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SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

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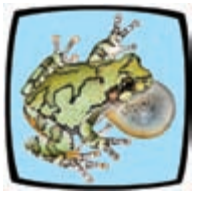

The Society for the Study of Amphibians and Reptiles, the largest international herpetological society, is a not-for-profit organization established to advance research, conservation, and education concerning amphibians and reptiles. Founded in 1958, SSAR is widely recognized today as having the most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

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

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

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

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

Future Annual Meetings

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

SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES: REACHING THE WORLD

PHOTO BY R. A. ODUM/TOLEDO ZOO

Our society thrives on the passion of our membership for all-things-herpetological. No doubt, most of us were childhood herpers. When I am introduced to young herpetologists, I sometimes tell them how I turned my childhood hobby into a career into my profession—so, clearly I have the best job in the world (for me)! I will use this theme of reaching out in order to address two important topics related to SSAR. The 7th World Congress of Herpetology takes place this year, in August, and we also have a societal commitment to reach out to the world. Lots of exciting things are happening on both of those fronts, so let's review them.

The World Congress of Herpetology is a great tradition that periodically brings together a diverse gathering of herpetologists. SSAR has always been a strong supporter of WCH in every sense, including direct financial contributions to help ensure its ultimate success; we contribute all of the proceeds from our Live Auction to WCH whenever we meet with them concurrently. We also produce commemorative materials such as David Dennis's iconic painting of the Eastern Box Turtle inspecting the berry, produced as giveaway posters for the First WCH in Canterbury. Wait until you see what David has produced for the upcoming WCH! You'll see it first on the current covers of *Journal of Herpetology* and *Herpetological Review*. We also produce special publications, and this year we are distributing *gratis* copies of *Herpetological Review* and *Contributions to the History of Herpetology (Volume 3)* to all delegates. All of the usual SSAR activities will be in place, including the Student Social, Student Workshop, Silent & Live Auctions, and more.

As SSAR continues to advance its commitment to membership diversity, we are rolling out two new programs this year. One is a scholarship opportunity for a gradeschool-student herpetologist (and parent) to attend one day of the event, and the other is our new Mentorship Program. Kris Kaiser developed and leads this latter program to help first-timers navigate the myriad events that constitute the annual meeting, help them meet like-minded peers, and introduce them to key members relevant to their interests. This year will also mark the rollout of our extension of eligibility of our paper/poster competitions and travel grants to include undergraduates. Considered together, these programs demonstrate how SSAR continually is expanding and creating programs to suit the ever-changing nature of modern herpetology, and our ongoing efforts to encourage diversity and involvement in herpetology. They also remind us that the term "student" means *all students* interested in herpetology and wherever they might be in the world.

This last point leads me to another topic involving an expansive and inclusive view of herpetology that SSAR exemplifies and embraces. There is a lot of great herpetology going on these days that is taking place outside of our traditional view of professional societies. Indeed, modern herpetology is a shape-shifting creature to behold, and it is exciting. Facebook is alive with really active pages devoted to herpetology; SSAR's Facebook page has many more friends and "likes" than we have actual members! We want to engage and encourage anyone with an interest in herpetology, and outlets like Facebook are allowing us to do so, at no real cost, outside the more traditional media of printed journals and books. Another Facebook page, called *Herpetofauna Mexicana,* is a real favorite of mine and has become a valuable research tool. Friends of this page post photographs of species encountered all over Mexico. Sure, some images are better than others, some have questionable identifications, and not all are accompanied by detailed locality data. But some of them represent perfectly valid locality records of great importance, especially for the dwindling amphibians that I study. A similar approach is seen by the online Global Reptile and Global Amphibian BioBlitz websites (which are formally endorsed by SSAR). These sorts of efforts are informally churning out thousands of valuable sightings of species, most of them date- and geo-referenced. Sure, I will always prefer a properly documented museum specimen and tissue sample, but we have to acknowledge that collecting permits are increasingly more restrictive and, in some cases, it simply is not ethically or legally possible to collect the full specimen. I, for one, would clamor for an online photo voucher snapped by an ecotourist in a national park somewhere that demonstrates to me that one of my long-lost study species is still extant. I can then proceed to pursue my own permits to obtain actual specimens, as appropriate.

I recently read a scathing criticism of such programs distributed via e-mail by one of our esteemed colleagues (name withheld). They claimed that these online photographic records are utterly useless scientifically, because the photographers usually are amateurs and thus not to be trusted to properly read a calendar or use the GPS unit built into their smartphone, and because there is no formal museum specimen. Our colleagues at the Cornell Laboratory of Ornithology have pioneered such citizen-science programs with great success, for example with their data-rich Project Feederwatch. With all due respect, esteemed colleague, you are wrong! The Geographic Distribution section of *Herpetological Review* has long published important records based on photographic evidence. As for data veracity, we have all discovered misidentified specimens in major museums and also

specimens with inaccurate locality data. It happens, and just like notes published in *HR* and with some museum specimens, if you aren't satisfied with the veracity of the data at hand, then simply exclude them from your analyses. We have all been reviewing our own data in such ways for our entire careers. These new online efforts simply promise to provide us all with substantial numbers of important new records from the field. I will also remind this colleague that, if advanced degrees in biology were required to publish in herpetology then we would be missing many thousands of valuable contributions offered to us by the likes of Laurence Klauber, Bertha Lutz, Ernest Liner, Malcom Smith, Joan Proctor, or Raymond Rollinat.

It is cliché anymore to dwell on the information revolution that the internet has given our profession. During SSAR's 2011 Annual Meeting, Robert Hansen and Raul Diaz led us in a very informative open discussion to solicit ideas about how members envision SSAR using our webpage to better move forward our Mission. We got great feedback, especially from students, and I am happy to announce that recently the SSAR Board of Directors voted to approve significant funding to move our society forward in the realm of online herpetology. Watch for these developments over the next year. These are exciting times and SSAR is at the leading edge. We will use our substantial and creative membership to endorse and support the sorts of endeavors I have discussed and do so with our famously inclusive ethos.

In closing I want to thank you for being a member of our society and I hope you appreciate our efforts to modernize. If you are not a member, please come join us. I cannot overstate how sincerely I mean "Everybody is welcome in SSAR." If we have not yet met, please introduce yourself when we cross paths at WCH in the beautiful city of Vancouver. If you cannot come to Vancouver, please always feel free to contact me directly at: jmendelson@zooatlanta.org

Joseph R. Mendelson III,
President

ABOUT OUR COVER: *Hydromantes shastae*

The web-toed salamanders (*Hydromantes*) comprise a group of plethodontids that have long puzzled students of animal geography. With three species on the Pacific Coast of N America (all in California), and seven species in southern Europe (often placed in the genera *Atylodes* and *Speleomantes*), they present a distributional pattern unique among terrestrial vertebrates. Indeed, until recently, with the remarkable discovery of the Korean Crevice Salamander (*Karsenia koreana*) on the Korean peninsula (Min et al. 2005. Nature [435]:87–90), the southern European species were the only members of the Plethodontidae found outside the New World.

Among the three Californian species of *Hydromantes*, *H. shastae* (Shasta Salamander) is the most northern, comprising a series of disjunct populations distributed over a fairly small area in the Sacramento and Pit River drainages bordering Shasta Reservoir in northern California, at elevations of 300–900 m (Wake and Papenfuss 2005. pp. 784–785 *In* M. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 784–785. University of California Press, Berkeley). Although described in 1953 by Gorman and Camp (1953. Copeia 1953[1]:39–43, the first specimens were discovered many years earlier and examined by Camp in 1915 but could not be assigned to species because of their poor condition. Initially thought to be a cave-associated species, field work over the last 40 years (e.g., Nauman and Olson 2004. Northwestern Naturalist 85:35–38) has shown that Shasta Salamanders occupy limestone outcroppings well away from cave systems.

Recent work by Bingham (2007. Differentiation Across Multiple Scales in Three Californian Amphibians. Unpubl. Ph.D. dissertation. University of California, Berkeley. 164 pp.) analyzed genetic and morphological variation across the range of *H. shastae* and affirmed the existence of three deeply diverged clades. Plans to raise the level of Shasta Reservoir to increase water storage would inundate populations associated with one of these lineages. Currently, the species is recognized as Threatened by the state of California.

Joe Gorman (1918–1999), co-describer of *Hydromantes shastae*, also discovered and named *H. brunus*, the Limestone Salamander (Gorman 1954. Herpetologica 10:153–158). These salamanders were the focus of Gorman's Ph.D. research at the University of California, Berkeley, under Robert C. Stebbins. His dissertation (completed 1954) was an extensive review covering systematics, ecology, physiology, and reproductive biology, but was never published. Gorman has recently been profiled by Adler (2012. Contributions to the History of Herpetology Volume 3. Contributions to Herpetology. Society for the Study of Amphibians and Reptiles, Ithaca, New York. 564 pp.) in a volume being issued in conjunction with the 7th World Congress of Herpetology, meeting in Vancouver in August, 2012.

Charles L. Camp (1893–1975), Gorman's collaborator in describing *H. shastae*, much earlier (1916) discovered the first *Hydromantes* in the New World, from high elevation in the Sierra Nevada of California. Although Camp's early interests in herpetology eventually shifted to paleontology (he later served as Director of the Museum of Paleontology at the University of California at Berkeley), his most important herpetological legacy was his "Classification of the Lizards" (published in 1923, reissued in 1971).

Our cover image of an adult Shasta Salamander was recorded by **Rob Schell**, a California-based wildlife biologist with a passion for photography (http://robschellphotography.com/). Rob's interests in herps and photography have taken him throughout the western USA and Mexico. He captured this image in the field using a tripod-mounted Canon 7D with a 16–35mm F/2.8L II USM lens (at 32mm) at f/22, with a 2-second exposure. A Canon 580EX II was used for fill flash.

PHOTO BY DANIEL CHASE

SSAR BUSINESS

2012 SSAR Grants-In-Herpetology

Applicants and proposals selected to receive funding:

Conservation.—**Tyler D. Hoskins**, Miami University of Ohio, "Differential pesticide tolerance among Blanchard's cricket frog (*Acris blanchardi*) populations: can genetic variation predict susceptibility?" Advisor: Michelle Boone

Education.—**Jacob Ngwava Mueti** and **Beryl A. Bwong**, National Museums of Kenya, "Creating awareness on the conservation of amphibians and reptiles in Kenya"

The Andrew H. Price Field Research Grant In Herpetology.—**Jesse Delia**, Boston University, "Ecology and evolution of parent-embryo interactions in Neotropical glassfrogs." Advisor: Karen Warkentin

Laboratory Research.—**Robert Literman**, Iowa State University, "Studying the molecular mechanisms underlying temperature-dependent sex determination: how do embryos sense temperature?" Advisor: Nicole Valenzuela

Travel.—**Rebecca Tarvin**, The University of Texas at Austin, "Does alkaloid insensitivity facilitate aposematism and diet specialization in poison frogs?" Advisor: David Cannatella

International.—**Stefano Canessa**, University of Melbourne, Australia, "The decline of *Bombina pachypus* in northern Italy: do increasing extreme rain events threaten reproductive success and influence extinction risks?" Advisor: Kirsten Parris

SSAR thanks the following reviewers.—Rebecca Christoffel (Iowa State University), Robert Fisher (USGS, San Diego Field Station, CA), Emília Martins (Indiana University), Greg Pauley (Natural History Museum of Los Angeles County), Christopher Phillips (Illinois Natural History Survey), Gary Roloff (Michigan State University), Allison Sacerdote (Lincoln Park Zoo, Chicago), Cameron Siler (University of Kansas), Bryan Stuart (North Carolina Museum of Natural Sciences), Steve Sullivan (Peggy Notebaert Museum, Chicago), David Wake (University of California, Berkeley), Rod Williams (Purdue University). The GIH Chair is Josh Kapfer (University of Wisconsin, Whitewater).

2012 SSAR Election

SSAR will hold an election in September of 2012. As in previous years, electronic voting is encouraged. If you would prefer to cast a paper ballot, please contact the Secretary (Marion Preest; e-mail: mpreest@jsd.claremont.edu). We encourage all members of SSAR to participate in the election.

NEWSNOTES

Losos Recognized by National Academy of Sciences

Jonathan B. Losos, the Monique and Philip Lehner Professor for the Study of Latin America and curator of herpetology in the Museum of Comparative Zoology at Harvard University, is the recipient of the Daniel Giraud Elliot Medal. Losos is recognized for his novel and penetrating evolutionary studies of adaptive radiation in vertebrates, notably his comprehensive study of *Anolis* lizards in tropical America, as summarized in his recent book, *Lizards in an Evolutionary Tree: Ecology and Adaptive Radiation of Anoles* (reviewed in *HR*, vol. 42, number 2—June 2011 issue). Established by a gift from Margaret Henderson Elliot in 1917, the Elliot Medal recognizes "a most meritorious, recently published work in zoology or paleontology." The medal, announced in January 2012, is given every four years and carries an award of US $15,000. Losos joins a long list of luminaries in evolutionary biology, including such names as Archie Carr, Theodosius Dobzhansky, Alfred S. Romer, George Gaylord Simpson, and Sewall Wright.

Carlos Vasquez Almazan Named Recipient of Whitley Fund for Nature Award

PHOTO BY TODD PIERSON

Carlos Vasquez Almazan, an amphibian expert from Guatemala, is one of seven winners of this year's Whitley Fund for Nature Awards. Carlos, who is associated with the conservation non-profit, FUNDAECO, received the honor during a ceremony in May 2012 at the Royal Geographical Society in London, hosted by Whitley Fund for Nature (WFN) – the UK-based sponsoring charity. His Whitley Award comprises a project grant of £30,000—donated by Fondation Segré—an engraved trophy, membership in the influential network of past Whitley Award winners, and professional development training.

The award recognizes his efforts to establish Guatemala's first-ever nature reserve for amphibians in the Sierra Caral, following the discovery there of many species previously believed extinct or unknown to science, and to create a national network of other sanctuaries across the country.

Congratulating Carlos on his success, WFN's acting director David Wallis said: "The aim of the Whitley Award scheme is to identify and support conservationists who are inspiring real and positive change for people and wildlife and the habitats they share. In the case of Carlos Vasquez Almazan, the judges were particularly impressed by how he is changing attitudes to, increasing awareness of, and fostering pride in these fascinating creatures, and for his determination to make Guatemala a 'zero extinctions' zone for amphibians." A video describing his work and narrated by Sir David Attenborough, may be seen here: http://www.youtube.com/watch?v=JqYVKVVF7uY&feature=share

State of the Union: Legal Authority Over the Use of Native Amphibians and Reptiles in the United States

Native amphibians and reptiles provide a resource that can be used in a unique way relative to other vertebrates managed by State Fish and Wildlife Agencies in the public trust. Herpetofauna are harvested for human food consumption, for their skins, as pets, for bait, and for hobbyist collection as well as for traditional wildlife uses such as for research or educational purposes. Each state has adopted laws and regulations pertaining to many of these various uses of amphibians and reptiles. The Association of Fish and Wildlife Agencies' (Association) Amphibian and Reptile Subcommittee, in partnership with the Association's Law Enforcement Committee, created this document to summarize these existing laws and regulations. This report is up-to-date as of February 2012, and will be maintained to incorporate changes each year (for most current laws/regulations, be sure to contact an individual state directly). The Subcommittee will be using this report to guide the development of Association committee-reviewed companion recommendations for model regulatory approaches for these uses of amphibians and reptiles.

The purpose and intended use of this report is to:

- Determine the current "State of the Union" with respect to laws and regulations in place for ***native*** amphibians and reptiles, legal and regulatory approaches for specific uses, and other special protections or policies.
- Identify commonalities among states, and unique or particular approaches that could inform the development of recommendations for model approaches
- Provide a quick-reference and resource for state agency biological, law enforcement, or management personnel as part of their own state's regulatory processes
- Facilitate communication and collaboration among states to address challenges in regulating amphibian and reptile use and in enforcing existing laws

http://www.fishwildlife.org/files/SOU_FULL-lo-res.pdf

For questions regarding this report, please contact Priya Nanjappa (e-mail: pnanjappa@fishwildlife.org).

Department of Defense PARC Formed

The United States Department of Defense (DoD) has established an exciting new program for reptiles and amphibians. Beginning in 2009, *Department of Defense Partners in Amphibian and Reptile Conservation* (DoD PARC) was formed. This effectively develops a partnership between the Department of Defense and its services, and PARC. DoD PARC is made up of a coalition of DoD professionals that supports the conservation and management of amphibians and reptiles on DoD lands in support of the military mission.

The DoD landscape includes approximately 29 million acres of federal lands, containing the highest densities of federally listed threatened and endangered species, including herpetofauna, of any federal landowner in the United States. Significant resources are allocated by DoD each year to herpetofauna-related conservation and management. The Army, Navy, Air Force, and Marine Corps now have the opportunity to work across services, species, and installations to better manage their respective herpetofaunal communities.

DoD PARC has successfully completed several projects already, including two transcontinental *Bd* detection transects, the development of a database of herpetofauna by military installation, a photo website of herpetofauna from respective military installations (http://dodparcphotolibrary.shutterfly.com/), and the ongoing development of a general website (http://www.dodnaturalresources.net/DoD-PARC.html).

Additional information regarding DoD PARC is available from Robert Lovich (robert.lovich@navy.mil) or Chris Petersen (chris.petersen@navy.mil).

The Reptile Database: New Version Released

In April 2012, an updated version of The Reptile Database (http://www.reptile-database.org/) was released, reflecting the following statistics:

- 9,596 species (up from 9,547, i.e. plus 49, including resurrections, etc.).
- 29,700 literature references (+401), including 177 published in 2012.
- 5,892 photos, representing 2,278 species (plus 161 species).

As usual, contributions, papers, comments, photos, or corrections should be sent to: comments@reptile-database.org.

MEETINGS

Meetings Calendar

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

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

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

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

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

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

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

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

19–23 September 2012—48th Annual Meeting of the German Society for Herpetology and Herpetoculture, Gera, Germany. Information: http://www.dght.de/index.php?option=com_content&view=article&id=151&Itemid=199

24–27 October 2012—Southwest Partners in Amphibian and Reptile Conservation (SW PARC) annual meeting, Las Vegas, Nevada, USA. Information: www.swparc.org/meetings.html

2–4 November 2012—Kansas Herpetological Society 39th annual meeting, Sternberg Museum of Natural History, Fort Hayes State University, Fort Hays, Kansas, USA. Information: http://cnah.org/khs/AnnualMeetingInfo.html

A Book Issued to Celebrate the 7th World Congress of Herpetology in Vancouver

Contributions to the History of Herpetology

Volume 3 by Kraig Adler, John S. Applegarth, and Ronald Altig

From the reviews of volume 1 (1989) and volume 2 (2007):

"Here is a portrait gallery that to browse will delay your next paper in progress!" —Joseph Ewan (Taxon).

"Of extraordinary interest." —Javier Valverde (Reptilia).

"An important original contribution to the history of herpetology . . . exacting and exhaustive scholarship, and an unmistakable touch of class." —Hobart M. Smith (Herpetological Review).

This book consists of three sections, each worldwide in coverage. **The first and longest section, by Kraig Adler**, is a series of new biographies of the leading contributors to herpetology beginning with the author of the oldest surviving book on the subject, Nicander of Colophon of the second century B.C.E. The accounts have a portrait, signature, and references. These feature 349 herpetologists and also include information about their colleagues, students, and many other persons. The comprehensive index encompasses volumes 1 to 3 and covers nearly 5,000 individuals.

Among the biographies included in volume 3 are these:

• Authorities on venomous snakes and antivenoms—Abati, Haast, Mead, Phisalix, Russell, and Wiley.

• Forster, Linnaeus's apostles (Forsskål, Hasselquist, Kalm, and Sparrman), Natterer, Olivier, d'Orbigny, Quoy, Voeltzkow, Xántus, Zarudny, and others who explored then-unknown continents.

• The classifiers Boie, Garsault, Jarocki, and Ritgen.

• Brandt, Gronovius, Reinhardt, and Temminck who built great museum collections.

• The anatomists von Baer, Ecker, Francis, Gaupp, Home, Kingsbury, Müller, Panizza, Perrault, and Schmidt. And the experimentalists Benedict, Evans, Ferguson, Galvani, Gans, Norris, and Spemann.

• Huxley, Hecht, Kammerer, Lamotte, Orton, Reig, and other evolutionists.

• The conservationists Frazer, Mendelssohn, and Thorbjarnarson.

• Popular writers, among them Boulenger, Brehm, Cooke, Dürigen, Gosse, Knauer, and Staněk.

• Notable amateurs: Langerwerf, Liner, Malnate, Mittleman, and Necker.

Coverage is global: *Africa* (Bianconi, Domergue, Pooley, Wager); *Asia* (Baig, Bogdanov, Daniel, Ewart, Griffin, Hatori, Hu, Inukai, Mao, Mitsukuri, Nutphand, Rabor, Tzarevsky, Vogt); *Australia and Pacific* (Bavay, Frost, Gow, Main, Moore, Zietz); *Europe* (Buresch, Cetti, Curry-Lindahl, Darevsky, De Filippi, Fatio, Frivaldsky, Houttuyn, Kiriţescu, Lenz, Lier, Metaxà, Pennant, Reuss, Savi, Schreiber, Sturm); *North America* (Banta, Garden, Garman, Harper, Holman, Hurter, Kelly, Kirtland, Maslin, Martof, McIlhenny, Patch, Storer, Surface, Tanner, Werler); and *Central and South America* (Cei, Cunha, Gay, Herrera, Lancini, Prado, de la Sagra, Santos, Soini, Velasco).

Also included are experts on taxonomic groups such as *salamanders* (Anderson, Despax, Gorman, Hairston, Kezer, Nesterov, Oyama); *turtles* (Babcock, Goode, Lambert, Lindholm, Lortet); and *snakes* (Bailey, Burger, Deuve, Fitch, Kramer, Latifi, Roux-Estève, Volsøe). The book contains 197 additional full biographies plus 180 mini-biographies.

The second section, by John S. Applegarth, is an index of 5,290 authors in taxonomic herpetology. This alphabetical list includes the full names, dates, countries of residence, and orders of taxa for everyone who has proposed a new taxon (genus or below) or has had a taxon named in their honor. This is a unique resource for zoologists, historians, and librarians. In five years (since the 2007 edition), the number of persons covered has increased by nearly 50 percent and many previously incomplete entries are now made whole.

The third section, by Ronald Altig, is a listing of herpetologists giving the names of their doctoral university, their major professor, and the date of their degree. This extensive revision is 57 percent longer than the second edition of 2007. The information is arranged in such a manner that the academic lineages can be followed from generation to generation, both forward and backward in time. 5,562 names are included and fully indexed.

Specifications: 570 pages (8.5 × 11 inches or 21.5 × 28 cm), bound in library-grade cloth. Color plates, 322 portraits. ISBN 978–0–916984–82–3. To be issued August 2012. • **Regular Price:** $75. • **Special Price to SSAR members** (if ordered before November 2012)**:** $55. • **Shipping:** USA address, add $5; non-USA shipping at cost. • **Orders to:** SSAR Publications Secretary, P.O. Box 58517, Salt Lake City, Utah 84158–0517, USA (*telephone and fax*: 801–562–2660; *e-mail*: ssar@herplit.com). • **Payment:** Make checks payable to "SSAR." Non-USA orders must be paid in USA funds using a check drawn on an American bank or by International Money Order. Books may be charged to American Express, Discover, MasterCard or VISA (please give account number and expiration date). • **SSAR Membership and Other Publications:** Membership information and a list of society publications can be obtained from the Publications Secretary at the address given above or at www.ssarherps.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, Beck Wehrle or Ben Lowe; e-mail addresses may be found on the inside front cover.

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

World's Smallest Frogs Discovered in New Guinea

With the description of two new diminutive microhylid species, it is becoming clearer that miniaturization in anurans is not just a fluke. Their discovery of *Paedophryne amauensis* (Microhylidae, Asterophryinae) from the Central Province of Papua New Guinea is particularly noteworthy, coming in as the smallest known vertebrate with an average snout-vent length (SVL) of 7.7 mm. From the Morobe Province of Papua New Guinea, their second microhylid discovery, *Paedophryne swiftorum*, is also incredibly miniaturized with an average SVL of 8.52 mm. A molecular phylogenetic analysis places the two new species in a clade with the only other included *Paedophryne* (*P. oyatabu*) and also reveals the deep divergence between these three species. Additionally, the discovery of these two new species expands the genus's known geographic range. Both new species are morphologically distinct from closely related species, most notably their smaller size. Though both are crepuscular, *P. swiftorum* was found calling during rainy days. Each species' call is acoustically distinct, though both are described to resemble the song of an insect. Like other *Paedophryne* species, *P. amauensis* and *P. swiftorum* have reductions in digits, cranial elements, and number of vertebrae. These morphological reductions are also typical of miniaturized frogs from other clades. The 29 smallest frog species represent five families and 11 genera, showing non-independent phylogenetic patterns. Additionally, like most anurans of extreme small size, these *Paedophryne* inhabit tropical wet-forest leaf litter. With diminutive size and life histories that depend on constant moisture in terrestrial environments, the authors suggest that these tiny frogs represent a new ecological guild. The stable moisture levels of the tropical leaf litter may allow this microhabitat to serve as an adaptive zone for miniaturization. Based on calling data, the two new *Paedophryne* are likely very common in the leaf litter, suggesting that they are an important predator of small leaf litter arthropods, as well as a food source for larger predators.

Rittermeyer, E. N., M. C. Gründler, D. K. Thompson, and C. C. Austin. 2012. Ecological guild evolution and the discovery of the world's smallest vertebrate. PLoS ONE 7:e29797.

Correspondence to: Christopher Austin, Department of Biological Sciences and Museum of Natural Science, Louisiana State University, Baton Rouge, Louisiana, USA; e-mail: ccaustin@llu.edu

Snakes Adjust Constriction, Cuing on Prey Heartbeat

Constricting prey is an energetically costly behavior for snakes. Thus, it is important for snakes to only constrict for the minimum time necessary to ensure the prey is dead. Using wild-caught and naïve captive-born boas (*Boa constrictor*), the authors investigated the effect of prey heartbeat on constriction behavior. Warmed dead rats were implanted with a simulated beating heart and two internal pressure sensors. In a pilot study, snakes constricted rats with beating hearts for an average of 20 minutes. Boa response was measured during the following three treatments: prey with a heartbeat throughout constriction, prey with the heartbeat shut off after the first ten minutes of constriction, and prey with no heartbeat. Snakes responded to the rat with a heartbeat by adjusting their coils frequently, a behavior they almost never exhibited when faced with the rats without heartbeats. Rats with heartbeats were constricted almost twice as long and with more than twice the pressure as were rats lacking a heartbeat. The ten-minute heartbeat rats elicited an average response intermediate to the extreme treatments. This duration/pressure effect was more pronounced in naïve boas, though the wild-caught snakes constricted all prey for longer and with more pressure than did their captive-born counterparts. As both naïve and experienced boas responded similarly, this study suggests that these responses of increased duration, pressure, and adjustment of coils are innate responses to a heartbeat cue. Because the magnitude of these responses varied between the two groups, the authors posit that the degree of constriction response can be honed with prey experience. This work is the first to demonstrate that snakes use heartbeat to determine that the prey has been successfully killed.

Boback, S. M., A. E. Hall, K. J. McCann, A. W. Hayes, J. S. Forrester, and C. F. Zwemer. 2012. Snake modulates constriction in response to prey's heartbeat. Biology Letters (*in press*). doi: 10.1098/rsbl.2011.1105.

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Timber Rattlesnakes form Social Aggregations with Kin

It is becoming increasingly clear that Timber Rattlesnakes (*Crotalus horridus*) display complex social life-histories. Though most research on kin-based social grouping focuses on structured, complex groups such as those found in birds and mammals, some seemingly asocial taxa, such as squamate species, may be participating in "cryptic sociality" with relatives. Timber Rattlesnakes gather together in hibernacula over the winter, then disperse several days after emergence. Gravid female Timber Rattlesnakes forgo migration to birth their young at rookeries in the fall. Using microsatellite markers, the relatedness of grouping rattlesnakes was compared to random individuals in the population. Tissue samples were collected from 29 pregnant females at 12 rookeries and from 419 rattlesnakes of various

sex and age-class from outside 18 wintering dens, 113 of which were found aggregating. Though snakes from the same hibernaculum were not more related than random, this was not the case at rookeries. In groups of two or more pregnant females at rookeries, at least two females were related. Female kin pairs occurred both in same-age and intergenerational patterns. Groups of rattlesnakes leaving wintering dens were often in same age-class pairs. Though adult snake pairs leaving hibernacula were not related, pairs of juveniles of the same age were significantly related, possibly due to continued association of littermates. These results suggest that there may be benefits afforded to pregnant females and juveniles found with kin that are linked to life stage. The authors note that gravid females are often more at risk for predation and that a related conspecific would accrue more indirect fitness benefits from engaging a predator than would an unrelated individual. Neonate rattlesnakes are known to perform certain thermoregulatory behaviors in the presence of their mothers, which may suggest other group thermoregulation social complexities. This study adds to the growing knowledge about Timber Rattlesnake social behaviors and shows the usefulness of molecular genetics approaches to detecting these types of cryptic sociality.

Clark, R. W., W. S. Brown, R. Stechert, and H. W. Greene. 2012. Cryptic sociality in rattlesnakes (*Crotalus horridus*) detected by kinship analysis. Biology Letters (*in press*). doi: 10.1098/rsbl.2011.1217.

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Everglades Mammals Experience Declines with Establishment of Invasive Burmese Pythons

Invasive Burmese Pythons (*Python molurus bivittatus*) have been sighted in Everglades National Park (Florida, USA) for the past 20 yrs, but have only been recognized as established in the area since 2000. Pythons are known to predate a wide range of mammals, birds, and sometimes other herps, including species considered declining or endangered. However, the impacts of pythons on native species have not been known. Using road survey data from 1996–1997 and 2003–2011, the authors compared surveys from before the pythons were common to contemporary mammal counts. In the earlier years, raccoons, opossums, and rabbits were the most common mammals encountered on roads, yet from 2003–20011, overall raccoon observations decreased by 99.3%, opossums decreased by 98.9%, and no rabbits were found. White-Tailed Deer numbers dropped 94.1% and Bobcat sightings fell 87.5%, though some other mammals, such as rodents and coyotes, experienced small increases, possibly due to cascade effects of the changing trophic landscape. Yet, providing more support to a Burmese Python linked decline, these mammal abundance patterns were not consistent across Everglades National Park. In areas where pythons have recently arrived and where their densities are low, mammal declines were less extreme than at sites longer populated by pythons. Moreover, at two sites outside of the pythons' range, raccoon and opossum numbers were comparable to the 1996–1997 abundances. Along with these findings, pythons are known to eat raccoons, opossums, bobcats, deer, and rabbits, providing a very compelling picture of invasive Burmese Python driven mammal declines. This study also shows that large snakes can be a generalist top predator exerting pressures on the rest of the ecosystem, including increases in other reptile species abundances (as raccoons are important predators of reptile eggs), increased competition among mammals, and even rebounds of currently declining mammal species such as Florida Panthers.

Dorcas, M. E., J. D. Willson, R. N. Reed, R. W. Snow, M. R. Rochford, M. A. Miller, W. E. Meshaka, P. T. Andreadis, F. J. Mazzotti, C. M. Romagosa, and K. M. Hart. 2012. Severe mammal declines coincide with proliferation of invasive Burmese pythons in Everglades National Park. Proceedings of the National Academy of Sciences 109:2418–2422.

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Exciting Caecilian Discoveries

In recent months, two exciting caecilian discoveries have surfaced. In one recent study[1], the authors announced the rediscovery of *Atretochoana eiselti* (Typhlonectidae), the enigmatic caecilian previously known only from a pair of specimens of unknown provenance or even century of collection. This caecilian is noteworthy for its large size (up to a meter in length) and the absence of lungs, making it the largest lungless tetrapod. Previous investigators have posited that given its small surface to volume ratio, this species is likely restricted to highly oxygenated mountain streams. The authors of this paper report specimens having recently been collected in two widely disjunct locations: one in the estuary of the Amazon River, and another in the Madeira River more than 3000 km upstream from the mouth of the Amazon. This is surprising, as both locations are characterized by warm, muddy water. More work is needed to further elucidate the distribution and ecology of this species and determine how such a large organism can respire sufficiently without lungs.

