordering railroad track that transects mature secondary forested area. Numerous foam nests observed on underside of leaves overhanging small, stagnant water body, at base of wall.

Collection permit issued by Bangladesh Forest Department (CCF[wildlife]/2M–37[part 3]/2007/1047). MKH and MFK would like to thank Mushfiq Ahmed for lab assistance and SM would like

to thank Barry Clarke (BMNH) for permitting access to collections.

Submitted by **MD. KAMRUL HASAN**, Jahangirnagar University Herpetological Group, Department of Zoology, Jahangirnagar University, Savar, Dhaka, Bangladesh (e-mail: hasan_wildlifeju@yahoo.com); **STEPHEN MAHONY**, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram, Tamil Nadu 603 104, India (e-mail: stephenmahony2@gmail.com); and **MD. MOFIZUL KABIR**, Jahangirnagar University Herpetological Group, Department of Zoology, Jahangirnagar University, Savar, Dhaka, Bangladesh.

GASTROPHRYNE OLIVACEA (Western Narrow-mouthed Toad). USA: NEBRASKA: WEBSTER Co.: 8.0 km S Red Cloud (40.017017°N, 98.51895°W; NAD 83). 21 and 23 July 2008. Keith Geluso and Greg D. Wright. Verified by Thomas E. Labeledz, University of Nebraska State Museum, Lincoln, Nebraska (UNSM ZM 23866–23867). New county record. Represents only second county in Nebraska with observations. Previous records reported from Gage Co. (Lynch 1985. *Trans. Nebraska Acad. Sci.* 13:33–57). Multiple individuals observed at night feeding on tiny ants on moderately vegetated slopes with small limestone rocks. An additional specimen from this location was collected on 03 June 1985 (UNSM ZM 8814).

Submitted by **KEITH GELUSO** (e-mail: gelusok1@unk.edu) and **GREG D. WRIGHT**, Department of Biology, University of Nebraska–Kearney, Kearney, Nebraska 68849, USA.

HYLA CINEREA (Green Treefrog). USA: TENNESSEE: MCNAIRY Co.: Finger, 294 Sherry Lynn Drive (35.357800°N, 88.635583°W; datum WGS84). 22 September 2009. Brian P. Butterfield and Joseph B. Butterfield. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 18975 color photo). First county record. Specimen was collected on the inside wall of a garage in a rural, residential subdivision located in an oak/hickory forest. (Redmond and Scott 1996. *Atlas of Amphibians in Tennessee*. Misc. Publ. No. 12. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions [<http://www.apsu.edu/amatlas/>]. Accessed 23 October 2009). Collection was made under the authority of Tennessee Wildlife Resources Agency Permit 1494.

Submitted by **BRIAN P. BUTTERFIELD**, Department of Biology, Freed-Hardeman University, Henderson, Tennessee 38340, USA (e-mail: bbutterfield@fhu.edu); and **JOSEPH B. BUTTERFIELD**, 294 Sherry Lynn Drive, Finger, Tennessee 38334, USA.

ISCHNOCNEMA OCTAVIOI (Octavio's Robber Frog). BRAZIL: ESPÍRITO SANTO STATE: Matilde, Municipality of Alfredo Chaves (20.330306°S, 40.480560°W; datum: Córrego Alegre; elev. 632 m). 22 July 2008. R. B. Dantas. Zoology Collection, Museu de Biologia Mello Leitão, Santa Teresa, Espírito Santo, Brazil (MBML 6762). Verified by G. M. Prado). First state record, extends range ca. 258 km NE from Casimiro de Abreu municipality, Rio de Janeiro state. Previously known only from Brazil, in the state of Rio de Janeiro (Vrcibradic et al. 2008. *Check List* 4:103–106).

Submitted by **ROBERTO DE BARROS DANTAS** (e-mail: dantasbio@hotmail.com); and **RODRIGO BARBOSA FER-**

REIRA (e-mail: rodrigoecologia@yahoo.com.br), Museu de Biologia Mello Leitão, Av. José Ruschi, N° 4, CEP 29.650-000, Santa Teresa, Espírito Santo, Brazil.

LEPTODACTYLUS FRAGILIS (White-lipped Frog). MÉXICO: OAXACA: Municipality of Santiago Jamiltepec, Atotonilco (16.189444°N, 97.819722°W; WGS 84), 68 m elev. 01 January 2006. Aurelio Ramírez-Bautista and Vicente Mata-Silva. Verified by Uriel Hernández-Salinas. Colección Herpetológica del Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB 2498–2503). First municipality records. Fill a gap between the closest reported localities ca. 210 km WNW near Acapulco, Guerrero (Flores Villela et al. 1991. Serie Cat. Mus. Zool. “Alfonso L. Herrera” Cat. [3]:1–222) and ca. 270 km ENE of several records in the vicinity of Tehuantepec, Oaxaca (Hartweg and Oliver 1940. Misc. Publ. Mus. Zool. Univ. Michigan [47]:1–31; Duellman 1960. Univ. Kansas Publ. Mus. Nat. Hist. 13:19–72). Casas-Andreu et al. (2004. In Garcia-Mendoza et al. [eds.], Biodiversidad de Oaxaca, pp. 375–390. Inst. Biol. UNAM, Mexico D.F.) reported that this species occurs in floristic-faunistic areas 9 and 10 in the eastern portion of Oaxaca. These animals were found within floristic-faunistic area 8 in the southern coastal/ foothills region. The frogs were found swimming along the cooler periphery of a hot spring.

Submitted by **VICENTE MATA-SILVA**, Department of Biological Sciences, The University of Texas at El Paso, El Paso, Texas 79968, USA (e-mail: vmata@utep.miners.edu); **AURELIO RAMÍREZ-BAUTISTA**, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo, A. P. 1-69 Plaza Juárez, Pachuca, Hidalgo, C.P. 42001, México (e-mail: aurelior@uaeh.reduaeh.mx); and **JERRY D. JOHNSON**, Department of Biological Sciences, The University of Texas at El Paso, El Paso, Texas 79968, USA (e-mail: jjohnson@utep.edu).

LITHOBATES CATESBEIANUS (American Bullfrog). USA: TENNESSEE: MAURY Co.: Tennessee Amphibian Monitoring Program (TAMP) Route 820513, Stop 6, Dry Creek Rd. 0.53 km S of intersection with Hwy 166 (35.50888°N, 087.21322°W; WGS84). 13 March 2007. Brian Stewart. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 18886 audio), New county record (Redmond and Scott 1996. Austin Peay St. Univ. Center Field Biol. Misc. Publ. 12:1–94).

Submitted by **BRIAN STEWART**, 850 Lion Parkway, Columbia, Tennessee 38401, USA.

NANORANA LIEBIGII (Liebig’s Hill Frog). BHUTAN: PARO DZONGKHAG: Susuna Highway, 28 km SW confluence with Haa Road (27.36°N, 89.31E; elev. 2350 m). 08 February 1969. B. Biswas and S. S. Saha. ZSIC A10964. SVL 129 mm, female. Verified by S. K. Dutta. First record from Bhutan (Das and Palden 2000. Herpetol. Rev. 31:256–258; Delorme and Dubois 2001. Alytes 19:141–153). Known from the Himalayan region of Nepal, northern and northeastern India and southern Xizang, China.

Submitted by **KAUSHIK DEUTI**, Zoological Survey of India, Amphibia Section, 27 Jawaharlal Nehru Road, Kolkata 700 016, India; e-mail: kaushikdeuti@rediffmail.com.

PHYLLODYTES ACUMINATUS. BRAZIL: PERNAMBUCO: Municipality of Buíque: Parque Nacional do Catimbau (08.489014°S, 37.716667°W; WGS 84; elev. 858 m). 09 March 2008. E. M. dos Santos, T. F. Campus, and G. L. da Silva. Coleção Herpetologica da Universidade Federal Rural de Pernambuco, Unidade Acadêmica de Serra Talhada, Serra Talhada, Pernambuco, Brazil (CHUFRPE 973). Adult specimen SVL 23.3 mm. Verified by M. T. Rodrigues. First state record from the semi-arid of state Pernambuco. Extends the known distribution 204 km NE from type locality and 267 km NE from municipality of Recife. Previously known only from the type locality: Municipality of Mangabeira, State of Alagoas (Bokermann 1966. An. Acad. Brasil. Cienc. 38:342); Zona da Mata, municipality Recife, State Pernambuco (Frost 2009. Amphibian Species of the World: An Online Reference, ver. 5.3. <http://research.amnh.org/herpetology/amphibia/>. American Museum of Natural History, New York, accessed on 17 December 2009).

Submitted by **EDNILZA MARANHÃO DOS SANTOS** and **GEANE LIMEIRA DA SILVA**, Unidade Acadêmica de Serra Talhada, Universidade Federal Rural de Pernambuco, 56900-000, Serra Talhada, PE, Brazil.

PSEUDACRIS FERIARUM (Upland Chorus Frog). USA: TENNESSEE: MAURY Co.: Tennessee Amphibian Monitoring Program (TAMP) Route 820513, Stop 3, S. Cross Bridges Rd. 0.44 km N of intersection with Ashwood Rd. (35.58850°N, 087.20668°W; WGS84). 13 March 2007. Brian Stewart. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 18884 audio). New county record (Redmond and Scott 1996. Austin Peay St. Univ. Center Field Biol. Misc. Publ. 12:1–94).

Submitted by **BRIAN STEWART**, 850 Lion Parkway, Columbia, Tennessee 38401, USA.

SCINAX LUIZOTAVIOI (Santa Barbara Snouted Treefrog). BRAZIL: MINAS GERAIS: Municipality of São José do Mantimento (20.06671°S, 041.75322°W, WGS84, elev. 415 m). 10–17 December 2008; 22–29 April 2009; 8–15 September 2009. M. D. Rocha. Museu de Ciências Naturais da Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil (MCNAM 11577–11578, 11582). Verified by L. B. Nascimento. Extends known distribution ca. 180 km E from Catas Altas, MG, near the frontier with Espírito Santo state. The species is known only from the southern portion of the Espinhaço Range, Minas Gerais, southeastern Brazil: Parque Natural do Caraça, in the municipality of Catas Altas, MG (Santa Bárbara in the original description of species) (Caramaschi and Kisteumacher 1989. Bol. Mus. Nac., Rio de Janeiro, N.S., Zool. 327:6; Estação Ambiental de Peti, in the municipality of São Gonçalo do Rio Abaixo, MG (Bertoluci et al. 2007. Herpetol. J. 17:18; Parque Estadual do Itacolomi, in the municipality of Ouro Preto, MG (Pedralli et al. 2001. Ciência Hoje 30 [178]:70–73); Área de Proteção da Captação da Mutuca, in the municipality of Nova Lima, MG (Nascimento et al. 1994. Bios 2:5–12); and Estação Ecológica de Fechos, also in the municipality of Nova Lima, MG (Bertoluci et al. 2007. *op. cit.*).

Submitted by **RONALD REZENDE DE CARVALHO JÚNIOR**, Táxon Meio Ambiente – Estudos e Projetos, Rua Marco Aurélio de Miranda, n. 406/903, Buritis, CEP 30575-210, Belo

Horizonte, Minas Gerais, Brazil (e-mail: rcjunior.bh@terra.com.br); **LUCAS GRANDINETTI**, Limiar Engenharia Ambiental, Avenida Luís Paulo Franco, n. 651/9º andar, Belvedere, CEP 30320-570, Belo Horizonte, Minas Gerais, Brazil (e-mail: grandinetti@terra.com.br); **MICHELLE DRUMOND ROCHA**, Rua Salinas, n. 2.410, Santa Tereza, CEP 31015-190, Belo Horizonte, Minas Gerais, Brazil (e-mail: mixcabr@gmail.com); **VIVIANE AMÉLIA FURTADO CALIXTO**, Rua Curupaiti, n. 751, Padre Eustáquio, CEP 31730-130, Belo Horizonte, Minas Gerais, Brazil (e-mail: vivitscalixto@yahoo.com.br); and **LEONARDO LOPES MACHADO**, Rua Paquetá, n. 1068, Giovanini, CEP 35170-094, Coronel Fabriciano, Minas Gerais, Brazil (e-mail: leolmachado@yahoo.com.br).

TESTUDINES – TURTLES

CHRYSEMYS PICTA (Painted Turtle). USA: NEBRASKA: FURNAS Co.: 0.3 km W, 5.0 km S Oxford (40.207183°N, 99.63923°W; NAD 83). 27 June 2009. Keith Geluso and Owen J. Johnson. Verified by Curtis J. Schmidt, Sternberg Museum of Natural History, Hays, Kansas (MHP 14675). New county record. Known from adjacent Red Willow County to the west (Lynch 1985. *Trans. Nebraska Acad. Sci.* 13:33–57). Found dead on road.

Submitted by **KEITH GELUSO** (e-mail: gelusok1@unk.edu) and **OWEN J. JOHNSON**, Department of Biology, University of Nebraska–Kearney, Kearney, Nebraska 68849, USA

CUORA AMBOINENSIS KAMAROMA (Malayan Box Turtle). PHILIPPINES: BALABAC: Barangays: Agutayan, Catagupan, Melville, Indalawan, and Salang; rice paddies near Basak Creek, Timbangan, Saray, Lagdong, Busay, and Baoang Creek. February 10–25 2007. P. Fidenci. California Academy of Sciences photo vouchers (CAS-HPV 48–54). Verified by Hallie Brignall. First records for Balabac (Diesmos et al. 2008. *Chelonian Conserv. Biol.* 7:157–177). One adult observed at rice paddies near Basak Creek, two adults at Timbangan Creek, one adult at Saray Creek, one adult in Lagdong Creek, three juveniles at Busay Creek, and two adults at Baoang Creek.

Submitted by **PIERRE FIDENCI**, Endangered Species International, 79 Brady St, San Francisco, California 94103, USA; e-mail: pfidenci@endangeredspeciesinternational.org.

GRAPTEMYS GEOGRAPHICA (Common Map Turtle). USA: INDIANA: LAWRENCE Co.: Buddha Bypass Bridge south of Buddha (38.7704250°N, 86.4093305°W; no datum available). 30 July 2008. Peter V. Lindeman. Verified by John B. Iverson. Florida Museum of Natural History Herpetology Dept. photographic archive (UF 153477). New county record (Minton 2001. *Amphibians & Reptiles of Indiana*, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Basking adult female.

Submitted by **PETER V. LINDEMAN**, Department of Biology and Health Services, 150 Cooper Hall, Edinboro University of Pennsylvania, Edinboro, Pennsylvania 16444, USA; e-mail: plindeman@edinboro.edu.

GRAPTEMYS GIBBONSI (Pascagoula Map Turtle). USA: MISSISSIPPI: PIKE Co.: Bogue Chitto River, 50 m upstream of Route 98 bridges (31.1773722°N, 90.2795194°W; no datum available).

25 May 2008. Peter V. Lindeman. Florida Museum of Natural History Herpetology Dept. photographic archive (UF 153478). Verified by Will Selman. New county record (Cliburn 1971. *J. Mississippi Acad. Sci.* 16:16–19), extending known range in the Bogue Chitto upstream by ca. 10 river km. Basking juvenile.

Submitted by **PETER V. LINDEMAN**, Department of Biology and Health Services, 150 Cooper Hall, Edinboro University of Pennsylvania, Edinboro, Pennsylvania 16444, USA; e-mail: plindeman@edinboro.edu.

GRAPTEMYS OUACHITENSIS (Ouachita Map Turtle). USA: INDIANA: LAWRENCE Co.: Buddha Bypass Bridge south of Buddha (38.7704250°N, 86.4093305°W; no datum available). 31 July 2008. Peter V. Lindeman. Verified by John B. Iverson. Florida Museum of Natural History Herpetology Dept. photographic archive (UF 153479). New county record (Minton 2001. *Amphibians & Reptiles of Indiana*, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Basking adult female.

Submitted by **PETER V. LINDEMAN**, Department of Biology and Health Services, 150 Cooper Hall, Edinboro University of Pennsylvania, Edinboro, Pennsylvania 16444, USA; e-mail: plindeman@edinboro.edu.

GRAPTEMYS OUACHITENSIS (Ouachita Map Turtle). USA: MINNESOTA: DAKOTA Co.: Pool 2 of the Mississippi River at approximately river mile 827 (44.8127°N, 093.009118°W; datum NAD83). 30 May 2009. Richard McCarthy. Verified by Kenneth Kozak and Amy Luxbacher. James Ford Bell Museum (photographic vouchers JFBM P317–P319). New county record (Oldfield and Moriarty 1994. *Amphibians and Reptiles Native to Minnesota*. University of Minnesota Press, Minneapolis. 233 pp.). Three individuals observed in slough and on adjacent mound in protected area bordering Pool 2. Northernmost known occurrence on Mississippi River. Species may have reoccupied Pool 2 following water quality improvements in recent decades.

Submitted by **RICHARD MCCARTHY**, Macalester College Ordway Natural History Study Area, 9950 Inver Grove Trail, Inver Grove Heights, Minnesota 55076, USA; e-mail: rmccarth@macalester.edu.

SQUAMATA – LIZARDS

ACRATOSAURAMENTALIS (NCN). BRAZIL: RIO GRANDE DO NORTE: Municipality of Tenente Laurentino Cruz, Serra Nova (06.109°S, 36.719°W; datum WGS84; elev. 704 m). 24 October 2009. M. Gogliath. Coleção Herpetológica do Departamento de Botânica, Ecologia e Zoologia, Universidade Federal do Rio Grande do Norte, Natal, Rio Grande do Norte (CHBEZ 2930). Verified by M. T. Rodrigues. First record in the state of Rio Grande do Norte, and extends the known geographical distribution of this species ca. 135 km N from the nearest record in the municipalities of São José dos Cordeiros/Sumé (Reserva Particular do Patrimônio Natural Fazenda Almas) (07.471°S, 36.881°W), state of Paraíba. According to Rodrigues (1986. *Pap. Avul. Zool.* 36[20]:237–250), *Acratosaura mentalis* has a disjunct distribution and has been found in Senhor do Bonfim (type locality), Mucugê (Freitas and Silva 2007. *Guia Ilustrado: A Herpetofauna das Caatingas e áreas de Altitudes do Nordeste Brasileiro*. Editora USEB, Pelotas, Bra-

zil. 384 pp.) and Maracás (Rodrigues et al. 2007. *Am. Mus. Nov.* 3565:1–27), state of Bahia; Grão Mogol (Rodrigues 1986, *op. cit.*) in the state of Minas Gerais; Estação Ecológica de Xingó, states of Alagoas/Sergipe (Bandeira 2000. *Aspectos Zoogeográficos e Ecológicos da Saurofauna da Estação Ecológica de Xingó, AL/SE*. Monograph, Universidade Federal de Alagoas, Maceió, Brazil. 35 pp.); Brejo da Madre de Deus, Pernambuco State (Queiroz and Lema 1996. *Biociências* 4[1]:87–90); Cabaceiras (Rodrigues 1986, *op. cit.*), Cacimba de Dentro (Arzabe et al. 2005. *In* Araújo et al. [orgs.], *Herpetofauna da área do Curimataú, Paraíba*, pp. 264–280. Ministério do Meio Ambiente, Brasília, Brazil), São José dos Cordeiros and Sumé (Reserva Particular do Patrimônio Natural Fazenda Almas; Delfim and Freire 2007. *Oecol. Bras.* 11[3]:365–382; Freire et al. 2009. *In* Freire [org.], *Répteis das Caatingas do Seridó do Rio Grande do Norte e do Cariri da Paraíba: Síntese do Conhecimento Atual e Perspectivas*, pp. 51–84. Editora Universitária da UFRN, Natal, Brazil), state of Paraíba.

We thank the municipal government of Tenente Laurentino Cruz for logistical support.

Submitted by **MELISSA GOGLIATH** (e-mail: melbiologa@gmail.com)^{1,2}, **LEONARDO B. RIBEIRO** (e-mail: ribeiro.lb@gmail.com)^{1,2}, and **ELIZA M. X. FREIRE** (e-mail: elizajuju@ufrnet.br)^{1,2}, ¹Laboratório de Herpetologia, Departamento de Botânica, Ecologia e Zoologia, Centro de Biociências, Universidade Federal do Rio Grande do Norte, Campus Universitário, 59072-970, Natal, RN, Brazil; ²Programa de Pós-graduação em Psicobiologia/UFRN, 59078-970, Natal, RN, Brazil.

AGAMA AGAMA AFRICANA (African Rainbow Lizard). USA: FLORIDA: DUVAL Co.: 15981 Croaker Road, Jacksonville (30.5285°N, 81.4820°W; WGS84). 07 August 2009. David Hoffer. Florida Museum of Natural History photographic voucher (UF 155901). Verified by Kenneth L. Krysko. First county record. Extends range ca. 195 km N of a population in Seminole Co. (Enge et al. 2004. *Florida Sci.* 67:303–310). Adult male observed on a pile of slate. Other individuals of different sizes have been observed on the property since 2008, indicating a potential breeding population of unknown provenance. This nonnative species has now been recorded from 10 counties in Florida.

Submitted by **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 1105 SW Williston Road, Gainesville, Florida 32601, USA (e-mail: kevin.enge@myfwc.com); **CHUCK HUBBUCH**, University of North Florida, 1 UNF Drive, Jacksonville, Florida 32224; and **DAVID HOFFER**, 15981 Croaker Road, Jacksonville, Florida 32226, USA.

CHALCIDES SEXLINEATUS BISTRATUS (NCN). SPAIN: CANARY ISLANDS: La Palma Island, Tazacorte, La Florida (28.639326°N, 17.928760°W; datum: WGS84; elev. 158 m). 08 September 2008, Two adults and two juveniles deposited in collection of Department of Animal Biology of La Laguna University (adults: DZUL 3018–3019; juveniles: DZUL 3020–3021). Verified by A. Martín. Species endemic to northern Gran Canaria Island. At least 60 individuals were brought to La Palma Island over 50 years ago. At the time, the species was absent from the island (Izquierdo et al. 2004. *Lista de Especies Silvestres de Canarias [Hongos, Plantas y Animales Terrestres]*. Gobierno de Canarias, Santa Cruz de Tenerife. 497 pp.). Presence of juveniles suggests an established

population. This species appears to occur over a small area (ca. 4 ha) dominated by intensive banana cultivation. Both native and introduced predators such as kestrels (*Falco tinnunculus*), lizards (*Gallotia* spp.), and feral cats (*Felis silvestris catus*) are known to eat skinks (Santana et al. 1986. *Vierarea* 16:113–117; Barbadillo 1987. *La Guía Incafo de los Anfibios y Reptiles de la Península Ibérica, Islas Baleares y Canarias*. Incafo, S.A., Madrid). These facts, together with the proximity of this population to villages and roads could affect the possible spread of the species to the rest of the island.

I thank A. Martín and M. Nogales for suggestions on the manuscript and J. A. Campbell for editorial assistance.

Submitted by **FÉLIX MANUEL MEDINA**, Consejería de Medio Ambiente, Cabildo Insular de La Palma, Avenida Los Indianos, 20, 2º, 38700 Santa Cruz de La Palma, Canary Islands, Spain; e-mail: felix.medina@cablapalma.es.

CHALCIDES VIRIDANUS (West Canary Skink). SPAIN: CANARY ISLANDS: La Palma Island: Los Llanos de Aridane (28.639326°N, 17.928760°W, datum: WGS84; elev. 158 m). 08 September 2008. Department of Animal Biology of La Laguna University, DZUL 3022. Verified by A. Martín. First island record with location data. Endemic to Tenerife Island, and probably introduced through wood commerce between both islands of the Canary Archipelago, and absent on La Palma Island (Izquierdo et al. 2004. *Lista de Especies Silvestres de Canarias [Hongos, Plantas y Animales Terrestres]*. Gobierno de Canarias, Santa Cruz de Tenerife. 497 pp.). This is the second record for this species on the island (Mateo 2002. *In* Pleguezuelos et al. [eds.], *Atlas y Libro Rojo de los Anfibios y Reptiles de España*, pp. 173–174. Dirección General de Conservación de la Naturaleza – Asociación Herpetológica Española, Madrid.

Submitted by **FÉLIX MANUEL MEDINA**, Consejería de Medio Ambiente, Cabildo Insular de La Palma, Avenida Los Indianos, 20, 2º, 38700 Santa Cruz de La Palma, Canary Islands, Spain; e-mail: felix.medina@cablapalma.es.

DAREVSKIA BRAUNERI SZCZERBAKI (Rock Lizard). GEORGIA: REPUBLIC OF ABKHAZIA: Gudauta District: Lzaa village, Pitsunda-Myussera Hills (Herpetological Collection of Zoological Institute, St. Petersburg, ZISP 24397, 25816–25818). Verified by Ilya S. Darevsky. First country record. 17 April 2006. Konstantin Milto and Mark Pestov. Additional specimens were seen on 5–7 July, 7–9 August 2008, and 7–12 August 2009 by Mark Pestov and Olga Bezman-Moseyko. Lizards were encountered on the clay-rock cliffs of the Black Sea coast between Lzaa settlement (43.16813°N, 40.4108°E) and mouth of Mysra River (43.15009°N, 40.45921°E). The previously known distribution of *Darevskia brauneri szczerbaki* is limited to a small territory on the northeastern coast of the Black Sea in Krasnodar Region, Russia. This subspecies is endemic of Crimea-Novorossisk subprovince of the East Mediterranean Province in Caucasus and inhabits a narrow coastal zone from Anapa town to the Cape of Utrish. New record is 297 km SE of previously documented locations. The Myussera Hills are probably the southernmost border of *D. b. szczerbaki* distribution.

Submitted by **KONSTANTIN D. MILTO** (e-mail: coluber@zin.ru), **MARK V. PESTOV**, and **OLGA S. BEZMAN-MOSEYKO**, Zoological Institute, Department of Herpetology, St. Petersburg, Universitetskaya emb., 1, 199034, Russia.

HELODERMA SUSPECTUM CINCTUM (Banded Gila Monster). USA: CALIFORNIA: SAN BERNARDINO Co.: Mojave National Preserve: Vulcan Mine (34.55353°N, 115.35160°W; WGS 84; elev. 1077m). 02 May 2009, 1615 h, 24°C air, 420 mm total length. Ron M. Ruppert. Verified by K. Beaman. Natural History Museum of Los Angeles County voucher photographs (LACM-PC 1461–1466).

There are only 26 records of *Heloderma suspectum* from California over the past 153 years. The most recent photographic documentation from the Vulcan Mine area was 1968. The most recent record in California was 2006 from an area 100 km to the north of Vulcan Mine (Lovich and Beaman 2007. *Bull. So. California Acad. Sci.* 106[2]:39–58).

Submitted by **RON M. RUPPERT**, Biology Department, Cuesta College, Highway One, San Luis Obispo, California 93403, USA; e-mail: rrupert@cuesta.edu.

HEMIDACTYLUS FRENATUS (Common House Gecko). MEXICO: BAJA CALIFORNIA SUR: Municipality of Comondú: Ciudad Constitución, Hotel Oasis (25.036472° N, 111.6795° W; WGS84; elev. 54 m) 25 October 2008. J. B. Granados. Verified by Oscar Flores-Villela. Herpetological collection of the Centro de Investigaciones Biológicas del Noroeste, La Paz, Baja California Sur, México (CIBNOR 0721–22). First records for the municipality. Bridges a distributional gap between La Paz (208 km SE) and Loreto (149 km NE) (Grismer 2002. *Amphibians and Reptiles of Baja California: Including its Pacific Islands and the Islands in the Sea of Cortez*. Univ. California Press, Berkeley, California. 399 pp.). Both juveniles were collected at night on the hotel wall, and because adults were also observed from the same location, this exotic species is assumed to be well-established there.

Submitted by **VÍCTOR H. LUJA** (e-mail: lujastro@yahoo.com), **JAVIER BRUNO GRANADOS**, and **RICARDO RODRÍGUEZ-ESTRELLA**, Centro de Investigaciones Biológicas del Noroeste (CIBNOR), Mar Bermejo #195 Colonia Playa Palo de Santa Rita, La Paz, Baja California Sur, 23090, México.

HEMIDACTYLUS MABOUIA (Wood Slave). USA: FLORIDA: ST. LUCIE Co.: Fort Pierce, 2100 Elizabeth Avenue (27.40840°N, 80.34595°W; WGS 84). 11 May 2009. Ken Hibbard. Verified by Kenneth L. Krysko. Florida Museum of Natural History, University of Florida (UF 155444). First county record. One adult female, heavily infested with ectoparasitic pterygosomatid mites, was collected from a porch screen of a residence at 2200 h. Three other individuals were observed at this same locality at 2000 h on 13 May 2009; they are common in sections of the Fort Pierce area. This invasive African species is currently the most widespread and rapidly spreading nonindigenous gecko in southern and central Florida (Meshaka et al. 2004. *The Exotic Amphibians and Reptiles of Florida*. Krieger Publ. Co., Malabar, Florida; Krysko and Daniels 2005. *Caribb. J. Sci.* 41:28–36), with a more recently established population in northern peninsular Florida (Krysko and Somma 2007. *Herpetol. Rev.* 38:352).

Submitted by **LOUIS A. SOMMA**, Department of Biology, PO Box 118525, 220 Bartram Hall, University of Florida, Gainesville, Florida, USA; e-mail: somma@ufl.edu.

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). USA: ARKANSAS: UNION Co.: South Arkansas Community College, El Dorado (33.209186°N, 92.666117°W; WGS 84). 30 September 2009. W. Bibby. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31385). First county record (Trauth et al. 2004. *The Amphibians and Reptiles of Arkansas*. University of Arkansas Press, Fayetteville. 421 pp.). This hatchling was found on the floor of the Whitfield Building on the campus of South Arkansas Community College. It has been previously collected in neighboring Columbia Co. (Fowler and Robison 2007. *Herpetol. Rev.* 38:218) and nearby Ouachita and Webster Parishes in Louisiana (Meshaka et al. 2006. *Herpetol. Conserv. Biol.* 1[1]:45–50).

Submitted by **MATTHEW B. CONNIOR**, Health and Natural Sciences, South Arkansas Community College, PO Box 7010, 300 South West Avenue, El Dorado, Arkansas 71731, USA; e-mail: mconnior@southark.edu.

MESOSCINCUS MANAGUAE (Managua Skink). GUATEMALA: ZACAPA: Municipality of Cabañas, El Arenal (14.8796°N, 89.7711°W; NAD27; elev. 410 m). 22 August 2004. Daniel Ariano-Sánchez and Gilberto Salazar. Verified by Carlos Vásquez and Theodore Papenfuss. Museo de Historia Natural de la Universidad de San Carlos de Guatemala (USAC 1128). Second record, but first documented locality for this species in Guatemala, extending the range ca. 5 km NE of an individual reported from Rosario, Guatemala (Acevedo 2006. *Biodiversidad de Guatemala*, Vol. 1. Univ. del Valle de Guatemala, Guatemala. 524 pp.), and ca. 110 km NW from the nearest confirmed record in Imposible National Park, El Salvador (YPM 12436). The lizard was found at 1100 h as it crawled through a dry gully within tropical dry forest dominated by the columnar cacti, *Stenocereus pruinosus*, and the thorn shrub, *Mimosa zacapana*, a vegetation formation similar to that depicted by Köhler (2008. *Reptiles of Central America*. Herpeton, Verlag Elke Köhler, Offenbach, Germany. 400 pp.).

Submitted by **DANIEL ARIANO-SÁNCHEZ** (e-mail: darianosanchez@gmail.com); **ANTONIO URBINA**, and **GILBERTO SALAZAR**, Research and Conservation Projects Direction, Asociación Zootropic, 12 Calle 1-25 Zona 10, Edificio Geminis 10 torre sur, nivel 18 oficina 1801A, Guatemala.

OPHISAURUS GRACILIS (Burmese Glass Lizard). THAILAND: CHAIYAPHUM PROVINCE: Khon San District: Phu Khiew Wildlife Sanctuary (16.3833°N, 101.5667°E; elev. 800 m) 10 April 2009. USDZ photographic archive, ZRC (IMG) 2.121. Verified by Olivier S. G. Pauwels. SVL 182 mm, TL 160 mm, 51 g. Released as species protected under Thai law. First record for Province. Found in lower montane forest near Sanctuary headquarters. P. Duengkae. Known from the provinces of Chiang Mai, Mae Hong Son, and Loei (Nabhitabhata et al. 2000 [2004]. *Checklist of Amphibians and Reptiles in Thailand*. Office of Environmental Policy and Planning, Bangkok. 152 pp.). Previous herpetological surveys in Phu Khiew Wildlife Sanctuary overlooked the species (Phophinit 1991. *Species Diversity and Distribution of Reptiles in Suborder Lacertilia at Phu Khiew Wildlife Sanctuary*. MS thesis, Kasetsart University. 129 pp.; Kamsook et al. 2000. *J. Wildlife Thailand* 8[1]:63–75; Kamsook et al. 2006. *BRT 2006 Research Reports* 2006:270–284).

Kelvin Kok Peng Lim and Olivier S.G. Pauwels are thanked for their assistance.

Submitted by **YODCHAIY CHUAYNKERN**, Thailand Natural History Museum, National Science Museum, Technopolis, Khlong 5, Khlong Luang, Pathum Thani, 12120, Thailand and Muséum national d'Histoire naturelle, Département de Systématique et Evolution, UMR 5202 CNRS OSEB, Reptiles et Amphibiens, Case 30, 25 rue Cuvier, 75005 Paris, France (e-mail: ychuaynkern@yahoo.com); and **PRATEEP DUENGKAE**, Department of Forest Biology, Faculty of Forest, Kasetsart University, Jatujak, Bangkok 10900, Thailand (e-mail: prateep.du@ku.ac.th).

PLESTIODON FASCIATUS (Common Five-lined Skink). USA: FLORIDA: CLAY Co.: Black Creek Ravines Conservation Area, 3.7 km E jct of State Road 21 and County Road 218 (30.0669°N, 81.8358°W; WGS84; 10 m elev.). Florida Museum of Natural History (UF 154255). Verified by Kenneth L. Krysko. New county record. 25 November 2008. Kevin M. Enge. Collected inside a large pine stump in mixed hardwood forest along a steephead stream ravine. Museum vouchers now exist for seven northern peninsular counties: Citrus, Clay, Columbia, Hamilton, Levy, Marion, and Suwannee. Ashton and Ashton (1991. Handbook of Reptiles and Amphibians of Florida. Part Two: Lizards, Turtles & Crocodylians. Windward Publ., Miami, Florida. 191 pp.) show eight additional peninsular counties, but the validity of their most southeasterly records from Volusia County is questionable. Specimens of *Plestiodon laticeps* with four labial scales anterior to the subocular scale on one side and five labials on the other side are sometimes mistakenly identified as *P. fasciatus*. In the Florida Museum of Natural History collection, the only purported specimens of *P. fasciatus* from Lafayette (UF 136039), St. Johns (UF 69883), and Taylor (UF 91096) counties were misidentified. Unverified reports exist for Baker, Bradford, and Taylor counties (see Enge 1997. A Standardized Protocol for Drift-fence Surveys. Florida Game Fresh Water Fish Comm. Tech. Rep. No. 14, Tallahassee).

Submitted by **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 1105 S.W. Williston Road, Gainesville, Florida 32601, USA; e-mail: kevin.enge@myfwc.com.

PLESTIODON MULTIVIRGATUS EPIPLEUROTUS (Variable Skink). USA: TEXAS: SCHLEICHER Co.: Eldorado, 12.9 air mi NW of jct U.S. Hwys 277 and 190, along Schleicher County Road 426 (30.94115°N, 100.79705°W; WGS 84) 2486 ft elev. 07 April 2006. M. S. Price and S. G. Price. Verified by Travis J. LaDuc (photographic voucher TNHC 7340100). First county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press. College Station, Texas. 421 pp.). Fills in distributional gap.

Submitted by **MICHAEL S. PRICE**, San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

SCELOPORUS CYANOGENYS (Blue Spiny Lizard). USA: TEXAS: KLEBERG Co.: Business Hwy 77 (State Loop 428), 0.65 road km NE from junction with FM 1355, below bridge overpass at intersection with San Fernando Creek (27.550267°N, 97.840796°W; WGS 84). Collected on 9 and 16 July 2009. Randy

Powell, William Lukefahr, William Moore, and Robert Rabe. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 78101–78102). Five additional specimens were captured at this location between 4 July and 11 August; the animals were measured, tagged with Passive Integrated Transponders (PIT), blood samples were taken, and they were released at the site. County record. An additional location within Kleberg County yielded two more specimens (TNHC 78103–78104). All specimens were caught in glue traps. The collection sites are ca. 1.6 air km apart and both are adjacent to San Fernando Creek and ca. 1.5–2 km S of the Nueces-Kleberg county line. Extends the range south one county (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M Univ. Press. College Station. 421 pp.).

Submitted by **RANDY L. POWELL** (e-mail: randy.powell@tamuk.edu), **WILLIAM D. LUKEFAHR**, **WILLIAM L. MOORE**, and **ROBERT W. RABE**, Department of Biological and Health Sciences, MSC 158, Texas A&M University, Kingsville, Texas 78363, USA.

SCELOPORUS CYANOSTICTUS (Blue-spotted Spiny Lizard). 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; elev. 785 m). 07 October 2007. Michael S. Price, Christopher R. Harrison, Travis J. Fisher, and David Lazcano. Verified by Hobart M. Smith. UANL 6987. First state record (Liner 2007. Occas. Pap. Mus. Nat. Sci. Louisiana St. Univ. [80]:1–59). A range extension of ca. 70 km E from the closest known locality in SW Coahuila (Lemos Espinal and Smith 2007. Anfíbios y Reptiles del Estado de Coahuila, México. UNAM, Tlalnepantla, Estado de México and CONABIO, México, D.F. 550 pp.). The lizard was found in a boulder pile at the base of a north-facing canyon wall bounded by Chihuahuan Desert scrub vegetation.

Submitted by **MICHAEL S. PRICE**, San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA (e-mail: michael.price@sanangelotexas.us); **CHRISTOPHER R. HARRISON**, Biology Department, Northwest Vista College, San Antonio, Texas 78251, USA (e-mail: rharrison@satx.rr.com); and **DAVID LAZCANO**, Universidad Autónoma de Nuevo León, Facultad de Ciencias Biológicas, Laboratorio de Herpetología, Apartado, Postal – 513, San Nicolás de los Garza, Nuevo León, C.P. 66450, México (e-mail: dlazcanov@hotmail.com).

SCELOPORUS JARROVII (Yarrow's Spiny Lizard). USA: NEW MEXICO: GRANT Co.: 2.3 km S of Pinos Altos, 17 Sanctuary Road (32.84231°N, 108.22386°W, datum WGS84). 03 August 2008. Shawn White. Verified by J. Lee. Western New Mexico University, Gila Natural History Collection (WNMU 14782, small adult female, 57 mm SVL). Second county record. Increases the range by ca. 37 km. An additional large adult male (90 mm SVL) was found nearby in a boulder pile in a wooded lot and one juvenile (41 mm SVL) was found inside a residential structure. Both locations within Grant Co. are widely separated and at different elevations. This indicates the spread of a lizard into suitable habitat which it could not historically invade because of inhospitable terrain. Grant County has numerous mountain ranges interspersed with lower elevation plateaus which create the so called "sky islands." We believe the second record represents expansion by human efforts

beyond the historical range and therefore has value in documenting this type of movement. This species has been recorded numerous times in neighboring Hidalgo Co.

Submitted by **SHAWN R. WHITE** (e-mail: whites7@wnmu.edu) and **RANDY D. JENNINGS**, Western New Mexico University, P.O. Box 680, Silver City, New Mexico 88062, USA (e-mail: jenningsr@wnmu.edu); **DOUGLAS E. RUBY**, University of Maryland Eastern Shore, Backbone Road, Princess Anne, Maryland 21853, USA (e-mail: deruby@umes.edu); and **GEORGE A. MIDDENDORF**, Howard University, Washington, District of Columbia 20059, USA (e-mail: gmiddendorf@howard.edu).

SCELOPORUS MERRIAM AUSTRALIS (Canyon Lizard). MEXICO: NUEVO LEON: Municipality of Mina: 58.7 air km SW of Sabinas Hidalgo along Mex. Hwy 53 (26.24959°N, 100.69002°W; WGS 84; elev. 785 m). 27 April 2008. Michael S. Price, Travis J. Fisher, and David Lazcano. Verified by Hobart M. Smith. UANL 6988. First state record (Liner 2007. Occas. Pap. Mus. Nat. Sci. Louisiana St. Univ. [80]:1–59). A range extension of ca. 70 km E from the closest known locality in SW Coahuila (Lemos Espinal and Smith 2007. Anfibios y Reptiles del Estado de Coahuila, México. UNAM, Tlalnepantla, Estado de México and CONABIO, México, D.F. 550 pp.). The lizard was found on a north-facing canyon wall bounded by Chihuahuan Desert scrub vegetation.

Submitted by **MICHAEL S. PRICE**, San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA (e-mail: michael.price@sanangelotexas.us); and **DAVID LAZCANO**, Universidad Autónoma de Nuevo León, Facultad de Ciencias Biológicas, Laboratorio de Herpetología, Apartado, Postal – 513, San Nicolás de los Garza, Nuevo León, C.P. 66450, México (e-mail: dlazcanov@hotmail.com).

SQUAMATA – SNAKES

CARPHOPIUS AMOENUS (Eastern Wormsnake). USA: INDIANA: PIKE Co.: Patoka River National Wildlife Refuge and Management Area (38.34910°N, 87.12384°W; NAD 83, Zone 16). 10 April 2009. Michael J. Lodato and Alisha Maves. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2009I). First county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed., revised. Indiana Academy of Science. vii + 404 pp.). Juvenile was found beneath a coverboard, adjacent to a cliff.

Submitted by **LINDSEY LANDOWSKI** (e-mail: Lindsey_Landowski@fws.gov), **MICHAEL J. LODATO**, and **ALISHA MAVES**. US Fish and Wildlife Service, Patoka River National Wildlife Refuge, 510 1/2 West Morton Street, P.O. BOX 217, Oakland City, Indiana 47660, USA.

COLUBER CONSTRICTOR (North American Racer). USA: NEBRASKA: DAWSON Co.: Hiles Canyon, 10.2 km S Gothenburg (40.835333°N, 100.16305°W; NAD 83). 13 June 2009. Keith Geluso and Owen J. Johnson. Verified by Curtis J. Schmidt. Sternberg Museum of Natural History (MHP 14676). First county record. Fills gap in distribution in central Nebraska (Lynch 1985. Trans. Nebraska Acad. Sci. 13:33–57). Known from adjacent Lincoln Co. to the west and Frontier Co. to the southwest (Lynch 1985, *op. cit.*).

Submitted by **KEITH GELUSO** (e-mail: gelusok1@unk.edu)

and **OWEN J. JOHNSON**, Department of Biology, University of Nebraska—Kearney, Kearney, Nebraska 68849, USA.