In a second study[2], the authors herald the discovery of a deeply-divergent, heretofore unknown lineage of caecilians existing in Northeast India. A poorly-preserved specimen collected in that region a century ago has since remained the sole Asian teresomatan (the tail-less crown group comprising about two-thirds of caecilian diversity) outside of India's Western Ghats. In an effort to rediscover this lost species and clarify caecilian diversity in Northeast India, the authors conducted extensive surveys targeting fossorial gymnophionans. Teresomatan caecilians were found at 58 sites, spanning the entire region. Genetic samples were taken, sequenced for multiple mitochondrial and nuclear DNA markers, and subjected to time-calibrated phylogenetic analyses aimed at revealing regional diversity and the placement of Northeast Indian teresomatans in the caecilian tree. These analyses showed that rather than forming a clade with Western Ghats teresomatans (Indotyphlidae), the sister group of the tail-less Northeast Indian caecilians resides instead in Sub-Saharan Africa (Herpelidae). However, as the split between the African and Northeast Indian caecilians predates the last Mesozoic connection between the two landmasses, neither tectonic rafting nor more recent overland dispersal can be ruled out in explaining this distribution. Furthermore, these analyses showed that these populations exist as numerous, geographically cohesive

haploclades, suggesting considerable species diversity in the region. The authors conclude by assigning these populations to a new family, Chikilidae (which is derived from a regional name for caecilians).

[1]Hoogmoed, M. S., A. O. Maciel, and J. T. Coragem. 2011. Discovery of the largest lungless tetrapod, *Atretochoana eiselti* (Taylor, 1968) (Amphibia: Gymnophiona: Typhlonectidae), in its natural habitat in Brazilian Amazonia. Boletim do Museu Paraense Emílio Goeldi. Ciências Naturais 6:241–262.

[2]Kamei, R. G., D. San Mauro, D. J. Gower, I. Van Bocxlaer, E. Sherratt, A. Thomas, S. Babu, F. Bossuyt, M. Wilkinson, and S. D. Biju. 2012. Discovery of a new family of amphibians from northeast India with ancient links to Africa. Proceedings of the Royal Society of London, Series B (*in press*). doi: 10.1098/rspb.2012.0150.

Correspondence to: [1]Marinus Hoogmoed, Museu Paraense Emílio Goeldi, Coordenação de Zoologia, Av. Perimetral, 1901 – Terra Firme, Belém, PA, Brazil, CEP 66017-970; e-mail: marinus@museu-goeldi.br. [2]S. D. Biju, Department of Animal Biology, Biodiversity Research Institute UB (IRBio), University of Barcelona, 08028 Barcelona, Spain; e-mail: sdbiju@cemde.du.ac.in

Genetic Evidence Indicates Extinct Galápagos Tortoise Likely Still Living

A number of studies have been published in the last decade broadening our understanding of Galápagos tortoise diversity, both extinct and extant. These studies have contributed to a growing consensus that these tortoises constitute a species complex comprised of as many as 15 species (a third of which are extinct or close to it). In a rare case of a thought-extinct species being rediscovered via genetic evidence, the authors of this study found hybrid Galápagos tortoises in the vicinity of Volcano Wolf, Isabella Island, carrying genetic material from *Chelonoidis elephantopus* (= *C. nigra nigra*), a species identified through genetic analyses of sub-fossil material from the island of Floreana and thought to have perished there in the 1800s. First, genetic samples were amassed for as many Galápagos tortoise taxa as possible, including from sub-fossil material from putatively extinct taxa. These samples were genotyped for 12 microsatellite loci and subjected to statistical analyses aimed at identifying potential parental gene pools. These analyses revealed 12 parental gene pools, some consisting of more than one species and others representing a subset of a species. Importantly, the species occupying the Volcano Wolf area, *C. becki*, was found to consist of two parental gene pools. Tortoises from the Volcano Wolf region (1669 individuals; ~20% of the population) were then genotyped for the 12 microsatellite loci and using genetic assignment methods, were assigned to either purebred or hybrid classes (e.g., F1, F2, backcross) where statistically possible. Eighty-four of these turtles were found to have genetic mosaics most consistent with having a purebred *C. elephantopus* parent. Because these tortoises are so long-lived and as more than 35% of these hybrids were under 15 years old, it is likely that their *C. elephantopus* parents are still living. Based on the amount of genetic diversity observed in the hybrid offspring, there would need to be at least 38 different *C. elephantopus* individuals who contributed to the parentage of the sampled hybrids. Only 20 individuals are required to start a captive breeding program, suggesting that *C. elephantopus* could be resurrected. An additional 122 tortoises were found to have *C. elephantopus* genes in other proportions consistent with more distant ancestry and eight individuals had nuclear DNA of *C. becki* but mitochondrial DNA of *C. elephantopus*, a pattern consistent with four generations of backcrossing with *C. becki*. In addition to the strong evidence that *C. elephantopus* persist on Isabela Island, the authors' discovery of these *C. elephantopus* hybrids alone is of great conservation value as it shows "extinct" genetic material lives on in their genomes.

Garrick, R. C., E. Benavides, M. A. Russelo, J. P. Gibbs, N. Poulakakis, K. B. Dion, C. Hyseni, B. Kajdacsi, L. Márquez, S. Bahan, C. Ciofi, W. Tapia and A. Caccone. 2012. Genetic rediscovery of an extinct Galápagos giant tortoise species. Current Biology 22:R10R11.

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Four New Species of Chameleons from Madagascar Found to Rank Among the World's Smallest Amniotes

With the variable habitats of Madagascar come interesting evolutionary radiations. Micro-endemism is particularly common on this island, a phenomenon the authors of this paper also suggest is linked with small body size. Recently, four new morphologically distinctive chameleon populations belonging to the northern Madagascar *Brookesia minima* clade were discovered. Prior to this discovery, *Brookesia* (leaf chameleons) already contained 26 small-bodied, ground-dwelling species with small distributions. In multiple cases, their simplified external morphologies have led to taxonomic difficulties. Yet, previous analyses of the *Brookesia minima* group have found high levels of genetic differentiation. For this study, the authors accumulated morphological and molecular (two nuclear genes; one mitochondrial gene) data for all 12 described and proposed *Brookesia minima* group species. These data were then incorporated into standard molecular phylogenetic analyses and principal component analyses of morphology. The molecular analyses exposed deep genetic differentiation in the clade, extended the range of some known species, and along with the morphological analyses, confirmed the distinctiveness of four new species (which the authors describe within the paper). *Brookesia tristis* is limited to low perches in the dry forest in the limestone mountains of Montagne des Français, Antsiranana Province. *Brookesia confidens* was found only at one site in the Ankarana National Park; as they were abundant at this one site but were not found at nearby sites exhibiting apparently suitable habitat, the authors infer a strong microhabitat preference. The smallest of the new species, *Brookesia micra* (female SVL 18.7–19.9, male SVL 15.1–15.3 mm) also has a shorter relative tail length compared to the rest of the clade. While several gecko species have a shorter SVL, when the tail is included, males of *B. micra* rank as the smallest known amniotes. *B. micra* is found only on the Malagasy island of Nosy Hara, a site where no *Brookesia* had been recorded during an extensive survey several years earlier. The largest of the new species, *Brookesia desperata* (female SVL 27.3–30.0 mm, male SVL 25.0–26.7) was found only in the Forêt d'Ambre Special Reserve. Morphometric analyses revealed differences in body size and tail-length by species, but of particular

note were the divergences in hemipene morphology. Each species was identifiable by hemipene alone. Given the dimensions and distributions of its members, the *B. minima* clade represents an unparalleled system for the study of microendemism and miniaturization.

Glaw, F., J. Köhler, T. M. Townsend, and M. Vences. 2012. Rivaling the world's smallest reptiles: discovery of miniaturized and microendemic new species of leaf chameleons (*Brookesia*) from northern Madagascar. PLoS ONE: e31314.

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Modeling Predicts Worldwide Range Shrinkages for Turtles as the Result of Climate Change

It has been documented that anthropogenic global climate change has already changed patterns of biodiversity and will likely lead to large-scale biodiversity declines. Some taxa, however, are more susceptible to these changes than others, varying with physiological sensitivity and geography. Turtles are particularly sensitive to climactic shifts as broadly distributed poikilothermic organisms with temperature-dependant sex determination. Chelonians are already declining at alarming rates due primarily to overexploitation and habitat loss. Thus, for conservation purposes, it is important to understand how this taxon may be further challenged. The authors of this study have developed species distribution models to assess the potential niche shifts of 199 turtle species at a global scale using 11 climate change scenarios. Using over 20,000 species records (primarily from the Word Turtle Database), they calculated richness within a 200 km buffer region around each species record location. Four chelonian species diversity hotspots were identified: the southeastern USA, Thailand and Malaysia, the Ganges–Brahmaputra–Meghna basin, and the Amazon basin. Current and future climate information was gathered from multiple databases, including the Intergovernmental Panel on Climate Change climate projections for the year 2080 under three different socio-cultural scenarios. Ten independent bioclimatic variables were included to describe the climate of each location. Overall, the mean diurnal temperature range and the minimum overall temperature was found to provide the most explanation for species spatial distributions, though most informative factors varied by taxon and location, suggesting differing mechanisms of climatic response. Though this model was constrained to only interpolate to climates existing within the training data (and therefore not extrapolate to non-analogous climatic conditions), it still predicts dramatic changes in turtle niche sizes and distributions. The four chelonian diversity hotspots are predicted to experience the greatest changes in species numbers. Given that previous studies have demonstrated that at least some turtle lineages display a pattern of strong niche conservatism, it can be predicted that climate change will shift turtles' ranges to areas with preferred climatic conditions or lead to extinction rather than inducing a broader range of climate tolerances.

Ihlow, F., J. Dambach, J. O. Engler, M. Flecks, T. Hartmann, H. Rajaei, and D. Rödder. 2012. On the brink of extinction? How climate change may affect global chelonian species richness and distribution. Global Change Biology (*in press*). doi: 10.1111/j.1365-2486.2011.02623.x.

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Species Tree Analysis Elucidates *Liolaemus darwinii* Complex Relationships

The *Liolaemus darwinii* group (Liolaemidae) is comprised of 18 lizard species occurring in northwestern and central Argentina. In an effort to apply recent phylogenetic methods to this group as well as conduct empirical evaluations of these methods, the authors of this study performed species tree analyses using the software program *BEAST on a 20-locus molecular dataset encompassing 16 *L. darwinii* group species. Importantly, they also conducted a myriad of analyses where the loci, locus length and informativeness, locus gene tree concordance with species tree, samples per species, and software program were varied and assessed accuracy and precision via comparison with the results from the preferred analysis. The preferred species tree analysis found a basal split resulting in two clades consisting of ten (Clade A) and six (Clade B) species. Neither the analyses using an alternate species tree program (BEST) nor those excluding the most informative loci recovered topologies in strong conflict with the preferred analysis. However, an analysis employing nuclear loci parsed into constituent alleles recovered one basally diverging Clade A species (*L. uspallatensis*) as a basally diverging member of Clade B with strong support. The analyses performed using subsets of the data revealed the threshold for recovering results equivalent with those of the preferred analysis (see paper for specifics). However, the authors stress that these benchmarks may be sensitive to clade age and degree of post-divergence gene flow. The recovered clades are largely geographically cohesive, with the smaller Clade B restricted to the low elevation Monte Desert of central Argentina and the highly supported crown clade within Clade A occupying the Puna, Prepuna, and extreme northern Monte Desert of northwestern Argentina. The two earliest diverging members of Clade A (*L. chacoensis*, *L. uspallatensis*) occur farther south, suggesting a southerly origin for Clade A. The authors suggest a similar subsampling method could be useful in determining if and where additional sampling is needed in studies employing species tree methods.

Camargo, A., L. J. Avila, M. Morando, and J. W. Sites Jr. 2012. Accuracy and precision of species trees: effects of locus, individual, and base pair sampling on inference of species trees in lizards of the *Liolaemus darwinii* group (Squamata, Liolaemidae). Molecular Ecology 61:272-288.

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HERPETOLOGICAL NOMENCLATURE

Beginning with this issue of *Herpetological Review*, a section dealing with all aspects of zoological nomenclature as they relate to herpetology will appear from time to time. The main focus in this section will be to call attention of the herpetological community to major issues in zoological nomenclature, pending herpetological cases under consideration by the International Commission on Zoological Nomenclature (ICZN), rulings (Opinions) by the Commission on these cases, and related articles by members of SSAR on nomenclatural matters.

As most herpetologists are aware, the naming and determination of priority for names of zoological taxa are governed by a set of rules embodied in the International Code of Zoological Nomenclature, hereafter the Code, first adopted at a meeting of the International Congress of Zoology in Leiden, the Netherlands, in 1895. The Code is now in its 4th edition (effective January 1, 1999) and is under review by the International Commission on Zoological Nomenclature (ICZN) which is in the process of preparing a 5th edition. Members of the Commission are distinguished systematists with a wide variety of knowledge pertaining to many different animal taxa. They are elected by secret ballot by the members of the Section of Zoological Nomenclature of the International Union of Biological Sciences (IUBS) at meetings of that body. The principal duties of the Commission, in addition to considering revisions to the Code, is to rule on cases through the Plenary Power where strict application of the Code would disturb stability or universality or otherwise cause confusion. Usually such rulings are in response to an application by a zoologist or zoologists to set aside a rule in a particular case.

The Commission's activities are supported by staff (the Secretariat) directed by an Executive Secretary, currently Elinor Michael, who also serves as Editor-in-Chief of the *Bulletin of Zoological Nomenclature* (BZN). The *Bulletin* contains articles of nomenclatural interest, applications for waivers of the Code in particular cases, commentary on pending cases, and the rulings of the Commission, among other items. Detailed information on the Commission and its activities may be accessed at http://iczn.org where there is an online copy of the Code, index, and abstracts of material in the *Bulletin of Zoological Nomenclature*, and other pertinent items. Also, a source of information on nomenclatural matters will be a website being developed by the American Association of Zoological Nomenclature (AAZN), whose office is at the National Museum of Natural History (Smithsonian Institution) in Washington, DC.

Current Major Issues

Two major issues relate to the ongoing preparation of the 5th edition of the Code. The first is the proposal adopted in principle of allowing new names proposed in electronic only form to compete for priority with those in print sources. A tsunami of comments has engulfed the ICZN and the BZN relating to this proposal. While e-publishing of new names seems inevitable, the essential questions are how can e-publishing provide a permanent record followed by the question of can it be manipulated to change dates of publication and/or content after initial dissemination?

A second proposal is to establish ZOOBANK as a register of ALL systematic works and ALL taxonomic names in zoology from 1758 forward. Inherent in this proposed mechanism is the idea that new names published after a certain date must be registered in order to be available. Implementation of this concept requires an enomous amount of supporting structure and staff over the long term—none of which is financially possible for the ICZN nor likely to be provided by the many scientific agencies, institutions, or Academies of Science that depend on and should have responsibility for the enhancement of stability and universality of zoological nomenclature. In my opinion, ICZN missed a chance to partner with the Zoological Record to create such a registrar only because the majority of Commissioners regarded the past annual issues of the Zoo Record as incomplete. Hey, you have got to start somewhere in such an ambitious project! In any event, go to the ICZN website and investigate the pros and cons of these two controversial proposals published in many issues of the BZN.

Major Herpetological Cases Under Consideration

Probably the most rancorous case now under consideration by the ICZN is Case 3463 on the proposed conservation of *Testudo gigantea* Schweiger, 1812, currently *Geochelone* (*Aldabrachelys*) *gigantea*, BZN 66:34–50. Details on the various references cited in the following summary may be found in BZN 66:44–50. The name *Testudo gigantea* was first used by Schweiger (1812) for a large tortoise from "Brasilia" in the Paris Museum that had been liberated by the French from the Royal Museum in Lisbon during the Napoleonic Wars. Over time the name came to be associated with the Aldabra Atoll giant tortoise and during most of the 20th century it was applied to that species following Rothchild (1897). Until recently the type specimen was presumed to be lost. Later, Loveridge and Williams (1957) proposed a subgenus of the genus *Geochelone* to be called *Aldabrachelys* (type species: *Testudo gigantea*) for the Aldabra tortoise.

A complication in following the history of the names for giant land turtles relates to the generic names variously applied to them. During the 19th century and the early part of the 20th century all of these tortoises were included in the genus *Testudo*. During the latter half of the 20th century they were usually placed in the large genus *Geochelone* which was further divided into a number of subgenera. Currently, most of these subgenera, e.g., *Aldabrachelys*, *Cykundrophis*, and *Chelonoides*, have been elevated to generic status. Where appropriate the current generic names will be used below.

Bour (1982, 1984) presented evidence based on comparison of the original description with characters of known Indian Ocean giant tortoises that the name *T. gigantea* applied to an extinct Mascarene tortoise *Cylindrophis indica* (Schneider, 1783) making both *Aldabrachelys* and *T. gigantea* junior synonyms. Bour then decided that *Testudo elephantina* Dumeril and Bibron, 1835 was the correct name for the Aldabra species and proposed a new genus-group name, *Dipsochelys* (type species: *Testudo elephantina*), to replace *Aldabrachelys*. Pritchard (1986) generally followed Bour but differed in concluding that the original description of *T. gigantea* referred to the South American tortoise *Chelonoidis denticulata*, a form that occurs in Brazil and would likely have been in the collection of the King of Portugal which was the source of the holotype of *T. gigantea*.

Further complicating this already complicated case is the name *Testudo dussumieri* Gray, 1831 which was originally

proposed in the synonymy of what was then *Testudo indica* but later made available by Fitzinger (1835). The type specimen was said to be from Aldabra, although this remains a matter of controversy. Several authors consequently used the name *Dipsochelys dussumieri* for the Aldabra tortoise rather than *Aldabrachelys gigantea* or *Aldabrachelys elephantina*.

In attempt to bring stability to this situation, Frazier (2006a) designated a neotype, definitely from Aldabra Atoll, for *T. gigantea* pointing out the overwhelming use of that name for the Aldabra tortoise in the scientific and conservation literature. Shortly after the appearance of Frazier's paper, Bour (2006) announced the discovery of an unlabelled, stuffed specimen of tortoise in the Paris Museum (MNHN 9554) that he claimed was the type specimen of *T. gigantea*. According to the catalog "this very old specimen of unknown origin" was from "Bresil." This turtle was positively identified as a representative of *Chelonoidis denticulata* a common South American species.

Frazier (2009) then petitioned the ICZN to a) validate his selection of a neotype (USNM 269962) from Aldabra Atoll for *Testduo gigantea* and b) suppress the name *Testudo dussumieri* Gray, 1831. In addition, he asked that *Aldabrachelys* and *Testudo gigantea* be placed on the Official Lists of Generic Names and Specific Names in Zoology, respectively, and that *Testudo dusseurmeri* be placed on the Official List of Rejected and Invalid Specific Names in Zoology. In response, a voluminous flood of comments, many rather heated, engulfed the BZN (vols. 66–68). About 60 of these are by different authors favoring the application, 11 strongly against, and three or four neutral but favoring a definitive solution. Some of these comments are long counter arguments rich in detail by Bour, Pritchard, Iverson, Hoogmoed, and others, or long replies, principally by Frazier and co-authors, also rich in contradictory details to those opposing the application. All profess a desire to establish stability for their favored names. However, there are broad differences as to which view of "stability" should prevail, that of professional systematists versus user groups in conservation and government bodies.

Who said nomenclature is dull and boring stuff? The Aldabra tortoise case certainly is not, especially for the giant land tortoise crowd. Stay tuned as there are likely to be more heated comments appearing in the BZN prior to any decision. It will be most instructive to see how the ICZN rules in this divisive case.

Recent Rulings on Herpetological Names

- Opinion 2223 (Case 3345): Conservation of the family-group name Dendrobatidae (Amphibia, Anura) over Phyllobatidae whenever the two are considered synonyms. BZN 66:103–105.

- Opinion 2255 (Case 3420): Buettneria Marsh, 1922 (Amphibia): generic name not conserved. The applicants asked that two earlier senior homonyms be suppressed in favor of Marsh's use but this was denied. BZN 67:263–265.

- Opinion 2256 (Case 3446): *Anolis chrysolepis* Dumeril & Bibron, 1837 (Reptilia, Squamata) to have precedence over *Anolis nitens* Wagler, 1830 whenever the two names are considered synonyms. BZN 67:266–268.

- Opinion 2282 (Case 3502): Conservation of the specific name *Coluber nummifer* Reuss, 1834 (currently *Hemorrhois nummifer*) (Reptilia, Serpentes) by suppression of the name *Coluber tyria* Linnaeus, 1758. BZN 68:228–229.

Pending Cases of Herpetological Interest

- Case 3351: Proposed precedence of *Chelodina rugosa* Ogilby, 1890 (currently *Macrochelodina rugosa*) over *Chelodina oblonga* Gary, 1841 (Reptilia, Testudines). BZN 63:187–193.

- Case 3506: Proposed conservation of the name *Allosaurus* Marsh, 1877 (Dinosuaria, Theropoda). BZN 67:53–56.

- Case 3510: Proposed conservation of the *Cyclodina aenea* Girard, 1857 (currently *Oligosoma aeneum*) (Reptilis, Squamata, Scincidae). BZN 67:307–313; modified to conserve *Tiliqua ornatum* Gray, 1843 (currently *Oligosoma ornatum*) as well. BZN 68:144.

- Case 3527: Proposed conservation of the name *Anguis jamaicensis* Shaw, 1802 (currently *Typhlops jamaicensis* (Reptilis, Serpentes). BZN 68:197–203.

- Case 3536: Proposed replacement of the type species of *Stegosaurus*, 1877 (Dinosauria, Ornithischia). BZN 68:127–133.

- Case 3571: *Crotalinus catenatus* Rafinesque, 1812 (currently *Sistrurus catenatus*) and *Crotalus tergeminus* Say in James, 1822 (currently *Sistrurus tergeminus*; Reptilia, Serpentes); proposed conservation by designation of neotypes. BZN 68:271–274.

Two Rulings of Interest to Zoologists in General

- Opinion 2245 (Case 3407): *Drosophila funebris* Fabricius, 1787 to be maintained as the type species of *Drosophila* Fallen, 1823 (Insecta, Diptera). An application had been made requesting that *Drosophila melanogaster* Meigen, 1830 should be ruled to be the type species of *Drosophila*. Recent taxonomic study strongly suggested that *Drosophila* (*sensu lato*) was going to be divided into a number of separate genera with *D. melanogaster* placed in a different genus from *D. funebris*. Under that scenario there would not be a *Drosophila melanogaster*, one of the most cited names in the biological, broad scientific, and general literature; thus the reason for the application. However, the ICZN decided that the petition was based on a hypothetical as no generic splitting had occurred and declined the request. BZN 67:106–115.

- Opinion 2283 (Case 3390): Conservation of usage of the name *Archeopteryx lithographica* von Meyer, 1861 (Aves) by designation of a neotype. The original type specimen consists of a fossilized feather that could not be positively associated with one of several nominal fossil taxa from the type locality site. This designation associates the name with a well preserved skeleton with attached feathers imprints. BZN 68:230–233.

The Amphibia (currently Amphibia and Reptilia) of Carl Linnaeus, later Carl von Linné

I end this initial effort by calling the attention of all herpetologists to the recently published *The Herpetological Legacy of Linnaeus*, Bibliotheca Herpetologica vol. 8, no. 2, 144 pp., edited

by Richard Wahlgren and Aaron M. Bauer. This compact volume includes a nearly complete survey of Linnaeus' works containing information on amphibians and reptiles. Many of Linnaeus' early works contain the original proposal of generic and species names in herpetology which, however, are not available as they were originally published prior to January 1, 1758, the starting date for modern nomenclature under the Code and are thus pre-Linnaean. Wahlgren expertly details the historical setting and content of the early *Systema Naturae* (editions 1, 2, and 6) actually published by Linnaeus, the many dissertations, the *Amoenitates* and the magnum opus on the collections of King Adolph Fredrik (1754). Among the most important dissertations treated in detail are *Amphibia Gyllenberg*, 1745 (defended by B. R. Hast), Museum *Adolphus Fridericiarum* = *Musuem Principis*, 1746 (defended by L. Baik), and *Surinamensis Grilliana*, 1748 (defended by P. Sundius).

The 10th edition of the *Systema Naturae* (1758) brought together the information contained in these earlier works with many additions. The final edition of the *Systema* authored by Linnaeus was the twelfth (1766). It is well to keep in mind that this edition was used as the starting point of zoological nomenclature under the so-called Strickland code, actually the official code of the British Association for the Advancement of Science. References to the *Syst. Nat.* in the many herpetological works of Günther and Boulenger refer to the 12th not the 10th edition, a fact often overlooked by some modern herpetologists. Other sections treat the contributions to herpetology of Linnaeus' students who carried out field work throughout the world (K. Adler); the pre-Linnaen sources of many herpetological names used by Linnaeus (A. Bauer); Linnaen names for South American (W. Duellman) and North American (E. Liner) taxa; and those of Asia (I. Das). The only area missing separate coverage is Africa.

In conclusion, every systematic herpetologist or person interested in the history of our science should have a copy of this marvelous monograph. It is available from the International Society for the History and Bibliography of Herpetology (www.t-ad.net/ishbb).

—Jay M. Savage, Section Editor

OBITUARIES

Herpetological Review, 2012, 43(2), 177–180.

Joseph T. Collins, Jr. (1939–2012): Herpetological Organizer and Author of Wildlife Books

Joseph Thomas Collins, Jr.—editor, photographer, and writer of books on the wildlife of eastern and central United States, and an organizer of state and national herpetological organizations including the Society for the Study of Amphibians and Reptiles (SSAR)—died of a massive coronary on 14 January 2012, at his vacation home on Saint George Island, Florida. He was born on 3 July 1939 in Crooksville (Perry County), central Ohio, but grew up in Norwood, a Cincinnati suburb. In those days, he was called "Tom" Collins, to distinguish him from his father, a Cincinnati podiatrist. He was one of a group of local boys including his closest friend, Corson J. Hirschfeld, who developed a strong interest in reptiles. (See accompanying commentary by James B. Murphy.). In 1958 Collins joined The Ohio Herpetological Society (OHS), a club that had been founded by amateurs earlier that year and, together with Hirschfeld, he soon became one of its principal organizers. They were among that brash group, mostly of teenagers, sometimes referred to as "The Ohio Mafia" and reviled in some quarters, who led the Ohio herp society to spectacular growth in membership and invented its innovative programs that presaged its development into what is today the world's largest academic herpetological society. By 1962, Collins was OHS Secretary and, except for a six-year gap in the 1970s, he held one or another post (as officer, editor, or committee chairman) continuously through 1998—a total of 30 years including the period when OHS transformed into SSAR. He was President in 1978.


PHOTO COURTESY SUZANNE L. COLLINS

Joseph T. Collins, Jr., 2010. Formal portrait.

In 1962–1963, Collins served in the United States Army at Fort Jackson (South Carolina) and then attended the University of Cincinnati (A.A. 1966). In January 1968, he was hired by the University of Kansas Museum of Natural History as Preparator for the ichthyology and herpetology collections. As such, he was in charge of accessions, cataloging specimens, loans, preparing skeletons, and related activities. His organizational skills and close attention to detail, honed through his years of work for OHS and SSAR, were a decided asset in his new duties. He also developed photographic skills and soon recognized the

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PHOTO BY DAVID M. DENNIS

"Tom" Collins demonstrating the finer points of a live gartersnake at the Third Annual Meeting of The Ohio Herpetological Society, held at the Cleveland Museum of Natural History, June 19, 1960.

PHOTO BY JAMES S. JACOB

Former officers and editors of The Ohio Herpetological Society (1958–1966) at a banquet in August 1982 in Raleigh, North Carolina, celebrating the society's 25th anniversary. *From the left*: Kraig Adler, Ray Ashton, Paul Daniel, Steve Tilley, David Dennis, Barry Valentine, Roger Conant (honorary advisor), Corson Hirschfeld, Joseph Collins, Ronald Brandon, and Henri Seibert. It was Collins who dubbed this group "The Ohio Mafia."

PHOTO BY JAMES S. JACOB

Joseph Collins was the perennial auctioneer at SSAR/HL meetings for nearly two decades, beginning at the Memphis meeting in 1981. His last appearance as auctioneer was for the 50th anniversary meeting in St. Louis in 2007. He was especially good at bidding up prices by getting rival groups interested in the same item, and then challenging them with irresistible taunts. Ray Ashton is at the right.

need for public education, interests that he later put to use in writing books and pamphlets for the general public.

In 1981, Collins moved from his collections job to become Managing Editor of the museum's scientific publications. In the 1970s he had been editor of SSAR's news-bulletin, *Herpetological Review*, and in 1982 took over its pamphlet series, *Herpetological Circulars*. He had also promoted the development of the Kansas Herpetological Society (KHS), which he modeled after OHS, and used the bylaws and organizational structure of SSAR. More than anyone else, Collins maintained the academic orientation of KHS, at a time when most other regional herpetological societies were moving into captive breeding. He was also responsible for the regular field surveys by KHS members, which have accumulated many valuable records from throughout the state over many years.

As part of Collins's interest in public outreach, he produced several books, which gave him the opportunity to further develop his photographic and writing skills. The first was an update of Hobart M. Smith's "Handbook of Amphibians and Reptiles of Kansas" (1950; second edition 1956), which by the early 1970s was out of date. Collins's completely new replacement, entitled "Amphibians and Reptiles in Kansas," was highly successful and went through four editions (1974, 1982, 1993 [jointly with his wife, Suzanne L. Collins, an excellent wildlife photographer], and 2010 [with Suzanne Collins and their colleague at Fort Hays State University, Travis W. Taggart]). With the museum's Curator of Ichthyology, Frank J. Cross, Collins wrote two editions of a handbook on the fishes of Kansas (1975, 1995). Collins was also co-author of a volume on reptiles and amphibians of Eastern and Central United States in the series of field guides edited by the ornithologist-artist, Roger Tory Peterson. The herpetological volumes in this series had been initiated by Roger Conant with the photographic and artistic assistance of his wife, Isabelle Hunt Conant, and they produced two editions (1958, 1975) with Collins joining as second author for the third (1991). Because of his many books on the wildlife of Kansas and North America, Collins was proclaimed "Kansas Wildlife Author Laureate" by the Governor of Kansas, Bill Graves, in 1996.

Collins also co-edited several academic volumes. Two were on snakes: "Snakes: Ecology and Evolutionary Biology" (1987, with Richard A. Seigel and Susan S. Novak) and "Snakes—Ecology and Behavior" (1993, with Seigel). Two others, both published by SSAR, were on captive animals: "Reproductive Biology and Diseases of Captive Reptiles" (1980, with James B. Murphy) and "Captive Management and Conservation of Amphibians and Reptiles" (1994, with Murphy and Kraig Adler).

In 1997, Collins took early retirement from his editorial position at the museum. Three years earlier, he and his wife had founded a non-profit organization, the Center for North American Amphibians and Reptiles (re-named Center for North American Herpetology [CNAH] in 2000). With the help of Taggart, who handled the web design, and Suzanne Collins, CNAH developed into the most active, on-line portal for herpetology in North America. Its programs included a constantly expanding directory of herpetologists; a library of downloadable PDFs of important papers; links to other websites; a meetings calendar; and an announcement service for the herpetological community. At one time, CNAH sponsored a facsimile reprints program modeled after that of SSAR, in cooperation with a natural history book company in Minnesota. When Brian Crother, Jeffrey Demuth, and Taggart established the first open-access, on-line herpetological journal, *Contemporary Herpetology*, in 1997 (with

PHOTO BY LARRY L. MILLER

A field excursion with students to Sumner County, Kansas, in May 2009 with Joseph and Suzanne Collins (at right). Joe has a small snake in each hand.

Joseph Slowinski as editor), Collins offered the CNAH website as the backup, mirror site.