DIADOPHIS PUNCTATUS ARNYI (Prairie Ring-necked Snake). USA: TEXAS: SCHLEICHER Co.: Eldorado, 12.8 air mi NW of jct U.S. Hwys 277 and 190, along Schleicher County Road 426 (30.9410167°N, 100.79505°W; WGS 84; elev. 2486 ft.). 07 April 2006. M. S. Price and S. G. Price. Verified by Travis J. LaDuc (photographic voucher TNHC 73400). First county record and fills a distributional gap (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL S. PRICE**, San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

ECHINANTHERA AMOENA. BRAZIL: MINAS GERAIS: Municipality of Santa Rita de Ibitipoca: Parque Estadual do Ibitipoca (21.703659°S, 43.885971°W; datum: SAD 69; elev. 1450 m). 16 December 1987. R. N. Feio. Museu Nacional / Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brazil (MNRJ 7706, 7707). RIO DE JANEIRO: Municipality of Cachoeiras de Macacu: Reserva Ecológica de Guapiaçu (22.392222°S, 42.739444°W; datum: SAD 69; elev. 500 m). 14 January 2009. D. Vrcibradic. (MNRJ 18068). All verified by R. Fernandes. Species is known in southeastern Brazil, from southern Minas Gerais to southern Paraná, with one record in Minas Gerais, Municipality of Baependi and one record in Rio de Janeiro, Pedra Branca, Municipality of Parati (Di-Bernardo 1992. Comun. Mus. Cienc. PUCRS, sér. Zool. 5[13]:225–256). The record for the Parque Estadual do Ibitipoca is the northernmost for the species and the second for the state of Minas Gerais, ca. 105 km ENE from the closest previous record, Baependi. The record from the Reserva Ecológica de Guapiaçu is the easternmost for the species and the second for the state of Rio de Janeiro, ca. 220 km ENE from the closest previous record, Parati. Both localities are within the Atlantic Forest biome.

Submitted by **ADRIANO LIMA SILVEIRA**, Setor de Herpetologia, Departamento de Vertebrados, Museu Nacional / Universidade Federal do Rio de Janeiro, Quinta da Boa Vista, São Cristóvão, 20940-040, Rio de Janeiro, RJ, Brazil (e-mail: biosilveira@yahoo.com.br); **DAVOR VRCIBRADIC** (e-mail: davor@centroin.com.br), **CARLOS FREDERICO DUARTE ROCHA**, Departamento de Ecologia, Universidade do Estado do Rio de Janeiro, Rua São Francisco Xavier, 524, 20550-011, Rio de Janeiro, RJ, Brazil (e-mail: cfdrocha@uerj.br); and **CARLA DA COSTA SIQUEIRA**, Universidade Federal do Rio de Janeiro, Programa de Pós-Graduação em Ecologia, Instituto de Biologia, Av. Carlos Chagas Filho 373 Bl. A, Cidade Universitária, 21941-902, Rio de Janeiro, RJ, Brazil (e-mail: carlacsiqueira@yahoo.com.br).

GEOPHIS TARASCAE (Tarascan Earth Snake). MÉXICO: JALISCO: Municipality of Quitupan: 28 km (airline) S of Valle de Juárez (19.6725°N, 102.921°W; WGS84; elev. 1965 m). 26 November 2006, 13 October 2007. Christoph I. Grünwald and Jason M. Jones, respectively. Verified by Luis Canseco-Marquez. UTA Digital Collection (UTADC 1091, 1092). New municipality record. Fills a distributional gap of ca. 157 km between Nevado de Colima, Jalisco, 67 km to the SW (Dixon 1968. Southwest. Nat. 13:452–454) and Parque Nacional near Uruapan, Michoacán

(the type locality), ca. 90 km to the SE (Downs 1967. Misc. Publ. Mus. Zool. Univ. Michigan [131]:1–193). Both snakes were found under rocks of a fallen stone wall in a clearing surrounded by pine-oak forest.

Submitted by **JACOBO REYES-VELASCO**, Centro Universitario de Ciencias Biológicas y Agropecuarias, Carretera a Nogales Km. 15.5, Las Agujas, Nextipac, Zapopan, Jalisco, México (e-mail: jackobz@gmail.com); **CHRISTOPH I. GRÜNWARD**, Careterra Chapala - Jocotepec Oriente #57-1, Col. Centro, Ajijic, Jalisco 45920, México (e-mail: cgruenwald@switaki.com); and **JASON M. JONES**, 16310 Avenida Florencia, Poway, California 92064, USA (e-mail: jjones@switaki.com).

LAMPROPELTIS TRIANGULUM (Milksnake). USA: TEXAS: SCHLEICHER Co.: Eldorado, 12.7 air mi NW of jct U.S. Hwys 277 and 190, along Schleicher County Road 426 (30.9410667°N, 100.7935333°W; WGS 84; elev. 2480 ft). 04 May 2001. M. S. Price and K. Conder. Verified by Travis J. LaDuc (photographic voucher TNHC 73402). First county record and fills distributional gap (Dixon 2000. *Amphibians and Reptiles of Texas*, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL S. PRICE**, San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: smichael.price@sanangelotexas.us.

LAMPROPELTIS TRIANGULUM ELAPSOIDES (Scarlet Kingsnake). USA: GEORGIA: MILLER Co.: Mayhaw Wildlife Management Area, Griggs Lucille Road, 0.23 mi E Cypress Creek (31.197972°N, 84.792792°W; WGS 84). 03 March 2006. Collected by E. Adair, A. M. Durso, J. C. Maerz, K. A. Buhlmann, L. L. Smith, T. M. Lühring, A. M. Grosse, J. Norman, and the UGA Herpetology class. FLMNH 154594. New county record (Jensen et al. 2008. *Amphibians and Reptiles of Georgia*. University of Georgia Press, Athens. 575 pp.). An adult *L. t. elapsoides* was found under bark by the margin of a pond at ca. 1600 h. Extends the range 32 km SW from Baker Co., Georgia. CALHOUN Co.: Chickasawhatchee Wildlife Management Area, unnamed road, 1.0 mi W Chickasawhatchee, (31.46611°N, 84.43340°W; WGS 84). 06 April 2008. Collected by K. T. Nelson, A. M. Durso, J. L. Devore, E. C. Susko, J. M. Pahlas, and R. C. Joshi. FLMNH 154398. New county record (Jensen et al. 2008, *op. cit.*). An adult *L. t. elapsoides* was found under bark at the base of a snag at ca. 1100 h. This record is 45 km NE from Miller Co., Georgia (FLMNH 154594) and 20.4 km N of a 2007 record from Baker Co., Georgia. Both specimens verified by Kenneth L. Krysko.

These two records, together with the 2007 Baker Co. record (Stevenson et al. 2009. *Herpetol. Rev.* 40:247–249), represent the first reports of this species from the Dougherty Plain region of Georgia. The previous dearth of records may be due to limited sampling effort. The majority of non-agricultural land in the Dougherty Plain is under private ownership, creating accessibility issues for large-scale sampling. This may indicate that other species with poorly documented distributions within this region could be found in larger numbers with a concerted search.

Submitted by **ANDREW M. DURSO**, Eastern Illinois University, Department of Biological Sciences, Charleston, Illinois 61920 (e-mail: amdurso@gmail.com); and **KERRY T. NELSON**, University of Georgia, Warnell School of Forestry and Natural Resources, Athens, Georgia 30602, USA (e-mail: kerrytnelson@gmail.com).

LAMPROPELTIS TRIANGULUM MULTISTRATA (Pale Milksnake). USA: NEBRASKA: GARDEN Co.: 100 m ESE Crescent Lake National Wildlife Refuge Headquarters (41.7605556°N, 102.4355556°W; WGS 84). 11 May 2007. Florida Museum of Natural History (UF 155187). Verified by K. L. Krysko. Third record for Garden County. Captured in pitfall trap by J. B. Iverson. ca. 14 km N of previous record (Converse and Baker 2000. *Herpetol. Rev.* 31:186). Previous records were from areas of rock outgroups, but new record is from sandhill country, at least 10 km (NW) from the nearest meager exposure of sandstone along an intermittent tributary of Blue Creek. This new specimen is also the first for the Crescent Lake Refuge despite field work at the site by Iverson over 29 years (ca. 46 field months, including 900–1100 m of drift fence with funnel traps and bucket traps run during most months), and 78 years of activity by Refuge personnel (including drift fences for snakes operated in 1939–1942 by Imler [1945. *J. Wildl. Mgmt.* 9:265–273]; and 7.4 km of drift fence run from 1987–94 [e.g., Smith and Iverson. 1993. *J. Herpetol.* 27:333–335]).

Submitted by **JOHN B. IVERSON**, Department of Biology, 801 National Road West, Earlham College, Richmond, Indiana 47374, USA; e-mail: johni@earlham.edu.

LAMPROPELTIS ZONATA (California Mountain Kingsnake). USA: CALIFORNIA: ALAMEDA Co.: Camp Ohlone Regional Park, 8 km E of Calaveras Rd., 394 m elev. (37.49°N, 121.74°W; WGS84). 23 May 2009. Dino Labiste. Verified by Mitchell F. Mulks (University of California, Santa Cruz). MVZ Obs-Herp 1. New county record. Extends the range ca. 11 km N of the nearest documented record for the species (CAS 190487). At ca. 1200 h an adult male (78.8 cm total length, 110.5 g) was observed moving along an exposed, rocky streambed of a semipermanent creek. The surrounding east–west running valley is an extensively grazed, riparian mixed oak woodland, with sandstone outcrops dominating the southern-facing slopes, habitat more commonly associated with the *Lampropeltis getula* rather than *L. zonata* (Hubbs 2004. *Mountain Kings: A Collective Natural History of California, Sonoran, Durango and Queretaro Mountain Kingsnakes*. Tricolor Books, Tempe, Arizona. 324 pp.). Although in certain regions, the co-occurrence of these two species may not be uncommon (R. E. Staub, pers. comm.).

The occurrence of *L. zonata* throughout the Diablo Range is poorly documented, and little is known about populations occupying this region. There are undocumented observations of this species at Camp Ohlone and ~ 10 km NW near Arroyo del Valle Creek, Alameda Co. (M. F. Mulks, pers. comm.; Hubbs 2004, *op. cit.*). Museum specimens confirm that the species occurs at Mount Hamilton (CAS-SUR 1812, MVZ 229892), Alum Rock Park (CAS 190487), and from Henry Coe State Park (MVZ 229890–91). However, suitable habitat is present elsewhere in the Diablo Range and the lack of records may reflect a lack of sampling rather than a disjunct distribution as figured in currently published maps (Hubbs 2004, *op. cit.*; Stebbins 2003. *A Field Guide to Western Reptiles and Amphibians*, 3rd ed. Houghton Mifflin Harcourt, Boston, Massachusetts. 560 pp.).

This research was funded by a National Geographic Society/Waite Grant #W17-08 to Rulon W. Clark, San Diego State University. Scientific collecting permit (SC-9704) was issued by the California Department of Fish and Game.

Submitted by **ZACHARY A. CAVA**, Department of Biology, Ithaca College, 953 Danby Road, Ithaca, New York 14850, USA (e-mail: zcava1@ithaca.edu); and **MATTHEW A. BARBOUR**, Department of Biology, San Diego State University, 5500 Campanile Drive, San Diego, California 92182, USA (e-mail: matthew.a.barbour@gmail.com).

PITUOPHIS MELANOLEUCUS MUGITUS (Florida Pinesnake). USA: FLORIDA: NASSAU Co.: Ralph E. Simmons Memorial State Forest, 2.4 km ENE State Hwy 301 at Boulogne (30.779768°N, 81.954327°W; datum unavailable). 21 October 2009. D. Stevenson. Verified by Kenneth L. Krysko. Florida Museum of Natural History (photographic voucher UF 156876). First county record (Ashton and Ashton 1988. Handbook of Reptiles and Amphibians of Florida. Part One: The Snakes. Windward Publ. Co., Miami, Florida. 176 pp.). Adult female found at active Gopher Tortoise (*Gopherus polyphemus*) burrow in xeric sandhill.

Submitted by **DIRK J. STEVENSON**, Project Oriante, Ltd., Indigo Snake Initiative, 414 Club Drive, Hinesville, Georgia 31313, USA; e-mail: dstevenson@projectorianne.org.

PROSYMNA BIVITTATA (Two-striped Shovel-snout). SOUTH AFRICA: KWAZULU-NATAL PROVINCE: Mkhuze Game Reserve (27.59903°S, 32.13666°E; 27.59812°S, 32.13637°E; 27.62135°S, 32.17783°E). 20 August 2007. J. K. Warner and X. Combrink. Port Elizabeth Museum, South Africa (PEM 17431–17433). Verified by W. R. Branch. First provincial records for the species. Three juveniles found under rocks at foothills of Lebombo Mountains.

Fieldwork financed by the iSimangaliso Threatened Species Project and Operation Wallacea, with permission from Ezemvelo KwaZulu-Natal Wildlife (EKZNW SR/014).

Submitted by **JONATHAN K. WARNER**, School of Biological and Conservation Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, Pietermaritzburg 3209, South Africa (e-mail: jonathan.k.warner@gmail.com); and **XANDER COMBRINK**, Ezemvelo KwaZulu-Natal Wildlife, P.O. Box 398, St. Lucia Estuary 3936, South Africa (e-mail: combrinx@kznwildlife.com).

PSAMMODYNASTES PULVERULENTUS (Mock Viper). INDIA: ANDHRA PRADESH: Mahendragiri (Eastern Ghats complex), Mandasa, Srikakulam District (18.56°N, 84.21°E; elev. 1093 m). BNHM 3462. Verified by Indraneil Das. First record for Andhra Pradesh State, and ca ~400 km S of previous locality. 1600 h on 23 August 2009. One animal (SVL 158 mm, TL 35 mm) found moving on the floor of a moist deciduous forest near road, 50 m from rocky hill stream. Previously known from Similipal Tiger Reserve, Mayurbhanj District, Northern Orissa (Sanyal 1993. Reptilia. *In* State Fauna Series I: Fauna of Orissa, Part 4, pp. 51–74. Zoological Survey of India, Calcutta; Whitaker and Captain 2004. Snakes of India. The Field Guide. Draco Books, Chennai. 481 pp.).

Submitted by **PRATYUSH P. MOHAPATRA**, Species Division, World Wide Fund for Nature, 172-B- Lodi Estate, New Delhi 100 003, India (e-mail: wolfsnakes@gmail.com); **ABHIJIT DAS**, Division of Herpetology, Aaranyak, Samanwoy Path, Survey, Beltola, Guwahati 781 028, Assam, India (e-mail: protobothrops@gmail.com); and **S. K. DUTTA**, P. G. Department of Zoology, North Orissa University, Takatpur, Baripada 757 003, Orissa, India (e-mail: sk_dutta@yahoo.com).

RHINOTYPHLOPS LALANDEI (Delalande's Beaked Blind Snake). SOUTH AFRICA: KWAZULU-NATAL PROVINCE: Mkhuze Game Reserve (27.60967°S, 32.17166°E). 16 November 2007. J. K. Warner and X. Combrink. PEM 17429, 17407. Verified by W. R. Branch. First provincial records for species. Two individuals captured in a pitfall trap at foothills of Lebombo Mountains.

Fieldwork financed by the iSimangaliso Threatened Species Project and Operation Wallacea, with permission from Ezemvelo KwaZulu-Natal Wildlife (EKZNW SR/014).

Submitted by **JONATHAN K. WARNER**, School of Biological and Conservation Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, Pietermaritzburg 3209, South Africa (e-mail: jonathan.k.warner@gmail.com); and **XANDER COMBRINK**, Ezemvelo KwaZulu-Natal Wildlife, P.O. Box 398, St. Lucia Estuary 3936, South Africa (e-mail: combrinx@kznwildlife.com).

SIBON DIMIDIATA (Slender Snail Sucker). BELIZE: CAYO DISTRICT: Chiquibul Forest Reserve (16.733333°N, 88.983333°W; WGS84; ca. elev. 500 m). 08 July 2008. Susanne Marczak. Verified by Paul Edgar. LACMPC 1467. New district record. A northern range extension in Belize from records in the Toledo District, and a 400 m elevational expansion for the country (Stafford and Meyer 2000. A Guide to the Reptiles of Belize. Academic Press, San Diego, California. 356 pp.). The snake was found at 2345 h crossing a dirt road surrounded by tropical evergreen forest. Photographed and released at the site.

We thank the Columbus Zoo for providing funding for our field work.

Submitted by **SUSANNE MARCZAK** (e-mail: susanimal@gmail.com), **MENEMSHA ALLOUSH**, **ROBIN M. JONES**, **KATHERINE MARTINEAU**, **MARK A. OLIVA**, and **KRISTINE KAISER** (e-mail: kristinekaiser@gmail.com), Department of Ecology and Evolutionary Biology, UCLA, Los Angeles, California 90095-1606, USA.

STORERIA OCCIPITOMACULATA OCCIPITOMACULATA (Northern Red-bellied Snake). USA: OHIO: WASHINGTON Co.: Independence Township, Upper Archers Fork Rd. 120 m W of intersection with Cady Run Rd. (39.482914°N, 81.206478°W; NAD 1983). 10 May 2007. Michael A. Austin. Ohio University Vertebrate Collection (OUVC 9187). Verified by Scott M. Moody. New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contrib. No. 10, Columbus). DOR.

Submitted by **MICHAEL A. AUSTIN**, Ohio Department of Transportation District 10, 338 Muskingum Drive, Marietta, Ohio 45750, USA; e-mail: michael.austin@dot.state.oh.us.

TRICHEILOSTOMA ANTHRACINUM. ECUADOR: PROVINCIA DE ZAMORA CHINCHIPE: 6.5 km SE of Tundayme (ca. 3.58712°S, 78.43307°W; datum WGS84; elev. 1300–1500 m). April 2004. E. O. Carrillo and S. Aldás A. Colección de Reptiles, Museo de Zoología, Pontificia Universidad Católica del Ecuador (QCAZ 7396). Verified by O. Torres-Carvajal. Southernmost record for the species, extends its distribution ca. 220 km SE from the nearest locality (Balsapamba, Provincia de Bolívar, ca. 1.76667°S, 79.18333°W) in central Ecuador. Adult female found during the day by mining workers that were unearthing primary forest vegetation with bulldozers). This species is known from

only three localities on the eastern and western versants of central Ecuadorian Andes at 1000–1800 m elev. (Cisneros-Heredia 2008. Check List 4[2]:178–181). The present locality lies within a Low Montane Humid Shrub formation (Palacios et al. 1999. *In* Sierra [ed], *Propuesta Preliminar de un Sistema de Clasificación de Vegetación para el Ecuador Continental*, pp. 109–119. Proyecto INEFAN/GEF-BIRF and EcoCiencia, Quito) and is located on the western versant of the Cordillera del Cóndor mountain range.

Submitted by **DAVID SALAZAR-VALENZUELA** (e-mail: davidosalazarv@gmail.com), **EDWIN O. CARRILLO**, and **SILVIA ALDÁS A.**, Museo de Zoología, Centro de Biodiversidad y Ambiente, Escuela de Biología, Pontificia Universidad Católica del Ecuador, Av. 12 de Octubre 1076 y Roca, Aptdo. 17-01-2184, Quito, Ecuador.

Herpetological Review, 2010, 41(1), 112–115.
© 2010 by Society for the Study of Amphibians and Reptiles

New Herpetofaunal Records from Southern Honduras

ROBERT E. LOVICH*

*Department of Earth and Biological Sciences, Loma Linda University
Loma Linda, California 92350, USA*

THOMAS AKRE

*Department of Biological and Environmental Sciences, Longwood University
Farmville, Virginia 23909, USA*

MASON RYAN

*Department of Biology, University of New Mexico
Albuquerque, New Mexico, 87131, USA*

SOFIA NUÑEZ

GUSTAVO CRUZ

GERARDO BORJAS

Universidad Nacional Autónoma de Honduras, Tegucigalpa, Honduras

NORMAN J. SCOTT

*Research Associate, Smithsonian Institution
PO Box 307, Creston, California 93432, USA*

SAUL FLORES

WILBIRTH DEL CID

ADAN FLORES

CESAR RODRIGUEZ

ILEANA R. LUQUE-MONTES

Universidad Nacional Autónoma de Honduras, Tegucigalpa, Honduras

and

ROBERT FORD**

*Department of Earth and Biological Sciences, Loma Linda University
Loma Linda, California 92350, USA*

**Corresponding author: rlovich@gmail.com*

*** Present address (RF): Center for GIS Training and Remote Sensing
National University of Rwanda, Huye, Rwanda*

Central American dry and pine-oak forests (Dinerstein et al. 1995; Olson et al. 2001) are among the most imperiled (Olson and Dinerstein 2002) yet understudied ecoregions (Sánchez-Azofeifa et al. 2005) within the Mesoamerican hotspot (Mittermeier et al. 2004; Myers et al. 2000). Less than 2% of the original dry forests and only 6% of pine-oak forests remain intact, with very little of

either (< 5%) set aside in protected areas (Dinerstein et al. 1995; Janzen 1988). Accordingly, these forests formerly covered nearly all of southern Honduras, including the departments of Choluteca and Valle, but the persistent human need for subsistence agriculture, cattle production, and timber extraction has degraded or destroyed most of them, and many of the remaining patches are small and unprotected (AFE-DAPVS 2006; Carrillo and Vaughan 1994; Dinerstein et al. 1995; McCranie and Wilson 2002; Vreugdenhil et al. 2002). Despite this history of pervasive environmental degradation, the herpetofauna of the region has been reasonably well documented (McCranie 2007; McCranie and Wilson 2002; Sasa and Bolaños 2004; Wilson and McCranie 1998). Fifty-one species have been reported in this region, but like dry and pine-oak forests elsewhere in the country and across Central America, the herpetofauna has received little attention compared to that for other forest types. To remedy this deficiency, we sought to assess the herpetofaunal diversity of the only terrestrial protected areas in southern Honduras (AFE-DAPVS 2006). During 26 days in November 2005 and January and June 2006, we inventoried three Multiple Use Areas (MUAs) in the departments of Choluteca and Valle (Montaña La Botija, Cerro Guanacaure, and Isla del Tigre). Our surveys resulted in the documentation of 51 species of amphibians (15) and reptiles (36) (Lovich et al. 2006). We documented seven reptile species that were unknown from, but expected in the region (*Ameiva undulata*, *Lampropeltis triangulum*, *Ninia sebae*, *Oxybelis fulgidus*, *Scolecophis atrocinctus*, *Senticolis triaspis*, and *Spilotes pullatus*) and five others (two amphibians, three reptiles) that were unexpected (*Craugastor laevisissimus*, *Ptychohyla hypomykter*, *Anolis cupreus*, *Hemidactylus frenatus*, and *Sceloporus malachiticus*), based on published accounts (IUCN, Conservation International, and NatureServe 2006; Köhler 2001, 2008; Köhler et al. 2006; McCranie 2007; McCranie and Wilson 2002; Villa 1972; Wilson and McCranie 1998) and unpublished field notes of Roy McDiarmid (pers. comm.). Two additional species (*Incilius coccifer* and *Oxybelis aeneus*), although known from the region, represent new records for Isla del Tigre, a volcanic island 1.9 km from the mainland, which contains the only protected dry forest in the Department of Valle. Museum acronyms follow Leviton et al. (1985). All vouchers were verified by J. R. McCranie unless otherwise noted. Locality coordinates were taken with a GPS device using map datum WGS84. If no English common name is available for a species, then the Spanish common names for amphibians are those found in McCranie and Castañeda (2007) and reptile common names are from one of the above listed publication sources in either Spanish or in English.

Anura – Frogs

Craugastor laevisissimus (Ranita de Arroyo de Piel Lisa). CHOLUTECA: Quebrada La Fortuna, Cerro Guanacaure MUA, 15 km ESE Choluteca (13.259949°N, 87.068716°W), 350 m elev. 7 January and 4 June 2006. Mason Ryan and Walther Monge. Verified by Jay Savage. UNAH 5152, UNAH 5156, SDSNH 72860–72861. First records for the department of Choluteca, with the closest localities occurring in the departments of El Paraiso, Honduras (McCranie 2007) and Nueva Segovia, Nicaragua (Köhler 2001). One non-vouchered specimen from the same locality was sacrificed to test for the fungus, *Batrachochytrium dendrobatidis*, and the result was negative. All frogs were found among rocks and leaf

litter along a riparian habitat.

Incilius coccifer (Southern Roundland Toad). VALLE: Isla del Tigre: La Laguna, ca. 1 km SSE Amapala (13.282400°N, 87.654717°W), 10 m elev. 14 June 2006. Robert Lovich. UNAH 5235. First record for Isla del Tigre, with the closest records occurring on the mainland in the departments of Valle and Choluteca (McCranie 2006), and in the neighboring departments of La Unión, El Salvador (Köhler et al. 2006) and Chinandega, Nicaragua (Köhler 2001, 2008). The frog was found at night along the shoreline of La Laguna.

Ptychohyala hypomykter (Rana Trepadora Común de Montaña). CHOLUTECA: Finca Jayacayan, Quebrada del Horno, Montaña La Botija MUA, 8 km SSW San Marcos de Colon (13.359615°N, 86.832380°W), 1000 m elev. 9 January 2006. Mason Ryan. Verified by Jay Savage. UNAH 5155. First record for the department of Choluteca, with the closest recorded localities occurring in the neighboring departments of El Paraiso, Honduras (McCranie 2007), and Esteli, Nicaragua (Köhler 2001). The frog was found in riparian vegetation on a tree branch overhanging a stream.

Squamata – Lizards

Hemidactylus frenatus (Common House Gecko). CHOLUTECA: La Fortuna, Cerro Guanacaure MUA, 15 km ESE Choluteca (13.259949°N, 87.068716°W), 350 m elev. 3 January 2006. Thomas Akre, Robert Lovich, Antonio Robinson, Mason Ryan, and Norm Scott. SDSNH 72726; UNAH 5185–5186. First records for the department of Choluteca and confirm the presence of a population in Cerro Guanacaure MUA. While the species is reported as “widely introduced” on the Honduran mainland (McCranie et al. 2005, 2006), the nearest published records are from the department of Atlántida (Franklin 2000). Introduced to several locations in Central America (Köhler 2001, 2008), this species was first collected in Honduras in 1997, although its colonization since has been poorly documented (McCranie et al. 2006). The closest reported localities to our records are in the neighboring departments of La Libertad, El Salvador (Greenbaum 2002), and Chinandega, Nicaragua (Köhler 2001). All specimens were collected on buildings at night.

Sceloporus malachiticus (Lagartija Espinosa Verde). CHOLUTECA: Quebrada de la Florida, Montaña La Botija MUA, 11 km SSW of San Marcos de Colon (13.335833°N, 86.840000°W), 1263 m elev. 9 January 2006. Robert Lovich. SDSNH 72765. Quebrada del Horno, Montaña La Botija MUA, 8 km SSW San Marcos de Colon (13.359615°N, 86.832380°W), 1000 m elev. 9 June 2006. Thomas Akre. UNAH 5136. Las Moras, Montaña La Botija MUA, 9 km SSE San Marcos de Colon (13.356667°N, 86.760000°W), 1600 m elev. 10 January 2006. Walther Monge. UNAH 5125. First published records for the department of Choluteca (Köhler 2008, Wilson and McCranie 1998), with the closest known records being from the departments of Nueva Segovia, Nicaragua (Köhler 2001) and San Miguel, El Salvador (Köhler et al. 2006). The lizards were collected either on rock outcrops or logs exposed to sunlight in mixed deciduous forest.

Anolis cupreus (Anolí Común). CHOLUTECA: La Fortuna, Cerro Guanacaure MUA, 15 km ESE Choluteca (13.259949°N, 87.068716°W), 350 m elev. 3, 4, 6 January and 4, 6 June 2006.

Sofia Nuñez. SDSNH 72729–72732, 72734, 72737–72739, 72741, 72743–72750, UNAH 5089–5091, 5093–5099, 5103–5110, 5111–5112. Cima de Cerro Guanacaure, Cerro Guanacaure MUA, 15 km SE Choluteca (13.243533°N, 87.064450°W), 950 m elev. 4 June 2006. Sofia Nuñez. SDSNH 72735. Tres Pilas, Montaña La Botija MUA, 5 km SE El Jocote (13.307568°N, 86.766220°W), 1160 m elev. 12 January 2006. Sofia Nuñez. SDSNH 72736; UNAH 5092). First published records for the department of Choluteca (Köhler 2001, 2008; Wilson and McCranie 1998), with the closest published localities being from the department of Chinandega, Nicaragua (Köhler 2001, 2008). Lizards were collected from shrub and tree branches in tropical deciduous forest no more than 2 m off the ground.

Ameiva undulata (Rainbow Ameiva). CHOLUTECA: La Fortuna, Cerro Guanacaure MUA, 15 km ESE Choluteca (13.259949°N, 87.068716°W), 350 m elev. 5 January and 6 June 2006. Sofia Nuñez. UNAH 5168, 5171, 5179, 5183, 5189; SDSNH 72692, 72697. Cima de Cerro Guanacaure, Cerro Guanacaure MUA, 15 km SE Choluteca (13.243533°N, 87.064450°W), 750–900 m elev. 4 January 2006. Sofia Nuñez. SDSNH 72693, 72696, SDSNH. Finca Guayabol, Cerro Guanacaure MUA, 16 km ESE Choluteca (13.253788°N, 87.056948°W), 590 m elev. 3 January 2006. Sofia Nuñez. UNAH 5180. La Isnaya, Montaña La Botija MUA, 0.5 km SSE Santa Rita (13.362283°N, 86.732517°W), 1140 m elev. 11 January and 11 June 2006. Robert Lovich. UNAH 5160, 5177; SDSNH 72695. La Pacaya, Montaña La Botija MUA, 5 km SW San Marcos de Colon (13.399552°N, 86.834444°W), 1000 m elev. 11 January 2006. Robert Lovich. SDSNH 72694. First published records for the department of Choluteca (Köhler 2001, 2008; Wilson and McCranie 1998). The closest known localities for this species are in neighboring departments of Chinandega, Nicaragua (Köhler 2001) and La Unión, El Salvador (Köhler et al. 2006). Specimens were collected among leaf litter and ground vegetation in disturbed tropical deciduous forest.

Squamata – Snakes

Lampropeltis triangulum (Milksnake). CHOLUTECA: Tres Piedras, Hwy 3, 7 km WNW of Nicaragua (13.086389°N, 87.009444°W), 70 m elev. 26 November 2005. Thomas Akre. LACM PC 1448. San Marcos de Colón (13.428889°N, 86.804722°W), 1000 m elev. 13 June 2006. Robert Lovich. UNAH 5044. First records for the department of Choluteca, with UNAH 5044 confirming the presence of the species in the newly declared Montaña La Botija MUA. Nearest published records are from the departments of Francisco Morazán, Honduras (Wilson and Meyer 1985), Jinotega and Matagalpa, Nicaragua (Köhler 2001), and San Miguel, El Salvador (Köhler et al. 2006). LACM PC 1448 was found on a road in disturbed tropical deciduous forest and UNAH 5044 was found in an urban setting.

Ninia sebae (Red-backed Coffee Snake). CHOLUTECA: Quebrada de la Florida, Montaña La Botija MUA, 11 km SSW San Marcos de Colon (13.337639°N, 86.844611°W), 1250 m elev. 9 January 2006. Thomas Akre and Norman Scott. SDSNH 72801; UNAH 5278. Las Moras, Montaña La Botija MUA, 9 km SSE San Marcos de Colon (13.356667°N, 86.760000°W), 1600 m elev. 10 June 2006. Sofia Nuñez. UNAH 5280. First records for the department of Choluteca, with the nearest published localities being from

the departments of Francisco Morazán and El Paraiso, Honduras (Wilson and Meyer 1985), Jinotega and Matagalpa, Nicaragua (Köhler 2001), and Morazán, El Salvador (Köhler et al. 2006). The specimens from Quebrada de la Florida were found under rocks in riparian habitats, whereas the Las Moras snake was beneath a rock near a cattle pond surrounded by disturbed cloud forest.

Oxybelis aeneus (Brown Vinesnake). VALLE: Playa Negra, 4 km S of Amapala, Isla del Tigre (13.251892°N, 87.649656°W), 25 m elev. 15 June 2006. Robert Lovich. UNAH 5267. First published record for Isla del Tigre, with the closest record known from nearby Isla Zacata Grande, Valle (Wilson and Meyer 1985). Nearest records in neighboring countries are from the departments of Chinandega, Nicaragua (Köhler 2001), and Morazán, El Salvador (Köhler et al. 2006). The snake was caught during the day on a roadside tree branch in disturbed dry forest vegetation, ca. 1.5 m above the ground.

Oxybelis fulgidus (Green Vinesnake). CHOLUTECA: Tres Pilas, Montaña La Botija MUA, 5 km SE El Jocote (13.307568°N, 86.766220°W), 1160 m elev. Norman Scott. UNAH5265. First record for the department of Choluteca, and highest elevation reported within its entire range (Köhler 2001, 2008). This species is known from nearby departments of Francisco Morazán, Honduras (Wilson and Meyer 1985), Chinandega, Nicaragua (Köhler 2001), and San Miguel, El Salvador (Köhler et al. 2006). The snake was caught during the day on a tree branch in a riparian habitat surrounded by pine-oak forest.

Scolecophis atrocinctus (Ringed Centipede Snake). CHOLUTECA: La Isnaya, Montaña La Botija MUA, 0.5 km SSE Santa Rita (13.362283°N, 86.732517°W), 1140 m elev. 7 October 2003. Charles Mayer. Verified by Kent Beaman. LACM PC 1455. First record for the department of Choluteca and increases the known elevational range by ca. 440 m (Köhler 2001, 2008). This species is also known from the nearby departments of Francisco Morazán, Honduras (Wilson and Meyer 1985), Esteli, Nicaragua (Köhler 2001), and San Salvador, El Salvador (Köhler et al. 2006). The snake was photographed along a trail in a pine-oak forest.

Senticolis triaspis (Green Ratsnake). CHOLUTECA: Las Moras, Montaña La Botija MUA, 9 km SSE San Marcos de Colon (13.356667°N, 86.76000°W), 1600 m elev. 5 February 2005. Charles Mayer. Verified Kent Beaman. LACM PC 1454. First record for the department of Choluteca and highest elevation reported for its range in Central America (Köhler 2001, 2008). This species is also known from nearby departments of Francisco Morazán, Honduras (Wilson and Meyer 1985), Esteli, Nicaragua (Köhler 2001), and San Salvador, El Salvador (Köhler et al. 2006). The snake was photographed along a trail in a remnant cloud forest.

Spilotes pullatus (Tropical Treesnake). CHOLUTECA: La Isnaya, Montaña La Botija MUA, 0.5 km SSE Santa Rita (13.362283°N, 86.732517°W), 1140 m elev. 11 January 2006. Charles Mayer. Verified Kent Beaman. UNAH 5275. First record for the department of Choluteca, with the closest localities found in neighboring departments of Francisco Morazán and Paraiso, Honduras (Wilson and Meyer 1985). The species is known from the departments of Matagalpa, Nicaragua (Köhler 2001) and San Miguel, El Salvador (Köhler et al. 2006). The snake was found on a tree branch ca. 2 m above the ground in mixed oak woodland.

Acknowledgments.—Funding was provided by Agency for International Development (USAID)/Manejo Integrado de Recursos Ambientales (MIRA). Permits were provided by Carla Cárcamo de Martínez of the Department de Areas Protegidas y Vida Silvestre (DAPVS), AFE-COHDEFOR, and Dahlia Merida of the United States Fish and Wildlife Service. Thanks to Edas Muñoz, Rafael Ochoa, Tim Wall, Antonio Corrales, Javier Tercero, Carlos Vicente Mendoza, and Charles and Hortencia Mayer for field and logistic assistance beyond all expectation. At Isla del Tigre we would like to thank the Honduran Navy and members of the installation for allowing us access onto Navy land.

LITERATURE CITED

- AFE-DAPVS (ADMINISTRACIÓN FORESTAL DEL ESTADO - DEPARTAMENTO DE ÁREAS PROTEGIDAS Y VIDA SILVESTRE). 2006. Informe Nacional: Estado de las áreas Protegidas de Honduras, Previo II Congreso Mesoamericano de áreas Protegidas, Ciudad de Panamá, Panamá.
- CARRILLO, E., AND C. VAUGHAN. 1994. La Vida Silvestre de Mesoamérica: Diagnóstico y Estrategia Para su Conservación. Editorial Universidad Nacional, Heredia, Costa Rica.
- DINERSTEIN, E., D. M. OLSON, D. J. GRAHAM, A. L. WEBSTER, S. A. PRIMM, M. P. BOOKBINDER, AND G. LEDEC. 1995. A Conservation Assessment of the Terrestrial Ecoregions of Latin America and the Caribbean. The World Bank, Washington, D.C.
- FRANKLIN, C. J. 2000. Geographic distribution. *Hemidactylus frenatus*. Herpetol. Rev. 31:53.
- GREENBAUM, E. 2002. Geographic Distribution. *Hemidactylus frenatus*. Herpetol. Rev. 33:65-66.
- IUCN, CONSERVATION INTERNATIONAL, AND NATURESERVE. 2006. Global Amphibian Assessment. (<http://www.globalamphibians.org>; accessed 12 October 2007).
- JANZEN, D. H. 1988. Tropical dry forests, the most endangered major tropical ecosystem. In E. O. Wilson (ed.), Biodiversity, pp 130–137. Nat. Acad. Press, Washington D.C.
- KÖHLER, G. 2001. Anfíbios y Reptiles de Nicaragua. Herpeton, Verlag Elke Köhler, Offenbach, Germany.
- . 2008. Reptiles of Central America, 2nd ed. Herpeton, Verlag Elke Köhler, Offenbach, Germany.
- , M. VESELY, AND E. GREENBAUM. 2006. The Amphibians and Reptiles of El Salvador. Krieger, Malabar, Florida.
- LEVITON, A. E., R. H. GIBBS, E. HEAL, AND C. E. DAWSON. 1985. Standards in herpetology and ichthyology: Part 1. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia* 1985:802-832.
- LOVICH, R. E., T. S. AKRE, M. J. RYAN, N. J. SCOTT, AND R. E. FORD. 2006. Herpetofaunal survey of Cerro Guanacaure, Montaña La Botija and Isla Del Tigre protected areas in southern Honduras. Report prepared for the United States Agency for International Development, Washington, D.C. 39 pp.
- MCCRANIE, J. R. 2006. Specimen locality data & museum numbers/ubicación y números de museo de los especímenes, información complementaria for/a la “Guía De Campo De Los Anfíbios De Honduras.” by/por James R. McCranie y Franklin E. Castañeda. *Smithson. Herpetol. Inform. Serv.* 137:1–39.
- . 2007. Distribution of the amphibians of Honduras by departments. *Herpetol. Rev.* 38:35–39.
- , AND F. E. CASTAÑEDA. 2007. Guía de Campo de los Anfíbios de Honduras. Bibliomania, Salt Lake City, Utah.
- , J. H. TOWNSEND, AND L. D. WILSON. 2006. The Amphibians and Reptiles of the Honduran Mosquitia. Krieger Publ. Co., Malabar, Florida.
- , AND L. D. WILSON. 2002. The Amphibians of Honduras. *SSAR Contrib. Herpetol.* 19:x + 625 pp.
- , ———, AND G. KÖHLER. 2005. Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania, Salt Lake City, Utah.

- MITTERMEIER, R. A., P. ROBLES GIL, M. HOFFMAN, J. PILGRIM, T. BROOKS, C. G. MITTERMEIER, J. L. LAMOREAUX, AND G. A. B. DA FONSECA. 2004. Hotspots Revisited: Earth's Biologically Richest and Most Endangered Terrestrial Ecosystems. *Agrupación Sierra Madre, S.C., CEMEX S. A. de C. V., México, D.F.*
- MYERS, N., R. A. MITTERMEIER, C. G. MITTERMEIER, B. A. B. DA FONSECA, AND J. KENT. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403:853–858.
- OLSON, D. M., E. DINERSTEIN, E. D. WIKRAMANAYAKE, N. D. BURGESS, C. V. N. POWELL, E. C. UNDERWOOD, J. A. D'AMICO, I. ITOUA, H. E. STRAND, J. C. MORRISON, C. J. LOUCKS, T. F. ALLNIT, T. H. RICKETTS, Y. KURA, J. F. LAMOREAUX, W. W. WETTINGEL, P. HEDAO, AND K. R. KASSEM. 2001. Terrestrial ecoregions of the world: a new map of life on earth. *Bioscience* 51:933–938.
- , AND E. DINERSTEIN. 2002. The global 200: ecoregions for global conservation. *Ann. Missouri Bot. Gard.* 89:199–224.
- SÁNCHEZ-AZOFEIFA, G. A., M. QUESADA, J. P. RODRÍGUEZ, J. M. NASSAR, K. E. STONER, A. CASTILLO, T. GARVIN, E. L. ZENT, J. C. CALVO-ALVARADO, M. E. R. KALCASKA, L. FAJARDO, J. A. GAMON, AND P. CUEVAS-REYES. 2005. Research priorities for Neotropical dry forests. *Biotropica* 37:477–485.
- SASA, M., AND F. BOLANOS. 2004. Biodiversity and conservation of Middle American dry forest herpetofauna. In G. W. Frankie, A. Mata, and S. B. Vinson (eds.), *Biodiversity Conservation in Costa Rica: Learning Lessons in a Seasonal Dry Forest*, pp. 177–193. University of California Press, Berkeley.
- WILSON, L. D., AND J. R. MCCRANIE. 1998. The biogeography of the herpetofauna of the subhumid forests of Middle America (Isthmus of Tehuantepec to northwestern Costa Rica). *Royal Ontario Mus. Life Sci. Contrib.* 163:1–50.
- , AND J. R. MEYER. 1985. *The Snakes of Honduras*, 2nd ed. Milwaukee Public Museum, Milwaukee, Wisconsin.
- VILLA, J. 1972. *Anfibios de Nicaragua*. Instituto Geográfico Nacional y Banco Central de Nicaragua, Managua, Nicaragua.
- VREUGDENHIL, D., J. MEERMAN, A. MEYRAT, L. DIEGO GÓMEZ, AND D. GRAHAM. 2002. *Map of the Ecosystems of Central America: Final Report*. The World Bank, Washington, D.C.

Herpetological Review, 2010, 41(1), 115–116.
© 2010 by Society for the Study of Amphibians and Reptiles

New and Noteworthy County Records of Amphibians and Reptiles from Southeastern Washington State

ROBERT E. WEAVER

*School of Biological Sciences, Washington State University
Pullman, Washington 99163, USA
e-mail: weaverr@wsu.edu*

and

ALEX DORNBURG

*Department of Ecology and Evolutionary Biology, Yale University
New Haven, Connecticut 06523, USA
e-mail: alex.dornburg@yale.edu*

Despite several extensive surveys and a wealth of historical records chronicling the distribution of reptiles and amphibians in Washington (for review see McAllister 1995), there are still large gaps in the documentation of species occurring within the southeastern portion of the state. This region comprises some 8800 km² and includes Asotin, Columbia, Franklin, Garfield, and Whitman counties. Most records for species reported to occur in this

area are nearly half a century old, with several over 70 years old (Metter 1960; Svihla and Svihla 1933). Given concerns over the documented decline of many amphibian species around the globe (Alford and Richards 1999; Beebee and Griffiths 2005), a current knowledge of species' distributions is of utmost importance for the implementation of conservation strategies. Indeed, the need for further surveys reconfirming the presence of species in this area of Washington State is warranted, as recent surveys have revealed several novel county records (Dornburg and Weaver 2007a, 2007b; Weaver and Dornburg 2007).