In 1977, Collins was appointed Chairman of SSAR's Common and Scientific Names Committee. The charge to them was to assume the function of a former committee of the American Society of Ichthyologists and Herpetologists, chaired by Roger Conant, that produced the first official list of standard names for North American amphibians and reptiles (published 1956 [1957]). SSAR's goal was to issue such a list on a regular basis, to reflect changes in scientific names and the addition of new taxa, through use of a committee of experts drawn from the herpetological community. The first two editions (1978, 1982) followed the plan and were authored by groups chaired by Collins, but beginning with the third edition (1990) Collins alone appeared as author, contrary to the original charge to the committee. SSAR's Board of Directors reminded Collins that the project was intended to reflect the communal judgment of the herpetological community through a representative committee. When Collins persisted, claiming the list was his own "intellectual property," and produced a fourth edition (1997) by himself (he was also editor of the *Circulars* series in which the standard names lists were published), he was terminated as chairman of the committee. He resigned as *Circulars* editor the next year. He then proceeded to produce his own standard names lists under the imprint of CNAH, as a rival to those produced by a new committee of experts in SSAR. This was the end of Collins's formal association with SSAR, although the society continued to honor him for his years of service to it, most recently at the society's 50th anniversary meeting in 2007.

Collins published research papers beginning in 1959 that covered his interests in distribution, life history, and systematics, originally on materials from Kentucky and Ohio, and later from Kansas and other parts of eastern and central United States. In one paper he co-authored the description of a new hylid frog (*Pseudacris fouquettei*). In 1991, he published a controversial, two-page paper in *Herpetological Review* in which he applied the then-new Evolutionary Species Concept to elevate 55 geographically disjunct subspecies of amphibians and reptiles to species status. He did not do so on the basis of any new research, but simply because these subspecies were, as he wrote, "mapped as allopatric" in various publications and were "in some way morphologically (and presumably genetically) distinct." There was an immediate reaction from the herpetological community, both positive and negative, and a series of follow-up articles in the *Review* including one by Collins himself (1992). There was much anticipation, therefore, at the 1992 SSAR meeting in El Paso (Texas) for a symposium dedicated to discussion of the subspecies concept in herpetology. Most of the persons who participated in the on-going debate on the pages of the *Review* were present in El Paso, including Collins. However, he left El Paso just before the symposium began.

Collins played a major role in the development of several herpetological organizations in the United States, as an innovative leader and a meticulous editor. He was a successful writer and photographer who produced a large number of popular books on amphibians, reptiles, and other wildlife. His role in promoting herpetology in Kansas is particularly noteworthy, and was instrumental in initiating the careers of many budding naturalists. Collins was also a lively speaker and raconteur whose intense focus on herpetology was contagious. "Birds are just herps gone bad," he used to say.

Joseph T. Collins's life's work made a significant difference in the way herpetology has developed in the United States. His presence will be greatly missed.

Joseph T. Collins: The Cincinnati Years and Beyond

When I came to Cincinnati, Ohio in 1957 to begin my undistinguished undergraduate academic career at Xavier University, I met a number of very strange herpetologists who were mostly unable to function well in polite society. These included George McDuffie, Marty Huelsman, Jim Corrado, Frank Kramer, and Joseph "Tom" Collins. For years, Collins used the name Tom and this appellation was what we called him; later, he wanted those of us from his Ohio days to call him Joe, but none of us was willing to accept his recommendation and refused to do so. This annoyed him greatly.

Collins was known as an incredibly poor poker player but wouldn't acknowledge this deficit. Each week we traveled to one of our abodes, pulled out the cards and chips, and played penny-ante poker until the wee hours. Usually when we played at the Collins household, his father would join us. Since I knew little about the game, both expected that I would be taken to the cleaners because I knew nothing about odds or showing a "Poker Face." For some miraculous reason, I regularly won, smiled broadly, and ceremoniously scooped up the pot after almost each game. Both Tom and his father became furious and so exasperated with my string of good luck that they would throw the cards on the table, walk away without a word, and barricade themselves in the bedroom. Naturally, we expected them to return but they rarely did, so we just continued playing.

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Huelsman, Corrado, Kramer, and Collins (and Collins's good friend Corson Hirschfeld) created the non-profit (vigorously so) Ohio Valley Herpetological Laboratory on the outskirts of Cincinnati. This building was in the middle of a sheep pasture, filled with metabolic waste so thick that it was hazardous to walk to the front door. Inside, a large room was divided in half with living reptiles and amphibians owned by the first two, and a large preserved collection curated by the latter two. Collins was planning to do a book on the herpetofauna of Kentucky so we often mounted collecting trips there to secure specimens, which were meticulously preserved. If a particularly desirable specimen was found, the herpetoculturists in the group wanted to keep it alive whereas Collins wanted it preserved as a voucher; this difference of opinion created major flare-ups and so the return trip was often traveled in silence. A few distinguished teenage visitors such as Kraig Adler and Dave Dennis from Columbus, were green with envy that this lab existed. Once again the boys from Cincinnati outstripped the Columbus crowd!

At the Lab one day, Collins pulled out a price list with a number of creatures (mealworms, newborn mice and rats, chicks, crickets, tree frogs, and so on), followed by dollar signs. When I asked what the purpose of this list was, he said that he would eat each of them for a fee, which was, he expressed explicitedly, not negotiable. This was to supplement his meager income. Although I was a destitute student, I saved up lunch money to watch him gulp down these strange food items. It was the highlight of my week!

One day, I complained to Collins that my social life was not robust; in fact, I was having trouble finding dates. He pointed out that he would instruct me as to proper grooming behavior and improving my fashion sense. He started by saying that my straggly beard and long hair looked like a Brillo pad and I should shave and get a short haircut immediately to be more presentable. He continued by comparing my wardrobe to an outfit worn by a clown: dirty plaid shirts, wrinkled pants, boots, and ill-fitting coats. He even called me a "hippie"! He felt that I needed to broaden my topics of conversation; incessant ramblings about herpetology were a real turnoff. Since my bank account was less than impressive, I was unable to incorporate his wardrobe suggestions to entice women and suffered the consequences as a result.

After I finally graduated and left town, our paths separated for some years. I saw the name Joseph T. Collins constantly but since he was only known as "Tom" to me, I never made the connection that he was at the University of Kansas. In 1971, I attended the SSAR meeting in Albuquerque, New Mexico, and saw this bald, bearded chap sitting at a table. I did not recognize him because he had been hirsute and clean-shaven in his younger days—until I overheard him speak. I sheepishly approached him and introduced myself; we reminisced throughout the meeting and remained in contact. When I was elected SSAR President in 1981, Collins signed up as Secretary because I was, as he told anyone who would listen, too disorganized to do the job by myself. In fact, during a visit to my home, he saw the ornately decorated SSAR president's gavel on my fireplace mantle and insisted that he carry it back to Kansas as it was inevitable that I would misplace it; I refused and did not lose it.

He was incredibly detail-oriented and organized. His penmanship was outstanding, unlike most herpetologists whose handwriting looks like chicken scratching. Collins was a superb editor, which I know firsthand because we worked on several projects together. One day in 1996, Kraig Adler and I visited his home in Lawrence and saw all of the old Ohio Herp Society correspondence between them encased in hardbound volumes. I spent many minutes reading through these papers to see how my two friends operated in the early days. There were plenty of disagreements, but clearly these were resolved and the herpetological community benefitted as a result.

My conversations with Collins about biology and herpetology were often very heated; we finally agreed to disagree but not be disagreeable, which took some self-control and negotiations as we both had strong opinions and did not easily compromise nor accept divergent opinions. It is a testament to the strength of our friendship, which lasted over 50 years, but we sometimes were quite frustrated with each other, especially if one of us was doing something that the other felt was self-destructive. It was an interesting dynamic between a "Zoo Guy" and a "Museum Guy" and we both benefitted greatly, in my view, by expanding our perspectives. Most importantly, I really loved this guy, warts and all, but he never understood that disagreeing with me was at certain risk to the truth.

HISTORY OF THE WORLD CONGRESSES OF HERPETOLOGY

Editor's note.—We are indebted to the following Secretaries-General: Kraig Adler, Marinus Hoogmoed, Marvalee Wake, Michael Tyler, Walter Hödl, and Local Committee Chair, Ernst Baard, for the retrospective summaries that follow. Each was asked to recall the key events associated with the planning, development, and hosting of "their" congress, as well as to note significant accomplishments and any congress-related publications. The result is the only comprehensive history available of the six World Congresses of Herpetology to date. Special thanks to Breck Bartholomew and Kenneth Dodd for their assistance.

Herpetology today is an international science, but this is a relatively recent development. If one compares current issues of *Copeia*, *Herpetologica*, and *Journal of Herpetology* to those of 30 years ago, there have been two relevant trends over this period: more articles by overseas authors and more articles by groups of authors from multiple countries. We are better connected today as an international community of herpetologists than ever before. And the six world congresses of herpetology that have been held to date* have played a role in this trend.

Other biological disciplines have enjoyed a tradition of world congresses for longer periods of time: the mammalogists since 1974, anatomists 1903, zoologists 1889, and the ornithologists 1884—the last group now for 128 years! In 1981, the three United States–based herpetological societies appointed a committee of three (David B. Wake, chair; William E. Duellman, and John W. Wright) to consider the possibility of establishing a world congress organization for herpetology, and they solicited comments from leading herpetologists throughout the world.

By coincidence, herpetologists were to meet in Raleigh (North Carolina) during August 1982 to celebrate the 25th annual meeting of the Society for the Study of Amphibians and Reptiles (Jacob 1982), and because this was a special anniversary meeting for SSAR, a large international attendance was expected. Letters of congratulations were received from US President Ronald Reagan and Governor James A. Rhodes of Ohio (the society was founded in Ohio in 1958), as well as from the leaders of numerous herpetological societies around the world. The SSAR President, Kraig Adler, had invited each society to send official delegates to the meeting and asked them to attend a special banquet in their honor on 2 August.

The Wake committee decided to recommend the formation of a world congress organization and used this banquet as an opportunity to discuss their proposal with a diverse group of herpetologists who were also the leaders of herpetological societies from all parts of the world. This group enthusiastically endorsed the committee's recommendation and voted to hold the first congress. Adler was presented by the Wake committee as the sole candidate for Secretary-General of the congress, and he was elected unanimously. He was given the task to establish an international advisory committee. By the end of the SSAR meeting, Marinus S. Hoogmoed of The Netherlands accepted Adler's appointment as Treasurer of the congress.

—Robert Hansen, Editor

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Foundation Meeting of the WCH. Leaders of national and international herpetological societies who voted WCH into existence at the SSAR meeting in North Carolina, August 1982. *Left to right* (*front row*): Mrs. Haslewood, G. A. D. Haslewood, Michael Lambert (all UK); Jorge Luis Piñero (Puerto Rico); James Fawcett (New Zealand); Marinus Hoogmoed (Netherlands); Hajime Fukada, Richard Goris (both Japan); (*rear row*): Jacek Szymura (Poland); Kraig Adler, Marvalee Wake (both USA); David Ball (UK); Robert Inger (USA); Konrad Klemmer, H. S. R. Glaser (both Germany); Benedetto Lanza (Italy); William Branch (South Africa); Mrs. Lanza (Italy). Also present for the meeting but not pictured: Jean-Marie Exbrayat (France) and Gregory Mengden (Australia).

*1: Canterbury, UK (1989); 2: Adelaide, Australia (1993–1994, over the New Year's period); 3: Prague, Czech Republic (1997); 4: Bentota, Sri Lanka (2001); 5: Stellenbosch, South Africa (2005); and 6: Manaus, Brazil (2008). The seventh congress will be held in Vancouver, Canada, during 8–14 August 2012.

History of the First World Congress of Herpetology (Canterbury, UK, 1989)

KRAIG ADLER*
(Secretary-General, WCH, 1982–1989)

The World Congress of Herpetology (WCH) was brought into existence on 2 August 1982 at a meeting of officers of national and international herpetological societies from around the world who came to Raleigh, North Carolina, to celebrate SSAR's 25th anniversary. This decision was based on a recommendation made by a committee headed by David B. Wake who pointed out the need for a global organization that could bring all herpetologists together from time to time in order to discuss common interests (Jacob 1982).

After establishing the WCH, the same group of officers elected me as Secretary-General and I was tasked to appoint an advisory committee to assist me to set up an ongoing congress organization and arrange for the first congress meeting. It is important to differentiate between the parent body, the WCH, which exists in perpetuity, and a particular WCH meeting, whose organization is temporary for the purpose of arranging and running a single congress. Each entity has its own officers, but there is occasionally some overlap.

Establishment of WCH Leadership and Its Initial Activities

My first act was to appoint Marinus S. Hoogmoed as WCH Treasurer. He became my closest colleague in founding WCH and in planning the First World Congress of Herpetology (1WCH) over the span of more than seven years. I then established the WCH Planning Committee (PC) consisting of an international group of distinguished herpetologists: Donald Broadley, Harold Cogger, J. C. Daniel, Ilya Darevsky, Toshijiro Kawamura, Michael Lambert, Federico Medem, Hubert Saint Girons, P. E. Vanzolini, and David Wake. The PC had the dual task to establish the WCH and to set the stage for the 1WCH.

Many questions had to be addressed—and most of them all at once! The PC decided that the dual themes of WCH would be science and conservation. We needed to announce our existence and goals to the herpetological community, so notices were placed in 16 herpetological journals, worldwide. The PC believed that WCH should have both a small Executive Committee (EC) to make decisions and a much larger advisory body, the International Herpetological Committee (IHC), to get the best advice from the diverse worldwide community of herpetologists. By September 1984, the PC had transformed into the EC with the addition of Robert Carroll, Gustavo Casas-Andreu, José Cei, Rainer Günther, Benedetto Lanza, and Ermi Zhao. The EC then elected the IHC, a group of 50 leading herpetologists from 30 countries.

The EC also established the category of Affiliated Organizations (AO) for national and international herpetological societies that wished to actively support the WCH and 1WCH. (By the time of the congress in 1989, 30 societies had joined as AO.) Because we also needed to build a budget to support WCH planning, we asked these societies to contribute funds proportionate to their memberships (one Dutch guilder per member, at that time about US$0.38). The AO served to channel advice to the EC and to advertise the upcoming congress in their respective country or region. In order to coordinate the EC with the IHC and AO, and to inform individual herpetologists who supported our work, a newsletter was established that requested feedback from all parties (Adler 1983–1988). This newsletter was also important in building global interest in the first congress.

Several other actions were taken at this early stage. To aid in identification of WCH, a logo was chosen (a chameleon, from Conrad Gessner's "Historia Animalium" of 1554), which has been used by WCH ever since (Fig. 1). In order to establish the legitimacy of WCH in the larger biological community, with advice from Marvalee Wake the WCH applied to the International Union of Biological Sciences (IUBS), which is the official body that sanctions world congresses, to become the Section of Herpetology of the IUBS. Among other reasons, this was important for delegates in some countries to obtain governmental travel funds to attend the congress. (This application required several years of advance planning, but was finally approved at the IUBS meeting in Budapest in 1985.)

There was also the matter of writing a Constitution for WCH. In June 1986, I appointed Harold Cogger to chair a panel (Natalia Ananjeva, Richard Goris, René Honneger, Jay Savage, and P. E. Vanzolini) to draft this document, which after several rounds of discussion with the EC, was approved by the delegates at the first congress. The overarching objectives of WCH, as stated in that document, are "to promote international interest, collaboration and co-operation in herpetology."

Selection of a Venue and Date for 1WCH

By early 1985, following discussion by the EC and IHC, we were ready to seek bids for the first congress. Criteria had been established for choosing a site and date. Several other related issues required careful consideration, for example, whether the congress would be an open meeting or by invitation only. At that time, another world congress organization had been embroiled in a destructive controversy over the issue of apartheid in South Africa. Protests were threatened for their meeting, so they excluded attendance by all South Africans. There were also the sensitive issues of China and Taiwan, and of ensuring attendance from the Soviet Union and Eastern Europe. The EC eventually decided that our congress would be open to herpetologists of all nations without prejudice.

Another controversial subject was the matter of whether there would be one official language or many at the 1WCH. The EC and IHC considered this point in depth, realizing that whatever we agreed to would set precedent. We decided to have an open discussion on the matter, which was held at the August 1985 meeting

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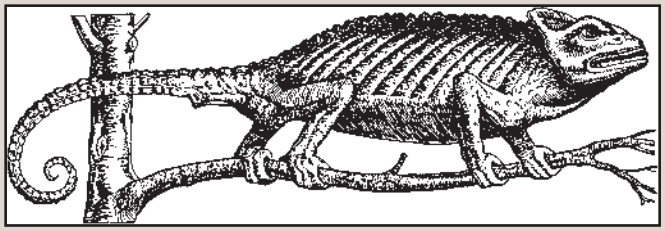

FIG. 1. WCH Logo. This chameleon image is from Conrad Gessner's book, "Historia Animalium" (1554). It has been used as the congress's logo ever since.

FIG. 2. WCH Executive Committee. The governing body of WCH in session at the 1WCH. *Left to right* (*seated*): Michael Lambert (UK); Marinus Hoogmoed (Netherlands); P. E. Vanzolini (Brazil); (*standing*): Gustavo Casas-Andreu (Mexico); Robert Carroll (Canada); Ermi Zhao (China); Ilya Darevsky (USSR); Rainer Günther (German Democratic Republic); Donald Broadley (Zimbabwe); Harold G. Cogger (Australia); Kraig Adler (USA); Ian Swingland (UK); Hubert Saint Girons (France). Also present but not pictured: José Cei (Argentina) and David Wake (USA).

of Societas Europaea Herpetologica (SEH) in Prague. The herpetologists assembled there felt that, to maximize communication and exchange of ideas, one language is preferred and that it should be English, although other languages would be permitted.

The EC and IHC nominated 50 possible venues, which were reduced to five finalists that were invited to submit proposals. One declined. By March 1985, the EC decided, by a narrow margin, to accept an invitation from Ian Swingland at the University of Kent, located in the ancient cathedral city of Canterbury in southeastern England. Following that vote, I visited Canterbury twice to inspect facilities and discuss logistics and costs. There was strong support from the British herpetological community, especially from The British Herpetological Society (BHS). We anticipated an attendance of 600 to 800, which turned out to be a conservative estimate.

By June 1986, the timing of the 1WCH was established—11 through 19 September 1989—not ideal for everyone in all parts of the world, but the best compromise that we could make. This information was widely announced over two years in advance so that would-be delegates could plan and raise funds to attend.

Establishment of a British-based Organization

The EC and IHC, being globally dispersed, could not be expected to do the detailed planning on the ground. Thus a new organization was formed—the First World Congress of Herpetology—a limited company whose sole purpose was to arrange the meeting including its financing. The WCH loaned a sum of money to 1WCH to cover their costs before they could raise their own funds. In addition, a local committee was formed at the University of Kent (Congress Secretariat; CS), headed by Swingland, the Conference Director. A national organization—the UK National Executive (UKNE)—headed by Roger Avery, was established to promote the congress in the UK and to assist the CS in the running of the meeting. So that the WCH EC could maintain its oversight of the planning, Hoogmoed, Lambert, and I were made members of the UKNE.

I took responsibility for the scientific program and recommended to the EC that no oral contributed papers be allowed, in order to give ample time for plenary lectures, topical symposia, and other activities. Contributed papers would be by poster only. Special attention was given to maximizing contacts by means of socials, workshops, roundtable discussions, commercial displays, excursions, audiovisual programs, and other activities. Because of the expected intensity of the congress, a break day was inserted into the middle of the meeting.

Fundraising for Delegates and the 1WCH

A wide range of mechanisms was employed to help delegates cover their expenses. The Royal Society of London was approached to provide funding for some persons in British Commonwealth countries. Books donated by Soviet herpetologists were sold to raise foreign exchange to cover their registration fees. National airlines were asked to donate vacant seats, on a standby basis, to the country's students. Two of the American-based herpetological societies (HL and SSAR) provided funds to support student travel to Canterbury. I wrote letters of invitation to any delegates who needed official invitations to obtain institutional funding. These and many other methods were tried, although not all were successful.

In order to better publicize the congress and raise interest and funds, I asked the Earl of Cranbrook, then the President of the BHS, to establish a group of honorary officers. Angus Bellairs was appointed Honorary President of 1WCH and 22 Vice Presidents were named including academics, conservationists, institutional leaders, and other UK notables. Among them were the Lord Archbishop of Canterbury, the Vice-Chancellor (in the UK system, effectively the president) of Oxford University, and the heads of the Natural History Museum and the Zoological Society of London. Later, H.R.H. Prince Philip agreed to serve as Patron of the 1WCH. Because of his active presidency of the World Wide Fund for Nature, Prince Philip's formal association with our congress gave special visibility to conservation issues.

Cooperation of Other Societies

To maximize our chances of a well-attended first congress, I approached three major herpetological societies to designate Canterbury as their own official meeting for 1989. Thus, HL, SEH, and SSAR did not hold competing meetings that year. In addition, BHS, the UK-based Fauna and Flora Preservation Society, and the Zoological Society of London became official co-hosts of the 1WCH. This wide support for the 1WCH from our sister organizations was essential to having a successful first congress, and thus provide a foundation for the future.

Scientific Program of the 1WCH

Our plan was to produce a program of broad scope. The EC, IHC, CS, and UKNE wanted to attract the largest possible international audience of herpetologists by creating a diverse and irresistible program of events. The scope and richness of that program is best illustrated by the abbreviated list given below.

• *Plenary Lectures* (held on the first and last days of congress): Carl Gans, Ilya Darevsky, Linda Maxson, Russell Mittermeier,

Gerald Durrell, Timothy Halliday, Ermi Zhao, Armand de Ricqlès, Donald Bradshaw, Eric Pianka, and David Wake.

• *Symposia* (Roger Thorpe, manager):
1. Conservation and Management of Species (Emilio Balletto and Brian Groombridge, convenors).
2. Effects of Environmental Pollution (Arnold Cooke and Claes Andrén).
3. Captive Management (René Honegger and Romulus Whitaker).
4. Health and Disease (John Cooper and Fredric Frye).
5. Sexual Selection and Communication (Murray Littlejohn and Stevan Arnold).
6. Environmental Sex Determination (Claude Pieau and Nicholas Mrosovsky).
7. Sensory Processing (Hans Schneider and John Phillips).
8. Long-term Studies (J. Whitfield Gibbons and Henk Strijbosch).
9. Ecology and Behavior of Snakes (Hubert Saint Girons and Richard Shine).
10. Ecology and Adaptations in Extreme Environments (Donald Bradshaw and Leo Borkin).
11. Amphibian Community Ecology (Robert Barbault and Masafumi Matsui).
12. Herpetofaunas: Explorations and Studies (Ermi Zhao and Donald Broadley).
13. Evolution and Phylogeny of Frogs (Raymond Laurent and Michael Tyler).
14. The Inter-relationships of Primitive Tetrapods: Fossil Evidence (Leonid Tatarinov and Robert Carroll).
15. Paleoherpetology: Impact on Neoherpetology (Richard Estes and Borja Sanchiz).
16. Evolution and Ecology of Island Herpetofaunas (Thomas Schoener and Ronald Nussbaum).
17. Evolution and Life Histories of Turtles (Justin Congdon and Colin Limpus).
18. Molecular Systematics (Herbert Dessauer and Eviatar Nevo).
19. Cytogenetics (Ettore Olmo and Midori Nishioka).
20. Modified Sexual Systems: Parthenogenesis and Hybridogenesis (John Wright and Rainer Günther).
21. Modern Approaches to Systematics and Phylogeny (William Duellman and Olivier Rieppel).
22. Biology of the Pipidae (Richard Tinsley and Linda Trueb).
23. Energetics (Warren Porter and Raymond Huey).
24. Determinants of Organismal Function (Harvey Pough and Roger Seymour).
25. Functional Morphology (Carl Gans and Jean-Pierre Gasc).
26. Reproductive Endocrinology (Paul Licht and Louis Guillette).
27. Developmental Processes (Angus Bellairs and James Hanken).

• *Roundtables* (organized discussion groups; Trevor Beebee, manager):
1. Conservation Needs Achieved (Keith Corbett, convenor).
2. Conservation Biology (Kenneth Dodd, Jr., Romulus Whitaker, and Gustavo Aguirre).
3. Optimal Sizes of Eggs and Clutches (Henry Wilbur and Laurie Vitt).
4. Antipredator Mechanisms (Edmund Brodie, Jr., and Harry Greene).
5. Ecology and Conservation of the Tuatara (Michael Thompson and Donald Newman).
6. Herpetofaunas: A Biogeographic Review of the Continents (Charles Blanc and Jay Savage).
7. Caecilian Biology and Evolution (Michael Delsol and Marvalee Wake).
8. Snake Systematics and Phylogeny (Herndon Dowling, Gregory Mengden, and Olivier Rieppel).
9. Laws, Research, and Conservation: A Conundrum (Harold Cogger and Stephen Edwards).
10. Amateur Contributions to Herpetology (Wolfgang Böhme).
11. Medical and Herpetological Aspects of Venoms and Skin Toxins (José Cei and Sherman Minton, Jr.).

• *Workshops* (practical demonstrations; Trevor Beebe, manager):
1. Skeletochronology and Aging Methods (Jacques Castanet and Ella Smirina).
2. Field Methods and Biotelemetry (Jan van Gelder and Stuart Mackay).
3. Molecular Techniques (David Hillis and Craig Moritz).
4. Amphibian Larvae (Barry Valentine and Richard Wassersug).
5. Quantitative and Phylogenetic Analysis (Roger Thorpe and Garth Underwood).
6. Photographic Techniques (David Curl and David Dennis).

• *Posters* (Richard Tinsley, manager).
250 posters were erected in 33 categories: Conservation and Management; Effects of Environmental Pollution; Captive Management; Health and Disease; Sexual Selection and Communication; Environmental Sex Determination; Orientation, Navigation, Nervous System and Senses; Egg Games–Optimal Size and Clutch Size; Long-term Studies; Snake Behavior and Ecology; Anuran and Urodele Ecology and Behavior; Lizard Ecology and Behavior; Chelonian Ecology and Behavior; Community Ecology; Herpetofaunas—Explorations and Studies; Skeletochronology; Field Methods and Biotelemetry; Origin of Amphibia and Reptilia; Paleoherpetology; Island Herpetofaunas; Caecilian Biology and Evolution; Molecular Systematics; Cytogenetics; Parthenogenesis and Hybridogenesis; Systematics and Phylogeny; Snake Systematics and Phylogeny; Phylogenetic Analysis; Energetics; Ecological Physiology; Functional Morphology; Reproductive Physiology; Developmental Processes; Medical and Research Aspects of Venoms.

The logistics of administering the many meeting rooms, projection, etc. were handled by several dozen stewards, mostly students. They were managed by Richard Griffiths and Henry Arnold.

Other Events Held During the Congress Week

Besides the main scientific program, several other events were held. The IUCN Species Survival Commission, chaired by George Rabb, met at the 1WCH, as did several of its specialist groups. Jay Savage arranged a meeting of the African Amphibian Group. Martha Crump and Garth Underwood organized a herp quiz.

Social activities were held every evening. The Lord Mayor of Canterbury hosted a welcoming reception at Westgate Gardens in the city, and the formal WCH banquet was held on another evening. The 70-member Regimental Band of the Royal Green Jackets, a regular British Army unit stationed near Canterbury, performed for the delegates. An auction of herpetological materials (books, prints, artwork) was held one evening, arranged by Michael Lambert. This event raised US$4,000 for herp conservation projects. Three different audiovisual programs were produced by David Dennis, Eric Juterbock, and me for evening

Fig. 3 (above left). The Abstracts volume contained half-page summaries of all oral and poster presentations. The drawings, by Tim Halliday, depict the six species of British amphibians. Britain's reptiles appeared on the cover of the Program volume.

Fig. 4 (above center). 1WCH Poster. This watercolor of an American box turtle (*Terrapene carolina*), drawn by David M. Dennis, was presented to all delegates at 1WCH by SSAR.

Fig. 5 (above right). This volume, entitled "Herpetology: Current Research on the Biology of Amphibians and Reptiles" and published by SSAR in 1992, includes the nine plenary lectures from the first congress. It was intended to be a benchmark for the status of herpetological science circa 1989.

Fig. 6. Delegates to the 1WCH. With an attendance of 1,368 persons from 61 countries, the Canterbury congress was the largest and most geographically diverse professional herpetological meeting ever held. The opening and closing sessions and the plenary lectures were held off-campus at the Marlowe Theatre in the city.

entertainment, entitled "Herpetology Past and Present," "Amphibians of the Appalachians," and "Herpetology of the American West."

Excursions were held on the free day midway through the meeting to London, Paris, etc., and to Down House, Darwin's home a short distance west of Canterbury. Commercial exhibits, managed by Thomas Langton, included books and print dealers, publishers, conservation displays, and herpetological society membership booths.

There was a staffed Congress Press Office to provide reports on congress news to television and print media.

EC Meetings and WCH Business Meeting

The EC (Fig. 2) met four times during the 1WCH to discuss various issues and to prepare recommendations to be acted upon at the WCH Business Meeting. About 200 delegates attended the Business Meeting. The Constitution drafted by the Cogger committee was approved and elections of new persons to the EC and IHC were made according to its provisions. To replace retiring members of the EC, the following persons were elected: Roger Avery, Wolfgang Böhme, William Duellman, Timothy Halliday, Konrad Klemmer, Jean Lescure, Jay Savage, Marvalee Wake, Yehudah Werner, and Romulus Whitaker. Among the 50-member IHC, 27 new members were elected representing 15 countries.

Two resolutions, both covering conservation issues, were approved at the Business Meeting. Formal invitations to host the Second Congress were announced: Adelaide (Australia), San José (Costa Rica), and Singapore. These were discussed and referred to the new WCH EC for decision.

Congress Publications

Each delegate received a 110-page "Programme" and a 334-page "Abstracts" volume, containing summaries of each oral and poster paper (Fig. 3). These were organized by Timothy Halliday. Delegates also received a copy of volume 1 of a book, "Contributions to the History of Herpetology," by John Applegarth, Ronald Altig, and me that was published by SSAR. The Society also donated the official congress poster (Fig. 4), depicting a North American box turtle (*Terrapene carolina*) feeding on some berries, that was drafted by David M. Dennis. Subsequently, a cloth-bound volume containing the plenary lectures, a full summary of the meeting, a list of 1WCH delegates with their addresses, and the WCH Constitution was published by SSAR (Adler 1992) (Fig. 5).

Final Results of the 1WCH

The success of the 1WCH can be measured in many ways. (A complete summary of 1WCH is in Juterbock 1990, and updated in Adler 1992.) We were treated to presentations of new research of great breadth and significance that clearly place herpetologists among the leaders of organismic biology. The congress reaffirmed the vitality and cohesiveness of herpetology as an interdisciplinary field of study and provided an impetus to its further development. That we are now about to celebrate our 7th congress in Vancouver later this summer is a testament to the sound foundation that we built in Canterbury in 1989. At the formal closing session of the 1WCH, I announced that the EC had elected Marinus Hoogmoed to be the new WCH Secretary-General and Robert Carroll the new Treasurer.

The final attendance at Canterbury was 1,368 persons from 61 countries, which was about double our original projections (Fig. 6). (As a result, the 1WCH secretariat repaid the loan made to it by WCH to the penny, but nothing more surprisingly.) With such a large and diverse international attendance, many friendships were made that doubtless have facilitated new research and other collaborations.

An Unexpected Further Result: Amphibian Declines as a Global Phenomenon

Perhaps the most important single result of the 1WCH, however, did not come from the scientific sessions but from hallway discussions and gatherings in local pubs. Herpetologists had noted declines in amphibian populations in eastern Australia, Brazil, Central America, and western United States, but until they met at the congress in Canterbury they had thought these were only local phenomena. Their discussions at the 1WCH, however, led them to think that the declines might result from some common global cause or causes.

This possibility required further discussion. David Wake quickly organized a "Workshop on Declining Amphibian Populations" in February 1990 (Wake 1991) at which an international group focused specifically on this issue. The popular press then picked up on this issue and specifically credited the 1WCH as the event where the conversation about amphibian declines first began (Barinaga 1990; Phillips 1990, 1994). Is this result not a perfect justification for continuing to have world congresses of herpetology?