In this note we report several first county records, in addition to noteworthy distribution records for reptile and amphibian species in southeastern Washington State. The records reported here were collected during 2005–2007 and verified by Kelly M. Cassidy at the Conner Museum, Washington State University (CMWSU). Coordinates listed use NAD83/WGS84 datum recorded with a hand-held Garmin[®] geographic positioning system (GPS) unit. The nomenclature used follows Crother et al. (2008). All specimens or photo vouchers were deposited within the Herpetology Collection, Department of Biological Sciences, Central Washington University, Ellensburg Washington.

Anura – Frogs

Anaryxus boreas (Western Toad). GARFIELD Co., Almota-Ferry Road (46.6708833°N, 117.5054°W). Two individuals (CWU 1685 and 1686) were observed on this road on 14 May 2007. These are the first verified reports of this species for this county in 50 years.

Spea intermontana (Great Basin Spadefoot). ASOTIN Co., Peola Grade Road (46.3852167°N, 117.112483°W). Four specimens were found along this road during a precipitation event on 02 May 2007. (CWU 1670–1674) These specimens represent the first verified records reported for this county in 34 years. COLUMBIA Co., Tucannon River Road (46.4820167°N; 117.9348333°W). A total of four specimens were collected on 26 June 2005. (CWU 1677–1681). An additional specimen (CWU 1682) was collected on 10 June 2007 along this road (46.4579833° N, 117.81495°W). These represent first county records. GARFIELD Co., State Route 127 (46.61255°N, 117.7904833°W). A single individual was observed (CWU 1687) on 18 April 2007. This is the first verified report of this species from this county in 50 years. WHITMAN Co., State Route 127. (46.6699333°N, 117.8033833°W). Two individuals (CWU 1688) were observed on 17 April 2007. These are the first verified reports of this species for this county in 56 years

Squamata – Lizards

Plestiodon skiltonianus (Western Skink). ASOTIN Co., Asotin Creek (46.3148333°N, 117.25335°W). A single individual was observed under a rock on 10 September 2007. (CWU 1699). This is the first verified report of this species from this county in 69 years. FRANKLIN Co., Palouse Falls State Park (46.6531333°N, 118.2246°W). An adult female and male (CWU 1683 and 1684) were observed under the same rock along the Palouse River within the state park on 07 June 2007. These represent first county records. WHITMAN Co., Snake River Canyon (46.6338167°N, 117 15.001°W). Three individuals (CWU 1688–1691) were observed on 01 May 2007. These are the first verified reports for this county in 54 years.

Sceloporus occidentalis (Western Fence Lizard). COLUMBIA Co., Tucannon River Hatchery (46.003 °N, 117.711111°W). Several individuals (one collected, CWU 1676) were observed basking on rocks along the river's edge on 27 July 2006. These are the first verified reports of this species from this county in 54 years.

Squamata – Snakes

Charina bottae (Northern Rubber Boa). ASOTIN Co., Asotin Creek Road (46.3290833°N, 117.1006667°W). A specimen was collected (CWU 1695) dead-on-road on 21 July 2008. This is the first verified report of this species from this county in 88 years. COLUMBIA Co., Tucannon River Road (46.3412 °N, 117.682°W). A single individual was observed alive-on-road (CWU 1675) on 16 October 2007. This is the first verified report of this species from this county in 77 years.

Hypsiglena chlorophaea (Desert Nightsnake). ASOTIN Co., Asotin Creek Road (46.3007167°N, 117.265333°W). An adult female was collected (CWU 1696) alive-on-road on 07 September 2007. Two additional specimens were collected (CWU 1697–1698) on 10 September 2007 along this same stretch of road. These represent first county records.

Acknowledgments.—We thank Kelly Cassidy for verification of these records. We thank David M. Darda for allowing us to deposit specimens and photo vouchers at Central Washington University. Specimens were collected by a Washington State Department of Fish and Wildlife scientific collecting permit issued to REW.

LITERATURE CITED

- ALFORD, R. A., AND S. J. RICHARDS. 1999. Global amphibian declines: A problem in applied ecology. *Ann. Rev. Ecol. Syst.* 30:133–165.
- BEEBEE T. J. C., AND R. A. GRIFFITHS. 2005. The amphibian decline crisis: A watershed for conservation biology. *Biol. Conserv.* 125:271–285.
- CROTHER, B. I. (ed.). 2008. Scientific and standard English names of amphibians and reptiles of North America north of Mexico. *SSAR Herpetol. Circ.* 37:1–84.
- DORNBURG, A., AND R. E. WEAVER. 2007. *Chrysemys picta*. Geographic distribution. *Herpetol. Rev.* 37:491.
- , AND ———. 2007. *Pseudacris pacifica*. Geographic distribution. *Herpetol. Rev.* 38:349–350.
- MCALLISTER, K. R. 1995. Distribution of amphibians and reptiles in Washington State. *Northwest Fauna* 3:81–112.
- METTER, D. E. 1960. The distribution of amphibians in eastern Washington. M.S. Thesis. Washington State University, Pullman. 89 pp.
- WEAVER, R. E., AND A. DORNBURG. 2007. *Hypsiglena torquata*. Geographic distribution. *Herpetol. Rev.* 38:355.

BOOK REVIEWS

Herpetological Review, 2010, 41(1), 116–118.
© 2010 by Society for the Study of Amphibians and Reptiles

Extinction in Our Times: Global Amphibian Decline, by James P. Collins, J. P. and Martha L. Crump. 2009. Oxford University Press, New York (www.oup.com). Hardcover. 304 pp. US \$29.95. ISBN 978–0–195316–94–0.

MARK D. THOMPSON

Northern Amphibian Monitoring Outpost Society
University of Northern British Columbia, 3333 University Way
Prince George, British Columbia, Canada V2N 4Z9
e-mail: ecology@namos.ca

The extinction and decline of amphibians is either approaching or it has already reached a precipitous wall. Authors Collins and Crump deliver an informative and accessible resource about global amphibian declines in their recently published book *Extinction in Our Times: Global Amphibian Decline*. This book is well-organized, well-researched, and presented in a format that can be read by naturalists, students, and scientists who are interested in the recent history of amphibian declines. Understanding the cause and nature of declines while navigating through the science, government, and civil society is critically important to those who want to address this great challenge.



The foreword written by Thomas Lovejoy highlights the most important aspects of the book in a few brief pages. His message is that the response to amphibian declines requires more than a science-as-usual approach. Addressing and understanding amphibian declines requires scientific teamwork, organizational learning, community involvement, educational programs, and socio-political engagement on biodiversity issues. This book covers these topics within the context of scientific studies that identify causes of global amphibian declines.

The book starts with an overview and introduction to biodiversity, conservation biology and key issues of amphibian decline. Collins and Crump adopt Noss and Cooperriders's (1994) definition for biodiversity, which includes and considers the evolving interactions, relations, and processes shared among genes, individuals, populations, and species. Adaptations and the sustaining functions of ecosystem services are supplied from all levels biodiversity.

Collins and Crump do not make clear the distinction between species extinction and population declines. The distinction is necessary so that conservation perspective and priorities address issues of decline to scale (Luck et al. 2003). The authors write that they will focus on and consider only the species level because it is "...easier, faster and cheaper (p. 1)." This assessment runs counter to the analysis by Naidoo et al. (2008) suggesting that species

targets as the conservation priority do not conserve optimal levels of global ecosystem services. Green (1997), Hugues et al. (1997), Molnar et al. (2004), and Wood and Gross (2008) also focus on and discuss the importance of conserving population levels of demographics and diversity. Contrary to the authors' statement that they will focus on the species level, examples of population decline are well described throughout the book. Collins and Crump even suggest, "...we need to monitor as many populations as possible (p. 45)." Researchers should not be monitoring population declines only to determine what species are threatened, but because population diversity holds the largest reservoir of ecological energy and biomass. Population levels of biodiversity are the main supplier of global ecosystem services (Luck et al. 2003).

Collins and Crump note that climate change, disease and pollution have reached beyond 'protected' boundaries of national parks and other 'pristine' areas, which was "historically the best way to ensure a species' survival (p. 88)." The 'historical' approach as based on species centered conservation and continues to be used as many conservation biologists seek to contain as many endangered species into protected and networked areas as possible for the least amount of cost (Kareiva and Marvier 2003; Molnar et al. 2004). Orchard (1999) also cites one of the significant dangers with the species conservation approach preventing researchers' eligibility for funding unless species are red-listed in their jurisdiction. Conservation efforts must shift the focus, effort and fund research on population declines (Molnar et al. 2004). Local populations are more familiar and meaningful to people than abstract species binomials for animals living in a far off place. "A more profound way to encourage public appreciation for wetlands and for the animals that live in them is to familiarize people with ponds, marshes, and lakes (p. 34)." Although there are few amphibian species in Canada, for example, the abundance of amphibian populations provides many places where conservationists can educate and communicate about the extinction process in a direct way (e.g., Green 1997). While Collins and Crump steer toward a species level approach, their book is a valuable resource for educators and conservationists living in places where there are few amphibian species.

Chapter 2 covers the history of organizational and institutional responses to amphibian declines since 1989. The history is informative and interesting to read with large amounts of personal insight into scientific meetings, organizations and government initiatives aimed at putting amphibian conservation plans into action. The third chapter reviews case examples by describing the behind-the-scenes work of researchers and organizations working together to face difficult challenges as they unravel the mystery and communicate on the nature of amphibian declines. Through their combined history, Collins and Crump have intimate knowledge and lots of personal anecdotes that bring to light some of the more interesting yet unpublished aspects of the research and response into amphibian declines.

Subsequent chapters use accessible language in reviewing scientific details that unravel the mystery behind the major threats and declines in amphibian populations around the globe. They book includes some surprising statistics on the economics of introduced amphibian species, amphibian commerce in the pet-trade, and amphibians for food and lab specimens. The authors relate this information back to conservation management and declines. Although it is mentioned on p. 197 that the Global Amphibian

Assessment (2008) identifies habitat loss and degradation as the greatest threats by far, the treatment of this topic by the authors is disproportionately small. There is a small section on land use change, but less discussion on the magnitude of declines caused by habitat fragmentation (e.g., Eigenbrod et al. 2008; Green 1997; Puky 2005). The conservation and management of populations poses significant challenges in context of roads, forestry, and urban development. The conservation topics chosen by Collins and Crump, in context of declines, include agricultural contaminants (although not others such as road de-icing contaminants), UV radiation, and emerging infectious disease. For each topic they explain how each issue relates to or is the cause of developmental abnormalities such as extra limbs or missing eyes.

Batrachochytrium dendrobatidis (Bd) causing chytridiomycosis (aka. the chytrid fungus) is discussed in every chapter. Chapter seven is devoted solely to this topic with an extensive review about the spread, epidemiology, biology, and effects of the Chytrid fungus. This story is both interesting and holds great importance in relation to the issue of amphibian declines because the disease has caused rapid and massive die offs in Central America and has spread to many other populations world wide (Lips et al. 2009). The authors highlight that chytridiomycosis has a unique and previously misunderstood relation to extinction; they call this the hyperdisease hypothesis (p. 200). Chytridiomycosis is indeed exceptional. With the single exception of the American chestnut blight no other infectious disease has been linked with or known to cause extinction.

Chapters 8 and 9 review the evolving and sometimes tense relationship between the scientist, the conservationist and the institutions they share. They explore the complex moral implications and challenges in decision-making among conservation biologists with respect to the spread of chytrid disease. Do we translocate wild animals to zoos and holding facilities when extinction is predicted via the path of a chytrid epidemic? Once the chytrid has spread it is likely to stay in the environment. This means that repatriation, difficult under 'normal' circumstances (Dodd and Siegel 1991), is unlikely to succeed. The authors address and review these and other challenges in context of the unique circumstances that the amphibian extinction crisis poses for conservation biologists. While the book raises some insightful points, clearer advice is needed for animal care committees, colleagues, scientific panels, government and granting agencies who may not weigh in appropriately on the morals, ethics, and priority in dealing with amphibian conservation research proposals. The authors mention a new field of 'ecological ethics' that is being established to address these problems (p. 188). This area of research is needed to put ecological consequences versus the individual rights of an animal into context. The debate surrounding the use of toe clips for mark-recapture studies (Funk et al. 2005) is recent example highlighting the importance of guidelines for ecological ethics.

The final chapter reviews the story of amphibian declines in context of what has been learned. The end of the chapter summary provides a list of questions in need of answers. In context of the types of questions being asked, Collins and Crump wonder if the 'canary in the coal mine' metaphor aptly describes the sensitivity of amphibians by noting that, "by the time amphibians respond, environmental quality has already deteriorated (p. 203)." The utility or truth to this metaphor is also questioned by Pechmann and

Wilbur (1994) who find no evidence to substantiate the proposal that amphibians are more susceptible to contaminants through their unique life history or because of their permeable eggs, skin, and gills.

In contrast to the arguments against the metaphor it may serve as a message to say that humanity must pay attention to amphibian declines as coal miners paid attention to a dying canary. A dead canary mobilized miners in much the same way that the ACAP has called for an unprecedented response to the declines (Gascon et al. 2007). In this framework, the metaphor is meaningful and serves a conservation utility. Metaphors can have different meanings and utilities (MacCormac 1985). Climatologists, for example, cite the canary in the coalmine metaphor in context of the rapid retreat of glaciers and climate change (Erdman 2009). With respect to amphibian declines, the metaphor delivers a message that we are in the midst of the sixth major extinction and amphibians are the predominant global extinction risk group (Wake and Vredenburg 2008). Amphibian declines are alerting us that there is a problem for life on earth. The loss of amphibians and their habitats threatens the steady supply of ecological services sustaining humanity, just as the mine atmosphere sustains a miner. Despite their contention with the metaphor, Collins and Crump do not lose sight of the message that “amphibians are a cautionary tale alerting us (p. 203)” or that “amphibians are a warning and a glimpse of possible future events (p. 203)”.

An alternate hypothesis stemming from the canary in coalmine metaphor suggests that amphibians serve as better sentinels, indicators, or a bellwether of environmental degradation and contamination compared to other organisms in a local context. This is the interpretation that Collins and Crump disagree with as they cite research suggesting that some amphibian species are not as sensitive an environmental indicator as other species. Moreover, as the scientific narrative in this book demonstrates, monitoring declines, deformities and causal stress factors is tough work that requires robust analytical and proven field methods to distinguish natural from abnormal fluctuations. Hence, amphibians may not serve as good indicators for monitoring the immediate local response often required in environmental assessments (e.g., Pearce and Venier 2009). As global indicators, however, amphibian declines are alerting humanity about a modern ecological process that is cataclysmic in magnitude (p. 203).

Extinction in our Times: Global Amphibian Decline is a highly recommended read for herpetologists, students of herpetology, conservation biologists, non-profit organizations, nature enthusiasts, and citizens who want to learn about the nature and response to the crisis. The message in the book is relevant, clear, and includes 28 pages of references and 23 pages of footnotes. The hardcover is affordably priced at US \$29.95 with good binding and effective black and white images capturing details of amphibians in crisis situations. While enjoyable to read, this book is also an important addition to the literature of amphibian declines that highlights the moral imperative and action that is needed to address extinction in our times.

LITERATURE CITED

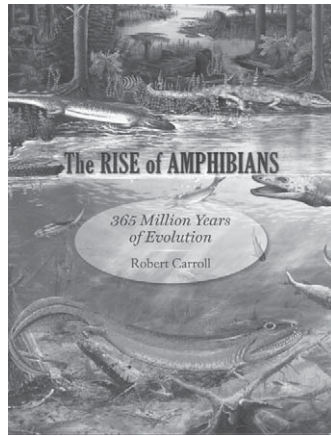
- DODD, C. K., AND R. A. SEIGEL. 1991. Relocation, repatriation, and translocation of amphibians and reptiles: Are they conservation strategies that work? *Herpetologica* 47:336–350.
- EIGENBROD, F., S. J. HECNARB, AND L. FAHRIG. 2008. The relative effects of road traffic and forest cover on anuran populations. *Biol. Cons.* 141:35–46.
- ERDMAN, S. L. 2009. Glaciers a canary in the coal mine of global warming. CNN online. 2009. Aug 8.
- FUNK, W. C., M. A. DONNELLY, AND K. R. LIPS. 2005. Alternative views of amphibian toe clipping. *Nature* 433:193.
- GASCON, C., J. P. COLLINS, R. D. MOORE, D. R. CHURCH, J. E. MCKAY, AND J. R. MENDELSON III (eds.). 2007. Amphibian Conservation Action Plan. IUCN/SSC Amphibian Specialist Group, Gland, Switzerland and Cambridge, UK. 64 pp.
- GREEN, D. M. 1997. Perspectives on Amphibian Population Declines: Defining the Problem and Searching for Answers. In D. M. Green (ed.), *Amphibians in Decline: Canadian Studies of a Global Problem*, pp. 291–308. *Herpetological Conservation* 1, Society for the Study of Amphibians and Reptiles, St. Louis.
- HUGHES, J. B., G. C. DAILY, AND P. R. EHLRICH. 1997. Population diversity: Its extent and extinction. *Science* 278:689–692.
- KAREIVA, P., AND M. MARVIER. 2003. Conserving biodiversity coldspots. *Amer. Sci.* 91:344–351.
- LIPS, K. R., F. BREM, R. BRENES, J. D. REEVE, R. A. ALFORD, J. VOYLES, C. CAREY, L. LIVO, A. P. PESSIER, AND J. P. COLLINS. 2006. Emerging infectious disease and the loss of biodiversity in a Neotropical amphibian community. *Proc. Natl. Acad. Sci. U.S.A.* 103:3165–3170.
- LUCK, G. W., G. C. DAILY, AND P. R. EHLRICH. 2004. Population diversity and ecosystem services. *Trends Ecol. Evol.* 18:331–336.
- MACCORMAC, E. R. 1985. *A Cognitive Theory of Metaphor*. The MIT Press, Cambridge, Massachusetts. 254 pp.
- MCCALLUM, M. L. 2007. Amphibian decline or extinction? Current declines dwarf background extinction rate. *J. Herpetol.* 41:483–491.
- MOLNAR, J., M. MARVIER, AND P. KAREIVA. 2004. The sum is greater than the parts. *Cons. Biol.* 18:1670–1671.
- NAIDOO, R., A. BALMFORD, R. COSTANZA, B. FISHER, R. E. GREEN, B. LEHNER, T. R. MALCOLM, AND T. H. RICKETTS. 2008. Global mapping of ecosystem services and conservation priorities. *Proc. Natl. Acad. Sci. U.S.A.* 105:9495–9500.
- NOSS, R. F., AND A. Y. COOPERRIDER. 1994. *Saving Nature's Legacy: Protecting and Restoring Biodiversity*. Island Press, Washington, D.C. 416 pp.
- PEARCE, J., AND L. VENIER. 2009. Are salamanders good bioindicators of sustainable forest management in boreal forests? *Can. J. Forest. Res.* 39:169–179.
- PECHMANN, J. H. K., AND H. M. WILBUR. 1994. Putting declining amphibian populations in perspective: Natural fluctuations and human impacts. *Herpetologica* 50:65–84.
- PUKY, M. 2006. Amphibian road kills: a global perspective. In C. L. Irwin, P. Garrett, and K. P. McDermott (eds.), *Proceedings of the 2005 International Conference on Ecology and Transportation*, pp. 325–338. Center for Transportation and the Environment, North Carolina State University, Raleigh.
- ORCHARD, S. 1999. The Gordian knots of the international and declining amphibian populations task force (DAPTF). In A. Campbell (ed.), *Declines and Disappearances of Australian Frogs*, pp. 9–13. Biodiversity Group, Environment Australia, Canberra.
- WAKE, D. B., AND V. T. VREDENBURG. 2008. Are we in the midst of the sixth mass extinction? A view from the world of amphibians. *Proc. Natl. Acad. Sci. U.S.A.* 105:11466–11473.
- WOOD, C. C., AND M. R. GROSS. 2008. Elemental conservation units: Communicating extinction risk without dictating targets for protection. *Cons. Biol.* 22:36–47.

The Rise of Amphibians, by Robert L. Carroll. 2009. John Hopkins University Press (www.press.jhu.edu). Hardcover. xii + 360 pp. US \$65.00. ISBN 978-0-8018-9140-3.

MICHEL LAURIN

Department "Histoire de la Terre"
UMR 7207, Muséum National d'Histoire Naturelle
75005 Paris, FRANCE
e-mail: michel.laurin@upmc.fr

This book would have been better titled "The Rise of Limbed Vertebrates" because the taxa called "amphibians" in the book include genuine amphibians (the largest clade which includes lissamphibians but not amniotes), stem-tetrapods, and reptiliomorphs (amniotes included). It is abundantly illustrated, and the color plates are nice, but the illustrations are generally of low resolution and appear to have been treated as grayscale images, even though they are really line art. This results in an annoying diffusion dither pattern, especially visible around the scale bars and lettering of the figures.



The book is organized into fourteen chapters. The first chapter, on the history of earth and life, is nice and briefly covers topics from the Big Bang to the Cambrian explosion in biodiversity.

Chapter two, on "Advanced metazoans and the ancestry of vertebrates," which also covers the evolution of primitively aquatic vertebrates, is not as good. Some statements are not supported by recent works. For instance, it states (p. 29) that anaspids are "thought to be the ancestors of the modern lampreys," and that bone "is lost in the living jawless fish." Neither statement is supported by a phylogenetic analysis of early vertebrates (Janvier 1996a), which shows that hagfishes and lampreys are excluded from the smallest clade of vertebrates with a bony skeleton. Strangely, neither that paper, nor the most detailed, up-to-date review of early vertebrates (Janvier 1996b), are cited. The chondrichthyans are reported to be divided into two "categories," the sharks and the rays. Actually, the most fundamental division in chondrichthyans is between the holocephalans (chimaeras; not mentioned in the book) and the elasmobranchs, which include skates and rays (forming a clade), as well as "sharks," a paraphyletic group, since skates and rays are nested within it (this paraphyly is not mentioned in the book). The book also states that early osteichthyans had a paired swim bladder used to control buoyancy (p. 31), but the taxonomic distribution of the lung (a primarily respiratory structure) and of the swim bladder (primarily involved in buoyancy control) suggests that the lung is more primitive, since most sarcopterygians (dipnoans and tetrapods) and the basalmost actinopterygians (polypterids) have a lung, whereas the swim bladder is restricted to part of Actinopterygii (Laurin 2008a). Carroll's idiosyncratic view of phylogenetics

peeks through in statements such as "These specializations of the feeding apparatus preclude lungfish from close affinities with terrestrial vertebrates." (p. 32), which will puzzle many readers. Similar statements are found in other chapters, about *Tiktaalik* (p. 44), *Ventastega* (p. 59) *Acherontiscus* (p. 107), *Ichthyostega* and *Acanthostega* (both on p. 151), amniotes and "lepospondyls" (p. 160), and some of them (e.g. for *Ventastega*) lead Carroll to suggest relationships that are not most parsimonious and are contradicted by the most recent phylogenies. Although Hennig (1966) clearly demonstrated that autapomorphies are phylogenetically uninformative (at least under parsimony) beyond demonstrating the monophyly of a taxon, Carroll states that autapomorphies can refute sister-group relationships (for instance, p. 212 on archegosaurids; pp. 262, 301 on aïstopods, adelogyrinids, and lysorophians), or that a taxon is sufficiently primitive to be a sister-group (p. 301, on "microsaurs"). Elsewhere (p. 160, ch. 5), Carroll uses widespread plesiomorphies to refute some relationships supported by synapomorphies (in this case, between "microsaurs" and lysorophians). Such statements presumably reflect Carroll's frequent confusion between sister-groups and ancestors, which surfaces in various sections of the book.

Chapter three provides a detailed description of the anatomy and evolution of the first limbed vertebrates and of their closest finned relatives. Some errors have crept in; for instance, figure 3.2 suggests that *Eusthenopteron* is more closely related to tetrapods than to *Panderichthys*, but this is contradicted both by the text and by conventional wisdom. The interpretation is sometimes naïve. For instance, the fact that *Tiktaalik* has been found in apparently freshwater deposits "indicates a major shift from marine to fresh water" (p. 41). In fact, sarcopterygians have frequently moved between both environments (Vermeij and Dudley 2000), and there is evidence of many marine limbed vertebrates (Laurin and Soler-Gijón 2006), including the barely more crownward Devonian *Tulerpeton* (Lebedev 1986), so this particular shift is unlikely to have been "major." This chapter includes a useful review of gene expression patterns in developing fin and limb buds, but it does not incorporate recent work on the basal actinopterygian *Polyodon*, which shows that many patterns previously considered unique to tetrapods are probably osteichthyan synapomorphies. Their loss in *Danio* is presumably an autapomorphy (possibly of a much larger group of teleosts) that may be associated with the loss of the metapterygial axis in teleost fins (Davis et al. 2007). There are also errors in the coverage of Devonian taxa. For instance, Carroll (p. 59) calls *Ventastega* an "unquestioned tetrapod," which is misleading given that digits are not preserved and that there is no guarantee that they were present (Laurin et al. 2000). The statement (p. 72) that "The retention of many primitive features of the skeleton confirms the position of *Ossinodus* near the base of tetrapods, and its divergence prior to the loss of the intertemporal bone and other derived features of *Ichthyostega* and *Acanthostega*" is contradicted by every phylogenetic analysis that has included *Ossinodus* (Warren and Turner 2004; Ruta and Coates 2007; Warren 2007).

Chapter four, on "the radiation of Carboniferous amphibians," includes detailed descriptions of early stegocephalians (limbed vertebrates) that constitute a strong point of the book. The taxa are presented in stratigraphic order, which does not always seem optimal, as when the earliest "microsaurs" are described on pages 107–117, and more recent ones on pages 128–130. Similarly, aïsto-

pods are described on pages 72, 97, and 130–141. The discussion of phylogenetic relationships is largely left to the next chapter, but many statements formulated in terms of ancestor-descendant relationships could have been replaced by statements of sister-group relationships (e.g., the statement on p. 141 that “No later amphibians are plausible descendants of this assemblage [aïstopods]”).

The nomenclature is not formulated in phylogenetic terms either, or these terms have an idiosyncratic meaning. For instance, the statement (p. 91) that baphetids are “close to the base of the tetrapod stem” disregards the fact that this stem encompasses many finned sarcopterygians (all those that are closer to the limbed ones than to the dipnoans), such as *Eusthenopteron* and *Osteolepis*; Carroll actually means something like “along the tetrapod stem, close to the base of the clade of limbed vertebrates.” Several statements suggest that Linnaean categories have an objective reality and that research can lead to “correct” rank assignments. One example (p. 141) mentions that for aïstopods, “as more has become known of these groups, it has become evident that there are no significant gaps allowing taxonomic distinction above the level of genera.” Other examples can be found on pp. 91, 93, and 99. In fact, Linnaean categories are purely artificial and even undefined constructs required by rank-based nomenclature (Laurin 2008b).

More serious problems concern the lack of alternatives presented. For instance, the enigmatic *Westlothiana* is presented as a relative of amniotes (p. 102); there is no mention of the fact that the most comprehensive phylogenetic analyses suggest that it is either a stem-tetrapod (Laurin and Reisz 1999) or a basal “lepospondyl” (Ruta et al. 2003, Ruta and Coates 2007). Similarly, Carroll assumes that a tympanum was present in most temnospondyls, even those with a massive stapes such as *Balanerpeton* (p. 102) or *Dendrerpeton* (p. 117). The stapes of *Dendrerpeton* is even described as “reduced” (p. 262, ch. 10), but it is much more massive than its homologue in tetrapods with a tympanum (Laurin and Soler-Gijón 2006: fig. 7); and the presence of a tympanum in most temnospondyls is highly debatable (Laurin 1998a; Laurin and Soler-Gijón 2006).

Several functional interpretations are dubious. For instance, we read (p. 93) that the largely cartilaginous endoskeleton of *Crassigyrinus* “would have increased buoyancy in the water.” Selective pressures to increase buoyancy are unlikely to have resulted in decreased ossification in an animal that presumably seldom came to the surface, and in which air in the lungs would instead created selective pressure to increase ossification to create a ballast, as we see in several aquatic tetrapods (Kriloff et al. 2008). The explanation is more likely to reside in the lower metabolic cost of producing and maintaining cartilage than bone.

Chapter five, on “adaptation, radiation, and relationships”, opens with a long, unnecessary discussion of gaps in the fossil record that fails to consider that Hennig developed cladistics as a way of inferring phylogeny even with a scanty (or absent) fossil record. It also makes the usual mistake of considering that cladistics assumes evolution to be parsimonious (p. 146), rather than just representing a way to choose between alternative hypotheses; in that respect, parsimony in the most general sense is part of the scientific method itself.

The chapter then presents several stegocephalian phylogenies in figure 5.1, but lissamphibians were pruned from most of them. Only Carroll’s (2007: fig. 77) phylogeny (reproduced in the book as

figure 5.1D) includes lissamphibians. This is a poor choice, given that it shows temnospondyls (represented by “basal temnospondyls”, Branchiosauridae and Amphibamidae) as the stem-group of a clade encompassing lissamphibians, “lepospondyls”, and even amniotes. Even Carroll did not seem to accept this topology, since he presented another, less parsimonious, tree (Carroll 2007: fig. 78) in which temnospondyls form the stem of batrachians (anurans and urodeles) only. Fortunately, another figure (5.3) shows a stegocephalian phylogeny with lissamphibians, although Ruta et al. (2003) was used as the source, rather than the more recent tree derived from the expanded dataset of Ruta and Coates (2007). Even that tree was perhaps not the best choice, given that two recent doctoral theses (Pawley 2006, Germain 2008) contain reevaluations of its supporting matrix and have reached drastically different conclusions, with a monophyletic origin of lissamphibians among “lepospondyls” rather than among temnospondyls (Marjanović and Laurin 2009).

Most of the text that discusses these phylogenies (pp. 146–147) is either plainly wrong or difficult to understand. For instance, we read (p. 147) that “A number of taxa at the base, including *Eusthenopteron* and other osteolepiform fish, *Acanthostega* and/or *Ichthyostega*, whatcheerids, *Crassigyrinus*, and baphetids appear as a series of separate lineages, without indication of the specific relationships between one another.” This suggests a large basal polytomy, but that is not what the phylogenies show; instead, we simply have highly asymmetrical trees showing several sister-groups of crown-tetrapods. Even more misleading is the statement (p. 147) that “the cladograms of both Laurin and Reisz (1997) and Ruta et al. [2003] were concerned with the interrelationships of the modern amphibian orders, and yet were based on very few characters of these groups and so were unable to resolve their specific affinities with any of the Paleozoic taxa.” In fact, both studies were based on numerous parsimony-informative characters (154 and 308, respectively), and both provided well-resolved and robust (though mutually incompatible) phylogenies showing a monophyletic origin of Lissamphibia either among “lepospondyls” (Laurin and Reisz 1997) or among temnospondyls (Ruta et al. 2003). Similarly misleading statements are made (p. 147) about the phylogenies presented by Clack (2002) and Ahlberg and Clack (1998). Chapter five is best ignored.

Chapter six on “the zenith of amphibian diversity” thoroughly describes the Permian diversity of stegocephalians. As elsewhere in the book, the interpretations do not always represent all plausible alternatives. For instance, it mentions (p. 163) “freshwater sharks” being associated with various stegocephalians. Probably this refers to xenacanthids, but Schultze and Soler-Gijón (2004) showed that at least some xenacanthids were able to live in saltwater. Similarly, we read (p. 185) that “Nearly all branchiosaurid species are represented by gilled larvae, but almost none are known from terrestrial adults. This implies that most were neotenic, spending their entire life in the water.” Another equally plausible alternative is that the adults lived in another, more terrestrial, environment and were not preserved for that reason.

Chapter seven on amniotes does not present a phylogeny. The only amniote phylogeny is presented on page 3, and is an old-fashioned “bubble diagram” in which the width reflects the number of families. Such use of taxa of higher ranks as proxies of biodiversity has been strongly criticized because taxa of

a given rank fail to share any objective properties (Bertrand et al. 2006; Laurin 2008b). This amniote phylogeny contains more artificial – paraphyletic – groups than clades. The former include mammal-like reptiles (non-mammalian synapsids), reptiles other than archosauromorphs (apparently lepidosaurs, turtles, and various unspecified extinct taxa), and archosauromorphs (normally a clade, but here redelimited to exclude birds). In fact, paraphyletic taxa are enthusiastically used throughout the book.

Instead of a phylogeny, chapter seven presents a list of amniote characters sorted into autapomorphies, synapomorphies with other (unspecified) taxa, and primitive characters. The criteria for these polarizations are not given, although they appear to assume Carroll's preferred phylogeny. For instance, the absence of an intertemporal, of labyrinthine infolding, of palatal fangs, of lateral-line canal grooves, and of an otic notch, which are synapomorphies of crown-tetrapods under some phylogenies (e.g. Vallin and Laurin 2004; Pawley 2006: 386, 393–394), are thus interpreted as autapomorphies of Amniota, which is misleading. Carroll (p. 196) also suggests that “Of the Paleozoic tetrapods, only anthracosaurs are plausible sister-taxa of amniotes, but this affiliation may lie at the level of *Tulerpeton*, which indicates a very long ghost lineage...” In fact, this hypothesis has never been supported by a single published data matrix. Recent analyses (e.g. Ruta et al. 2003; Vallin and Laurin 2004) clearly show that diadectomorphs are the sister-group of amniotes, and that “lepospondyls” are the next sister-group of amniotes.

Carroll's scenario on the origin of the amniotic egg, originally proposed in 1970, is presented, but there is no mention that the only quantitative, statistical test of that hypothesis confirmed only one of its three predictions about body size evolution (Laurin 2004). Similarly, the possible taphonomic explanation for the small size of the earliest amniotes (preserved in tree trunks, which may have introduced a size filter) is not evoked.

Chapter eight on stereospondyls starts with an interesting review of extinction events, especially the end-Permian event. It also reviews recent phylogenies on this large clade of temnospondyls and scenarios about its origin.

Chapter nine on “The enigma of modern amphibian origins” is mostly phylogenetic and contains several misleading statements. For instance, Carroll (p. 229) states that herpetologists think that extant amphibians form the clade Lissamphibia, but that “Paleontologists... have suggested that they may have evolved from two or three separate groups of ancestral amphibians.” This is a false dichotomy because many paleontologists consider lissamphibians to form a clade that excludes all known Paleozoic vertebrates. Carroll then erroneously states (p. 231) about the matrices presented by Laurin and Reisz (1997) and Ruta et al. (2003) that “none of the many unique derived features that distinguish each of the three groups of living amphibians from one another were included in these databases.” Both matrices included such characters; for instance, characters 33 and 34 of the matrix of Laurin and Reisz (1997) are autapomorphies of Gymnophiona (maxilla palatal shelf and tentacular foramen). Carroll adds (p. 232) that “Even if it were true that frogs, salamanders, and caecilians had an immediate common ancestry from a single antecedent stock, there would still be many problems of determining how and when the key characters of the living orders had evolved and what was the nature of the immediate common ancestor. Neither of these questions is even

considered in the analyses of Laurin and Reisz or Ruta and his colleagues.” This is misleading because Laurin and Reisz (1997) focused on amniote origins, so lissamphibians were not extensively discussed, but a revised and expanded version of the matrix was presented by Laurin (1998a, b), and the two questions raised by Carroll were discussed there. Carroll states (p. 234) that “If the prior applications of PAUP have failed to resolve the specific patterns of interrelationships among the modern amphibian orders or to find their plausible ancestry among one or more Paleozoic lineages, what other means of analysis might be followed?” In fact, applications of PAUP have not failed; they have only failed to support Carroll's hypotheses.

Fortunately, chapter nine provides anatomical and functional data on lissamphibians (about breathing, prey capture, and locomotion, among others), which makes the non-phylogenetic parts of this chapter worth reading. These do not enable the reader to understand lissamphibian origins, but they are interesting in their own right.

Chapter ten reviews “The ancestry of frogs.” It is framed in the age-old search for ancestors. Of course, the possibility that lissamphibians are monophyletic is not evoked in that context. An extensive list of nested synapomorphies assumes that anurans (alone) originated among amphibamid temnospondyls. This is inconsistent with the hypothesis of urodele origins among branchiosaurid temnospondyls, which are nested among amphibamids (Fröbisch and Schoch 2009). But the descriptive parts of the chapter are useful.

Chapter eleven, on “The ancestry of salamanders,” describes several Jurassic and Cretaceous urodeles. Carroll states that (p. 280) “In fact, it is the larvae that provide much of the data that enable us to trace the ancestry of salamanders into the Paleozoic.” In light of this assertion, the simplistic interpretations of such data are surprising. For instance, Carroll opposes the “gradual” pattern of ossification in branchiosaurs with the “complete ossification of the skull at a very small size” in other stegocephalians and “as far back as *Eusthenopteron*.” Yet, on the same page, he mentions that “In nearly all branchiosaurs that had been described previously, the smallest preserved specimens had already ossified nearly all the dermal bones of the skull.” On the next page, he adds “At present, no branchiosaurids other than those of the genus *Apateon* clearly show the protracted sequence of ossification of the dermal skull.” From all this, he concludes that “the capacity of branchiosaurs to ossify the dermal bones of the skull in a slow, sequential manner evolved only later, between the Westphalian D and near the end of the Carboniferous.” Is it not much more likely that poorly ossified, weakly mineralized, tiny larvae have a low preservation potential and that they are thus generally not known? Hence, the absence of well-documented cranial ossification sequences in “lepospondyls” is almost certainly a taphonomic artifact. Developmental biologists usually consider that simultaneity in developmental events simply reflects lack of temporal resolution reflecting limitations in data, rather than true simultaneity (Bininda-Emonds et al. 2003: 341).

Chapters twelve covers “*Eocaecilia* and the origin of caecilians”. For lack of space, the specific strengths and weaknesses of this chapter will not be discussed; they are similar to those of the other sections of the book. Chapter thirteen, “the success of modern amphibians”, covers the fossil record of lissamphibians and their phylogeny. Chapter fourteen, “the future of amphibians,” surveys

their fate in extinction events, especially in the current one caused by anthropic effects. These last two chapters are among the best in the book.

The bibliography is highly selective. For instance, Carroll cites Zhang et al. (2005), the first paper that provides molecular dating of the origin of Lissamphibia, Lee and Anderson (2006), a commentary, and other recent studies (San Mauro et al. 2005; Roelants et al. 2007). All these papers concluded an Early Carboniferous or Late Devonian origin of Lissamphibia, which is, as Carroll states (pp. 304–305), consistent with a polyphyletic origin of Lissamphibia. Yet, these ancient ages of Lissamphibia have been shown to reflect a suboptimal choice of dating constraints (Marjanović and Laurin 2007), and three dating techniques with very different assumptions point to a Permian origin (Marjanović and Laurin 2008), which is clearly incompatible with the polyphyly hypothesis. Molecular dating performed in another lab (Hugall et al. 2007: table 3) also concluded to a Late Carboniferous to Early Permian origin of Lissamphibia – even though no calibration points lay inside that clade, which is expected to lead to overestimation of all dates for nodes in it (Brochu 2004a, b; Marjanović and Laurin 2007), as Hugall et al. (2007:558) noted themselves. Omission of these papers from the bibliography will give readers the erroneous impression that molecular data unequivocally supports an Early Carboniferous origin of Lissamphibia and hence its polyphyly.

Similarly, Carroll cites Schoch and Carroll (2003), who concluded that developmental similarities between branchiosaurs and urodeles suggested an origin of the latter among the former, but he cites neither Schoch (2006), who showed that these similarities are primitive, nor Germain and Laurin (2009), who showed that these similarities are far fewer than initially proposed (although the second paper may have been published too late to be discussed in the book).

To sum up, this book contains much useful anatomical information, and is abundantly illustrated. It thus constitutes a valuable factual account of anatomical diversity of early stegocephalians. However, the large-scale phylogenetic interpretations, especially those concerning the origin of lissamphibians, are best ignored. The book also indulges in extensive story-telling which is, fortunately, not representative of modern paleontological thought. For more objective and rigorous assessments of early stegocephalian evolution and the origin of extant amphibians, the readers should consult some recent reviews (e.g. Anderson 2008; Coates et al. 2008; Marjanović and Laurin 2009).

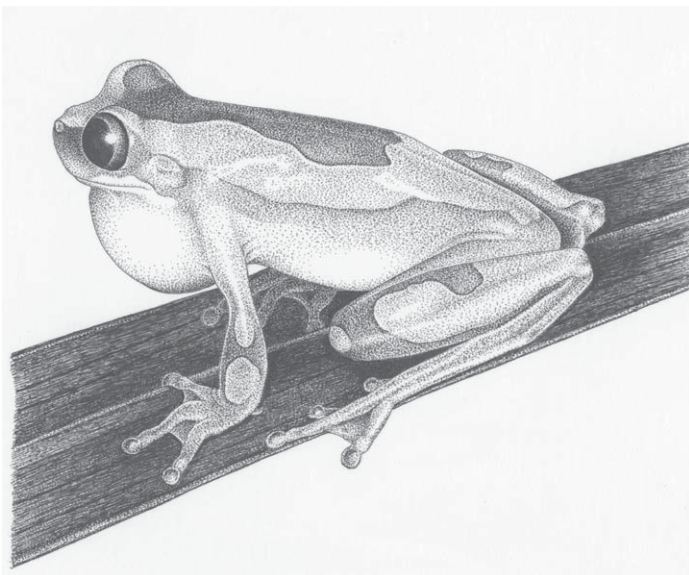
I thank D. Marjanović for constructive comments on an earlier draft.