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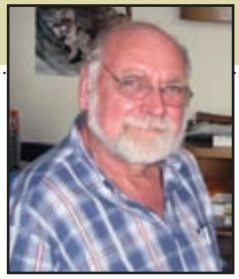
World Congress of Herpetology in the Period 1989–1994, Leading up to and Including the Second WCH



MARINUS S. HOOGMOED*
(2nd Secretary-General of WCH)

After having served the WCH in the period 1982–1989 as Treasurer, with Kraig Adler as Secretary-General (SG), I was elected 2nd Secretary-General of the World Congress of Herpetology (WCH) at the last meeting of the WCH Executive Committee (EC) on September 19, 1989 in Canterbury, England. Both the EC and the International Herpetological Committee (IHC) that were to serve for the period 1989–1994 were elected at the Business Meeting of WCH in Canterbury as well (for names of members of the committees, see Juterbock 1990). After Kraig Adler had announced the election of Robert Carroll as Treasurer and of me as Secretary-General at the plenary closing ceremonies of the First WCH, my first task as new Secretary-General was to officially close the First WCH and wish all delegates a safe trip home.

Selecting a Venue for the 2 WCH

At the WCH business meeting in Canterbury three invitations for hosting the Second WCH were received, namely of Adelaide, Australia, Costa Rica and Singapore. In the period directly following First WCH, I started to look into the matter of the venue of the Second WCH and prepared a number of questions about organization, locality, possible field trips, and finances that had to be answered by the three prospective venues in a bid-book. These questions were submitted to EC and IHC for their approval and for further input. Finally all questions were submitted to the three prospective venues with the request to provide answers and formulate a budget. Unfortunately, during this process Dr. Douglas Robinson from Costa Rica died, and with his untimely death this venue became an impossibility. Thus only Adelaide and Singapore remained as contestants; each submitted a bid-book and additional (mainly touristic) promotional material, both printed and on video. Submitted to the postal vote of EC, Adelaide obtained the majority of votes, so Michael Tyler, the Australian proponent, was named Congress Director of the Second WCH and asked to go ahead and on behalf of WCH start the preparations for the Second WCH as outlined in the bid-book Adelaide had submitted. In contrast to the First WCH, which was run by a group of academic biologists, Adelaide had opted to contract a professional event organizer and also hired a full time Executive Director, Lyall Klaffer. The Scientific Committee was established with Dr. Michael Bull of Flinders University, Adelaide, as Chairman and an international group of herpetologists as members (Tyler 1994). WCH provided an interest free loan (duly repaid by the Second WCH) to start up the congress, but which only covered part of the initial expenses, so the organizers had to loan more money from several government and private organizations (Tyler 1994).

Planning for Adelaide

In March 1992, I was a member of the Dutch delegation to the CITES Conference of Parties in Kyoto, Japan, and on my way back to Holland I could make a detour via Australia in order to get acquainted with some of the key personnel in Adelaide (19–26 March 1993), inspect the premises of the University where the meeting would be held, and get an idea of the possibilities for mid-Congress fieldtrips. I also visited Hardy's Winery at Reynella, 20 km south of Adelaide, where the New Year's Eve party of 1993/1994 would take place, and got a foretaste of what could be expected there wine-wise. I liked what I tasted, and it was clear that there would not be a shortage of wine at the New Year's party to be held in the cellars of the winery. It was to be one of the highlights of the congress.

Michael Tyler and Lyall Klaffer started early trying to boost participation at Second WCH, by visiting herp meetings in the USA and in Europe and actively lobbying. I vividly remember a very animated evening with these two gentlemen in a wine cellar in Eger near Budapest, Hungary, during the Societas Europaea Herpetologica meetings in August 1991 (Fig. 1). Mike also had some postcards made, promoting Second WCH, figuring some very artistic, colorful and morphologically rather novel tree frogs, one card featuring a species with three toes on the hind limb, and another card featuring a species with four toes (Fig. 2). These cards were sold in order to raise money for WCH 2. Furthermore, Michael Tyler and his team started a campaign to interest Australian sponsors in the Second WCH and they succeeded in raising a considerable sum for running the congress and also obtained funds from several sources to support travel of 40 participants that applied for this assistance. WCH was able to contribute US $ 2500 to this end (Tyler 1994).

In 1992 Mike Tyler (*Herpetological Review* 23[2]:37) announced the dates of the Second WCH, to be held from 29 December 1993 to 6 January 1994, and at the same time asked for timely return of the Provisional Registration Forms. The decision to hold the Congress in the middle of a world wide family holiday was a risky one, but as turned out later, it paid off.

In contrast to the First WCH, none of the American or European herpetological societies was interested to hold their business meetings at Second WCH, partly because of statutory constraints, partly because of fear of lack of quorum in such a distant venue.

Plenary Lectures

Nevertheless we got a good number of participants (about 750) from all over the world (more than 80 countries), although there was a certain preponderance of Australians, as could be expected (Fig. 3). The venue of the meeting was the city campus of the University of Adelaide. The opening session of the congress was on 30 December 1993. During the sessions of the Congress

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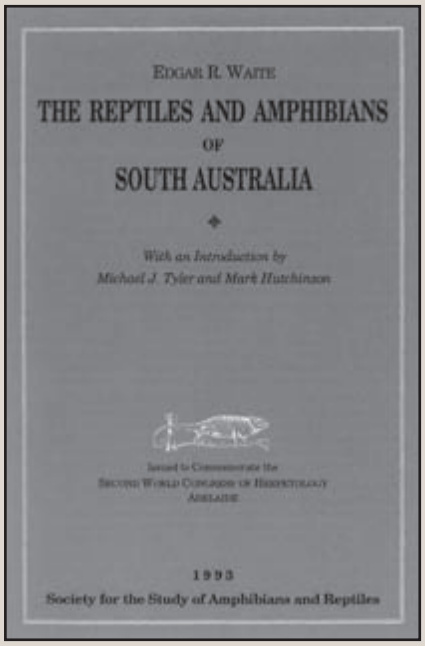

FIG. 1 (above left). Sixth meeting Societas Europaea Herpetological, Eger, Hungary. Wine party: Lyell Klaffer (left) and Marinus Hoogmoed (right).

FIG. 2 (above center). World Congress of Herpetology 2 promotional postcard.

FIG. 5. Edgar Waite's publication on the herpetofauna of South Australia was distributed gratis as a facsimile reprint to all delegates.

there were two plenary lectures each morning between 0900 and 1030 h on the following broad themes: Evolution (Arnold Kluge and Roger Thorpe, chairperson Marinus Hoogmoed), Zoogeography (Joel Cracraft and Paul Müller, chairperson Michael Tyler), Physiology (Raymond Huey and Roger Seymour, chairperson Kraig Adler), Ecology (Rick Shine and Joe Travis, chairperson Murray Littlejohn), Ethology (Michael Ryan and Judy Stamps, chairperson Rick Shine), and Conservation and Captive Care (Craig Moritz and Rene Honegger, chairperson Harold Cogger).

Specialized Symposia: The State of Our Science

The plenary lectures were followed by six concurrent symposia sessions dealing with the same subject matter as the plenary lectures, but subdivided in 30 specialized items (conveners in parentheses):

1. Evolutionary Insights from Molecular Biology and Karyology (Max King and Craig Moritz).
2. Paleoherpetology (Anna-Maria Baez and Robert Carroll)
3. Hybridization and Systematics (Yehudah Werner and Graeme Watson).
4. Functional Morphology (David Cannatella and Anthony P. Russell).
5. Development and Differentiation (Pere Alberch and James Hanken).
6. Biodiversity: Are Australian Ecosystems Different? (Harold Cogger and Graeme Watson).
7. Regional Faunal Patterns of Amphibians (John Poynton).
8. Island Biogeography (Ivan Ineich and Gregory Pregill).
9. Biogeograpy of Deserts (S. Donald Bradshaw and Roger Avery).
10. Reproduction and Environmental Endocrinology (Joan Whittier and Frank L. Moore).
11. Ecophysiology of Reptiles (S. Donald Bradshaw and Roger Avery).
12. Adaptations to Marine Life (Harold Heatwole and Harvey Lillywhite).
13. The Structure and Function of Anuran Skin (Phillip Withers and Stanley D. Hillyard).
14. Population Dynamics (Ross Alford and Keith Christian).
15. Parental Investment and Life History Strategy (Rick Shine and Laurie Vitt).
16. The Biology of *Bufo marinus*: Prospects for Biocontrol (Brian Green and Ross Alford).
17. Ecology of Varanids (Dennis King and Gerard Visser).
18. Ecology of Marine Turtles (Colin Limpus and Karen Bjorndal).
19. Communication (Murray Littlejohn and Neville Passmore).
20. Foraging and Food Choice (Dirk Bauwens and Richard Griffiths).
21. Antipredator Behavior (Dan Formanowicz and Edmund Brodie II).
22. Mating Behavior (Tim Halliday and Kent Wells).
23. Threatened New Zealand Species (Don Newman and Charles Daugherty).
24. Contraction of Ranges, Disappearance, and Extinction (James Vial and Robert Johnson).
25. The Role of Amateurs in Herpetology (Chris Banks and Helmut Zimmermann).
26. Diseases and Captive Care (W. Ahne and Helen McCracken).
27. Commercial Utilization of Reptiles and Amphibians (Grahame Webb and Rob Jenkins).
28. History of Herpetology (Liliane Bodson).
29. Thermal Biology of Amphibians and Reptiles: Fifty Years Since Cowles and Bogert (Raymond B. Huey and Victor Hutchison).
30. Snake-Bite (Julian White).

Roundtable Discussions

Moreover, there were roundtables on Data Recording (Marco Zuffi), Elapid Phylogeny (J. Scott Keogh), Caecilian Biology (Marvalee Wake), Galapagos Tortoises (Chris Banks), a workshop on

Fig. 3. Group photo of WCH2 delegates.

the Cane Toad *Bufo marinus*, an open forum on Commercial Trade in Reptiles and Amphibians, and contributed papers in 34 paper sessions. A total of 570 papers were presented in symposia or as contributed papers. Moreover there were 215 posters (Hoser 1994; Tyler 1994). The Australian SSC Amphibian and Reptile Specialist Group, the Australian Society of Herpetologists, the Society for Research on Amphibians and Reptiles of New Zealand, and the directors of the SSC Declining Amphibian Populations Task Force held meetings during the congress (Tyler 1994).

Herp-themed Auction

One of the nights an auction (traditional at SSAR meetings, and wholeheartedly adopted by WCH as a means to obtain some extra money for research projects by young herpetologists or other worthy herpetological projects) of all kinds of things herpetological (books, T-shirts used by herpetologists, herpetological art, etc.) was organized. Surprisingly (also to the Secretary General) just before that auction of herpetological items and books it turned out that the proceeds would go to the Australian Red Cross and would not be used for supporting herpetological projects of young herpetologists as was done at First WCH. Actually, the money from the First WCH auction went to herp conservation projects worldwide. Anyway, this fact apparently did not inhibit the bidding, which was vivid and animated and many objects obtained new owners, sometimes after heated exchanges of bids.

Apart from the auction and the New Year's Eve party there were many other possibilities for informal contacts during the congress.

Executive Committee Meetings

The EC met twice (29 December 1993 and 4 January 1994) at the Second WCH to discuss matters concerning finances, the election of a new SG and EC. One of the main items during these discussions was the fact that hardly any of the proceeds of the First WCH had been turned over to WCH as the mother organization, but instead had been used for projects of the University of Canterbury and the Congress Director. Only the money provided by WCH as a loan was repaid and helped to kick start the Second WCH. The auditing of the First WCH had been done in a rather peculiar, although apparently legal (in the UK) way, which did not meet with everybody's agreement. But as it seemed nothing could be done, the matter was put to rest.

Herpetologists Bring in the New Year

New Year's Eve was spent at Harvey's Winery, in Reynella, 20 km south of Adelaide, to where participants were transported by a fleet of buses. The evening was a huge success, both food and wine-wise. The menu card offered a range of rather strange items (Tyler 1994; Fig. 4), but in reality the food on the plates turned out to be rather normal and good. Everybody seemed to be enjoying themselves and at the change of 1993 to 1994 a real bagpiper played Auld Lang Syne, to which everybody of course joined in. The change of 1993 into 1994 was a good reason for many toasts on a healthy and herpetologically prosperous New Year. Apparently, after our return to Adelaide quite a lot of herpetologists continued the New Year festivities in the local bars until sunrise.

WCH Business Meeting

At the Business Meeting (2 January 1994) a number of motions on different subjects were adopted to be presented to several authorities. Fred Rocha, on behalf of the Brazilian herpetological community presented Rio de Janeiro as the next venue for WCH 3. No other proposals were presented, so the expectation of many was that Rio would be the next venue (Hoser 1994), although some people expressed worries about safety in Rio, apparently only based on press reports. At the plenary closing

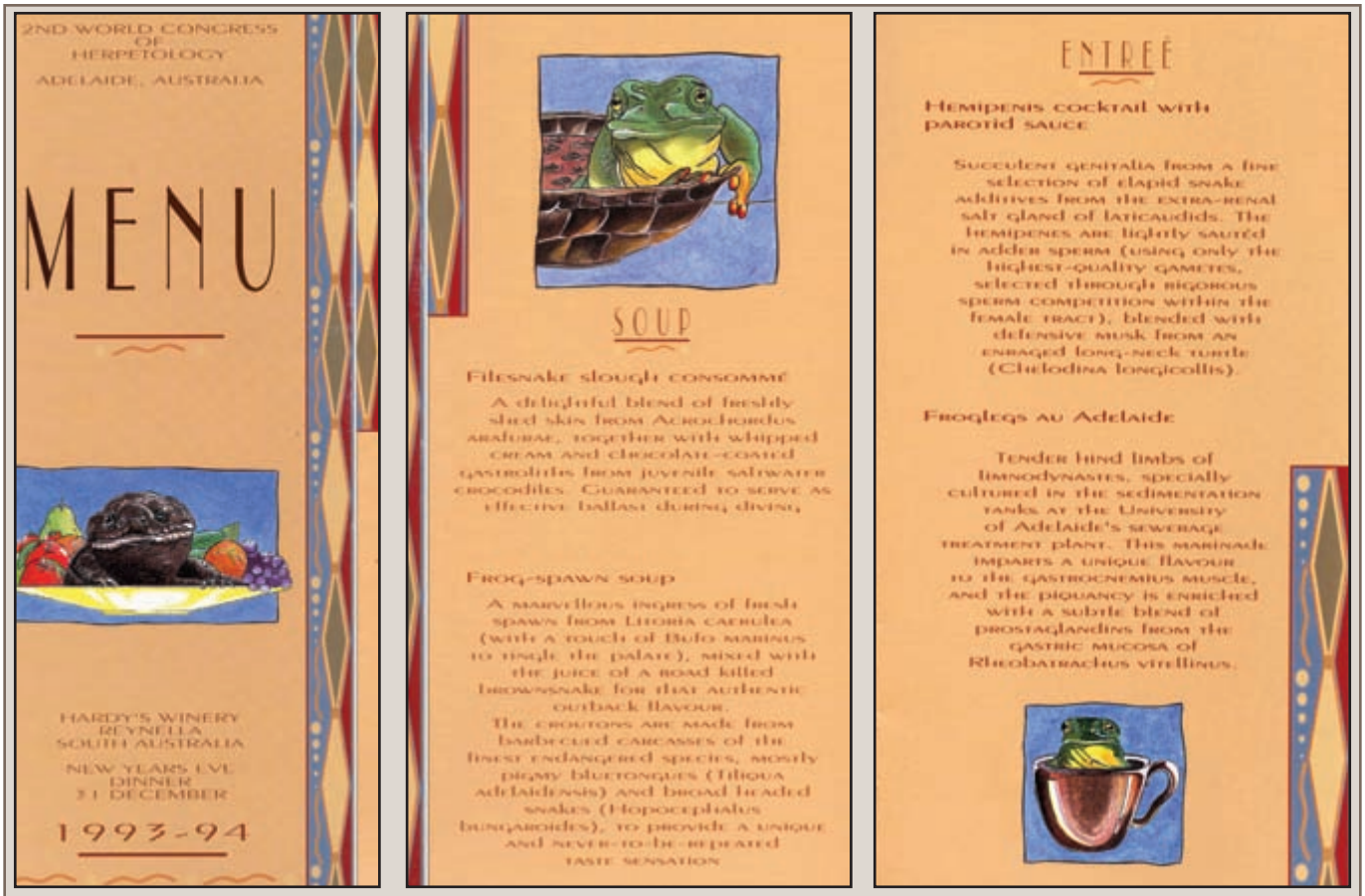

FIG. 4. A herpetologically themed menu awaited guests at the New Year's Eve party, but fortunately, more traditional fare was available.

session of the congress (6 January 1994) the newly elected members of EC and IHC were mentioned and it was announced that the Executive Committee had elected as new Secretary-General, Dr. Marvalee Wake of the USA, and as Treasurer, Dr. Roger Avery, U.K. Marvalee Wake took over from me to close the Second WCH.

Congress Publication

To commemorate the Second WCH, SSAR produced a reprint (1000 copies in a limp back edition were printed in Adelaide) of E. R. Waite's (1929) *The Reptiles and Amphibians of South Australia*, which was provided free (normal price US $35) to all participants of the Second WCH (Moriarty and Bartholomew 2007; Tyler 1994) at registration (Fig. 5).

Australian Herpetofauna on Display; Mid- and Post-Congress Field Trips

Coinciding with the congress was the large (temporary) exhibition of Australian herpetofauna "Narana," that offered an excellent opportunity for everyone to get a good impression of the Australian herpetofauna. The then recently re-discovered local *Tiliqua adelaidensis* without the shadow of a doubt was the star of the exhibition. Possibilities to photograph specimens were provided and enthusiastically used by many.

During the mid-week field trip to Parawirra on 1 January 1994 (the day after the New Year's Eve party) many of the non-Australians got their first view of wild kangaroos and a good sample of the Australian herpetofauna, including several of the more famous venomous snakes. After the congress many persons took the opportunity to make herpetological field trips to several parts of Australia. Here follows a sample of possible trips: Goanna Dreaming, Burgaree Sheep Station, Warrawong Sanctuary, Kuitpo Forest, Whyalla Reptile Park, Kangaroo Island, Outback, Great Barrier Reef, and Rainforests. Among the areas I visited after the congress were Ayers Rock and the Olga's where I met several herpetologists that had attended the congress and where some of us had the luck to see and photograph a specimen of *Moloch horridus*, high on any herpetologist's wish list.

Acknowledgments.—I want to thank Kraig Adler, Marvalee Wake, and Mike Tyler who helped to remember points that nearly got lost in the cracks of my memory. In making this report I heavily borrowed from Mike Tyler´s 1994 report in *Herpetological Review*.

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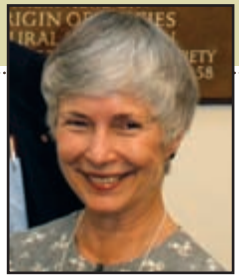
The Third World Congress of Herpetology (Prague, Czech Republic, 1997)



MARVALEE H. WAKE*
(Secretary General, WCH 3)

Meeting in Prague

The Third World Congress of Herpetology was held in Prague, Czech Republic, 2–10 August 1997. It included the 9th Ordinary Business Meeting of the Societas Europaea Herpetologica. The Prague Congress Centre was the venue, easily accessible by public transportation from the many hotels in which participants were quartered (Fig. 1). The scope of the Congress was all of herpetology, as represented by its many foci, with special emphasis on the increasing awareness of the declines of amphibian populations and species at many places in the world, and the need to develop more knowledge about all species in order to develop maintenance plans for the protection of our biodiversity. 707 delegates were registered, representing 55 countries; the full list of registered participants is available on the WCH3 and the WCH7 websites. The host organizations were the Academy of Sciences of the Czech Republic and the Czech Herpetological Society. The planning for the meeting was ably led by the chair of the local organizing committee, Zbyněk Roček. He and his colleagues did virtually all of the arrangements for the venue and for the program, aided by a professional congress organizing firm associated with the Czech Medical Association. Sponsors and supporters included Czech Airlines; the Faculty of Natural Science, Charles University, Prague; the Geological Institute, Academy of Sciences of the Czech Republic; the Ministry of Environment of the Czech Republic; the National Museum, Prague; Northern Bohemian Mines, Bilina; A Rent Car, Prague; and many other organizations, institutions, and individuals, all acknowledged in the Programme. The International Union of Biological Sciences (IUBS; of which WCH is a Scientific Member) provided an interest-free loan for Congress start-up; individuals and institutions contributed to the WCH travel fund; contributions were received from two Czech concerns to support printing costs; many individuals provided field trip support and preparation; and Professor Rudolf Zahradnik, President of the Academy of Sciences of the Czech Republic was the Patron of the Congress and provided extensive support. The extensive report by the Secretary General to WCH3 discusses the planning and communication that took place from the end of WCH2 to the resultant WCH3; it is on the WCH3 and WCH7 websites for anyone interested in the details. My personal thanks continue to be extended to Zbyněk Roček, without whose diligence, hard work, management skills, and good humor the Congress could not have happened!

Plenary Lectures

Plenary speakers included Carl Gans, Michael Shishkin, Carl Gerhardt, Andrew Milner, Jean-Claude Rage, and Michael J. Tyler, with three plenaries in the opening session, and three preceding the closing ceremony on the last day. The Congress was a busy one. Typically each day, there were six concurrent sessions of symposia and contributed papers from 0900 to 1540 h, followed by poster sessions. The lists of all abstracts and authors, and of the poster titles and authors, are also available on the two websites mentioned above.

Symposia

Eleven symposia were organized, as follows:

- Herpetofauna and Environmental Contaminants
- History of Herpetology: Herpetological Expeditions and Voyages
- Declining Amphibian Populations: Geography and Possible Causes
- Climate Variation and its Impact on Herpetofauna
- The Eurasian Green Toad as a Model Species for Studies in Evolutionary Biology
- Sea Turtle: Biology, Ecology, Management
- Plasticity in Amphibian Reproduction, Development, and Evolution
- Africa—the Neglected Continent: Biodiversity and Biology of the African Herpetofauna
- Phylogeny and Systematics of the Viperidae
- Conservation Biology of Reptiles
- Neonatology of Reptiles: Character States Expressed Most Strongly within the First Year of Life
- Conservation of Europe's Threatened Herpetofauna (workshop).

I note considerable overlap with symposium topics for WCH7, and look forward to seeing how our science has advanced!

Contributed Papers

The contributed papers were organized into 32 topical sessions, representing the scope of herpetology—development, ecology, population biology, morphology, physiology, behavior, systematics, evolution, conservation, etc. of amphibians and reptiles broadly, and often for particular subsets of taxa. The caliber of the science presented was excellent! The opportunities for discussion by students and more senior folk from a great diversity of countries and areas of interest were facilitated by useful (and nutritious!) coffee breaks and lunches in the meeting arena (Fig. 2). Many publications resulted from the presentations at the Congress.

Meetings

In addition to the Societas Europaea Herpetologica business meeting, the Declining Amphibian Populations Task Force held its Executive Committee meeting and an extensive, open Business Meeting, and the Executive Committee and Business meetings of the World Congress of Herpetology held discussions of major issues.

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Fig. 1. The Prague Congress Centre is characterized by a dramatic two-story entryway, shown here filled with delegates outside of the sessions.

Fig. 2. Delegates enjoyed excellent buffet luncheons.

Fig. 3. Zbyněk Rocěk, Chair of the Local Organizing Committee, welcomes delegates to the concert in the Rudolfinum.

Fig. 4. The Rudolfinum was the site of a special concert for WCH delegates, here shown in a view from the balcony.

Fig. 6. A great benefit of international gatherings such as WCH is the opportunity to meet colleagues in person. Here, Marvalee Wake introduces Zbyněk Rocěk to George Rabb. Ilya Darevsky standing, left rear.

Social Activities

The splendid Social Programme included a welcome party with a plentiful buffet at the Prague Congress Centre on the first evening, a beer party and dinner in the well known Flek's Brewery (established in 1499), a steamboat cruise on the Charles River with music and dancing, an exquisite concert of old Czech music in the Rudolfinum (Figs. 3, 4), and it closed with a cocktail farewell party in the National Museum in Wenceslas Square. In addition, there was an extensive program of trips within and around Prague for accompanying persons, and several post-Congress tours were available.

Congress Publication

To commemorate the Third WCH, SSAR produced a facsimile reprint Leopold Fitzinger's *Neue Classification der Reptilien*, 1826 (Fig. 5), distributed free to all delegates.

Accomplishments of WCH3

WCH3 dealt with several substantive issues, both for perpetuating WCH and for the benefit of global herpetology. The report from the Secretary-General about all of the planning, discussions, contacts, and issues that arose during the three and one-half years between WCH2 and WCH3 and the Treasurer's report are available on the websites already mentioned. The SG established, with the advice of the Executive Committee, committees to deal with 1) review of the WCH Constitution, as mandated at WCH2 (chaired by Linda Trueb; the revision was approved by members at the Business Meeting); 2) a statement of ethics, also as mandated at WCH2 (chaired by Michael Tyler; also approved at the Business Meeting); 2) a Finance committee, charged with seeking a plan for short- and long-range financial stability for WCH and its work; 4) a committee to advise the International Commission on Zoological Nomenclature on herpetological matters (mandated at WCH1 and WCH2; chaired by Masafumi Matsui). Major areas of concern were the financial status of WCH (for example, more than 100 people requested travel support—more than 20 times the number that could be given any assistance) and the representation by WCH of herpetology in international and broadly scientific contexts—in other words, should WCH be content to present a Congress every 3–5 years, or should it be a proactive organization that promotes understanding of taxon-based biology, research on amphibians and reptiles, conservation of amphibians and reptiles, communication among herpetologists internationally, and species databases, etc., and other activities. The latter stance was encouraged by many (not all) participants; how to do it was not resolved. The International Herpetological Committee volunteered to maintain a WCH website that would facilitate communication; however, this was not followed up. It is difficult for all organizations, not just WCH, to maintain impetus and promise when delegates return to their normal responsibilities. Notwithstanding that problem, a number of individuals have stepped up over the years to provide leadership in communication and conservation, as well as basic research. Election of new and returning members of the WCH Executive Committee and the International Herpetological Committee helped to facilitate activity. Two substantive resolutions were produced at the WCH Business meeting; one dealt with commending the DAPTF for its activities and encouraging it to continue and extend its work, and endorsing its support by all organizations and individuals possible; its diversification, commitment, and success remain notable and important to herpetology to this day. The other resolution, presented by 20 signatories, was directed to the International Commission on Zoological Nomenclature regarding the problem of "phantom names," and requesting that the then-in-preparation revision of the Code should require a diagnosis, designation of a holotype, deposition of the holotype in a public scientific collection, and a description of the holotype. These resolutions were transmitted to the relevant international institutions.

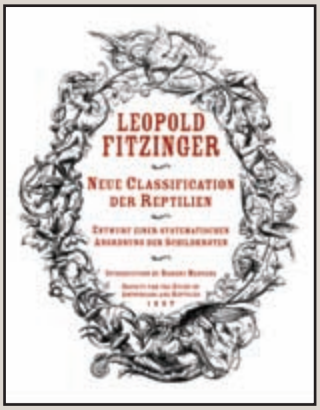

FIG. 5. SSAR reprinted Fitzinger's *Neue Classification der Reptilien* in honor of WCH3.

This dry and terse report on the scientific and social activities of more than 1000 herpetologists and colleagues in an exciting and stimulating venue in a spectacularly interesting city does not adequately capture the concerns and camaraderie about our science that were shared by the participants (Fig. 6). WCH3, in retrospect, illustrated the ongoing science and the communication about ideas that should characterize such international meetings. I expect that participation in WCH7 will have the same effect!

4th World Congress of Herpetology (Bentota, Sri Lanka, 2001)

MICHAEL J. TYLER*
(Secretary-General, 4WCH)

Planning for the 4WCH: Challenges from World Events

It is to be hoped that no future World Congress has to be organized under the difficult circumstances faced by the 4th WCH in Sri Lanka in 2001 (Figs. 1, 2). The choice of Sri Lanka was made following a detailed review of their facilities, but the Organising Committee progressively experienced numerous difficulties necessitating several complete changes of plan.

The most major of those changes occurred in September 2001 due to the horror of "9/11," which temporarily halted all international travel. Then, to compound those travel problems, the Tamil Tigers in the north of Sri Lanka travelled south to raid the international airport in Colombo and destroyed several aircraft lined up on the airstrip. Additionally, the Sri Lankan parliament had been dissolved.

Cancellation or Forge Ahead?

The consequence of those events was that many herpetologists who had planned to attend WCH4 withdrew their registrations. It was then proposed that the conference be cancelled. Although cancellation appeared attractive to the Organising Committee, it had been impossible to obtain any legal liability

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FIG. 1. Promotional piece developed for the 4th WCH.

PHOTO BY M. J. TYLER

FIG. 2. Snake charmers added to the local flavor of the meeting venue.

PHOTO BY M. J. TYLER

FIG. 6. Shown here are two examples of Sri Lankan frog art, in wood and bronze.

FIG. 5. A special set of stamps celebrating Sri Lankan frog diversity was released to commemorate the congress.

FIG. 3. Group photo of WCH4 delegates.

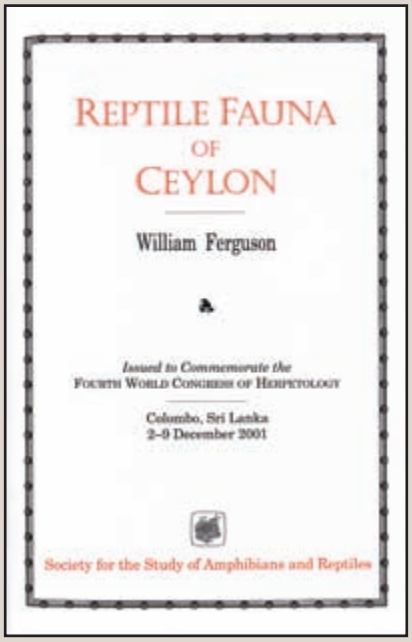

FIG. 4. SSAR produced a facsimile reprint of Ferguson (1877), distributed free to all delegates.

PHOTO BY M. J. TYLER

FIG. 7. This wooden plaque was presented to each of the WCH 4 delegates.

insurance. Thus cancellation would have exposed the Organising Committee, and possibly the Congress as an entity, to all expenses accrued to date. In those circumstances, despite the greatly reduced attendance, there was no alternative but for the Congress to proceed as planned. However, to ensure the utmost safety of all participants, the venue was changed from Peradeniya in central Sri Lanka, to Bentota on the southwestern coast. The nearby Colombo was avoided because of the risks associated with using the capital city.

The Venue and Attendees

The vast majority of delegates stayed in the five-star Taj Exotica Hotel Resort—a beautiful beachside area where baby turtles hatched. The total attendance was 208 delegates from 34 countries (Fig. 3). However, only six countries had representatives in double figures: UK 29, Sri Lanka 24, USA 21, Australia 20, Japan 16, and India 13. The number of presentations, including posters, is uncertain because the Abstracts volume had been prepared before many of the withdrawals were received. Nonetheless, the small attendance created a warm and relaxed atmosphere and the Conference Director, Anslem de Silva deserves particular praise for his efforts to ensure the smooth running of the program.

One topic rarely mentioned in conference reports is that of food. Sri Lanka is a major world center for the production of spices and especially curries. It is no exaggeration to describe the variety of dishes served at all meals as superb, unless you prefer cornflakes for breakfast!

Uncertainty about the possibility of another attack by the Tamil Tigers caused the imposition of a nighttime curfew by the Sri Lankan authorities, but some of the herpetologists present considered that as no more than a minor impediment to their nocturnal collecting activities! As a consequence they now have a more intimate understanding of the Sri Lankan Police!

Plenary Lectures

The tradition of excellent plenaries was continued at WCH4 by Anita Malhotra (evolution of Asian pitvipers), Yehudah Werner (foraging behavior in gekkonomorph lizards), Wolfgang Wüster (pitvipers and South American biogeography), David Warrell (current trends in toxinology), and Walter Hödl (visual communication in anurans). Details of special topic sessions were provided by Dodd and Bartholomew (2002). The reduction in the number of papers meant that there were no more than two concurrent sessions.

Congress Publications

Six publications were issued in association with WCH4. Among these were a facsimile reprint from SSAR of Ferguson's (1877) *Reptile Fauna of Ceylon* (Fig. 4) and a special issue of the journal *Lyriocephalus* featuring research on Sri Lankan amphibians (edited by Anslem de Silva).

Herp-themed Art and Collectibles

Of special note was the release of a commemorative set of four postage stamps featuring Sri Lankan frogs, issued to coincide with the congress (Fig. 5). A frog theme was prevalent in local art (Fig. 6), and delegates also received a special WCH4 plaque containing herpetological icons (Fig. 7).

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Fifth World Congress of Herpetology (Stellenbosch, South Africa, 2005)

ERNST BAARD*
(Congress Director, WCH 5)

WCH 5: A South African Setting

From 19 to 24 June 2005, the Western Cape Nature Conservation Board, trading as CapeNature (the provincial nature conservation agency), together with the University of Stellenbosch, hosted the Fifth World Congress of Herpetology at the Conservatorium of Music on the Stellenbosch University campus. Stellenbosch is the second oldest town in South Africa, next to Cape Town, the latter which was settled in 1652 by a Dutch governor and his people. Here the Europeans met up with the indigenous Khoi and San peoples who were important suppliers of fresh meat and other food to the settlers, as well as sea travellers around the Cape of Good Hope from Europe to the East Indies, as well as opening important trade routes to the South African interior. Stellenbosch is an historic town, established in 1680 by the then Dutch Governor at the Cape, Simon van der Stell, and to this day retains much of its Old Cape Dutch style and character with many historical buildings having been restored to their original style and declared as national monuments.

This international congress, the fifth one held since the inception of the WCH and held for the first time on the African continent (previously in the United Kingdom, Australia, Czech Republic, and Sri Lanka), brought together 407 academics and other scientists, conservationists, hobbyists, and students from 49 countries (all continents including North and South America, Europe, Africa, Asia, and Australasia) in total—all with an interest in amphibians and reptiles. For the vast majority of delegates, it was their first visit to Africa and many expressed their surprise at the fact that Stellenbosch was so developed, expecting perhaps an Africa filled with savannah, and streets roamed by lions and elephants! Instead, they were treated to typical South African and Western Cape friendliness, hospitality, good food, and even better wine. Some fine winter weather completed the ingredients required for a very successful meeting.

Local Committee

Ernst Baard (Chair), Andrew Turner, and Atherton de Villiers of CapeNature, together with le Fras Mouton and Alex Flemming of Stellenbosch University's Zoology Department formed the Local Organising Committee for the Congress; the committee who managed to get everything in place before the delegates arrived. Ms Eloise Costandius was appointed as the project manager, while Ms Sulet Gildenhuys and Ms Riki de Villiers helped with administration, and Ms Mandi Alblas assisted with arranging accommodation at the many Stellenbosch guest houses and one of the University's ladies' residences on campus to ensure an enjoyable stay for all the delegates.

The Science of WCH 5

The scientific program, very ably compiled by Aaron Bauer and Alex Flemming, comprised four and a half days of oral presentations with six parallel sessions each day. A total of 288 oral presentations and just over 150 posters were presented during the week of the conference. The scientific program comprised four plenary lectures by leading herpetologists (Simon Stuart and colleagues, Miguel Vences, Claude Miaud and Olivier Marquis, and Scott Keogh) and 11 symposia on the decline in international amphibian populations, African herpetological diversity, sex determination in reptiles, techniques for studying the ecology of freshwater turtles, biology of *Xenopus*, lizard visual ecology, South American anuran diversity, recent advances in the study of foraging modes, quantifying the ecology of burrowing herpetofauna, reptilian viviparity, and a symposium on

PHOTO BY ELOISE COSTANDIUS

FIG. 1. Delegates to WCH5 browsing herpetological reprints and original texts made available from various sources.

PHOTO BY ELOISE COSTANDIUS

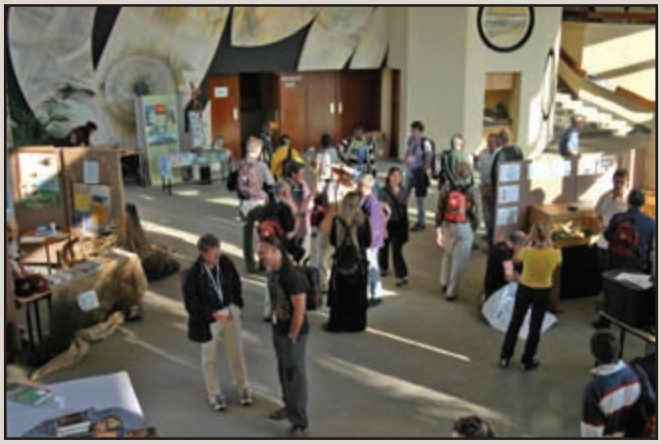

FIG. 2. Delegates to WCH5 gathering in the foyer of the Congress venue prior to sessions starting.

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caecilians in honor of Himstedt. Other sessions on chelonian biology, squamate ecology and behavior, morphology, captive breeding of frogs, road-kills in Europe, sexual selection in Kalahari geckos, reptile and frog diversity in remote mountains in Borneo, and training dogs to sniff out hard-to-find lizards in New Zealand formed part of the program as well.

Social Events

An opening function, hosted by the Stellenbosch University's Dean of the Faculty of Science, was held at the Conservatorium of Music on the Sunday evening prior to the start of the scientific program on Monday morning.

On Wednesday evening, delegates visited the Oude Libertas Art and Theatre Centre outside Stellenbosch for a traditional (and hopefully memorable) South African barbeque with African traditional music and dancing, loads of meat, side dishes, and good wine—some of it sponsored by the Jordan Winery (they produce a range of "Chamaeleon" white and red wines to "honour" Cape Dwarf Chamaeleons that frequent the area), and the Paddagang (= "Frog Alley") and Anura wine estates. Thursday evening was spent at the Moyo Restaurant of the famous Spier wine estate for the formal congress dinner. Everyone had a fantastic time enjoying the excellent food, good entertainment, and good wine! A number of successful post-Congress field trips were offered and a great time was had by all.

Congress Publication

In keeping with a tradition begun with the First WCH, SSAR produced a facsimile reprint of 10 herpetological papers by Andrew Smith on South African Herpetology, 1826–1838, distributed gratis to all delegates.

PHOTO BY ELOISE COSTANDIUS

PHOTO BY ELOISE COSTANDIUS

FIG. 3. Delegates enjoying the late afternoon wintery sun at the Congress venue. Marc Franch (Universidad de Barcelona, Spain), Reinier Mann (Univ. Aveiro, Portugal), Sara Rocha (CIBIO, Portugal), Vasco Batista (CIBIO), Antigoni Kaliontzopolou (CIBIO), and Miguel Angel Carretero (CIBIO).

All in all, the Fifth World Congress of Herpetology was a huge success, resulting in a major financial boost to the World Congress of Herpetology, and it is a pity that not more delegates could attend due to the great travel distance to South Africa for many. However, everybody enjoyed the South African hospitality and agreed that it would be wonderful to return.

The 6th World Congress of Herpetology (Manaus, Brazil, 2008)

PHOTO BY PETER NARINS

WALTER HÖDL
(Secretary-General, WCH 6)

Planning for the 6th WCH

After five WCH gatherings in Europe, Asia, Australia, and Africa it was generally understood that the 6th WCH would have to take place in the Americas. Originally there was an invitation to host the 6th WCH as a joint meeting with the American herpetological societies at Montreal, Canada, but this offer was withdrawn in early 2005. Due to his long-term connections to the Brazilian herpetological community and its rapidly increasing scientific activities, the then Secretary General-Elect negotiated with his Brazilian colleagues at the 5th WCH in Stellenbosch, South Africa in June 2005 to hold the next congress in Brazil. Richard ("Dick") Vogt, a highly renowned and charismatic specialist on neotropical turtles from the Instituto Nacional de Pesquisas da Amazõnia (INPA), offered to host the congress in Manaus in 2008. This proposal was approved unanimously by the Executive Committee of WCH. The international symposium committee with its thoughtful chair Carlos F. D. da Rocha, Universidade do Estado do Rio de Janeiro (UERJ), was responsible for selection of symposia and plenary lectures. The Secretary-General visited Manaus twice in 2007 and 2008 during the preparatory phase of the congress, which included an intensive correspondence of over 600 emails and (too) many phone calls between Austria and Brazil.

The congress was financed by funds provided by Conservation International, WCH, and the Brazilian Science Funds FAPEAM and CNPq, totaling about US $65,000. Unfortunately, funds approved by Manaus Tourism and IBAMA were never received.

Venue and Delegates

The Sixth World Congress of Herpetology took place at the Hotel Tropical in Manaus, Amazonas, Brazil, 17–22 August 2008 (Fig. 1). There were 565 delegates from 39 countries: Australia, Austria, Belgium, Brazil, Brunei, Canada, China, Colombia, Costa Rica, Cuba, Ecuador, Egypt, Estonia, France, Germany, Hungary, India, Iran, Israel, Japan, Lebanon, Luxemburg, Malaysia,

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PHOTO BY WALTER HÖDL

PHOTO BY EVA RINGLER

FIG. 1 (above left). The Hotel Tropical in Manaus, Amazonas, Brazil, was the venue for the Sixth World Congress of Herpetology.

FIG. 2 (above center). Peter Narins during his plenary lecture on ultrasonic communication in frogs.

FIG. 3 (above right). Walter Hödl (left) receiving his birthday present—a wood inlay art piece (representing *Allobates hodli*) created by the technique of intarsia—from Adolfo Amézquita and Albertina Lima.

Mexico, Netherlands, New Zealand, Peru, Poland, Russia, South Africa, Spain, Sweden, Switzerland, Thailand, United Kingdom, USA, United Arab Emirates, Uruguay, Uzbekistan, Venezuela. North America was represented by 117 (21%) registrants, South and Central America with 256 (45%), Europe with 98 (17%), Asia and Oceania with 83 (15%), and Africa 11 (2%). This cosmopolitan group of herpetologists included 270 professionals, 167 students, 18 accompanying persons, and 110 local committee and support staff.

Scientific Program

I continue by freely citing from the report of Vogt (2008): "The quality of the scientific presentations was outstanding. There were 293 oral presentations including the 15 distinguished plenary lectures, 15 symposia, and contributed oral paper sessions. The poster presentations were held at the end of each day in the book and equipment exhibition room complete with bar service, providing the exchange between authors and audience in a more relaxed atmosphere. Each day a different group of 50 posters was presented following various themes, most notably genetics, conservation, and ecology. The abstracts were available online prior to the meeting on the 6th WCH web site and also distributed on CD during the meeting. The meeting got underway early at 1230 h on Sunday August 17, with the Conservation International sponsored Amphibian Conservation Workshop. The event got a send off pitch from Claude Gascon and Jim Collins, followed by 13 reports from around the world. This well attended event was followed by the first two Plenary Lectures, Bill Magnusson speaking of the evolution of herpetological studies in the Brazilian Amazon and Russ Mittermeier delineating priorities for global reptile and amphibian conservation. Throughout the week each morning and afternoon session was initiated by a Plenary Presentation followed by six papers in five different lecture rooms simultaneously. One of the most exciting plenary lectures was that of Peter Narins, who enlightened us about the ultrasonic vocalizations made by some species of Bornean frogs, whose mating calls are given amidst the din of waterfalls. This opened up an entirely new dimension in anuran communication studies" (Fig. 2).


THE LIFE AND HERPETOLOGICAL CONTRIBUTIONS OF
AUGUST FRIEDRICH
SCHWEIGGER
(1783-1821)

With an Introduction by
ROGER BOUR

Society for the Study of Amphibians and Reptiles
Issued in commemoration of the Sixth World Congress of Herpetology, Manaus, Brazil, 17–22 August, 2008

FIG. 4. Delegates to WCH6 in Manaus received a free copy of Schweigger (1812–1814), courtesy of SSAR.

Social Events

The congress director R. Vogt organized all local activities and performed those duties in his legendary manner. Ably assisted by many dedicated students from INPA and the Universidade Federal do Amazonas (UFAM), he ran "his" congress at the fancy Hotel Tropical. Picnics and banquets as well as the auction were highly memorable events driven by Dick's characteristic style. Finally, in order to celebrate his 60th birthday with his collaborators, colleagues, and friends, the Secretary-General—at his cost—invited a group of over 150 herpetologists to enjoy Amazonian dishes and fish specialities at the Manaus Bier House, all organized by R. Vogt (Fig. 3).

Congress Publication

A facsimile reprint of Schweigger's *Prodromus Monographiae Cheloniorum*, 1812–1814, was produced by SSAR and distributed free to all delegates (Fig. 4).

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INTERNATIONAL AND REGIONAL ORGANIZATIONS

Herpetological Review, 2012, 43(2), 199–200.

Herpetological Societies in Canada

The first Canadian herpetological organization was the Canadian Amphibian and Reptile Conservation Society (CARCS), formed in 1960. CARCS membership consisted of a mix of professionals in the field, amateur naturalists, and herpetoculturists, and the society published a bulletin twice a year. CARCS was centered in southern Ontario and never really spread much beyond that base. CARCS distributed its last bulletin in 1991 and then quietly disappeared.

During the CARCS era, few Canadian scientists called themselves herpetologists, but that began to change in the 1980s as, by then, interest in the biology of amphibians and reptiles and in their conservation had risen dramatically. A corps of professional academic herpetologists in Canada had begun to form and by the mid-1980s, there was significant interest in forming a more scientifically oriented herpetological society in Canada. The golden opportunity presented itself when the 66th annual meeting of the American Society of Ichthyologists and Herpetologists (ASIH) was held at the University of Victoria in British Columbia in 1986. During that conference, several Canadian herpetologists (including the two of us) met to discuss the possibility of forming a national herpetological society whose aim would be to disseminate news and information of particular relevance to Canadian herpetologists. Those in attendance were mostly academics, with interests in amphibians and reptiles ranging from morphology and systematics to ecology and behavior. From that meeting arose the fledgling Canadian Association of Herpetologists (CAH) / *Association Canadienne des Herpétologistes* (*ACH*). The first President of CAH was David Green.

Undoubtedly, the most important society officer for CAH has always been the Editor of the CAH/ACH *Bulletin*, which has been the society's publication vehicle from the outset. David Green initially did extra duty by also serving as the first Editor and guided the *Bulletin* through its first seven volumes, beginning in 1987. Tony Russell and Herb Rosenberg then took the reins for the next four volumes, after which they were succeeded by Shane de Solla. Altogether, this first incarnation of the CAH/ACH *Bulletin* was produced for 13 years, until 1999, when a replacement for Shane could not be found. CAH produced two issues of the *Bulletin* per year, although the final volume ended with just a single issue. For the next few years, CAH lay dormant but, in 2006, the CAH/ACH *Bulletin* was revived with Jackie Litzgus as new Editor.

Although the *Bulletin* has always been the centerpiece of the CAH, the society has also involved itself in other herpetological activities. In 1989, CAH coordinated and presented a symposium on "The Biology of Amphibians and Reptiles in Seasonally Cold Environments" at the ASIH meeting in San Francisco. The society also provides two travel grants of $300 each year for students to attend conferences and present their work. Finally, CAH recognizes lifetime accomplishments in Canadian herpetology with its Michael Rankin Distinguished Canadian Herpetologist Award. To date, there have been four recipients of this award—James P. Bogart, Francis R. Cook, Ronald J. Brooks, and David M. Green.

At heart, CAH has always been a fairly laid-back organization. For many years, the society had no formal meetings, but members attending conferences such as JMIH typically got together for a business meeting cleverly disguised as a dinner. The first item on the agenda, announced by the President, was invariably to order food and beer. Accompanying dessert would be brief reports from the Treasurer and other officers. CAH still has Canadian herpetologist dinners at meetings such as JMIH and WCH where members can get together, but in recent years, CAH also has started meeting more formally, co-hosting annual meetings with its sister organization, CARCNET.

The Canadian Amphibian and Reptile Conservation Network (CARCNET) / *Réseau Canadien de Conservation des Amphibiens et des Reptiles* (*RÉCCAR*) owes its origins to a 1991 meeting organized in Burlington, Ontario, by Bob Johnson and Christine Bishop to discuss the new recently recognized crisis of declining amphibian populations. Those participating agreed to form a Canadian working group of the global Declining Amphibian Populations Task Force (DAPTF), and David Green became its first National Co-ordinator. In subsequent years, DAPCAN, as the working group became known, met annually to discuss amphibian conservation and ecology, and to work on producing a report to the DAPTF. DAPCAN was a very goal-oriented organization and published news of its progress in the CAH *Bulletin*. In 1994, David Green stepped down as National Co-ordinator of DAPCAN to concentrate on preparing the group's report, which was published in book form (Green 1997).

In 1995, with its primary task of reporting to DAPTF on the conservation and status of amphibian populations in Canada apparently well in hand, the members of DAPCAN considered where to go next. The group decided to expand its interests to include reptiles as well as amphibians and to change its focus towards actively working for the conservation of Canada's herpetofauna. By 1996, DAPCAN had metamorphosed into the Working Group on Amphibian and Reptile Conservation in Canada, with Stan Orchard as its Chair and editor of a new newsletter, *The Boreal Dipnet*. The following year, the Working Group renamed itself the Canadian Amphibian and Reptile Conservation Network and set to work on another book, this time on reptiles (Seburn and Bishop 2007). The editorship of *The Boreal Dipnet* eventually passed to Kerrie Serben and then to Sara Ashpole.

CARCNET continued to hold annual meetings, as DAPCAN did, alternating their location among the east, west, and center of the country. CARCNET's meetings became Canada's most important gatherings for herpetologists from coast to coast, almost always culminating in a field trip to visit some of the local creatures, including the herpetofauna. The group instituted a

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number of awards. Annually, CARCNET gives out student travel and presentation awards and the Silver Salamander, given to an individual or an organization in recognition of a specific contribution to the conservation of amphibians and reptiles in Canada. CARCNET's premier award is the Blue Racer, which is given in recognition of long-standing contributions to the research and conservation of amphibians and reptiles in Canada. Honored recipients of the Blue Racer Award have been Francis Cook, Bill Preston, Bob Johnson, Ronald J. Brooks, Patrick T. Gregory, David M. Green, John Gilhen, and Wayne Weller.

Although CAH and CARCNET came together in 1997 for a joint meeting in Wolfville, Nova Scotia, until recently the two organizations have led fairly separate lives. Lately, however, CAH and CARCNET have begun collaborating more intently. CAH still has Canadian herpetologist dinners at meetings such as JMIH and WCH, but in recent years, CAH and CARCNET have also started routinely co-hosting the annual meetings. This year, CAH and CARCNET are co-sponsoring a symposium at the WCH7 in Vancouver entitled: "The Canadian Herpetofauna: What are the Threats?"

In addition, the two societies recently merged their two bulletins, the CAH/ACH *Bulletin* and *The Boreal Dipnet*, into a single twice-yearly publication jointly edited by Jackie Litzgus and Sara Ashpole. *The Canadian Herpetologist* (*L'Herpétologiste Canadien*) continues many of the regular offerings of both its parent publications, including summaries of herpetological meetings such as JMIH, feature articles on an eclectic variety of herpetological subjects, abstracts of Canadian theses and dissertations on amphibians and reptiles, book reviews, alerts to new papers by Canadian herpetologists, and news items. *The Canadian Herpetologist* Vol. 1, No. 1 appeared in spring 2011 and featured a 30-year career retrospective by Fred Schueler, field notes on herpetological work in England by Steve Hecnar, and assorted other articles, abstracts, and news items.

The time when Canada's herpetologists could not even fill a telephone booth is well and truly in the past. We now have a vibrant and active herpetological community in Canada, and CAH and CARCNET together represent our collective faces to the world. Both societies would be delighted to have more members from both Canada and other countries. To learn more, e-mail Jackie Litzgus (jlitzgus@laurentian.ca) for CAH membership details and visit http://www.carcnet.ca/ for information about CARCNET.

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Seburn, C. N. L., and C. A. Bishop (eds.). 2007. Ecology, Conservation and Status of Reptiles in Canada. Herpetological Conservation, No. 2. Society for the Study of Amphibians and Reptiles, Salt Lake City, Utah. x + 246 pp.

Presidents of CAH (1987–present)
David M. Green (1987–1989)
Mike Rankin (1990–1991)
Lawrence E. Licht (1992–1993)
Bob St. Clair (1994–1995)
Ron J. Brooks (1996–2000)
Patrick T. Gregory (2001–present)

National Co-ordinators of DAPCAN (1991-1995) and Chairs of CARCNET (1995–present)
David M. Green (1991–1994)
Stan Orchard (1995–1999)
Christine Bishop (2000–2003)
David Galbraith (2004–2006)
Bruce Pauli (2006–2009)
Pam Rutherford (2010)
David M. Green (2011–present)

INSTITUTIONAL PROFILES

Herpetological Review, 2012, 43(2), 200–203.

Herpetology at the Redpath Museum, McGill University, Montreal, Canada

Herpetology at McGill University is centered at the Redpath Museum, which is located in the heart of McGill's downtown Montreal campus. The Redpath is one of the most prominent buildings of the university and enjoys the distinction of being the first building in Canada purposefully designed and constructed to be a museum (Fig. 1). It was commissioned in 1880 by local philanthropist, Peter Redpath, designed by local Montreal architects and opened to great acclaim in 1882. The "Peter Redpath Museum" was built expressly to serve Sir William Dawson, who was McGill's Principal at the time and an internationally respected natural scientist. It was intended to be his laboratory, teaching facility and, above all, repository for his extensive natural history and paleontology collections. Dawson made fundamental contributions to herpetology through his paleontological work, including the discovery of the earliest basal reptile, *Hylonomus*. He presided at the Redpath Museum's opening as its first Director and this year marks its 130th anniversary.

Research at the Redpath Museum today carries on from the scientific tradition established by Dawson. The current Director is Professor **David M. Green**, who studies the evolution, ecology,

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859 Sherbrooke St. W., Montreal, QC, H3A 0C4, Canada

and conservation biology of modern amphibians. Green's current research centers largely on species' ranges and boundaries as an approach to understanding biodiversity origins and maintenance. Compared to the attention given to the factors that influence population size and persistence, little has been paid to what determines the extent of a species' range. Population declines leading to species endangerment are essentially species range contractions. Conversely, species invasions can be modelled as rapid range expansions. In this context, because amphibians exhibit a range of life history strategies, often breed in discrete sites such as ponds, are not highly mobile and often can be easily sampled, they are excellent subjects for landscape ecology and studies in conservation. Green maintains a long-term study of Fowler's Toads (*Anaxyrus fowleri*) at Long Point, Ontario, which has run continuously for over two decades (Fig. 2). Stemming from this work, numerous papers on population regulation, body size variation, habitat use, age structure, winter survival, movement, and dispersal are in progress.

Associate Professor **Hans C. E. Larsson,** who holds a Canada Research Chair in vertebrate palaeontology, studies macroevolution, largely among archosaurian reptiles of the Mesozoic. Larsson's research has two main thrusts. One focuses on paleomacroecology and estimating large-geographic scales of paleobiodiversity across large time scales. Much of this work collects fossils, some of which are amphibians and reptiles, in the Canadian High Arctic (Fig. 3), western Canada, and South America to assess how the ancient latitudinal diversity gradient evolved over the changing climates during the Mesozoic Era. Larsson's lab also examines large-scale patterns of phenotypic skeletal evolution in crocodiles (Fig. 4), dinosaurs, birds, and some amphibians to quantify evolutionary rates and types of skeletal changes, particularly across the fish-to-amphibian and dinosaur-to-bird transitions. From characterizing the evolutionary transformation, Larsson goes on to investigate the implicated developmental changes using embryological and molecular data (Fig. 5). The breadth of Larsson's research is not an accident. His approach is to synthesize new understanding from seemingly disparate research on large-scale themes, which he sees as the best training ground for intellectual growth and new understanding.

Emeritus Professor **Robert L. Carroll** remains active in vertebrate palaeontology though he is no longer accepting graduate students. Carroll is a leading authority on the origin, early evolution, anatomy, and natural history of Paleozoic tetrapods. His latest book, "The Rise of Amphibians," synthesizes findings from the rich fossil record of amphibians to trace their evolution back to their origins some 365 million years ago.

Green and Larsson both maintain links with many other departments, schools, and programs within McGill University. They teach undergraduate courses for both the Redpath Museum (REDM) and the Biology Department (BIOL). These include the lecture courses BIOL 305 *Animal Diversity* (Green and Larsson), BIOL 352 *Vertebrate Evolution* (Larsson), BIOL 427 *Herpetology* (Green), BIOL 465 *Conservation Biology* (Green), and REDM 400 *Science and Museums* (Green and Larsson). Field courses include BIOL 452 *Ecology and Development in Africa* (Green), BIOL 573 *Vertebrate Paleontology Field Course* (Larsson), and REDM 405 *East African Natural History* (Green). Aside from the Department of Biology, Green and Larsson are also affiliated with McGill's Department of Natural Resource Sciences and Department of Earth and Planetary Sciences, as well the McGill School of Environment.

Several research labs are housed within the Redpath Museum building, with facilities for specimen examination, microscopy, computer work, and fossil preparation. A 130-year old museum building does pose some problems for outfitting labs up to modern standards so the Museum's molecular ecology and evolution lab is set up in McGill's Stewart Biology Building. Field work opportunities for students studying in the Museum include McGill's many field stations. The Gault Reserve on Mont St.-Hilaire is located 30 minutes east of Montreal and preserves the only remaining old growth forest in the St. Lawrence Valley. Other field stations are located on Barbados in the Caribbean, Shefferville in the boreal forest of east-central Quebec, and Axel Heiberg Island in Canada's High Arctic. In addition, Green and Larsson maintain their own field research sites on Lake Erie in southern Ontario (Green) and southern Saskatchewan (Larsson). Green also participates regularly in McGill's African Field Study Semester in Kenya and Tanzania.

Three Ph.D. students, three M.Sc. students, and two postdocs are currently working in the Green lab, largely focusing on aspects of amphibian ecology and evolution. Katharine Yagi (Ph.D.) has begun to investigate the concepts of niche breadth and habitat partitioning using Fowler's Toads, *Anaxyrus fowleri*, and American Toads, *A. americanus*, in and around areas where their ranges overlap in southern Ontario and New England. Elizabeth McCurry (Ph.D.) is investigating the traits and ecological circumstances leading to declines and extinction with a series of field experiments and computer simulations. David O'Connor (Ph.D.) is looking into the ecology and phylogeography of American Toads in previously glaciated eastern North America. Among the M.Sc. students, Jay Ploss is using landscape models to map habitat for Spring Salamanders, *Gyrinophilus porphyriticus*, in Quebec, Jessica Middleton is studying somatic

PHOTO BY GORDON CAMPEY

FIG. 1. McGill University's 130-year-old Redpath Museum building is located in downtown Montreal.

PHOTO BY DAVID M. GREEN

PHOTO BY HANS LARSSON

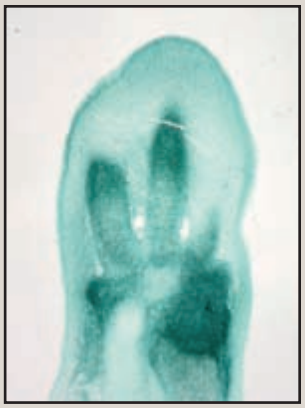


PHOTO BY HANS LARSSON

FIG. 2 (above left). Fowler's Toad (*Anaxyrus fowleri*), here represented by an individual sporting a radio-transmitter, has been the focal species for many studies in David Green's lab, including movement ecology.

FIG. 3 (above center). Much of Hans Larsson's work involves fossil collection in the Canadian High Arctic, as seen here at a site on Ellesmere Island, Northwest Territories.

FIG. 5 (above right). *Alligator* embryonic hand stained for early skeletal condensations, prepared for a paper supporting the idea that bird finger identities have evolved via a homeotic transformation shifting their identities backward.

PHOTOS BY ANTHONY HOWELL, MONTAGE BY DAVID M. GREEN

FIG. 6. A modest but growing collection of amphibians and reptiles comprise the Redpath Museum's herpetology holdings.

PHOTO BY FELIPE MONTEFELTRO AND HANS LARSSON

FIG. 4. *Pissarrachampsa sera*, exemplar of a newly described clade (Baurusuchia) of crocodylians from Brazil.

PHOTO BY DAVID M. GREEN

FIG. 7. The Dawson Gallery is a popular attraction for visitors to the Redpath Museum.

growth rate and population age structure in relation to density in Fowler's Toads, and Daniel Greenberg is beginning work on landscape resistance and connectivity of Spotted Salamander, *Ambystoma maculatum*, and Eastern Newt, *Notophthalmus viridescens*, populations in fragmented landscapes. Postdocs Trond Sigurdsen and Philippe Girard are, respectively, working on the early evolution and functional mechanics of frogs and individual-based modelling of salamander movements in relation to hydrogeography at Covey Hill, in southern Quebec. Also in the Green lab are recently graduated MSc students, Morgan Boenke, who is writing up papers from his thesis on terrestrial habitat use, home range, and movements by Fowler's Toads, and Alan Schoen, who is developing an image-based software system for recognizing individual animals, particularly toads, based on position, size, and shape of dorsal markings. Finally, B.Sc. student, Mohamad Rabbani, is investigating geographic variation in color pattern in Fowler's Toads to look for evidence of local adaptation and selection.

In the Larsson lab, Alex Dececchi (Ph.D.) studies dinosaurs and the ancestry of birds, more specifically the morphological changes in the forelimb and pectoral girdle of theropod dinosaurs as they began to take to the air. Alterations in bone morphology suggest changes in forelimb moblity, muscle attachment or utility involved with the origin of a novel locomotory mode—flight. Rui Tahara (Ph.D.) is looking at archosaurian cranial sinuses, which are important features shared among crocodylians, bird-like dinosaurs, and birds. This work uses non-destructive CT scanning of fossils and extant bird embryos in order to construct developmental evolutionary scenarios of these structures. Luke Harrison (Ph.D.) is examining the skeletal phenotypic changes associated with the fish-to-amphibian transition and compiling a large set of coding and non-coding gene sequences to test for evolutionary rates of candidate genes likely to have been involved. Ben Wilhelm (Ph.D.) is also examining the fish-to-amphibian transition by focusing on the muscles in the pectoral girdle and (fin or limb). This work incorporates gross dissections and micro-CT scanning of extant fishes and amphibians as a means to generate developmental evolutionary models explaining the origin of the complex tetrapod limb musculature.

With recent additions from the research of an increased number of professors and their students, the Museum has close to three million objects and specimens in its collections including, rather surprisingly, the second largest collection of Egyptian antiquities in Canada. Herpetologically, the Redpath Museum holds a modest collection of some 4,000 alcohol preserved specimens, largely from Quebec and eastern Canada, as well as skeletal material, tissues, and DNA (Fig. 6). It also contains some surprises and has considerable material from Peru, the West Indies, Congo, and New Zealand. Until fairly recently, though, the Redpath Museum had no herpetological collection to speak of and did not even acquire a reasonable teaching collection until Green's arrival in 1986. Initially in his career at the Redpath, Green sent his specimens to the Canadian Museum of Nature because the Redpath had no adequate storage for preserved specimens until the mid-1990s. In contrast, the Redpath Museum has an extensive and historic collection of fossil amphibians and reptiles. These are mainly from the Paleozoic, including the extensive collections made by Sir William Dawson and Bob Carroll. Lately, the Museum is acquiring more Cretaceous reptiles, including crocodylians and dinosaurs, via Larsson's work. Housing the Museum's growing collections, as well its growing number of personnel has become a considerable problem for the old building. This year, though, a new 2,000 square foot collections facility is being built for the Museum, marking the first time the Redpath has acquired new permanent storage space.