LITERATURE CITED

- AHLBERG, P. E., AND J. A. CLACK. 1998. Lower jaws, lower tetrapods – a review based on the Devonian genus *Acanthostega*. *Trans. R. Soc. Edinburgh* 89:11–46.
- ANDERSON, J. S. 2008. The origin(s) of modern amphibians. *Evol. Biol.* 35:231–247.
- BERTRAND, Y., F. PLEJEL, AND ROUSE, G. W. 2006. Taxonomic surrogacy in biodiversity assessments, and the meaning of Linnaean ranks. *Syst. Biodiv.* 4:149–159.
- BININDA-EMONDS, O. R. P., J. E. JEFFREY, AND M. K. RICHARDSON, M. K. 2003. Is sequence heterochrony an important evolutionary mechanism in mammals? *J. Mammal. Evol.* 10:335–361.
- BROCHU, C. A. 2004a. Calibration age and quartet divergence date estimation. *Evolution* 58:1375–1382.
- . 2004b. Patterns of calibration age sensitivity with quartet dating methods. *J. Paleont.* 78:7–30.
- CARROLL, R. L. 2007. The Palaeozoic ancestry of salamanders, frogs and caecilians. *Zool. J. Linn. Soc.* 150:1–140.
- CLACK, J. A. 2002. An early tetrapod from ‘Romer’s Gap.’ *Nature* 418:72–76.
- COATES, M. I., M. RUTA, AND M. FRIEDMAN. 2008. Ever since Owen: changing perspectives on the early evolution of tetrapods. *Annu. Rev. Ecol. Evol. Syst.* 39:571–592.
- DAVIS, M. C., R. D. DAHN, AND N. H. SHUBIN. 2007. An autopodial-like pattern of Hox expression in the fins of a basal actinopterygian fish. *Nature* 444:473–477.
- FRÖBISCH, N. B., AND R. R. SCHOCH. 2009. Testing the impact of miniaturization on phylogeny: Paleozoic dissorophoid amphibians. *Syst. Biol.* 58:312–327.
- GERMAIN, D., AND LAURIN, M. 2009. Evolution of ossification sequences in salamanders and urodele origins assessed through event-pairing and new methods. *Evol. Dev.* 11:170–190.
- HENNIG, W. 1966. *Phylogenetic Systematics*. University of Illinois Press, Urbana. 263 pp.
- HUGALL, A. F., R. FOSTER, AND M. S. Y. LEE. 2007. Calibration choice, rate smoothing, and the pattern of tetrapod diversification according to the long nuclear gene RAG-1. *Syst. Biol.* 56:543–563.
- JANVIER, P. 1996a. The dawn of the vertebrates: characters versus common ascent in the rise of current vertebrate phylogenies. *Palaeontology* 39:259–287.
- . 1996b. *Early Vertebrates*. Oxford University Press, Oxford. xiii + 393 pp.
- KRILOFF, A., D. GERMAIN, A. CANOVILLE, P. VINCENT, M. SACHE, AND M. LAURIN. 2008. Evolution of bone microanatomy of the tetrapod tibia and its use in palaeobiological inference. *J. Evol. Biol.* 21:807–826.
- LAURIN, M. 1998a. The importance of global parsimony and historical bias in understanding tetrapod evolution. Part I. Systematics, middle ear evolution, and jaw suspension. *Ann. Sci. Nat., Zool., 13^e Sér.* 19:1–42.
- . 1998b. The importance of global parsimony and historical bias in understanding tetrapod evolution. Part II. Vertebral centrum, costal ventilation, and paedomorphosis. *Ann. Sci. Nat., Zool., 13^e Sér.* 19:99–114.
- . 2004. The evolution of body size, Cope’s rule and the origin of amniotes. *Syst. Biol.* 53:594–622.
- . 2008a. *Systématique, paléontologie et biologie évolutive moderne : l’exemple de la sortie des eaux des vertébrés*. Ellipses, Paris. 176 pp.
- . 2008b. The splendid isolation of biological nomenclature. *Zool. Scripta* 37:223–233.
- , M. GIRONNDOT, AND A. DE RICQLÈS. 2000. Early tetrapod evolution. *Trends Ecol. Evol.* 15:118–123.
- , AND R. R. REISZ. 1997. A new perspective on tetrapod phylogeny. *In* S. Sumida and K. Martin (eds.), *Amniote Origins—Completing the Transition to Land*, pp. 9–59. Academic Press, San Diego.
- , AND ———. 1999. A new study of *Solenodonsaurus janenschii*, and a reconsideration of amniote origins and stegocephalian evolution. *Can. J. Earth Sci.* 36:1239–1255.
- , AND R. SOLER-GIJÓN. 2006. The oldest known stegocephalian (Sarcopterygii: Temnospondyli) from Spain. *J. Vertebr. Paleontol.* 26:284–299.
- LEBEDEV, O. A. 1986. The first record of a Devonian tetrapod in the USSR. *Dokl. Akad. Nauk.* 278:220–222.
- LEE, M. S. Y., AND J. S. ANDERSON. 2006. Molecular clocks and the origin(s) of modern amphibians. *Mol. Phyl. Evol.* 40:635–639.
- MARJANOVIĆ, D., AND M. LAURIN. 2007. Fossils, molecules, divergence times, and the origin of lissamphibians. *Syst. Biol.* 56:369–388.
- , AND ———. 2008. Assessing confidence intervals for stratigraphic

ranges of higher taxa: the case of Lissamphibia. *Acta Palaeont. Pol.* 53:413–432.

- , AND ———. 2009. The origin(s) of modern amphibians: a commentary. *Evol. Biol.* 36:336–338.
- PAWLEY, K. 2006. The postcranial skeleton of temnospondyls (Tetrapoda: Temnospondyli). Doctoral thesis, La Trobe University, Melbourne, Australia. 442 pp.
- ROELANTS, K., D. J. GOWER, M. WILKINSON, S. P. LOADER, S. D. BIJU, K. GUILLAUME, L. MORIAU, AND F. BOSSUYT. 2007. Global patterns of diversification in the history of modern amphibians. *Proc. Natl. Acad. Sci. U.S.A.* 104:887–892.
- RUTA, M., AND M. I. COATES. 2007. Dates, nodes and character conflict: addressing the lissamphibian origin problem. *J. Syst. Paleontol.* 5:69–122.
- , ———, AND D. L. J. QUICKE. 2003. Early tetrapod relationships revisited. *Biol. Rev.* 78:251–345.
- SAN MAURO, D., M. VENCES, M. ALCOBENDAS, R. ZARDOYA, AND A. MEYER. 2005. Initial diversification of living amphibians predated the breakup of Pangaea. *Am. Nat.* 165:590–599.
- SCHOCH, R. R. 2006. Skull ontogeny: developmental patterns of fishes conserved across major tetrapod clades. *Evol. Dev.* 8:524–536.
- , AND R. L. CARROLL. 2003. Ontogenetic evidence for the Paleozoic ancestry of salamanders. *Evol. Dev.* 5:314–324.
- SCHULTZE, H.-P., AND R. SOLER-GUIÓN. 2004. A xenacanth clasper from the uppermost Carboniferous–Lower Permian of Buxières-les-Mines (Massif central, France) and the palaeoecology of the European Permo-Carboniferous basins. *Neues Jahrb. Geol. Paläontol. Abh.* 232:325–363.
- VALLIN, G., AND M. LAURIN. 2004. Cranial morphology and affinities of *Microbrachis*, and a reappraisal of the phylogeny and lifestyle of the first amphibians. *J. Vertebr. Paleontol.* 24:56–72.
- VERMEIJ, G. J., AND R. DUDLEY. 2000. Why are there so few evolutionary transitions between aquatic and terrestrial ecosystems? *Biol. J. Linn. Soc.* 70:541–554.
- WARREN, A. 2007. New data on *Ossinodus pueri*, a stem tetrapod from the Early Carboniferous of Australia. *J. Vertebr. Paleontol.* 27:850–862.
- , AND S. TURNER. 2004. The first stem tetrapod from the Lower Carboniferous of Gondwana. *Palaeontology* 47:151–184.
- ZHANG, P., H. ZHOU, Y.-Q. CHEN, Y.-F. LIU, AND L. H. QU. 2005. Mitogenomic perspectives on the origin and phylogeny of living amphibians. *Syst. Biol.* 54:391–400.



Dendropsophus ebraccata (Hourglass Treefrog), Belize. Illustration by Peter Stafford.

Snakes: Ecology and Conservation, edited by Stephen J. Mullin and Richard A. Seigel. 2009. Cornell University Press (www.cornellpress.cornell.edu). xiv + 365 pp. Hardcover. US \$60.00. ISBN 978-0801445651.

GAD PERRY

and

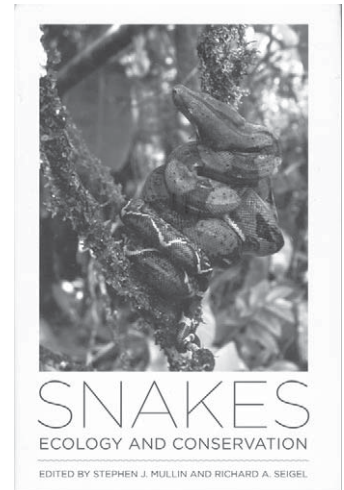
WESLEY M. ANDERSON

*Department of Natural Resource Management, Box 42125
Texas Tech University, Lubbock, Texas 79409-2125, USA
e-mail: Gad.Perry@ttu.edu*

There are many books about snakes. Just a few examples: a decade ago, Greene (1997) published one, illustrated with stunning photos by the Fogdens; half a decade earlier, Seigel and Collins (1993) informed “herpetologists, biologists, and others” about snake ecology and behavior; and half a decade earlier yet, Seigel et al. (1987) focused on the ecology and evolution of snakes. Do we need yet another one?

Early in their Introduction, Mullin and Seigel point out that habitat loss, caused by the seemingly endless increase in the human population and coupled with escalating technological abilities and standards of living, is causing the declines of many organisms. A decade ago, Gibbons et al. (2000) pointed out that in the rush to focus on declining amphibians – certainly a real and pressing problem – the roughly equal declines in reptile populations are mostly being ignored. Although a number of the snake books that have appeared since then include a conservation component – the attractive contribution from Henderson and Powell (2007) has seven conservation-related papers, for example, and both previous “snake” books (Seigel et al. 1987; Seigel and Collins 1993) had a chapter on the subject – none have *focused* on this important topic. Of the eleven numbered chapters in the current volume, seven include the word “conservation” in their title and all at least touch on the topic. Each chapter also contains a short “future directions” section identifying areas requiring additional attention.

The first half of the book (Chapters 1–4, pages 5–148) is methodological in nature. Whole books have been written about the material covered in these chapters. The extensive coverage provides for an excellent starting place for anyone designing a new snake study, but for details, especially of complex software packages or procedures, one will probably need to proceed to more specialized literature once an approach is chosen. Many advances have occurred since research methods were reviewed by Fitch in the first “snake” book (Seigel et al. 1987), and Chapter 1 starts with those but quickly goes beyond them. There is more overlap with the recent contribution by Ferner (2007; strangely missing



from the reference section). Some of the newer or more complex methods covered here, such as occupancy modeling, are not covered by either previous publication, however. The second chapter is focused on using molecular techniques to infer the processes that determined current distribution. The authors cover sources of DNA, the methods for constructing trees, and—most important, and supported by several full-page illustrations—the biological significance of possible phylogenetic patterns. How phylogeography informs conservation decisions is also covered, although not in great detail; that task is taken over by Chapter 3, which focuses on population genetics. A long table—3.5 pages—detailing available microsatellite primers for snake species is likely to be a useful resource, though additional ones will doubtlessly be available before long. Tables listing studies and levels of intra-population (6 pages) and inter-population (3 pages) genetic variation will also be convenient references. The fourth chapter focuses on another new set of tools, habitat modeling. These have recently attracted much attention when they were carefully applied to predicting the potential final distribution of large constrictors that have invaded and are expanding their ranges and impacts in Florida (Rodda et al. 2008). The chapter touches not only on the models and their data requirements, but also on conservation applications. Unfortunately, it does not provide advice on how to respond to hysterical complaints from readers who do not like model outputs.

The second half of the text (Chapters 5–10, pages 149–280) offers reviews. The question of how behavioral data can be incorporated into conservation decisions is addressed in Chapter 5, which is arranged by study area (e.g., “invasive prey and predators”). Chapter 6 focuses on reproductive biology and its conservation implications—arguing that habitat protection, for a variety of reasons, simply isn’t enough and an understanding of reproductive processes is essential for long term population viability. Captive rearing, and what to do with the individuals produced, are covered in Chapter 7, which provides a useful review of snake translocation projects—few of them successful, unfortunately. Chapter 8 addresses a complaint made by Dodd in the second “snake” book (Seigel and Collins 1993): that the efficacy of habitat manipulation tools such as creation of corridors has not been carefully assessed. A five-page table summarizing existing studies suggests very mixed impacts on snakes, and many other studies that do not provide conclusive results. Managers, who often rush to act without ensuring funding for long-term assessment of impacts, need to hear the authors’ recommendation: “Until the safety and effectiveness of habitat manipulation is firmly established ... [such] projects should be monitored experimentally.” The authors of Chapter 9 take an unusual tack: instead of always being on the defensive, given the bad name snakes generally have in the general public and among managers, why not show that they are useful? In this case, they are suggesting snakes can act as indicators of environmental health—a term that is often poorly defined. They explore how snakes could be appropriate in monitoring for chemical contamination, for example, but point out that such use “by resource managers has been almost nonexistent.” Chapter 10, which focuses on the widespread fear of snakes in many cultures, may both explain why this has been the case and suggest that it is not likely to change any time soon. The authors point out that familiarity breeds tolerance and focus on education as the only possible solution.

In the final chapter, the editors sum up where we are and consider

where the future might lead. The chapter is divided into several sections, some of which summarize previous chapters and many that do not. Some of these are important for scientists with an interest in conservation to consider if they have not done so before. Two important examples: we need to acknowledge that some measure of uncertainty will remain no matter how much research we do, so we need to become better at learning when to feel secure enough to make recommendations for management; and we need to learn to better communicate these recommendations to managers. Among the priorities they identify for future work: add studies of processes, rather than individual species; examine the impacts of roads; better integrate molecular tools; and rely more on experimental, rather than correlational, inference. The summary is followed by over 60 pages of references, ranging from the 1500s to 2008, a five-page taxonomic index, and a shorter subject index.

This is not a book for the general public, but managers and scientists, both beginning and well-established, will find something of value. Upper-level undergraduate and graduate students may particularly benefit from this book as they begin to conduct their first research projects. Regardless, one topic we wished was covered is urban ecology. Conservation biologists have unfortunately long treated urban environments as worthless, something the extensive urban herpetology volume (Mitchell et al. 2008) shows to be untrue. Not only do urban settings offer the only growth industry in our field—as pointed out by the first line of the Introduction—but they also offer a great opportunity to educate a public increasingly disassociated from anything “natural.” We feel this book may have also benefited from a chapter reviewing our current understanding of the natural histories of each major clade, and what conservation measures may be unique to these groups. The editors acknowledge the need for “research on a much broader array of snake taxa.” Scolecophidians, for example, comprise around 10% of ophidian diversity yet are granted only three sentences in the entire book. These caveats aside, don’t let the unassuming cover photo dissuade you from getting a copy of this book if you study or manage snakes—it belongs in your bookcase.

This is manuscript T-9-1177 of the College of Agricultural Sciences and Natural Resources, Texas Tech University.

LITERATURE CITED

- FERNER, J. W. 2007. A review of marking and individual recognition techniques for amphibians and reptiles. *Herpetological Circular* 35. Society for the Study of Amphibians and Reptiles, Salt Lake City. 72 pp.
- GIBBONS, J. W., D. E. SCOTT, T. J. RYAN, K. A. BUHLMANN, T. D. TUBERVILLE, B. S. METTS, J. L. GREENE, T. MILLS, Y. LEIDEN, S. POPPY, AND C. T. WINNE. 2000. The global decline of reptiles, déjà vu amphibians. *BioScience* 50:653–666.
- GREENE, H. W. 1997. *Snakes: the Evolution of Mystery in Nature*. University of California Press, Berkeley. xiii + 351 pp.
- HENDERSON, R. W., AND R. POWELL (eds). 2007. *Biology of the Boas and Pythons*. Eagle Mountain Publishing, Eagle Mountain, Utah. x + 438 pp.
- MITCHELL, J. C., R. E. JUNG BROWN, AND B. BARTHOLOMEW (eds). 2008. *Urban Herpetology*. Society for the Study of Amphibians and Reptiles, Salt Lake City. xvii + 586 pp.
- RODDA, G. H., C. S. JARNEVICH, AND R. N. REED. 2008. What parts of the US mainland are climatically suitable for invasive alien pythons spreading from Everglades National Park? *Biol. Invasions* 11:241–252.
- SEIGEL, R. A., AND J. T. COLLINS. 1993. *Snakes: Ecology and Behavior*. McGraw-Hill, New York. xvi + 414 pp.

Reptiles and Amphibians of the Southern Pine Woods, by Steven B. Reichling. 2008. University Press of Florida (www.upf.com). Softcover. xxi + 252 pp. US \$29.95. ISBN 978-0-8130-3250-4.

JEFF BOUNDY

Louisiana Department of Wildlife and Fisheries
2000 Quail Drive, Baton Rouge, Louisiana 70808, USA
e-mail: jboundy@wlf.la.gov

“I trekked through this landscape in a perpetual state of anticipation.” Thus, the author describes his first foray into the southern pine woods. These words aptly describe my own first experiences as well – anxious to see a unique herpetofauna previously known to me only from books. I had the unique opportunity to explore the pine woods herpetofauna as a salaried biologist with a perspective on management. I was repeatedly told that the woods needed to be managed. Ecologists, foresters, naturalists ... all knew how the forests functioned and were sure of the keys to managing them: ‘lightning-caused fires are vital,’ ‘fires by indigenous people had to supplement lightning,’ ‘a high stocking rate keeps a closed canopy, thereby preventing hardwood succession,’ ‘herbicide must replace fire,’ ‘prescribed burns in winter...or in summer;’ one-by-one they offered clues, often conflicting, about pine woods management. Thus, when I opened Reichling’s book, I looked first for a chapter on managing the southern pine woods. There was none.

Instead, the book begins with two introductory chapters and ends with an epilogue. The remaining 200 pages contain species accounts of amphibians and reptiles that characterize the Pine Woods herpetofauna. Reichling begins the Introduction with a wise disclaimer that assembling a catalogue of species that are defined by an ecotype is subjective. He then presents his criterion for how he selected each species: they are restricted primarily to what was, or remains of, woods dominated by four species of fire-resistant pines in the coastal plain from North Carolina to eastern Texas. Chapter One characterizes the Southern Pine Woods in terms of geography, stand structure, hydrology and other factors. The woods are subdivided into hydrologic series (flatwoods, ridge, savanna and rockland), and into areas of regional endemism (e.g., central Florida ridges, Apalachicola), each of which is further described in terms of the geographic and environmental factors that have produced and maintained each series. A section on pine plantations is included, and each of the categorized pine woods types is

illustrated by a color photograph.

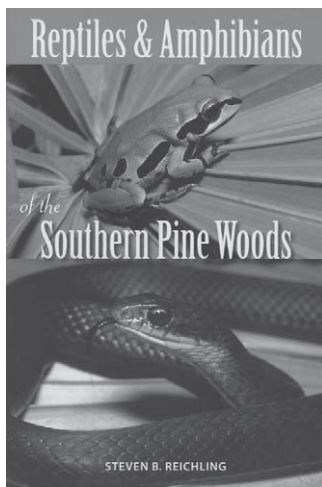
Chapter Two, “Observing amphibians and reptiles,” begins with conflicting guidance. Reichling starts by encouraging the reader to seek out the pine woods herpetofauna, but follows with a plea that animals not be collected and a frightening paragraph on how destructive one’s footfalls are to the fragile ecosystem of the litter layer—the basis for his next plea—to remain on established trails. The next paragraph describes the amount of hardcore, off-trail work needed to efficiently locate the pine woods herpetofauna: the logs to be rolled, the amount of ground to be covered, and the value of dumping tin sheets and cover boards about the landscape. The literal reader will be quite frustrated attempting to see a Pine Barrens Treefrog or Blue-tailed Mole Skink from the trail. “Locating suitable habitats” begins with a summary of state and federal sites that maintain natural pine stands, and follows with a summary of microhabitats and how some species of amphibians and reptiles use them. Absent from the list of state-owned pine lands are Louisiana’s Wildlife Management Areas, including Sandy Hollow and Sicily Island Hills.

The species accounts are segregated into generalists, then flatwoods, savanna, ridge and rockland specialists, and finish with an “other” category of species not restricted to pine woods, but often found therein. Each species account begins with a topical essay—one that is pertinent to that species but also covers a broader concept such as cooperative agreements, land development, scientific discovery, field techniques, biogeography, captive management, invasive species, etc. A morphological description follows the introductory essay, always very detailed, including descriptions of larvae for amphibians. All but two of the 38 taxa are illustrated by a color photograph, and many are accompanied by specific habitat photographs as well.

Distribution Notes discusses the historic range, which is compared to recent records of occurrence. A map is associated with this section (except for the “other” species), which can be misleading if the reader has not read pages 6–7. The maps show existing pine woods enclaves currently inhabited by each species rather than the actual range of the species. Additional sections cover Habitat, Ecology and Natural History, and Conservation, and each account ends with a Summary. The habitat is described in terms of hydrologic series and dominant tree species, followed by microhabitat use by the animal. Aspects of natural history covered include feeding habits and reproduction, and there are frequent recurrences of microhabitat discussion.

For some taxa, Reichling discusses physiological adaptations and responses such as thermal preferences and dehydration rates. In these latter sections, he presents much information about the interactions of each species with their immediate environment. The essays are modestly referenced, and many of the details seem novel. At times, I wished I could put the book down, dash off to the local pine woods, and try some new search method suggested by Reichling.

Discussions under “Conservation” are inconsistent between species: for *Plethodon kisatchie* only habitat preferences are reiterated; for *Pantherophis slowinskii* I gather that forest cutovers and trash dumps are positive conservation measures; for *Terrapene carolina major* we learn how to properly keep them as pets. For other species, conservation is discussed in terms of threats, typically direct human take, timber harvest practices or land development.



Remedies must be inferred.

The ten species considered in the “other” pine woods species category receive only a page or two that serve to introduce the species, then discuss some aspect of its biology; e.g., *Sceloporus undulatus* inhabits sites where it can bask; the defensive behavior of *Masticophis* is detailed; *Lampropeltis elapsoides* thermoregulates under pine bark. I agree with the author about the subjectivity of the species he has assembled, but I believe it would have been reasonable to have included *Rana capito* and *Plestiodon inexpectatus* in this section. Literature references are scattered within the species accounts, and approximately 180 citations are included in the Bibliography.

Despite the upbeat first paragraphs, the overall tone of the book is one of lamentation: the problem is loss of the pinelands, the culprits are industry and development. In the epilogue, Reichling’s pessimism is unbridled, and any hope of saving the pinelands seems almost futile. He notes that local objectives such as protecting the Trans-Mississippi sandhills tend to be ignored, as global environmental issues have achieved top priority with the media and public. He offers few solutions, and these only on the last few pages. Here and elsewhere in the book Reichling offers provocative opinions on issues with which some readers may disagree. For example, he and I differ on the utility of Endangered Species listing, but I commend his view that conservationists should learn forest economics. Overall, Reichling has masterfully mingled his topics within the entirety of the book, and these are covered in various formats throughout the text. I finally discovered that pine woods management is covered extensively in the book—you just have to read the entire thing: forest dynamics on page 23, plantation silviculture on page 58, soil disturbance on page 160, prescribed burning on page 234, etc.