For well over half a century after it was opened, the Redpath Museum and its contents were reserved primarily for the professors and students of McGill College and University, and only secondarily for the education of public school students and the public. In 1952, the Museum changed course. It radically broadened its focus and for the next 20 years served, effectively, as a public natural history museum for Montreal elementary and high school students. In 1971, however, under extreme financial pressure, McGill chose to dramatically reduce public access and the Museum once again focussed entirely on its scientific research and university teaching roles. But the financial crisis passed and by 1985, the doors of the Redpath Museum once again were opened to the general public (Fig. 7).

Over the past 25 years, the Redpath has finally been able to strike a balance between its many roles as a university museum, research institute, academic unit, promoter of public education, and tourist attraction. In 1995, the Redpath was at last brought into the Faculty of Science and though it has rebuilt an extensive public program, it has not lost sight of its primary responsibilities as a university institution. The Redpath Museum now has more faculty members, more students, more courses, more programs, more outreach, more activities, more specimens, more research, and more prominence than ever before in its 130-year history.

ZOO VIEW

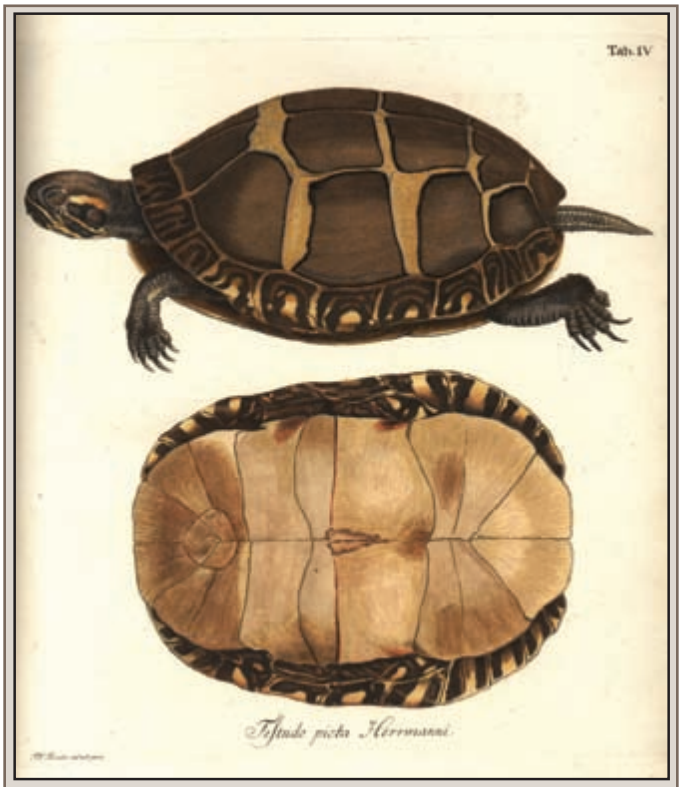
THE FIRST OF THE INNOVATIONS MADE BY THE STEM REPTILES WAS IN A WAY THE MOST EXTRAORDINARY AND AMBITIOUS OF ALL—THE MOST DRASTIC DEPARTURE FROM THE BASIC REPTILE PLAN EVER ATTEMPTED BEFORE OR SINCE. BY A CRYPTIC SERIES OF CHANGES, FEW OF WHICH ARE ILLUSTRATED IN THE FOSSIL RECORD, THERE EVOLVED A CURIOUS AND IMPROBABLE CREATURE WHICH, THOUGH IT RETAINED THE OLD COTYLOSAUR SKULL (WITH NO OPENING IN THE TEMPORAL REGION), HAD A HORNY, TOOTHLESS BEAK AND A BENT AND TWISTED BODY ENCASED IN A BONY BOX THE LIKE OF WHICH HAD NEVER BEEN SEEN. AND MORE THAN THIS, WITHIN THE BOX THE GIRDLES CONNECTING THE LEGS WITH THE REST OF THE SKELETON HAD BY SOME LEGERDEMAIN BEEN UPROOTED AND HAULED DOWN TO AN AWKWARD POSITION UNDERNEATH THE RIBS.

THE NEW ANIMAL WAS A TURTLE. HAVING ONCE PERFORMED THE SPECTACULAR FEAT OF GETTING ITS GIRDLES INSIDE ITS RIBS, IT LAPSED INTO A STATE OF COMPLACENT CONSERVATISM THAT HAS BEEN THE CHIEF MARK OF THE BREED EVER SINCE.

—ARCHIE CARR, *HANDBOOK OF TURTLES* , 1952

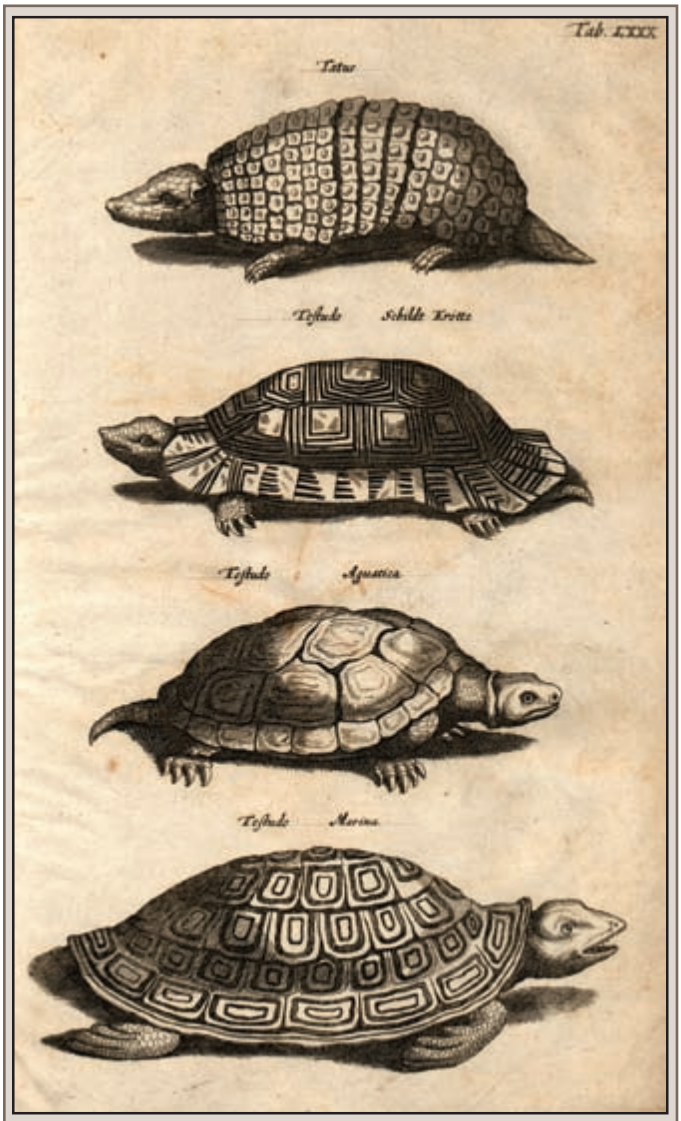
For zoos maintaining aquatic turtles, particularly those with outdoor exhibits in temperate climates, the book entitled *Life in A Shell. A Physiologist's View of a Turtle* by Donald C. Jackson (2011, Harvard University Press, Cambridge, Massachusetts; London, ISBN 978-0-674-05034-1) is a comprehensive treatment of the challenges confronted by turtles as they make their daily livings. The book is divided into eight chapters: "The turtle's shell," "Buoyancy," "The breathing turtle," "Tortuguero," "Overwintering without breathing," "Living without oxygen," "The heart of the turtle," and "Life in the slow lane."

With the advent of cell phones, visitors spend much more time taking pictures in a reptile building. Since aquatic turtles breathe infrequently, the public waits patiently to see turtles



COURTESY OF ERNST MAYR LIBRARY, MUSEUM OF COMPARATIVE ZOOLOGY, AT HARVARD UNIVERSITY.

Donald C. Jackson mainly discusses the physiology of three chelonians: Red-Eared Slider (*Trachemys scripta elegans*), Painted Turtle (*Chrysemys picta*), and Green Sea Turtle (*Chelonia mydas*). Shown here is the Painted Turtle from Ioannis Davidis Schoepff's *Historia testudinum iconibus illustrata* published in 1792[-1801]. This species is remarkably tolerant to low oxygen levels during hibernation.
IMPRINT: Erlangae [Erlangen] : Sumtibus Ioannis Iacobi Palm. [German edition *Naturgeschichte der Schildkröten* (Erlangen : J.J. Palm, 1792[-1801]).



COURTESY OF ERNST MAYR LIBRARY, MUSEUM OF COMPARATIVE ZOOLOGY, AT HARVARD UNIVERSITY.

Because an armadillo has a leathery armor shell, it was grouped with chelonians in this early plate! On the plate, it was called "Tatus" or Brazilian Hedge Hog by Jonstonus. He described the animal "as big as a Malta dog" so the drawing is the endangered Giant Armadillo (*Priodontes maximus*), also colloquially known as Tatou.
IMPRINT**:** Jonstonus, Joannes. 1657–1665. *Historiae naturalis . . . Cum aeneis figuris. / Joannes Jonstonus . . . concinnavit.* Amstelodami, apud I.I. Fil. Schipper.

surface to gulp air for that special picture and are bewildered when it takes so long. This book could be used as an excellent primer to develop graphics to explain the unique physiology of the turtle and its relationship to air.

Natura Artis Magistra's Animal Print Gallery

One of the world's oldest reptile buildings began its operation at this zoo in 1852. The reptile collection was worldwide in scope and had a sizeable number of giant reptiles in 1864, including giant constrictors, turtles, and crocodilians. Illustrators like Gerrit Schouten (Surinam, 1779–1839) made detailed drawings of all kinds of creatures, including the Four-toed Tegu (*Teius teyou*). Natura Artis Magistra, Amsterdam's Zoo, has just published its collection of prints of animals online.

COURTESY OF ERNST MAYR LIBRARY, MUSEUM OF COMPARATIVE ZOOLOGY, HARVARD UNIVERSITY.

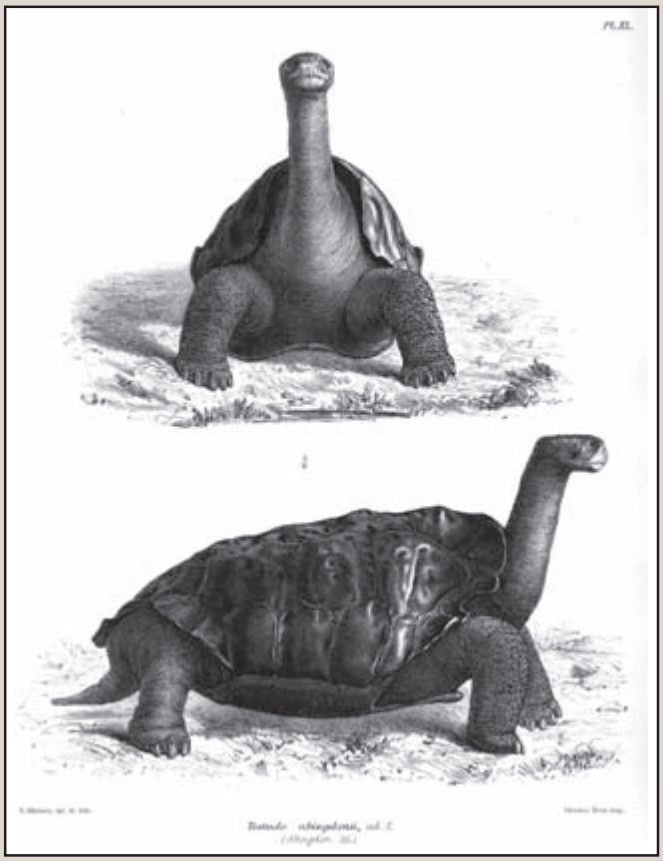
Natura Artis Magistra, Amsterdam's Zoo, has just published its collection of prints of animals online such as this illustration of Common Chameleon (*Chamaeleo vulgaris*, now *C. chamaeleon*). This colored plate is in Albert E. Brehm's *Illustrirtes Thierleben für Volk und Schule. Brehm's Illustrirtes Thierleben für Volk und Schule; bearb. von Friedrich Schödler. Mit, Abbildungen nach der Natur, ausgeführt unter leitung von R. Kretschmer. Neue Stereotypausg. Bibliographisches institut, Leipzig* (*Illustrated Animal Life for the People and the Schools; edited by Friedrich Schödler. With Illustrations from Nature, Made under the Direction of R. Kretschmer. New Stereotypical Edition, Bibliographic Institute, Leipzig.*).

Artis developed its own scientific picture library in 1881: the Iconographia Zoologica. This library contains thousands of prints, many of amphibians and reptiles, mostly from the 18th and 19th century. Over 20,000 of them are available for viewing on the Zoo's site.
http://www.rnw.nl/english/article/artis-zoo-puts-animal-print-gallery-online

Lonesome George

On 1 December 1971, American snail biologist Joseph Vagvolgyi and his wife Maria were on Pinta when they came face to face with a giant tortoise. "The tortoise was walking slowly when we first encountered him, but withdrew into his shell with a loud hiss as we moved closer to take his picture", Vagvolgyi recalled. "He soon relaxed, and resumed his walk." Vagvolgyi took a photograph and returned to the undergrowth and his search for snails. Neither he nor his wife realized the immense significance of their encounter. To most other visitors, the sight of a tortoise on Pinta would have been incredible. As far as everyone knew (except, it seems, the Vagvolgyis), there were no tortoises left on the island. Two centuries of exploitation at the hands of buccaneers and whalers had taken their toll; the last tortoise seen on Pinta was collected by scientists in 1906.

—Henry Nicholls , *Lonesome George*, 2010



COURTESY OF ERNST MAYR LIBRARY, MUSEUM OF COMPARATIVE ZOOLOGY, AT HARVARD UNIVERSITY.

Two view of Pinta Tortoise (*Geochelone nigra abingdonii*) from *The gigantic land-tortoises (living and extinct) in the collection of the British Museum*, by Albert C. L. G. Günther.
Imprint: London: British Museum (Natural History). Dept. of Zoology. Printed by order of the Trustees, 1877.

There are over 1000 Galápagos tortoises in zoo collections throughout the world but Lonesome George, likely the last remaining tortoise from Pinta Island (= Abingdon Island), is rarely used in presentations on endangered species. This perfect symbol could be effectively featured to stress the precarious future of all giant tortoises from these islands. Zoo graphics designers should craft their conservation messages by covering the history of human exploitation of Galápagos tortoises. In 1925, Charles Haskins Townsend, Director of the New York Aquarium, estimated that over 13,000 were removed from the islands. It has been a long time coming but conservationists are now trying to turn the tide—the elimination of feral animals from many islands, and the collection of wild tortoises for captive management programs featuring breeding, head-starting, and reintroduction.

To create this signage, read *Lonesome George: The Life and Loves of a Conservation Icon* by Henry Nicholls (2006, reprinted 2010; London; New York: Macmillan).

Free Download

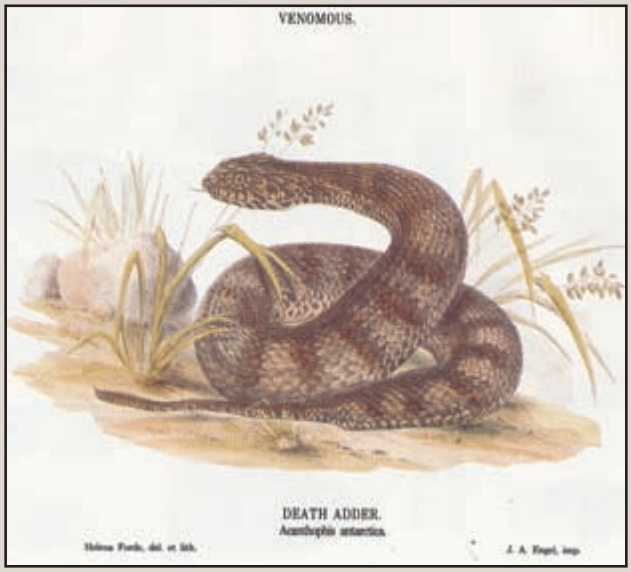
Tandora Grant from the Applied Animal Ecology Division of the San Diego Zoo Institute for Conservation Research has alerted the zoo community to a free download of an interesting book: *Conservation Biology for All*, by Navjot S. Sodhi and Paul R. Ehrlich (eds). Book in PDF from Oxford Press.

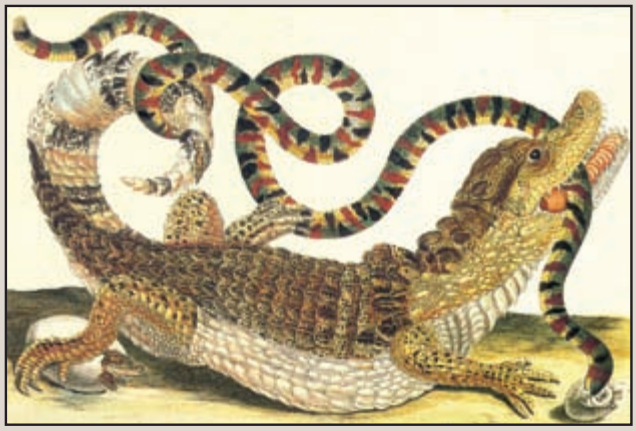
http://www.mongabay.com/conservation-biology-for-all.html

Snakes and Their Ways

> …surely the splendid colors and intricate patterns, beauty of line and motion, with which nature has endowed the snakes so generously, are sufficient to attract anyone who has a love of beauty and a reverence for life.
>
> And as one grows to know them better, snakes become more and more wonderful and satisfying —not only to the aesthetic sense, but to the intellectual as well.
>
> —Carl F. Kauffeld, *Snakes. The Keeper and the Kept*, 1969

During the past decade or two there are so many excellent books covering snakes that have appeared on the market. Editors Robert D. Aldridge and David M. Sever have added yet another one, *Reproductive Biology and Phylogeny of Snakes* (2011, CRC Press, Boca Raton, Florida. 759 pp.). Eighteen chapters cover many aspects of snake biology and thus are relevant to zoo herpetology: evolution and taxonomy (morphological and molecular), and an extensive review of development, placentation, spermatogenesis, male and female reproductive anatomy, hormonal control of reproduction, reproductive cycles, sex pheromones, and parental care. The Reproductive Biology and





Editors Robert D. Aldridge and David M. Sever have published a comprehensive book on snakes which includes these taxa: Common Death Adder (*Acanthophis antarcticus*) from *The Snakes of Australia: An Illustrated and Descriptive Catalogue of All the Known Species,* by Gerard Krefft in 1869; Coral Cylinder Snake (*Anilius scytale*) from *Dissertation sur la generation et les transformations des insectes de Surinam,* by Maria Sibylla Merian in 1717; Indian Cobra (*Naja tripudians,* now *N. naja*) from *The Thanatophidia of India,* by Sir Joseph Fayrer in 1874.

Phylogeny series, edited by Barrie G. M. Jamieson, includes other herpetological treatments: Urodela, Anura, and Gymnophiona.

Latest Zoo & Conservation News: Research Shows a Visit to a Zoo Boosts Science and Environment Knowledge

Research conducted by the University of Warwick at ZSL London Zoo shows that "a trip to the zoo can boost your child's science and conservation education more than books or classroom teaching alone." From the article (emphasis added): "[M]ore than 3,000 school children aged between seven and 14 were asked about their knowledge of animals, habitat and conservation and then tested again after their trip. *The results show that 53% had a positive change in educational or conservation-related knowledge areas, personal concern for endangered species or new empowerment to participate in conservation efforts.* The study proves that their trip around the zoo provided a statistically significant increase in scientific learning about animals and habitats. *When zoo visits were supplemented by an educational presentation by zoo staff this increase in learning almost doubled against self-guided visits.*"

The research showed that "children came away with a greater understanding of ideas such as conservation, habitat and extinction," and they were more likely to use correct scientific terms and place animals in the correct habitat after visiting a zoo.

http://esciencenews.com/articles/2011/05/27/research.shows.a.visit.a.zoo.boosts.science.and.environment.knowledge

Johnny Arnett

Johnny R. Arnett, longtime herpetologist at the Cincinnati Zoo and Botanical Garden in Ohio, has died after a long bout with diabetes. His background was unique. He was hired in the mid-1960s as the lone reptile keeper at the zoo through a federal job corps program but had no training with any herp. In fact, he was terrified of snakes. Slowly, by trial and error, he taught himself how to care for them. Later, he was the head of the herpetological department at the Knoxville Zoo, returning near the end of his career to Cincinnati. He is likely best known for his work with Komodo Dragons, collecting samples from wild and captive specimens for bacterial analysis by veterinarian Don Gillespie. In 1997, he returned to Indonesia to help researchers collect dragon saliva for medical research. The trip was chronicled in the documentary "Komodo: To Capture A Dragon," on the cable channel Animal Planet.

Johnny Arnett and one of his snappy charges at Cincinnati Zoo and Botanical Garden in 1966.

CINCINNATI ZOO AND BOTANICAL GARDEN ARCHIVES, PROVIDED BY WINSTON CARD.

Zoos and Biodiversity

> Because ex situ conservation programs can be challenged when called into action at the last possible moment with only a few remaining individuals of a species, captive breeding should not be simply seen as "emergency-room treatment." It is a tool that should be considered before the species has reached the point of no return.
>
> —Conde et al. 2011

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—James B. Murphy, Section Editor

Herpetological Review, 2012, 43(2), 208–209.

New Panama Amphibian Rescue and Conservation Project Exhibit at Smithsonian National Zoological Park

In 2008 Amphibian Ark and AZA launched a Year of the Frog campaign to highlight the global amphibian crisis and the leadership role that zoos and aquaria should be playing to mitigate impending extinctions (Gagliardo et al. 2008; Zippel and Mendelson 2008). Realizing that Panama was one of the most significant frontlines for conservation as chytridiomycosis continued to spread through Latin America (Woodhams et al. 2008), Africam Safari, Autoridad Nacional del Ambiente, Cheyenne Mountain Zoo, Defenders of Wildlife, Houston Zoo, Smithsonian Institution, Summit Municipal Park, and Zoo New England came together in 2009 to launch the Panama Amphibian Rescue and Conservation Project. In 2009, these institutions signed a Memorandum of Understanding providing funding and support for three complementary actions: 1) the construction and operation of the new Amphibian Rescue Center at the Summit Zoological

FIG. 1. Rescuing Panama's Frogs exhibit at Smithsonian National Zoological Park. Left panel shows SEM *Bd* image, the spread of *Bd* through Central America, and description of the project. Center panel called "Froggy Baths" shows the quarantine procedures and anti-fungal remedies used to treat amphibians that are at risk from *Bd*. Right panel shows the collection of wild amphibians and the installation of the shipping containers (called "rescue pods"). These are climate-controlled, disease-free units housing the new anuran residents.

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FIGS. 2a, b, c. Three endangered species are on exhibit: Lemur Frog (*Agalychnis lemur*), Spiny-Headed Treefrog (*Anotheca spinosa*), and functionally extinct Panamanian Golden Frog (*Atelopus zeteki*).

FIG. 3. Graphic panel of Panamanian Golden Frog (*Atelopus zeteki*).

Park in Panama; 2) the ongoing operation of the El Valle Amphibian Conservation Center in western Panama (with the Houston Zoo as the main partner); and 3) the amphibian chytrid cure research program to be initiated at the National Zoo in collaboration with other research institutions. The mission of this project is to rescue and establish assurance colonies of amphibian species that are in extreme danger of extinction throughout Panama and focus efforts and expertise on developing methodologies to reduce the impact of the amphibian chytrid fungus (*Bd*) so that one day captive amphibians may be re-introduced to the wild.

Work in Panama has progressed steadily over the last two years; see www.amphibianrescue.org for updates. The project has built an active online constituency (3700 Facebook fans, 1000 Twitter followers as of April 2011), but we realized that we needed to use our existing exhibit space better to highlight the global amphibian crisis and to link our field conservation programs to our zoo-going constituents. The objectives of this exhibit were:

- To promote the value of Panamanian frogs to zoo-goers by highlighting a few interesting Panamanian species.
- To tell the story of chytridiomycosis spread in Panama and our conservation actions to prevent further extinctions by building an amphibian ark, and efforts to develop a cure that will one-day allow reintroduction of captive amphibians back into the wild.
- To provide an interpretive tool for our volunteer docent community to engage the public.
- To raise funding for the project through a guide-by-cell 'Text FROG' campaign, where people can donate $5 to the amphibian project simply by texting the word 'FROG' from their cell phones to a certain number.

The goals of our education program through this exhibit and associated volunteer docents are to engage people in behaviors that will directly assist our project to 1) raise funds, 2) build a social media constituency and 3) to recruit volunteers to assist with our program in Panama. The real challenge now is in training the volunteer docents to use this exhibit to actively pursue our project goals.

Acknowledgments.—All photographs were taken by Mehgan Murphy, Smithsonian National Zoological Park. Judy Tasse from the Zoo's Graphics Department assisted in the development of this display. Paul Pallansch installed the panels for the exhibit.

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Herpetology in Japanese Zoos

Japan, a country about the size of Montana, USA, is heavily populated with zoos and aquariums. Nearly 160 live animal exhibit facilities (89 zoos and 67 aquariums) were listed by the Japanese Association of Zoos and Aquariums (JAZA, formerly Japanese Association of Zoological Gardens and Aquariums, or JAZGA) as of March 2010 (JAZA 2011). Although there exist non-JAZA member animal exhibit facilities, it is safe to assume that JAZA literature covers the basic data on the vast majority of animal collections open to the public. Little is known about those facilities outside of this island nation, creating a huge information and communication vacuum concerning the eastern edge of Asia. Not surprisingly the number of published herpetological collection accounts in English is limited (e.g., Kawata 2003, 2004, 2006; Murphy 2007). This article briefly examines the birth of the modern zoo in Japan, its expansion, cultural differences from the Western counterparts, growth of herpetological collections and various programs including breeding and conservation. Taxonomic nomenclature has been adopted from the JAZA publications; as needed, scientific names have been updated, based on Amphibian Species of the World Database (Frost 2011) and The Reptile Database (Uetz et al. 2012). Common English names are mostly taken from ISIS (2011) and Goris et al. (2004). Possible errors in data compilation from the Japanese sources are mine.

Dawn of the Modern Zoo: an Overview of History

The early residents.—As Japan was transforming itself to become a modern nation, feudal warlords began to lose the firm grip that they had held for centuries over the people and the land. It was in the late nineteenth century when a cluster of forward-thinking men emerged to formulate a plan for a national museum after a European model. The plan eventually included a zoo patterned after Menagerie du Jardin des Plantes in Paris (Itoh 2010; Kawata 2001). The first zoo in the country opened on 20 March 1882 in Ueno Park, Tokyo. Prior to the establishment of this zoo, the government opened an exhibit station, also in Tokyo; the emperor reviewed this facility on 13 March 1872. In this exhibit station, which could be defined as the origin of Japan's zoos, were the Japanese Giant Salamander (*Andrias japonicus*) and the Reeve's Pond Turtle (*Mauremys reevesii*). The first aquarium of the country was a small facility with a collection, including the Japanese Giant Salamander, which was added to the Ueno Park Zoo (hereafter Ueno Zoo) on 20 September 1882. This species was a regular exhibit material since it was the research subject of Professor Chiyomatsu Ishikawa of the Imperial University of Tokyo, who also held the title of the zoo administrator from 1900 to 1907. (It might be noted that Ishikawa's Frog, *Odorrana ishikawae*, was named in his honor.) By 30 September 1885 the herpetological collection increased to five amphibians in two species and 19 reptiles in eight species (Ueno Zoo 1982).

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Following Tokyo's example, and in order to commemorate the wedding of the crown prince, the second zoo in Japan was opened in the ancient capital of Kyoto on 1 April 1903 by the city government. In the inventory of 238 animals in 61 species at the opening, no amphibian or reptile was listed (Takizawa 1986). In the country's commercial hub of Osaka, on 1 January 1915 the third zoo, Tennoji Zoo (another municipal facility), opened its gate with 60 species of animals, which included American Alligator and pythons. The former marked the first arrival of its species in Japan (Osaka Tennoji Zoo 1985). (The Japanese nouns usually do not distinguish between singular and plural, hence these documents often do not reveal the exact numbers of the animals. Also, it was common in zoos to use generic terms such as "python" or "rattlesnake" until decades later, when identifying the taxonomic name became a common practice.) The small number of above specimens represented the first residents of amphibians and reptiles in Japan's animal exhibit institutions. However during the critical developmental stage of zoos and aquariums, herpetology, in terms of collection and husbandry, fell far behind other animal groups.

This becomes evident when Japanese zoos are compared with their Western counterparts. In Paris, many important scientific discoveries were made at the Menagerie in early years. The London Zoo opened the world's first reptile building in 1849 (Murphy 2007, 2009). As of 1858, Rotterdam Zoo in the Netherlands kept 28 reptiles in 10 species and one amphibian (Visser 2003). In Germany, at Leipzig Zoo within the first years of opening in 1878, large reptiles were kept and even bred (Schmidt 2010). On this side of the Pacific Ocean, Hornaday (1918) stated that in the Bronx, New York, "The Reptile House was the first large building erected in the Zoological Park." (The zoo opened in 1899.) In 1930, statistics revealed that there were five zoos in the United States that maintained more than 400 specimens in more than 70 species of amphibians and reptiles (Doolittle 1932). During the 1930s "reptiles were one of the central kinds of animals that zoos used to draw Americans through their gates" and thanks to the funds from President Franklin Roosevelt's New Deal programs, some zoos had large and modern reptile houses, built or improved by the New Deal (Donahue et al. 2010).

By contrast, even into the post WWII era, Japanese institutions paid little attention to the amphibians and reptiles. Looking for answers for this curious imbalance will necessitate a review on historical aspects.

The duo controls the zoo.—The liaison between the academic world and zoos has been historically rare in Japan. The aforementioned Professor Ishikawa abruptly resigned from the position of the Ueno Zoo administrator in 1907, after getting tangled up in politics with higher officials. This German-educated zoologist envisioned a grand zoo with Carl Hagenbeck as a consultant; had he stayed in the position, the future course of Japanese zoos might have been quite different (Ueno Zoo 1982). In Kyoto, Professor Tamiji Kawamura of the Imperial University of Kyoto, who was known as the father of ecology in Japan, was appointed the zoo director in 1934. His tenure lasted only 14 months, as he left the position after disagreements with city fathers (Takizawa 1986).

In 1924 the administration of Ueno Zoo was transferred to the City of Tokyo, and by then it became common for mainstream zoos to be municipally owned and operated. It also became a

PHOTO BY TOKYO ZOOLOGICAL PARK SOCIETY

FIG. 1. A python arriving at Ueno Zoo, Tokyo, in 1898, was placed in a makeshift cage. Few tropical reptiles survived the first winter.

PHOTO BY TOKYO ZOOLOGICAL PARK SOCIETY

FIG. 2. Treatment of a Reticulated Python (*Broghammerus reticulatus*) at Ueno Zoo, 1938.

PHOTO BY TOKYO ZOOLOGICAL PARK SOCIETY

FIG. 3. A renovated indoor reptile exhibit, Ueno Zoo, 1937.

PHOTO BY TOKYO ZOOLOGICAL PARK SOCIETY

FIG. 4. The first Komodo Dragons (*Varanus komodoensis*) to Japan arrived at Ueno Zoo in October 1942.

PHOTO BY TOKYO ZOOLOGICAL PARK SOCIETY

FIG. 5. Aquatic and Reptile Building, Japan's first large-scale exhibit complex for amphibians, reptiles, fish, and invertebrates opened at Ueno Zoo in 1964.

PHOTO BY AKIYOSHI NAWA

FIG. 6. Ueno Zoo Vivarium aquatic exhibits.

practice to appoint a municipal manager with no training in zoology or zoo experience to the helm of a zoo for only a brief period. To cite an example, in its 50-year history beginning in 1942, Inokashira Nature and Culture Park (hereafter Inokashira Park Zoo), in a Tokyo suburb, had 21 directors. Being in Tokyo, this zoo uniquely had several transferees from Ueno and Tama zoos (Inokashira Nature and Culture Park 1992). Still, the average tenure of less than two and a half years barely gives a director enough time to familiarize himself with the operation of his institution (note: zoo directors in Japan are still predominantly male). Instead, the

position of a zoo director is a convenient stepping stone for municipalities to shuffle bureaucratic positions.

To assist the director with animal collections, the municipality assigns veterinarians, also for a brief period in most cases, transferred from other divisions that have little to do with wild animals or zoology, such as the public health department. As a result, the critical managerial positions of a zoo are occupied by those with no expertise or interest in zoos or wild animals. In the public's mind a veterinarian is automatically an animal expert, but at best, this is only partly correct. The education for veterinary medicine is limited to the health aspect of only a handful of domesticated species, mostly mammals. Besides, until the early 1980s the requirements to become a veterinarian consisted of only four years of post-secondary school, a lower level of training compared with the American system. Even today, they still are *the* college-graduated group responsible for wild animals in captivity, and they oversee keepers, often with a firm hand. In this situation there exists little professional continuity. Operational continuity, if any, is barely maintained by a small number of dedicated keepers, who are entry level employees. There are exceptional zoos and individuals, but they are in the minority. (Privately owned zoos have taken different developmental stages, but they are not considered mainstream institutions. By comparison to zoos, aquariums have evolved differently. However, that is a subject outside of the scope of this article.)

From a promising beginning in the dawn of modernization, Japan's zoos thus stumbled into a quicksand during infancy; to this day they lag far behind their cousins in Europe and America in nearly all aspects. Popular as they are to the public, zoos are diametrically different from their Western counterparts. They are regarded as a showplace of exotic animals, so far removed from the world of zoology. For a zoo director, his accomplishment is measured by an increased gate attendance during his brief tenure. To achieve this he brings in amusement rides, side by side with animal exhibits, an element alien to the modern zoo. For the same reason he focuses on high-profile animals, the "ABC animals" such as large felids, bears, primates, elephants, and giraffes. The animal collection becomes mammalocentric, and while it can be said that the same trend is predominant across the world, in Japan, the focus on mammals is so prominent that birds are given a second-class status, and other groups are pushed even further down. Amphibians and reptiles are outside the interest of veterinarians and non-zoologist directors, resulting in herpetological poverty.

This does not mean that the public has little interest in this group of animals. Reptiles had been in sideshows and traveling menageries from earlier times. Around the turn of the twentieth century, half a dozen large-scale traveling menageries crisscrossed Japan. The largest of them stayed in business from 1907 to the end of 1928, a surprisingly long period for a sizable animal collection with no permanent housing facility. Their picture postcards show a crocodile, a python (both appear adult), and a monitor (Kawata 2005). Returning to the municipal zoo operation, there is no doubt that zoos had a potentially fertile soil for patronage to be developed, had they spotlighted reptiles in a specialized facility. Unfortunately the public's curiosity went unsatisfied, as animal collections remained limited in scope. As Sasaki aptly pointed up (Sasaki et al. 1977), the duo of municipal bureaucrats and veterinarians hand in hand promoted the vulgarization of zoos, the modus operandi that firmly gripped zoos for generations. Fortunately, as we will later review, in more recent years there has been a crack in this monolith.

The sakoku mentality.—The uniqueness of Japanese zoos is also noticeable in the cultural aspect. From 1639 to 1868 the feudal government closed Japan's door to the outside world, a policy that was aided by its geographical isolation. This self-imposed seclusion, or *sakoku*, has cast a profound influence on the people; even today, they are unable to free themselves from the harness of *sakoku*. On the surface Japan appears to be a Westernized island nation floating on the edge of Asia, but this image is misleading. As Itoh asserts: "The *sakoku* mentality still gravely affects the Japanese mind. The Japanese public is unwilling to integrate foreigners into Japanese society and is reluctant to assume a more active role in the international community." She also notes: "Although Japan achieved its status as the world's second-largest economy more than a decade ago, it still has not been able to demonstrate international leadership ability or earn international respect" (Itoh 1998). Their reluctance to get involved in international affairs extends into the zoo world, and it refers back to the aforementioned information and communication gap between them and the outside world.

A herpetological editor once commented: "…until recently Japanese zoos and aquariums kept information about what herps and how many they had among themselves. In a world where coordination between those who care has become increasingly important, so the little resources like money and knowledge we have can be used wisely, this secrecy can only be called a moral crime" (Salzberg 2003). This view prompted an objection from a graduate program director of a university (A. H. Savitzky, pers. comm., 2003). Japanese culture is extremely deceiving; naiveté and ignorance would easily lead an outside observer to an inaccurate conclusion. In truth, Japanese *choose* to stay in their cocoon but do not purposely hide information, and therefore the perceived secrecy is by no means intentional. Simply put, the world outside of that arc-shaped archipelago does not exist in their perceptual radar and therefore, the need to share information internationally does not even occur to them.

Early Decades and World War II

Protection from winter.—Zoos in industrialized nations are primarily located in the northern temperate zone, where overwinter facilities are required to maintain ectotherms during cold months. In Japanese zoos resources to build and maintain heated buildings were traditionally allocated for popular mammals, such as primates and large herbivores. In Kyoto, a heated building was opened and a python was placed in it in 1923 (Takizawa 1986) but its size or the extent of the thermal capacity is not documented. The lack of heated housing capacity led to zoos' inability to keep tropical reptiles beyond the first summer after arrival. The way the Ueno Zoo staff had to cope with the rudimentary conditions was chronicled by Fukuda (1968): "13 November 1922, clear weather; preparation for winterizing reptiles." They placed 30 native turtles in a wooden box and buried the bottom half; American Alligators were put in a wooden box, water was added and then placed in the feed storing corner of the hippopotamus building.

When a three-meter long Saltwater Crocodile arrived in May 1932, the lack of a permanent reptile facility became all too evident. The crocodile was first housed in the heated hippopotamus building, but chronic anorexia developed. In December the crocodile was moved to a new building for small mammals and reptiles, but anorexia persisted and it died after nine months at the zoo (Ueno Zoo 1982). Many reptiles of tropical origin did not

survive the first winter, yet we find occasional exceptions. On 17 June 1936, Ueno Zoo's python, which had arrived in October 1925, died of hemorrhagic enteritis; it weighed 101.6 kg, and the total length was 6.47 m (Fukuda 1968). The exact species of this python is not listed but the geographic origin was said to be the Malay Peninsula, indicating it to be a Reticulated Python.

It was in January 1937 that a reptile house, capable of housing larger species, was finally completed, with a skylight that allowed tropical plants to grow (Ueno Zoo 1982). But across the country, the zoo reptile collections in the pre-WWII years were basically represented by giant snakes, monitors, and crocodilians, mostly from Southeast Asia due to geographic proximity, with the exception of commonly imported American Alligators. Every now and then, smaller species and some rarity arrived at zoos. The military often brought in reptiles, among other animals, to Ueno. February 1923 saw the Imperial Navy delivering Aldabra Tortoise, and on 30 October 1942 two Komodo Dragons, first in Japan, were donated. Captured by the navy on Komodo Island, they arrived during the war, the worst period in the zoo history when every supply was short; they died on 16 February and 12 June, 1943 (Ueno Zoo 1982).

Wartime zoo policy.—Military expansion over the vast regions of Asia led Japanese people to the ultimate disaster of WWII. Even before the attack on Pearl Harbor in December 1941, the signs of hard times were everywhere. At Ueno Zoo employees began to be conscripted to the armed forces in 1937. By 1940 zoos were under serious shortages of essential supplies, such as animal feed, as the nation's resources were directed to the war effort. Some zoo animals, such as goats and ducks, were used for feeding carnivores. Fuel shortage further jeopardized animal life (Fukuda 1968). Akiyoshi Nawa, who was a keeper at Ueno from 1941 through 1943, recalled (pers. comm., 2011): "Small reptiles, such as chameleons, were housed in a heated building with birds and mammals such as bats but they did not live long. After steam heating was discontinued large reptiles were placed in wooden boxes, which were then piled up in the building where chimpanzees were kept, or in the keeper service area. Many did not survive to meet the mandatory killings."

Itoh ably documented the wartime zoo policy by the government, which mandated that the so-called "dangerous" animals be destroyed, and how they were executed. Between August 1943 and December 1944, a total of 170 animals were killed in 14 zoos; nearly all were mammals but reptiles, such as rattlesnakes and pythons, were included. The policy did not exempt circuses; a total of 133 animals were destroyed, among them 58 snakes (Itoh 2010). The herpetological roster of three zoos as of September 1945 (immediately after the end of the war) shows the zoo staff's effort to maintain them under difficult conditions: Ueno Zoo, 10 reptiles in five species including two Chinese Alligators and a turtle from New Guinea (Ueno Zoo 1982); Kyoto Zoo, 85 native freshwater turtles in three species (Takizawa 1986); Tennoji Zoo, one giant salamander and one "crocodilian" (Osaka Tennoji Zoo 1985). Aside from the above, there were a few that continued to live through the war years into decades afterwards including an American Alligator, a Chinese Alligator and an Alligator Snapping Turtle (Murphy 2007). As for the ubiquitous American Alligator, it does appear that more survived the war in the private sector, such as a hot spring resort where aquatic thermal comfort was in unlimited supply. As a child in southern Japan, I saw a large American Alligator in a sideshow. It was in the post-war period before large-scale animal shipments began to arrive, and somehow the animal must have survived the war years.

Reconstruction and Expansion of Zoos

Reptiles begin recovery era.—As the nation's cities lay in ashes and ruins, Japan put itself on an almost forced march out of devastation and toward economic recovery, no small feat for a people who had lost everything. In zoos nearly all popular animals were gone; cages that previously housed lions and tigers were filled with farm animals, to the disappointment of visitors seeking out relief from the daily hardship. International traffic of animals began in small bits, such as pet Crab-eating Macaques (*Macaca fascicularis*) donated to the local zoo by soldiers of the occupation forces. At this point, previously little known Hogle Zoo in Salt Lake City, Utah, stepped forward to make zoo history by sending the first post-war good will animal ambassadors to Ueno Zoo. The Ueno Zoo staff wished to receive large carnivorous mammals that had been lost during the war, but bringing in meat-eating animals would have required approval from the occupation force at this time of severe food shortage for humans. On 17 April 1949, four musk turtles (*Sternotherus odoratus*) and four box turtles (*Terrapene* sp.) arrived by air from Salt Lake City, and were enthusiastically welcomed by the public. Soon Hogle Zoo sent mammals and birds of various species (Ueno Zoo 1982). Thus, just as they marked the beginning of Japanese zoos, reptiles made a mark again nearly eight decades later.

The boom years.—Around 1950 trade restrictions began to be relaxed, enabling large-scale wild animal importations, first from Southeast Asia. Somewhat ironically, the period of catastrophic disasters was followed by an era of unprecedented economic prosperity. As of 1940 when the first general assembly of JAZGA was held in Tokyo, there were 19 member institutions including 16 zoos (two of them were in Korea and Taiwan, which were exterior territories under Japanese control) and three aquariums. After the war, citizens began to enjoy peaceful life for the first time in decades, and aided by newly-gained economic base for the public, they were ready for more zoos. An unprecedented zoo construction boom swept Japan, as zoos spread from larger cities to middle-sized cities. By 1961, merely 16 years after the war's end, JAZGA listed 84 member institutions including 52 zoos and 32 aquariums. As for herpetological collections, the animal inventory of JAZGA member institutions as of 31 August 1961 listed 33 species of amphibians and 61 species of reptiles, or a total of 94 species. The largest holder was Ueno Zoo with 13 species of amphibians and 34 species of reptiles, or a total of 47, which added up to one-half of the species in the inventory (JAZGA 1962).

Tokyo still stood on top, but the balance of quantity was to shift appreciably in the coming decades. A number of animal housing and exhibit facilities were built, and the budding interest in herpetology was growing in other zoos and aquariums. Such changes, however, moved at the speed of a tortoise, certainly not that of a frog. This was because the zoo world was a conservative lot heavily guarded by the aforementioned duo, which possessed no passion for zoo work or zoology, and their firm belief "Zoos only need ABC mammals" continued to prevail. At this point, Tokyo made the move again.

In 1960, the senior staff of Ueno Zoo was well aware that herpetology was the area that was most left behind by Japanese zoos. Ueno Zoo's "new" aquarium, which was built as the seventieth year commemorative project in 1952, already showed wear and tear of its partially wooden structure, and was being outmoded by newer aquariums being built across the country. A plan was on the drawing board to design a large building to accommodate

exhibits of not only fish, but also marine invertebrates, amphibians, and reptiles. Fish, amphibians, and reptiles share common requirements for life support systems, it was argued, and combined exhibit buildings had precedents in Europe, such as Zoo Berlin and Frankfurt Zoo. The decision was made to build a large exhibit complex, tentatively named "aquatic and reptile building" as the eightieth year commemorative project for the zoo, to open in 1962 (Ueno Zoo 1982).

Growth and Development in Herpetology Underway

The trailblazer.—According to the plan of this four-storied complex, the first two floors were devoted to fish, aquatic amphibians were to be housed on the third floor, and the entire fourth floor was devoted to the rest of the amphibians and reptiles. Two years after construction began, the building with a floor space of 5,478 m^2 was opened to the public on 30 October 1964. However, due to construction delays the amphibian and reptile section was not completed until June 1973 (Ueno Zoo 1982). In some ways, this 1964 building reflected Japan's peculiar dichotomy; the country may be divided into two sectors, Tokyo the capital and the rest, and Tokyo often sets the pace for the rest in terms of politics, economy, and culture. To put it in the American perspective it is an equivalent of Washington, DC, New York, and Los Angeles all rolled up into one mega-city. The debut of Ueno's large multi-taxonomic exhibit complex was an epoch-making event, to set the stage for other zoos and aquariums, even though it took a decade for the trend to catch up. Gradually, medium-sized zoos began to follow suit.

In the prosperous port city of Yokohama, south of Tokyo, a new reptile house opened in Nogeyama Zoo in 1971, replacing the 1965 facility that housed only nine species. The new building was five times larger. In 1973 a reptile building opened in Nihondaira Zoo in Shizuoka. The following year saw the unveiling of a two-storied building in Asa Zoo, Hiroshima; nocturnal exhibits for small mammals occupied the first floor while reptiles took up the second floor. Another young and medium-sized zoo in Sendai in the northern part of Honshu, Yagiyama Zoo opened a reptile house in 1978. Although designs of these buildings followed the traditional style consisting of rows of individual cages, a debut of a large-scale indoor application of the immersion landscape concept made history in Osaka. Opened in 1995 at Tennoji Zoo, this exhibit complex was later named IFAR, representing invertebrates, fish, amphibians, and reptiles. As the name implies, a wide variety of animals are housed to depict the world's fauna and flora. Back in Tokyo, Ueno Zoo demolished the 1964 building in 1992, replacing it in 1999 with a new building named Vivarium, to exhibit amphibians and reptiles (Kawata 2004).

Beachhead for herpetology.—These facilities became the foundation for expanding exhibitory, specialized husbandry techniques and breeding, not only for the traditionally popular species such as giant snakes, monitors, and crocodilians, but also for smaller ones, particularly indigenous taxa. While this development was underway, the number of new zoos and aquariums kept growing. What captured zoo enthusiasts' eye was the birth of privately owned specialized reptile collections, such as Atagawa Tropical & Alligator Garden (opened in 1958) and Izu Andyland (opened in 1986). Also, it might be noted that the emergence of a large number of aquariums has made Japan "a nation of aquariums" (Kawata 2009). In recent decades, these aquariums have made contributions to various herpetological programs. These new institutions have begun to demonstrate the strength in the field. The old-establishment "classic" zoos with large, generalized animal collections, typically Ueno and Tennoji, could no longer continue to claim the leadership positions in expertise in all animal groups.

Growing collection size.—There is an impression in the American zoo scene that the collector's days are over. A large collection of taxa of a specific animal group is targeted for criticism by the mainstream zoo pundits as an anachronistic postage-stamp collection. The zoo's resources, they argue, should better be directed toward global conservation endeavors. Also, they prefer larger outdoor exhibit spaces and mixed species exhibits. Such a philosophy appears to be originated in mammalocentricism, as public-pleasing ABC zoo animals happen to be large mammals. However, biological programs in zoos and aquariums must be based on the characteristics and requirements of each taxonomic group. Thus the "yardstick" for mammal programs should not always be applied to amphibians and reptiles. A row of cages, each with a different species of monkey, may not be popular today, but can the same be said about other animal groups? A variety of taxa of one group, be it frogs or rattlesnakes, exhibited in an attractive indoor setting, will show visitors the diversity within a particular group. Formulating a plan for herpetological programs, therefore, should be independent of political correctness for mammals. As Table I shows, Japan's herpetological collections include a large number of species, yet

TABLE 1. Amphibian and reptile species held in Japanese collections, 1969–2009. The numbers in parenthesis represent institutions that do not have amphibians and reptiles.

Years	No. zoos ( )	No. aquariums ( )	Amphibian species	Reptile species	Total
1969	60 (16)	38 (4)	47	185	232
1979	63 (17)	44 (7)	67	220	287
1989	93 (30)	57 (1)	87	314	401
1999	98 (27)	65 (5)	117	295	412
2009	89 (16)	67 (7)	95	236	331

TABLE 2. Eight largest collections of amphibians and reptiles in Japan. Data taken from eight collections that hold a minimum of 50 species of amphibians and reptiles combined as of 31 December 2009.

Institutions	Amphibians species / specimens	Reptiles species / specimens	Total
Ueno Zoo	51/398	88/336	139/754
Higashiyama Zoo (Nagoya)	53/269	75/282	128/551
Izu Andyland	0/0	106/652	106/652
Toba Aquarium	26/119	50/172	76/291
Okinawa Children Land Zoo & Aquarium	7/39	62/524	69/563
Tennoji Zoo (Osaka)	13/77	43/174	56/251
Noboribetsu Marine Park Nixe	16/47	37/95	53/142
Echizen Aquarium	40/320	10/42	50/362

FIG. 7. Yellow-margined Box Turtle (*Cuora evelynae*) at Ueno Zoo.

FIG. 8. Reeve's Pond Turtle (*Mauremys reevesii*) at Ueno Zoo.

this should not be viewed in a negative light. Data for the tables have been culled from the JAZGA/JAZA Annual Reports (JAZGA 1970, 1980, 1990, 2000; JAZA 2010b).

Some holders meticulously report subspecies and melanistic forms in their collections, but taxa in both tables have been lumped into full species to simplify statistics. Hybrids are not included. For these reasons, the actual numbers of "forms" of animals can be higher than what is shown in the tables. Table 1 depicts the chronological increase in species held by member institutions in the last half century. Some holders still submitted generic and non-specific designations such as "giant tortoise," "box turtle," or "monitor" for 1969; these were excluded from the Table, and thus the actual number of taxa may be higher for 1969. Also, one zoo and two aquariums failed to submit data for that year. With amphibians and reptiles combined, the largest holder for 1969 (167 species) and again 1979 (179 species) was Ueno Zoo. Probably due to the plan to demolish the 1964 building, Ueno's collection declined for 1989, and Higashiyama Zoo in Nagoya, another large urban and municipal zoo, took the lead, with 116 species. For 1999 Kusatsu Tropicana came out on top with 140 species, only to drop out for 2009, when Ueno Zoo, with the new Vivarium, again claimed the largest with 139 species; Nagoya was a close second in 2009, with 128 species.

Table 2 shows the eight largest holders as of 2009; combined, these eight kept one half of all species of amphibians and reptiles in the JAZA inventory. Large municipal zoos in Tokyo, Osaka, and Nagoya still held strength in the collection size. Yet, the shift toward aquariums (Andyland, a holder of a large number of reptiles, is listed as an aquarium) is quite obvious, illustrated by two relatively little known aquariums at the end of the list. It might be interesting to note that distribution of collection sizes leans heavily toward smaller holdings. Ten percent of the holders had 40 or more species each; only three holders had 80 or more species. Of all holders 80% had fewer than 20 species each; 45% had 10 or fewer species each. Active participations in herpetological programs by more institutions will require more holding spaces and skilled staff. This, however, will take a long period to materialize. Herpetology in Japanese zoos and aquariums is still in its infancy, and it shows not only in the limited diversity in collections, but also in the quality of exhibitory, husbandry, and conservation programs, compared to European and American institutions.

Husbandry, Breeding, Research and Conservation

Charismatic giant.—A special note is in order for the only Japanese species (of amphibians and reptiles combined) that carries a larger-than-life image in the international herpetological arena. The Japanese Giant Salamander (*Andrias japonicus*), a huge aquatic amphibian, is a folklore legend, often called hanzaki or hanzake, literally "cut in half" which refers to the superstitious assumption that it will regenerate itself even if cut in half. From early years it has been sought out by overseas zoos and aquariums. Aforementioned Rotterdam Zoo had one in its inventory as of 1858 (Visser 2003); the first captive breeding in the world took place in the Amsterdam Aquarium in 1903 (van Bruggen 2003). The species has been on the short list of candidates for good-will animal ambassadors along with the Manchurian Crane (*Grus japonensis*) and the Japanese Macaque (the so-called Snow Monkey, *Macaca fuscata*). Not too long after WWII a request for giant salamanders was made by William Mann, director of National Zoo in Washington, DC. At this time Japan was still under occupation, and the shipment was arranged through the office of General Douglas MacArthur of the Supreme Commander of the Allied Powers General Headquarters. In May 1947, 15 specimens were flown to Washington, DC, by an American military aircraft. Giant salamanders have since been sent to overseas institutions every now and then (Ueno Zoo 1982), including another group to the National Zoo in 2010.

In earlier times, this charismatic amphibian became the subject of research by Japanese scientists after the arrival of modern zoology from the West. As for zoos and aquariums, beginning in the 1970s, Asa Zoo and Himeji Aquarium have made significant contributions concerning this species in field research, husbandry, captive breeding, and public education, resulting in numerous publications. (Since 2005, the Himeji Aquarium program has basically been transferred to the Japan Hanzaki Institute.) Recent accomplishments have been introduced in English publications (e.g., Kawata 2006, 2008; Murphy 2007) and this article does not reiterate the work by Japanese biologists.

Husbandry.—The giant salamander programs stand out, and should be a model for similar programs for indigenous species. However, college-educated biologists assigned to herpetological collections are a relatively new phenomenon in Japan. Attempts to cultivate husbandry methods beyond feeding and cleaning

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FIG. 9. Daruma Pond Frogs (*Pelophylax porosus*). A) adult; B) amplectant pair.

seem to have begun about four decades ago. It appears also, that the last three decades have seen more written accounts being published in various periodicals, almost all in Japanese. The variety of species covered by authors has also increased with time. These articles range from "case reports" of breeding and care procedures, to long-range reviews and data analysis. The contents of such reports often are intertwined with husbandry protocol, breeding, research, and conservation, and it becomes tricky to divide them into rigid categories. Here follow examples of analytical accounts beyond daily care procedures. Being surrounded by oceans, interest in marine biology is high in this island nation, represented by articles on sea turtles.

The staff of Enoshima Aquarium compiled data on sea turtles from 42 aquariums and 30 zoos as of July 1970 on the number, locations of collection, captive environments, feeding practice, diseases, sizes and weights, and longevity. The number in captivity was 326 in six taxa (Anon. 1970). More than three decades later, as the number in captivity flourished, breeding in captivity had taken place and awareness of sea turtle conservation was rising, Kamogawa Sea World staff conducted an update of the national survey, collecting data from 61 aquariums and 70 zoos as of December 2003. The number jumped to 842 in five taxa; in addition, there were 16 hybrids including those between Loggerhead and Green Turtles, and between Loggerhead and Hawksbill Turtles (Anon. 2006). As for unusual species, the former account reported that prior to 1970, 16 aquariums kept Leatherback Turtles (*Dermochelys coriacea*) but all adults died within one month (exceptionally a juvenile lived for 16 months), indicating the difficulty in maintaining this turtle in captivity. In fact there exist only a limited number of Japanese articles on this species. One of them deals with feeding practice, episodes of injuries and healing in an adult, kept at Shimonoseki Aquarium for 10 months at the time of writing (Oka et al. 1983). Another is a brief note from Kushimoto Marine Park Center, reporting of a specimen kept in a pool made of tent canvas (to avoid injuries on the snout); it passed benchmark duration of 250 days (Miyawaki 1984).

Breeding.—In 1957 JAZGA inaugurated the annual First Breeding Award, to be issued to member institutions that bred a species successfully for the first time in the country. Applicants must follow strict guidelines. Only entries based on records after 1945 can be considered and offspring conceived *in situ* will not be acceptable. Moreover, the offspring must survive for half a year to qualify (JAZA 2005). These rules can filter out viable data that might not reflect actual records. A case in point: the White-naped Crane (*Grus vipio*) reproduced in Kyoto Zoo shortly after its opening in 1903 although the exact date is not clear (Takizawa 1986); the Award was given to a zoo for a 1953 breeding. Also, behind the rewarded "first" there may have been neonates that perished before the required duration was met; such a rule may be taken as mammal-biased. The Award, nevertheless, encourages member institutions to promote captive breeding, and it also serves as an indicator of the accomplishments by members. Table 3 depicts the awarded taxa, and for the above reasons, it should highlight the selected or representative taxa that have been bred successfully by Japanese zoos and aquariums.

Some of the recipient institutions closed since, or are no longer JAZA members. Also, modifications were necessary when interpreting JAZA data for the table. The First Breeding Award rules allow multiple-award issuances for the same taxon under separate categories, such as via artificial insemination, artificially incubated, parent-raised, hand-reared, and the like. However, Table 3 takes only the first entry of a taxon and thus, the second and succeeding awards for the same taxon in the original documents were deleted. The Awards are also issued for full species as well as subspecies within the same species, again resulting in multiple issuances for one species. Table 3 follows this rule, therefore *Terrapene carolina* has been admitted as a full species as well as for subspecies. It might be noted also, that many award winners may represent single occurrences, and their offspring do not always establish self-sustainable, multiple-generation breeding groups.

A quick glance at the table reveals growing trends that began in the 1990s. Long-established, elite zoos in big cities, namely Ueno and Tennoji, used to be the domineering presence by breeding practically all classes of terrestrial tetrapods. Today they still project an impressive image (e.g., since the 1980s, Ueno has bred numerous small amphibian and reptile species). Increasingly, however, small to medium-sized zoos and emerging new aquariums, many of them lesser known, began to catch up.

TABLE 3. Selected taxa of amphibians and reptiles bred in Japanese collections, 1967–2008. Data have been tabulated from the following, all in Japanese: New Husbandry Handbook: Breeding and Related Material (2005), Japanese Association of Zoos and Aquariums (JAZA); Journal of JAZA 47/1, 47/2, 2006; 48/1, 48/2, 2006; 49/1, 2008; 50/2, 2009a; 51/1-2, 2010a. No breeding awards were issued for amphibians and reptiles for 1970, 1973, 1974, and 1982.

Year	Species	Collection
1967	Asian Rock Python, *Python molurus*	Ueno Zoo
1968	Diadem Snake, *Spalerosophis arenarius*	Ueno Zoo
	Speckled Kingsnake, *Lampropeltis getula holbrookii*	Ueno Zoo
	Rainbow Boa, *Epicrates cenchria maurus*	Ueno Zoo
1969	Leopard Gecko, *Eublepharis macularis*	Ueno Zoo
	Diadem Snake, *Spalerosophis diadema atriceps*	Ueno Zoo
1971	Ball Python, *Python regius*	Ueno Zoo
1972	Fire Salamander, *Salamandra salamandra*	Ueno Zoo
	Spectacled Caiman, *Caiman crocodilus*	Oga Aquarium
	West African Dwarf Crocodile, *Osteolaemus t. tetraspis*	Ueno Zoo
1975	Kenyan Sand Boa, *Eryx colubrinus loveridgei*	Asa Zoo (Hiroshima)
	Four-lined Ratsnake, *Elaphe obsoleta quadrivirgata*	Kyoto Zoo
	Taiwan Beauty Snake, *Orthriophis t. taeniura*	Tennoji Zoo (Osaka)
1976	Yellow-margined Box Turtle, *Cuora evelynae*	Ueno Zoo
	Paraguayan Caiman, *Caiman crocodilus yacare*	Nihondaira Zoo (Shizuoka)
1977	Florida Kingsnake, *Lampropeltis getula floridana*	Kyoto Zoo
	Yellow Anaconda, *Eunectus notaeus*	Tennoji Zoo
1978	Spotted Turtle, *Clemmys guttata*	Himeji Aquarium
	Puff-faced Watersnake, *Homalopsis buccata*	Tennoji Zoo
1979	Japanese Giant Salamander, *Andrias japonicus*	Asa Zoo
	Siamese Crocodile, *Crocodylus siamensis*	Nagashima Tropical Botanical Garden
1980	Reticulated Python, *Broghammerus reticulatus*	Takarazuka Zoo
	Water Monitor, *Varanus salvator*	Maruyama Zoo (Sapporo)
1981	Alligator Snapping Turtle, *Macrochelys temminckii*	Nagashima Sunny
1983	Hida Salamander, *Hynobius kimurae*	Kyoto Zoo
	Asian Brown Pond Turtle, *Mauremys mutica*	Himeji Aquarium
	Gulf Coast Bay Turtle, *Terrapene carolina major*	Miyazaki Safari Park
	Leopard Tortoise, *Stigmochelys pardalis*	Miyazaki Safari Park
	Corn Snake, *Pantherophis guttatus*	Yagiyama Zoo (Sendai)
1984	Red-footed Tortoise, *Chelonoidis carbonaria*	Kyoto Zoo
	South American Slider, *Trachemys scripta*	Yagiyama Zoo
	Congo Dwarf Crocodile, *Osteolaemus tetraspis osbornii*	Asa Zoo
1985	Asian Water Dragon, *Physignathus cocincinus*	Yagiyama Zoo
1986	New Guinean Snake-necked Turtle, *Chelodina novaeguineae*	Kyoto Zoo
	Snapping Turtle, *Chelydra serpentina*	Toba Aquarium
	California Kingsnake, *Lampropeltis getula californiae*	Asa Zoo
1987	Red-eyed Tree Frog, *Litoria chloris*	Ueno Zoo
	Eastern Box Turtle, *Terrapene c. carolina*	Asa Zoo
	Yellow Ratsnake, *Pantherophis o. obsoletus*	Tennoji Zoo
1988	Black Marsh Turtle, *Siebenrockiella crassicollis*	Himeji Aquarium
	Blood Python, *Python curtus*	Nihondaira Zoo
1989	Toad-headed Turtle, *Mesoclemmys gibba*	Korankei Snake Center
	Australian Snake-necked Turtle, *Chelodina longicollis*	Himeji Aquarium

TABLE 3. Continued.