My wish list for this book, some directed at the publisher, includes better photographic reproduction and more anecdotes. Many of the 100 color photos are too dark (e.g., plates 1.19, 3.4, 6.14). The paucity of personal stories leaves me wondering how many of these species Reichling has found afield, and makes his personal affection for the pine woods seem a little distant. A few instances of strict adherence to the metric system are awkward: “approximately 324 ha;” “storm surge was 61–122 cm” (stick with 2–4 feet).

Reptiles and Amphibians of the Southern Pine Woods is less a textbook and more a story of the pinelands and their herpetofauna. After reading the book, I ventured into familiar pine woods with a revitalized spirit, with a modified perspective, as if a fresh set of eyes were pointing out things I had never realized, renewing in me the boundless enthusiasm that Reichling and I both experienced in our respective first trips to the pines.

Rattlers, Peepers, and Snappers, produced by Vince Franke, Science Advisor Jim Andrews. 2008. Peregrine Productions (www.peregrineproductions.com or www.rpsdvd.com). DVD. US \$24.95.

GREGORY J. WATKINS-COLWELL

*Yale Peabody Museum of Natural History, 170 Whitney Avenue,
New Haven, Connecticut 06511, USA
e-mail: gregory.watkins-colwell@yale.edu*

and

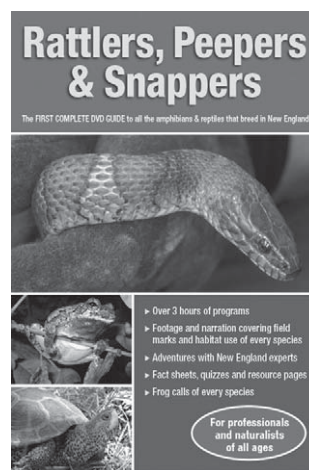
ALEX DORNBURG

*Department of Ecology and Evolutionary Biology, Yale University,
New Haven, Connecticut 06520, USA
e-mail: alex.dornburg@yale.edu*

Rattlers, Peepers, and Snappers represents the first complete DVD field guide to all of New England’s breeding reptiles and amphibians, focusing on the general ecology, life history, and conservation concerns of each of the region’s 52 species. This is presented in two main sections, which may be viewed as a whole or as individual “adventures” (chapters) covering amphibians and reptiles respectively. The program includes narrations from ten researchers and conservation specialists working with various New England species in addition to over an hour and a half of extra features not in the primary film segments.

The primary amphibian segment has a run time of 38 minutes and is partitioned into six chapters. These draw on the research and experiences of Jim Andrews (The Vermont Reptile and Amphibian Atlas), Tom Tynning (Berkshire Community College), Aram Calhoun (University of Maine), Rebecca Chalmers (Vermont Department of Conservation), and Sean Blomquist (University of Maine). It opens with a discussion of amphibian spring migrations and introduces the common theme of the DVD: how the complex ecology and natural history of these organisms is often at odds with anthropogenic factors. The program next takes the viewer from the topic of spring migrations to the impact of road crossing mortality on amphibian populations, giving a first hand account of the challenges these organisms face when moving between habitats. Habitats are discussed in more detail in the next three sections that in turn cover species most often associated with vernal pools, streams, or bodies of permanent water. The program ends with a chapter on wood frog responses to various degrees of deforestation around vernal pool breeding sites featuring the research of Sean Blomquist, a Ph.D. candidate at the University of Maine.

The primary reptile segment runs for 49 minutes across nine chapters hosted by Jim Andrews, Liz Willey (University of Massachusetts), Tom Tynning, Chuck Smith (University of Connecticut), Dave Paulson (University of Massachusetts), Steve Parren



(Vermont Wildlife Division of Non-Game), and naturalist Alcott Smith. This program follows a similar theme of depicting the delicate balance of reptilian life history and ecological needs with their current and future conservation concerns. It opens with Jim Andrews guiding a field group through several continuous habitats to find multiple species of native snake and New England's only lizard species, the five-lined skink. The central themes are carried through the next sections on box turtle habitat use, the state of timber rattlesnake populations in New England, and cryptic suburban populations of wormsnares. These sections are followed by a chapter focusing on habitat mitigation for racers in Vermont, demonstrating to the viewer that primary research can be incorporated into conservation use by non-wildlife state agencies. Chuck Smith's section on copperheads is next, followed by three sections covering fall migration, man-made turtle tunnels to prevent high levels of road mortality, and a concluding section on turtle nesting along the shores of the heavily developed Lake Champlain.

The DVD contains many additional features that enhance its educational value. Fact sheets for each species, including introduced species, highlight the conservation status of each of the species in the six individual New England states. These also contain an extra video discussing identification, natural history, and conservation concerns for each species. The video quizzes are designed for use in classroom settings and test the viewer's ability to visually identify several common species and frog calls. A chapter on taxonomy narrated by Jim Andrews explains that the taxonomy follows the Scientific and Standard English Names list published by SSAR (Crother 2008). Finally, a section entitled "what you can do," provides a downloadable pdf list of resources and suggested conservation projects that may give the viewer direction for further involvement.

Errors are minimal and include a typographical error on a quiz answer (e.g., Spadefott vs. Spadefoot), and editing errors such as video of an eastern gartersnake release during a section on ribbonsnakes. Additionally, the species list may be difficult to navigate if the viewer does not know the current common name, though the diversity of each species group is low making this a slight inconvenience at most. Overall these are very minor points and do not detract from the presentation of the material.

The section hosts give a human face and personality to each topic, allowing the viewer to witness wildlife professionals working with several northeastern species, many of which are declining. This is exemplified by the repeated appearance of Jim Andrews, whose presence provides not just visual continuity, but also a contagious, near-childlike enthusiasm for these animals that is coupled with an appreciation for the various habitats in which they reside. He manages to avoid alienating the viewers with subjects as potentially off putting as road kill (in which he stacks crispy snake and frog wafers he found while walking along a small stretch of road) or taxonomy where the presence of a Star Trek mug on the shelf behind his head further endears him to the viewers.

What may be the most complete DVD of amphibians and reptiles for any region in North America, *Rattlers, Peepers, and Snappers*, provides teachers, educators, and interested individuals with a resource from which to gain insights into the lives of these often misunderstood animals. Although most segments were filmed in Vermont, the overall messages apply to a broader stage and are most certainly applicable to the rest of the New England region

if not larger sections of North America. The species fact sheets and included quizzes act as teaching aids and greatly enhance the potential value of the primary film segments for teachers and educators wanting a new way of engaging students' interests in local biodiversity. To conclude, the film segments are well thought out and clearly represent a labor of love. We highly recommend this DVD.

LITERATURE CITED

CROTHER, B. I. (Committee Chair). 2008. Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in Our Understanding, 6th ed. SSAR Herpetological Circular 37. Society for the Study of Amphibians and Reptiles, Shoreview, Minnesota. [4] + 84 pp.

PUBLICATIONS RECEIVED

The Fruit, the Tree, and the Serpent, Why We See So Well, by Lynne A. Isbell. 2009. Harvard University Press (www.hup.harvard.edu). Hardcover. xi + 207 pp. US \$45.00. ISBN 978-0-674-03301.

This intriguingly titled book outlines the author's 'Snake Detection Theory' which attributes a significant role to snakes as a driving force in the evolution of primates. Constricting snakes are argued to have evolved roughly concomitantly with primates and to have played a role in the increased role of vision over olfaction in these mammals and in the evolution of larger brain size. More specifically, catarrhine primates, including anthropoid apes, are part of a lineage that evolved along with venomous snakes and developed the most sophisticated visual system and the largest brains of any primates (versus, for example, the smaller-brained, more olfactory lemurs of venomous snake-free Madagascar). The author links changes in diet and sensory modalities to brain size and an enhanced 'fear module' that are key elements in the evolutionary arms race between primates and their ophidian predators. The underlying neurological bases of the theory are outlined, testable predictions are presented, and the relationship between the theory and human fears and mythology are explored in this extensively referenced book. The book is accessible to a general readership and, although focused on the mammalian perspective, will be of equal interest to herpetologists concerned with the evolution of snakes.

Sex, Size and Gender Roles, Evolutionary Studies of Sexual Size Dimorphism, edited by Daphne J. Fairbairn, Wolf U. Blanckenhorn, and Tamás Székely. 2007. Oxford University Press (www.oup.com). ix + 266 pp. Softcover. US \$60.00. ISBN 978-0-19-954558-2 [also available in hardback edition].

The 20 chapters in this volume are derived from a workshop on sexual size dimorphism (SSD) held in Switzerland in 2005. The book is divided into three main sections exploring macro-patterns, micro-patterns, and mechanisms. Five of the chapters are herpetological in focus. In the macro-pattern part are chapters dealing with amphibians (by Alexander Kupfer) and reptiles (by Robert Cox,

Marguerite Butler, and Henry John-Alder) in general. The former chapter examines ontogenetic patterns in dimorphism, whereas the latter explores phylogenetic and geographic trends in SSD and considers the roles of selection and constraint in the patterns observed. Studies by Evgeny Roitberg on variation in dimorphism in the widespread Palearctic lizard *Lacerta gailis* and by Lukáš Kratochvíl and Daniel Frynta on SSD in eublepharid geckos are more fine-scaled analytical investigations. Finally, at the mechanistic level, John-Alder and Cox consider the role of testosterone in influencing SSD through growth rates. Other chapters deal with birds, mammals, insects, spiders, and even plants. The book as a whole includes an extensive list of approximately 1000 references and a glossary of nearly 100 terms. The contributed chapters represent a spectrum of approaches to the topic of SSD and the book should be of particular value to herpetologists with interests in behavioral and evolutionary ecology, as well as physiology and endocrinology.

My Life in Natural History: An Autobiograph, by Walter J. Breckenridge. 2009. Bell Museum of Natural History, 10 Church St. SE, Minneapolis, Minnesota 55455. V + 178 pp., 44 pp. pls. Softcover. US \$29.95. ISBN 978-1-885209-59-7.

This is the autobiography of Minnesota's greatest naturalist, Walter Breckenridge, who died in 2003 at the age of 100. His notes for the autobiography were transcribed and organized by his daughter, Barbara Breckenridge Franklin, and have been published by the Bell Museum, with which he was affiliated starting in 1926. Breckenridge's detailed reminiscences paint a detailed portrait of both his personal and professional life. His 300+ publications (1929–1999) are enumerated in an appendix compiled by John Moriarty. Although most of his work was ornithological, Breckenridge's interests were varied and he published 34 papers on amphibians and reptiles and is known to most herpetologists for his 1944 book *Reptiles and Amphibians of Minnesota*, based on his Ph.D. dissertation — a pioneering work for the upper Midwest. The text provides some anecdotes about this research, as well as later work on toads and softshell turtles. Although known for his studies in Minnesota, Breckenridge traveled widely in the U.S. and Canada as well as the Neotropics. Beginning as a taxidermist at the Bell Museum he rose to become director. Aside from his academic and administrative activities, he also lectured widely to the general public across America and was a talented natural history artist. Forty-four color plates illustrate 67 of Breckenridge's paintings (most ornithological, but including two reptiles). This inexpensive book will be of special interest to herpetologists with an historical bent and those working or living in Minnesota, Breckenridge's native Iowa, or elsewhere in Midwest.

Erratum

In the September 2009 issue (vol. 40, no. 3, page 367), the range extension note for *Storeria dekayi texana* by Streicher used the term "longitudinal gap," when it should have appeared as "latitudinal gap."



Final Volume of the Series

BIOLOGY OF THE REPTILIA

Comprehensive Literature
of the Reptilia

Nearly 23,000 references with cross-referenced subject index in 1,400 pages (clothbound)

Pre-publication price to SSAR members: \$95

For ordering information and full description, see *Herpetological Review*, September 2009, p. 258, or visit SSAR online: <http://www.ssarbooks.com/>

Cover Images for *Herpetological Review*

We are looking for photographic images to appear on future covers of *HR*. To be considered, preferred images should have the following qualities:

- Should be technically superior photographs (e.g., composition, lighting, etc., should be excellent; subject must be in focus).
- Should be taken in vertical format, or, if in landscape format, permit cropping to achieve a vertical orientation.
- Should be based on film or digital media; if the latter, the native resolution must be sufficiently high to permit cropping and/or enlargement to print publication quality (many "point-and-shoot" digital cameras do not produce image files with sufficient resolution for print publication).
- Preference will be given to images that depict poorly known species. These could include recently described taxa or species for which a color illustration has never been published.
- Preference will be given to images that communicate some aspect of the biology of the organism (e.g., predation, feeding, courtship, crypsis).

Images for consideration should be submitted as low-resolution jpg or pdf files. Do not send full resolution images via email. All submissions or questions should be directed to the Editor (herpreview@gmail.com).

**SSAR COMMITTEE CHAIRS
AND COORDINATORS**

CHAIRPERSONS

Standard English and Scientific Names

BRIAN I. CROTHER
Department of Biological Sciences
Southeastern Louisiana University
Hammond, Louisiana 70402, USA

Conservation

BETSIE ROTHERMEL
Archbold Biological Station
PO Box 2057
Lake Placid, Florida 33862, USA

Grants-In-Herpetology

ERIK R. WILD
Department of Biology
University of Wisconsin-Stevens Point
Stevens Point, Wisconsin 54481-3897, USA

JOSHUA M. KAPFER
Natural Resources Consulting, Inc.
119 South Main Street, PO Box 128
Cottage Grove, Wisconsin 53527, USA

Kennedy Student Award

LYNNETTE SIEVERT
Department of Biological Sciences
Emporia State University
Emporia, Kansas 66801, USA

Metter Memorial Award

JOSEPH J. BEATTY
Department of Zoology
Oregon State University
Corvallis, Oregon 97331-2914, USA

Nominating

GREGORY WATKINS-COLWELL
Yale Peabody Museum of Natural History
New Haven, Connecticut 06520-8118, USA

Resolutions

STUART NIELSEN
Department of Biology
University of Mississippi
University, Mississippi 38655, USA

Seibert Awards

PATRICK OWEN
Department of EEO Biology
The Ohio State University at Lima
Lima, Ohio 45804, USA

Student Travel Awards

MATTHEW VENESKY
Department of Biology
The University of Memphis
Memphis, Tennessee 38152, USA

CARI HICKERSON
Biological, Geological & Environmental Science
Cleveland State University
Cleveland, Ohio 44115, USA

Webmaster

RAUL E. DIAZ
University of Kansas Medical Center
Lawrence, Kansas 66160, USA
e-mail: lissamphibia@gmail.com

COORDINATORS

Electro

DANIEL NOBLE
Department of Brain, Behaviour and Evolution
Macquarie University
Sydney, NSW 2109, Australia

Symposium Coordinator

RICHARD D. DURTSCHKE
Department of Biological Sciences
Northern Kentucky University
Highland Heights, Kentucky 41099, USA

INFORMATION FOR CONTRIBUTORS

Herpetological Review is a peer-reviewed quarterly that publishes, in English, articles and notes of a semi-technical or non-technical nature, as well as book reviews, institutional features, commentaries, regional and international herpetological society news, and letters from readers directed to the field of herpetology. Articles reporting the results of experimental research, descriptions of new taxa, or taxonomic revisions are not published in *HR*, but should be submitted to the *Journal of Herpetology* (see inside front cover for Editor's address). To submit a manuscript to *HR*, please consult the SSAR webpage at:

<<http://www.ssarherps.org/pages/HRinfo.php>>

Reprints and Page Proofs

Reprints of notes or articles published in *HR* may be ordered through EZReprints (EzReprint@odysseypress.com), an online reprint ordering system. Authors will receive email notification as the issue goes to press. Page proofs are sent electronically to authors of all articles, book reviews, and obituaries, but are not sent for natural history notes or geographic distribution notes. Proofs are sent as pdf files approximately 2–4 weeks prior to publication.

Advertising

Herpetological Review accepts commercial advertising. Rates and copy information are available from the SSAR web page (<http://www.ssarherps.org/pages/HRinfo.php>).

Herpetological Review (ISSN: 0018-084X) is published quarterly (March, June, September, and December) by the Society for the Study of Amphibians and Reptiles at Central Michigan University, Department of Biology, 217 Brooks Hall, Mt. Pleasant, MI 48859, USA. Periodicals postage paid at Mt. Pleasant, MI 48859 and at additional mailing offices. All rights reserved. No part of this periodical may be reproduced without written permission of the Editor, except that authors and their agents are permitted to reproduce and distribute their own articles and notes. **POSTMASTER:** Send address changes to Breck Bartholomew, SSAR Publications Secretary, P.O. Box 58517, Salt Lake City, UT 84158. **MISSING OR DAMAGED ISSUE?** Please notify Breck Bartholomew, SSAR Publications Secretary (e-mail: ssar@herplit.com) for a replacement.

SSAR Publications

SSAR publishes seven different series: *Journal of Herpetology*, *Herpetological Review*, *Facsimile Reprints in Herpetology*, *Contributions to Herpetology*, *Herpetological Circulars*, *Herpetological Conservation*, and the *Catalogue of American Amphibians and Reptiles* (see below for CAAR details). SSAR members receive pre-publication discounts on all *Facsimiles* and *Circulars* and on volumes in the *Contributions* and *Herpetological Conservation* series. A complete pricelist of Society publications is available at: <http://www.ssarbooks.com/>.

Catalogue of American Amphibians and Reptiles

The *Catalogue* consists of loose-leaf accounts of taxa prepared by specialists, including synonymy, definition, description, distribution map, and comprehensive list of literature for each taxon. Covers amphibians and reptiles of the entire Western Hemisphere. Available for purchase from the SSAR Bookstore (<http://www.ssarbooks.com/>). Use the prices below to order back issues.

COMPLETE SET: NUMBERS 1 – 840	US \$460
INDEX TO ACCOUNTS 1 – 400: Cross-referenced, 64 pages	\$6
INDEX TO ACCOUNTS 401 – 600: Cross-referenced, 32 pages	\$6
SYSTEMATIC TABS (Ten tabs to fit binder: "Class Amphibia," "Order Caudata," etc.)	\$6
IMPRINTED POST BINDER (Note: one binder holds about 200 accounts)	\$35
INCOMPLETE SET: NUMBERS	
1 – 190	\$75
191 – 410	\$85
411 – 840	\$320

To order: make checks payable to "SSAR" and mail to Breck Bartholomew, SSAR Publications Secretary, P.O. Box 58517, Salt Lake City, Utah 84158, USA (fax 801/453-0489). e-mail: ssar@herplit.com. Online orders at: <http://www.ssarbooks.com/>.

The Official News-Journal
of the
Society for the Study of
Amphibians and Reptiles

Herpetological Review

Volume 41, Number 1
March 2010

ARTICLES

- Rediscovery of the Rare Autlán Long-Tailed Rattlesnake, *Crotalus lannomi*
..... by J. REYES-VELASCO, C. I. GRÜNWARD, J. M. JONES, AND G. N. WEATHERMAN 19
- Checklist of Terrestrial Reptiles in Three Protected Areas in the Kingdom of Saudi Arabia by P. L. CUNNINGHAM 25
- A Proposed Weight-Length Relationship for the Common Mudpuppy by A. J. VANDEVALK AND J. T. H. COLEMAN 29
- Sex Differences in the Genitalia of Hatchling *Caiman latirostris* by N. B. NUÑEZ OTAÑO, A. IMHOF, P. G. BOLCATTO, AND A. LARRIERA 32
- New Herpetofaunal Records from Southern Honduras by R. LOVICH AND COLLEAGUES 112
- New and Noteworthy County Records of Amphibians and Reptiles from Southeastern Washington State
..... by R. E. WEAVER AND A. DORNBURG 115

TECHNIQUES

- Dual-Energy X-ray Absorptiometry (DXA) as a Non-Invasive Tool for the Prediction of Bone Density and Body Composition of Turtles
..... by M. D. STONE, B. H. ARJMANDI, AND M. B. LOVERN 36
- The Biology of Crawfish Frogs (*Lithobates areolatus*) Prevents the Full Use of Telemetry and Drift Fence Techniques
..... by J. L. HEEMEYER, V. C. KINNEY, N. J. ENGBRECHT, AND M. J. LANNOO 42

AMPHIBIAN DISEASES

- Batrachochytrium dendrobatidis* in Adult *Notophthalmus viridescens* in North-Central Alabama, USA
..... by K. A. BAKKEGARD AND A. P. PESSIER 45
- Batrachochytrium dendrobatidis* Detected in Amphibians from National Forests in Eastern Texas, USA
..... by D. SAENZ, B. T. KAVANAGH, AND M. A. KWIATKOWSKI 47

HERPETOLOGICAL HISTORY

- Very Early Photographs of Reptiles by M. NIEKISCH 50

HERPETOLOGICAL HUSBANDRY

- Observations on the Captive Reproduction of the Horned Marsupial Frog *Gastrotheca cornuta* (Boulenger 1898)
..... by R. GAGLIARDO, E. GRIFFITH, R. HILL, H. ROSS, J. R. MENDELSON III, AND E. TIMPE 52

BOOK REVIEWS

- Extinction in Our Times: Global Amphibian Decline reviewed by M. D. THOMPSON 116
- The Rise of Amphibians reviewed by M. LAURIN 119
- Snakes: Ecology and Conservation reviewed by G. PERRY AND W. M. ANDERSON 123
- Reptiles and Amphibians of the Southern Pine Woods reviewed by J. BOUNDY 125
- Rattlers, Peepers, and Snappers reviewed by G. J. WATKINS-COLWELL AND A. DORNBURG 126

SSAR BUSINESS 1

NEWSNOTES 1

MEETINGS 2

CURRENT RESEARCH 2

ZOO VIEW 6

LETTERS TO THE EDITOR 17

NATURAL HISTORY NOTES 58

GEOGRAPHIC DISTRIBUTION 102

PUBLICATIONS RECEIVED 127

ERRATUM 128