Year	Species	Collection
1990	Reed Frog, *Hyperolius horstokii*	Higashiyama Zoo
	Green Tree Frog, *Hyla cinerea*	Higashiyama Zoo
	Ornate Horned frog, *Ceratophrys ornata*	Ueno Zoo
	Oriental Fire-bellied Toad, *Bombina orientalis*	Higashiyama Zoo
	East African Black Mud Turtle, *Pelusios subniger*	Izu Andyland
	Large-headed Mud Turtle, *Sternotherus m. minor*	Izu Andyland
	Yellow-spotted Amazon River Turtle, *Podocnemis unifilis*	Himeji Aquarium
	Australian Big-headed Turtle, *Emydura macquarii*	Izu Andyland
	Brown Basilisk, *Basiliscus vittatus*	Higashiyama Zoo
	Lined Gecko, *Gekko vittatus*	Higashiyama Zoo
	Tokay Gecko, *Gekko gecko*	Yagiyama Zoo
	Moorish Gecko, *Tarentola mauritanica*	Higashiyama Zoo
1991	Knight Anole, *Anolis equestris*	Higashiyama Zoo
	Milksnake, *Lampropeltis triangulum*	Higashiyama Zoo
	Western Ribbonsnake, *Thamnophis proximus*	Higashiyama Zoo
	Siebenrock's Snake-necked Turtle, *Chelodina steindachneri*	Toyohashi Zoo
	Okada's Five-lined Skink, *Plestiodon latiscutatus*	Ueno Zoo
1992	Japanese Warty Newt, *Echinotriton andersoni*	Nagasakibana Parking Garden
	Sword-tailed Newt, *Cynops ensicauda*	Nagasakibana Parking Garden
	d'Orbigny's Toad, *Rhinella dorbighyi*	Asa Zoo
	Amami Green Tree Frog, *Rhacophorus viridis amamiensis*	Nagasakibana Parking Garden
	Ryukyu Kajika Frog, *Buergeria japonica*	Nagasakibana Parking Garden
	Egyptian Tortoise, *Testudo kleinmanni*	Nogeyama Zoo (Yokohama)
	Brown Basilisk, *Basiliscus basiliscus*	Yagiyama Zoo
1993	Ishikawa's Frog, *Odorrana ishikawae*	Nagasakibana Parking Garden
	Red-bellied Short-necked Turtle, *Emydura subglobosa*	Toba Aquarium
	Spot-bellied Side-necked Turtle, *Phrynops hilarii*	Toba Aquarium
	Aldabra Tortoise, *Dipsochelys dussumieri*	Izu Andyland
	Green Crested Basilisk, *Basiliscus plumifrons*	Kusatsu Tropicana
	Blue-tongued Skink, *Tiliqua scincoides*	Higashiyama Zoo
	Hibakari, *Amphiesma v. vibakari*	Ueno Zoo
	African Rock Python, *Python sebae*	Tobe Zoo
	Uracoan Rattlesnake, *Crotalus durissus vegrandis*	Ueno Zoo
	Hime Habu, *Ovophis okinavensis*	Nagasakibana Parking Garden
1994	Ryukyu Brown Frog, *Rana "okinavana"*	Nagasakibana Parking Garden
	Rice Frog, *Occidozyga diminutivus*	Kusatsu Tropicana
	New Guinea Snapping Turtle, *Myuchelys novaeguineae*	Toba Aquarium
	Eastern Mud Turtle, *Kinosternon subrubrum*	Osaka Aquarium
	Sakishima Tree Lizard, *Japalura polygonata ishigakiensis*	Ueno Zoo
1995	Misty Salamander, *Hynobius nebulosus*	Nagasakibana Parking Garden
	Green-and-black Poison Dart Frog, *Dendrobates auratus*	Higashiyama Zoo
	Green Anaconda, *Eunectus murinus*	Sasebo Subtropical Zoo & Botanical Garden
	Loggerhead Sea Turtle, *Caretta caretta*	Kushimoto Marine Park Center
	Prehensile-tailed Skink, *Corucia zebrata*	Asahiyama Zoo
	Frilled Lizard, *Chlamydosaurus kingii*	Kusatsu Tropicana
	Blue Spiny Lizard, *Sceloporus cyanogenys*	Tennoji Zoo
	Warren's Girdle-tailed Lizard, *Smaug warreni*	Tennoji Zoo
	Elongated Tortoise, *Indotestudo elongata*	Izu Andyland
1996	Tohoku Salamander, *Hynobius lichenatus*	Marinpia Matsushima Aquarium
	Green Iguana, *Iguana iguana*	Kyoto Zoo
	Madagascar Giant Day Gecko, *Phelsuma madagascariensis*	Kusatsu Tropicana
	Ryukyu Watersnake, *Amphiesma p. pryeri*	Nagasakibana Parking Garden
1997	African Clawed Frog, *Silurana tropicalis*	Toba Aquarium
	Rio Madeira Poison Dart Frog, *Adelphobates quinquevittatus*	Higashiyama Zoo
	Geoffroy's Side-necked Turtle, *Phrynops geoffroanus*	Toba Aquarium
	Asian Brown Tortoise, *Manouria emys*	Nogeyama Zoo
	Peninsula Cooter, *Pseudemys peninsularis*	Tennoji Zoo
	Star Tortoise, *Geochelone elegans*	Oji Zoo (Kobe)
	Chinese Watersnake, *Enhydris chinensis*	Izu Andyland

TABLE 3. Continued.

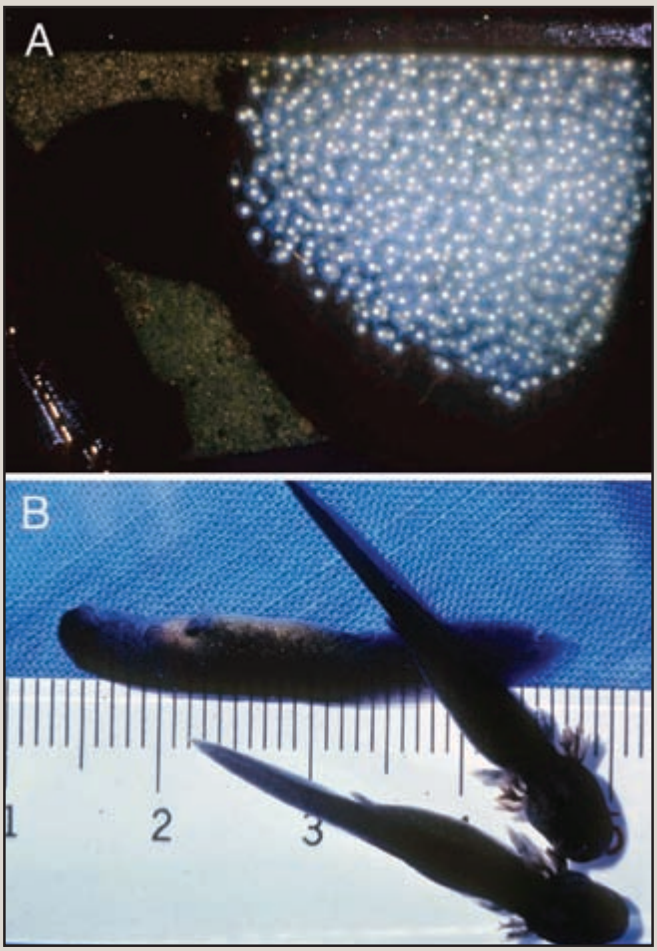
Year	Species	Collection
1998	Smoky Jungle Frog, *Leptodactylus pentadactylus*	Toba Aquarium
	Poison Dart Frog, *Epidobates tricolor*	Toba Aquarium
	Annam Leaf Turtle, *Mauremys annamensis*	Izu Andyland
	Pacific Boa, *Candoia carinata*	Ueno Zoo
1999	Emperor Newt, *Tylototriton verrucosus*	Higashiyama Zoo
	Yellow-and-blue Poison Dart Frog, *Dendrobates tinctorius*	Higashiyama Zoo
	Kokoe-pa Poison Dart Frog, *Oophaga histrionicus*	Higashiyama Zoo
	Yellow-banded Poison Dart Frog, *Dendrobates leucomelas*	Port of Nagoya Public Aquarium
	Golfodulcean Poison Dart Frog, *Phyllobates vittatus*	Port of Nagoya Public Aquarium
	Cuban Tree Frog, *Osteopilus septentrionalis*	Sunshine Aquarium
	South American Waxy Tree Frog, *Phyllomedusa hypocondrialis*	Toba Aquarium
	Green Turtle, *Chelonia mydas*	Okinawa Expo Aquarium
	African Pancake Tortoise, *Malacochersus tornieri*	Ueno Zoo
	African Spurred Tortoise, *Geochelone sulcata*	Kofu Yuki Park Zoo
2000	Otton Frog, *Rana subaspera*	Nagasakibana Parking Garden
	Bicolored Poison Dart Frog, *Phyllobates bicolor*	Port of Nagoya Public Aquarium
	Isla Mona Robber Frog, *Eleutherodactylus monensis*	Toba Aquarium
	Common Mud Turtle, *Sternotherus odoratum*	Izu Andyland
	Three-toed Box Turtle, *Terrapene carolina triunguis*	Kofu Yuki Park Zoo
	Inland Bearded Dragon, *Pogona vitticeps*	Tobu Zoo
	Common Blind Snake, *Ramphotyphlops braminus*	Ueno Zoo
2001	Hokuriku Salamander, *Hynobius takedai*	Ishikawa Zoo
	River Terrapin, *Pangshura tecta*	Nogeyama Zoo
	Burmese Star Tortoise, *Geochelone platynota*	Higashiyama Zoo
	Chinese Alligator, *Alligator sinensis*	Maruyama Zoo
2002	Florida Red-bellied Turtle, *Pseudemys nelsoni*	Tennoji Zoo
2003	Hawksbill Turtle, *Eretmochelys imbricata*	Port of Nagoya Public Aquarium
	Chinese Eyelid Gecko, *Goniurosaurus luii*	Higashiyama Zoo
	Yellow-billed Watersnake, *Enhydris plumbea*	Toba Aquarium
	False Gavial, *Tomistoma schlegelii*	Kusatsu Tropicana
2004	European Yellow-bellied Toad, *Bombina variegata*	Tennoji Zoo
	Indochinese Box Turtle, *Cuora galbinifrons*	Maruyama Zoo
	Johnson's Crocodile, *Crocodylus johnsoni*	Atagawa Tropical & Alligator Garden
2005	Schlegel's Foam-nest Frog, *Rhacophorus schlegelii*	Osaka Aquarium
	Surinam Toad, *Pipa pipa*	Noichi Park Zoo
	Splashback Poison Dart Frog, *Adelphobates galactonotus*	Sunshine Aquarium
	Common Watersnake, *Enhydris enhydris*	Toba Aquarium
2006	Lovely Poison Dart Frog, *Phyllobates lugubris*	Ueno Zoo
	Bell's Hingeback Tortoise, *Kinixys belliana*	Yokohama Zoo
	Forest Stumptail Chameleon, *Rieppeleon kerstenii*	Yokohama Zoo
	African Flat-tailed Gecko, *Hemitheconyx caudicinctus*	Fukuoka Zoo
2007	Japanese Black Salamander, *Hynobius nigrescens*	Gifu World Freshwater Aquarium
	Wrinkled Frog, *Glandirana rugosa*	Inokashira Park Zoo
	Central Asian Tortoise, *Testudo horsfieldii*	Chausuyama Zoo
2008	Japanese Brown Frog, *Rana japonica*	Tokyo Sea Life Park
	Fly River Turtle, *Carettochelys insculpta*	Port of Nagoya Public Aquarium

Along the way the variety of species that bred for the first time skyrocketed, as if it had passed the tipping point somewhere in recent history. Among the species, earlier years saw larger and "exotic" reptiles, such as giant snakes, frequenting the list. (To be fair, it is commendable to breed them, for it requires investment for larger captive spaces.) The newer data show reproduction by a wider range of families and genera, particularly smaller native species, both common and rare ones. Many of the latter are from small islands well off the mainland, and their ranges represent little dots on the map. This marks a significant step for professionals and public alike.

Japan forms a chain of islands strung out over a surprisingly vast area, and the general public has no idea about indigenous species from remote islands, such as those in the Okinawa region, home to unique wildlife. There is a need for the public to be made aware of these small living treasures, and having them in local zoos and aquariums signals a good start. Breeding results of these species seem to indicate refreshing interest taken by zoos and aquariums. Potentially, such successes could also signal the beginning of a departure from the tight grip by the aforementioned old-style duo of the typical municipal zoo. Symbolizing such a departure, possibly, are little-known small creatures with seemingly little public appeal, such as Sword-tailed Newt (*Cynops ensicauda*), Japanese Warty Newt (*Echinotriton andersoni*), Ishikawa's Frog (*Odorrana ishikawae*), Otton Frog (*Rana subaspera*), Ryukyu Brown Frog (*R. "okinavana"*), Amami Green Tree Frog (*Rhacophorus viridis*), Ryukyu Kajika Frog (*Buergeria japonica*), Sakishima Tree Lizard (*Japalura polygonata*), Hime Habu (*Ovophis okinavensis*), and Ryukyu Watersnake (*Amphiesma pryeri*).

Among examples of accounts on native species is a brief note on the Wrinkled Frog (*Glandirana rugosa*) from Inokashira Park Zoo in a Tokyo suburb, which indicates animal care employees' own initiative and interest in a common local species (Anon. 2009). For more uncommon species, a report from Nagasakibana Parking Garden reveals bits and pieces on reproductive biology of little known Ishikawa's Frog (*Odorrana ishikawae*), including reference to *in situ* survival of the larvae (Shiihara et al. 1995). As for common reptiles, an article on the breeding of the Japanese Burrowing Ratsnake (or earth snake, *Euprepiophis conspicillata*) at Yagiyama Zoo states that the opening of the reptile building in 1978 enabled the maintenance of parent snakes in an indoor setting (Takechi et al. 1984). This emphasizes the importance of such permanent facilities to accommodate the needs of the animals. The number and variety of taxa in Table 3 may not be impressive in the eye of experts in Western zoos, yet they reflect progress toward one of the goals of modern zoos and aquariums.

Research activities.—Herpetological research in zoos and aquariums tends to be empirical by nature. Much of the body of literature from Japan consists of applied fields and leans toward practicality, such as microbiological and pharmacological notes or pathological examinations by veterinarians, feeding methods, and data on reproductive biology. One report dealt with chemical immobilization of reptiles for sexing (Yamamoto et al. 1991); another was a summary of a 14-year experience in parasitology (Miyashita et al. 1987). Other accounts explore beyond the realm of problem-solving of daily care, and dig into more familiar areas of biology. For instance, Hatase (2001) made observations on parental behavior of the West African Dwarf Crocodile (*Osteolaemus tetraspis*). A rather unusual work by Doi (2005) reported that albino Black-spotted Pond Frogs (*Pelophylax nigromaculata*) were preferred over normal-colored individuals by predators.



PHOTOS BY ASA ZOO

FIG. 10. A) Eggs of the Japanese Giant Salamander (*Andrias japonicus*) and a defending male, den master (below left); B) larvae.

Among the published work inclined toward more analytical and quantitative bent are accounts on Loggerhead Turtles (*Caretta caretta*) by the staff of Port of Nagoya Public Aquarium. Opened in 1992, this newcomer has already laid down an impressive track record. However, inadvertently they have illustrated a familiar Japanese pattern, that in a technical domain such as scientific research, aquariums are ahead of zoos. Here follow a few examples. Authors helped to establish baseline values in hematologic characteristics and plasma chemistry in captive juvenile turtles, from one month to three years old (Kakizoe et al. 2007). Observations were also made on reproductive behavior, focusing on the relationship between mating history and reproductive successes of individual females, by fully utilizing the close proximity of subject animals in captivity, and sophisticated equipment such as supersensitive cameras (Sakaoka et al. 2007). Furthermore, they investigated the effects of the order of sequential matings in females on the paternity of their successive clutches (Sakaoka et al. 2011).

Ex situ conservation.—In 1988, the JAZGA (now JAZA) board created the Species Survival Committee of Japan, or SSCJ, to formulate a collective species management program similar to European Endangered Species Programme (EEP) in Europe, Joint Management of Species Group (JMSG) in the British Isles, and Species Survival Plan (SSP) in North America. An initial list of 32 taxa was heavily mammalocentric, with no amphibians or reptiles. During the conference in the following year the Japanese Giant Salamander was added. A coordinator was assigned

FIG. 11. Loggerhead Sea Turtles (*Caretta caretta*) copulating.

FIG. 12. Ovipositioning of a Loggerhead Sea Turtle (*Caretta caretta*) in an indoor facility.

FIG. 13. Emergence of Loggerhead Sea Turtle hatchlings.

FIG. 14. Hand-feeding of a Leatherback Sea Turtle.

to each taxon to oversee the program (Kawata 1991). By 2008, 15 herp species were on the list as follows: Japanese Giant Salamander (*Andrias japonicus*), Hokuriku Salamander (*Hynobius takedai*), Hakuba Salamander (*H. hidamontanus*), Japanese Warty Newt (*Echinotriton andersoni*), Ishikawa's Frog (*Odorrana ishikawae*), Aldabra Tortoise (*Dipsochelys dussumieri*), Radiated Tortoise (*Astrochelys radiata*), Spotted Pond Turtle (*Geoclemys hamiltonii*), Indian Roof Turtle (*Pangshura tecta*), Ryukyu Black-breasted Leaf Turtle (*Geoemyda japonica*), Chinese Alligator (*Alligator sinensis*), Dwarf Crocodile (*Osteolaemus t. tetraspis*), Gharial (*Gavialis gangeticus*), False Gavial (*Tomistoma schlegelli*), and Ryukyu Ground Gecko (*Goniurosaurus kuroiwae*) (JAZA 2009b).

During 2007, the ninth conference of amphibians and reptiles and the fourth giant salamander conference were held for various issues and problems. On the agenda for the 2008 SSCJ conference were timely topics, such as the Amphibian Ark Year of the Frog campaign, and JAZA was to participate in public education to increase the awareness concerning the critical status facing frogs of the world. Also, preventative strategies were discussed to keep the chytrid infection from spreading (JAZA 2009b).

In situ conservation.—More recently, interest in indigenous species and conservation activities have been gradually increasing across the country. (The giant salamander program represents by far the most significant accomplishment by zoo and aquarium staff; see above for references.) Subject species range from the larger and more prominent, to smaller and less noticeable to the general public. As an example for the former, Hitachi Zoo staff noted that the local coastal area is close to the northernmost breeding beaches of the Loggerhead Turtle in Japan. Eggs are often in vulnerable conditions, prompting zoo staff to collect and artificially incubate them and release the neonates. Between 1976 and 1992, 604 eggs were collected, 233 hatched and neonates were released (Oikawa 1993).

The Japanese Fire-bellied Newt (*Cynops pyrrhogaster*) was once considered a common species with a wide distribution. It now has disappeared almost completely from lowlands for many reasons (Goris et al. 2004). Beginning in 2002, staff members from Tama and Inokashira Park Zoos have been gathering various basic ecological data in the nearby field (e.g., Nakamura et al. 2008). Compared to this species, the Misty Salamander (*Hynobius nebulosus*) has a smaller distribution in western Japan, and its habitat is believed to be rapidly disappearing. Upon request by a municipal government in 2007, the staff of Gifu World Freshwater Aquarium took the first step toward saving the species by keeping egg sacs and larvae in captivity from collectors. This was an emergency measure, and future approaches include coordination of activities by various agencies (Tanoue et al. 2008). Another smaller institution with limited resources, Wanpaku Kochi Animal Land, made it an institutional commitment to inaugurate a conservation program of the locally threatened Oita Salamander (*Hynobius dunni*) in 2001. The staff has collected basic data on ecology and reproductive biology (Nakanishi et al. 2005). A similar project began in 2008 for the Japanese Black Salamander (*Hynobius nigrescens*) by another smaller institution, Nagano

PHOTO BY KEN KAWATA

Fig. 15. Atagawa Tropical Garden & Alligator Farm.

Chausuyama Zoo, after the staff was inspired by the international Year of the Frog campaign (Takada 2010).

For centuries, rice paddies in Japan provided home for wildlife including frogs, which harmoniously coexisted with humans. The Daruma Pond Frog (*Pelophylax porosus brevipoda*) spends its entire life in the rice paddies. As development began to encroach into rural areas its safe haven now faces serious threats. In 2008, construction site preparation was being planned in the frog's habitat in Hiroshima Prefecture, at the western limits of its distribution. To save them from certain destruction, 232 larvae were captured and taken to five organizations including Asa Zoo, a medium-sized zoo opened in Hiroshima in 1971. Thus began the zoo's conservation project, to breed and release the frogs into safer areas as well as to educate the public, especially children, about the importance of this native species. A breeding tank and overwintering facilities have been set up, where the frogs matured and began breeding in June 2005.

A total of 1600 tadpoles were hatched, and in July 2005 they were released at two new sites. In such a project it is vital for local residents to participate, and the staff made every effort to develop rapport with them. In one county the cooperation of the local people was obtained when the zoo staff conducted a meeting, attended by hundreds of enthusiastic residents along with elementary school students. Releases have continued every year in this community, and survival and breeding have subsequently been confirmed. Establishment at another site remains unconfirmed, and plans are being made to improve conditions at the site. The frogs are also on exhibit at Asa Zoo, and events are held to highlight the plight of the frogs (Chamura et al. 2008). Thus Asa Zoo, which inaugurated the pioneering giant salamander conservation project in the early 1970s, continues to make contributions to conserve native wildlife.

Envoy

For a special issue on herpetology for *Zoo Biology* in 1996, recruitment for authors was made: "…we sought colleagues who were conducting research at zoos and those at academic institutions who were conducting research that had relevance to zoo herpetology. Numerous workers have recently made compelling arguments that increased interactions between academic and zoo biologists would be mutually beneficial. They identified several areas of research that seemed important and would make wise use of the often under-utilized herpetological collections of zoos. A few key areas identified were stress and husbandry, competence of captive animals, and veterinary herpetology" (Garrett et al. 1996). What surfaces from this brief note, made a decade and a half ago, is the keen awareness for the need of productive interactions and collaborations between the two worlds. It also points up the existence of a core group of herpetologists, who have been the source of activities and published accounts.

By comparison, to the best of my knowledge Japan has yet to produce such a core group, despite persistent efforts by a small number of individuals. I often wonder if this lack of crystallization of a core group is partly due to Japan's culture that uniquely discourages individualism, embodied by the saying: "A nail that sticks out shall be hammered down." The culture does not allow an outstanding individual to grow, develop, and become visible. A potential high achiever is often forced to blend into the very fabric of the society: group loyalty and acceptance. Cultural difference or not, however, an embryonic movement in zoo herpetology has already begun, albeit slowly, as indicated in this account. From all indications the seed has been sown, and the movement is there to stay, but still largely unnoted by the Western zoo world. What will the future hold? This article is meant to be a brief review. More detailed accounts, including those that cover future events, have to be published and preferably that will be the work of authors from Japan.

Acknowledgments.—This article is dedicated to my long-time friend Richard C. Goris, a native of Buffalo, New York. A resident of Japan since 1950, he was the principal mover in founding the Herpetological Society of Japan in 1967, for which he served 12 years as president. Dr. Goris has been a mentor to generations of herpetologists in Japan. I am grateful to the Japanese Association of Zoos and Aquariums for providing publications over the decades and to Mr. Katsunori Sotani of Tokyo for giving me access to related literature. Photos for this article have been generously provided by Ms. Yoriko Mochimaru of Tokyo Zoological Park Society, Messrs. Shinichiro Chamura of Asa Zoo, Ken Sakaoka of Port of Nagoya Public Aquarium, and Akiyoshi Nawa of Tokyo.

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A KERANGAS FOREST FLOOR (2011)

acrylic on illustration board 30" x 20"

Of all of Borneo's varied ecosystems, perhaps none is more surprising than the biologically impoverished (by equatorial standards) dwarf forests that occur throughout the island, but more commonly in the west. The ecologist P. W. Richards called them "heath forests" after the similarly infertile lands of his native England, but they're better known by the Iban term *kerangas*, which means "land which will not support rice cultivation." Kerangas soil is typically acidic, sandy, and podzolized, or heavily leached. Essential elements enter the soil from decaying leaf litter, but most of these—magnesium, carbon, nitrogen, and calcium in particular—leach away very quickly, and are only available in the top few inches. Phosphorus seems to leach away more slowly. Continual deposition of leaf litter is critical to the system, and disease, fire, and logging or clearing for agriculture will convert kerangas to a barren habitat dominated by grasses and sedges known as *padang* ("field" in Malay).

Despite the poor soil, healthy kerangas forests are dense with trees, most of them under 30 feet tall and three inches in diameter. In contrast to most equatorial forests, only a few species are represented. Dominant tree species usually belong to the mangosteen family, Clusiaceae, and to one or more of the genera *Cratoxylum*, *Calophyllum*, and *Ploiarium*. Orchids show the greatest species diversity among kerangas plants, and terrestrial as well as epiphytic species are usually in evidence. Species of melastomes, laurels, myrtles, and gingers are also commonly represented.

Many kerangas plant species bear nitrogen-fixing bacterial nodules on their roots, and carnivorous plants also thrive. Borneo's kerangas forests are a center of diversity for the pitcher plant genus *Nepenthes*, which trap insects in leaves that are modified into water-bearing pitchers. At least one Bornean species, *N. rajah*, secretes a nectar that attracts tree shrews whose droppings are captured in the pitcher to nourish the plant. In perennially wet padang habitat, Bladderworts (*Utricularia* spp.) and Sundews (*Drosera* spp.) also trap small arthropods. Another famous kerangas denizen is the epiphytic ant plant (*Hydnophytum* spp.), which forms a symbiotic relationship with ants, providing them shelter, while receiving protection from the colony and nutrients from its wastes.

This painting depicts a small patch of kerangas forest floor. Included in the leaf litter are shed leaves of the dominant tree *Cratoxylum glaucum* and shed needles of the podocarp (primitive conifer) *Dacrydium becarii*. Various mosses of the family Calymperaceae and the showy terrestrial slipper orchid *Paphiopedilum javanicum* grow from the soil and a single dried *Nepenthes ampullaria* pitcher sits on the floor while pitchers of *N. stenophylla* hang from epiphytic vines. Duméril's Monitor (*Varanus dumerilii*) occurs near rivers in various types of forest throughout the island. The hatchlings, like the one shown, are well known for their striking coloration. It has been suggested that the colors, which begin to fade at the age of six weeks, mimic the dangerously venomous Red-headed Krait (*Bungarus flaviceps*), which shares its Southeast Asian range. Among Borneo's diverse and beautiful dragonflies, probably none is more conspicuous than the Red Swampdragon (*Agrionoptera insignis*), a member of the skimmer family, Libellulidae. Other subjects include the left-handed land snail *Dyakia kintana* and a Giant Forest Ant (*Camponotus gigas*), whose dimorphic workers forage for honeydew and other organic matter on the ground and in the canopy. At over an inch in length, the major workers of this species are among the world's biggest ants. Finally, a procession of *Longipeditermes longipes* termites returns to the nest with balls of lichen in tow. Both the workers and soldiers of this monotypic genus come in two sizes. Like other members of their subfamily, Nasutitermes, the heads of the soldiers are distorted into nozzles, through which they can spray noxious chemicals at enemies, chiefly ants.

The Artist

With over 20 years as a professional artist, naturalist, and author, **Carel Pieter Brest van Kempen's** artistic mission has always been to deepen awareness of the natural world and how it functions. His work has been exhibited worldwide in such venues as The Smithsonian, The American Museum of Natural History, The British Museum, and The National Museum of Taiwan. He has been named a "Most Honored Artist of Utah" (2002) and a "Master Signature Member" of the Society of Animal Artists (2008). He has illustrated over a dozen books, including *Dinosaurs of Utah* (1998), *Biology of the Gila Monsters and Beaded Lizards* (2005), *Biology of the Boas and Pythons* (2007), *Urban Herpetology* (2008), and *Conservation of Mesoamerican Amphibians and Reptiles* (2010), and authored the popular coffee-table book, *Rigor Vitae: Life Unyielding* (2006). His touring one-man show, "Biodiversity in the Art of Carel Pieter Brest van Kempen" has most recently been held over at the Hiram Blauvelt Art Museum in New Jersey through June of 2012. Additional paintings may be viewed at: http://www.cpbrestvankempen.com/.

ARTICLES

Herpetological Review, 2012, 43(2), 226–230.

Genetic Identity, Geographic Ranges, and Major Distribution Records for Frugivorous Monitor Lizards of Luzon Island, Philippines

Some of Southeast Asia's most enigmatic reptile species include the arboreal, frugivorous monitor lizards of the central and northern Philippines (Auffenberg 1988; Gaulke and Curio 2001; Welton et al. 2010). Comprised of just three known species, this morphologically, ecologically, and phylogenetically distinct group has even been assigned to its own subgenus, *Philippinosaurus* (Mertens 1962; Pianka et al. 2004) on the basis on cranial features and dentition.

Knowledge on the biology of the Philippines' frugivorous monitor lizards has been slow to accumulate. The first known species (*Varanus olivaceus*, of Luzon, Polillo, and Catanduanes islands; Fig. 1) has been shrouded in mystery and confusion from the time that it first became known to science (Gray 1845; Hallowell 1857; Mertens 1942a–c, 1959, 1962; Taylor 1922). For more than a century it was thought to be extinct, until a rediscovery made possible the first thorough taxonomic description (Auffenberg 1976). Later Auffenberg (1988) performed extensive studies of its diet, natural history, habitat, home range ecology, and demographic population structure. Unfortunately, no additional studies on this elusive and poorly known species have been published in peer-reviewed, scientific literature.

In 2001, Gaulke and Curio (2001) published the description of an exceptionally rare and severely threatened second species in this group, *V. mabitang*. The biology of this species has been studied in some detail and we now have a general appreciation of its diet, ecology, geographic range (Gaulke et al. 2002, 2005; Gaulke 2005, 2010; Gaulke and Demegillo 2008) and conservation status ("Vulnerable;" IUCN 2011) on Panay Island.

A third species, *V. bitatawa*, was described in 2010 (Welton et al. 2010; Siler et al. 2010) in the central and northern Sierra Madre Mountain Range of Luzon Island (Fig. 1). Although the study by Welton et al. (2010) demonstrated the morphological, ecological, and phylogenetic distinctiveness of *V. bitatawa*, no additional data on its distribution, natural history, or conservation status have been forthcoming.

For the past several years, as part of extensive biodiversity studies aimed at understanding the patterns of distribution of Luzon's amphibians and reptiles (Brown et al. 1996, 2000, *in press*; Devan-song and Brown 2012; McLeod et al. 2011; Siler et al. 2010), we have accumulated additional distribution records and genetic samples for *Varanus olivaceus* and *V. bitatawa*. Because little to no new information for the Luzon faunal region has been provided, aside from the studies of Auffenberg (1988) and Welton et al. (2010), our new findings constitute major range extensions for both species. Additionally, to circumscribe geographic ranges and species boundaries, we present new genetic data from the northern and western-most records for both species. Our results greatly extend the known ranges of both species, bolster species boundaries, contribute to our current understandings of genetic divergence between the taxa, and provide new opportunities for studies of natural history and conservation genetics of these rare, endemic Philippine forest monitors.

Materials and Methods.—Field survey protocols have been reported in Brown et al. (1996, 2000), Diesmos et al. (2005), Siler et al. (2011), and McLeod et al. (2011). We obtained vouchered (preserved specimens deposited in the National Museum of the Philippines, PNM, and Biodiversity Institute, University of Kansas, KU) genetic samples from new localities for *V. olivaceus* and *V. bitatawa*, and supplemented Welton et al.'s (2010) mitochondrial dataset with new genetic sequences from the NADH dehydrogenase subunit 1 (*ND1*) and flanking tRNAs (Welton et al. 2010). Because we prefer to use specimens from known localities whenever possible, we did not include Ast's (2001) *V. olivaceus* sequence (obtained from a zoo animal), which is of unknown provenance. We follow the same methods reported in Welton et al. (2010), including primer identity and use, PCR amplification and sequencing protocols, purification techniques,

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alignment methods, targeted gene region, and methods for phylogenetic analysis (additional details are provided in the supplemental information accompanying Welton et al. [2010]). Thus, we added four additional sequences to the same *ND1* data set presented in Welton et al. (2010) and re-ran the same analyses, including the new genetic samples reported here. All specimens were initially identified on the basis of patterns of coloration (Fig. 2) and scalation (Auffenberg 1976, 1988; Welton et al. 2010). The *V. olivaceus* specimens included PNM 9726, from the boundary between the Municipalities of Polillo and Burdeos, Polillo Island; KU 322186 from the Municipality of Presentacion, Camarines Sur Province; KU 329517 from Angat Dam Watershed, Bulacan Province; PNM 9780 from Mt. Palaya-Palay, Cavite Province. The *V. bitatawa* samples include PNM 9719 (holotype), from the Municipality of Casiguran, Aurora Province; KU 322188 (paratype), the Municipality of San Mariano, Isabela Province; KU 330730, Barangay Magrafil, Municipality of Gonzaga, Cagayan Province; and KU 330636, Barangay Santa Clara, Municipality of Santa Clara, Cagayan Province. New mitochondrial gene sequences collected in this study are deposited in Genbank (KU Catalog numbers/Genbank Accession numbers: KU 329517/JQ413241, PNM 9780/JQ413242, KU 330636/JQ413243, KU 330730/JQ413244).

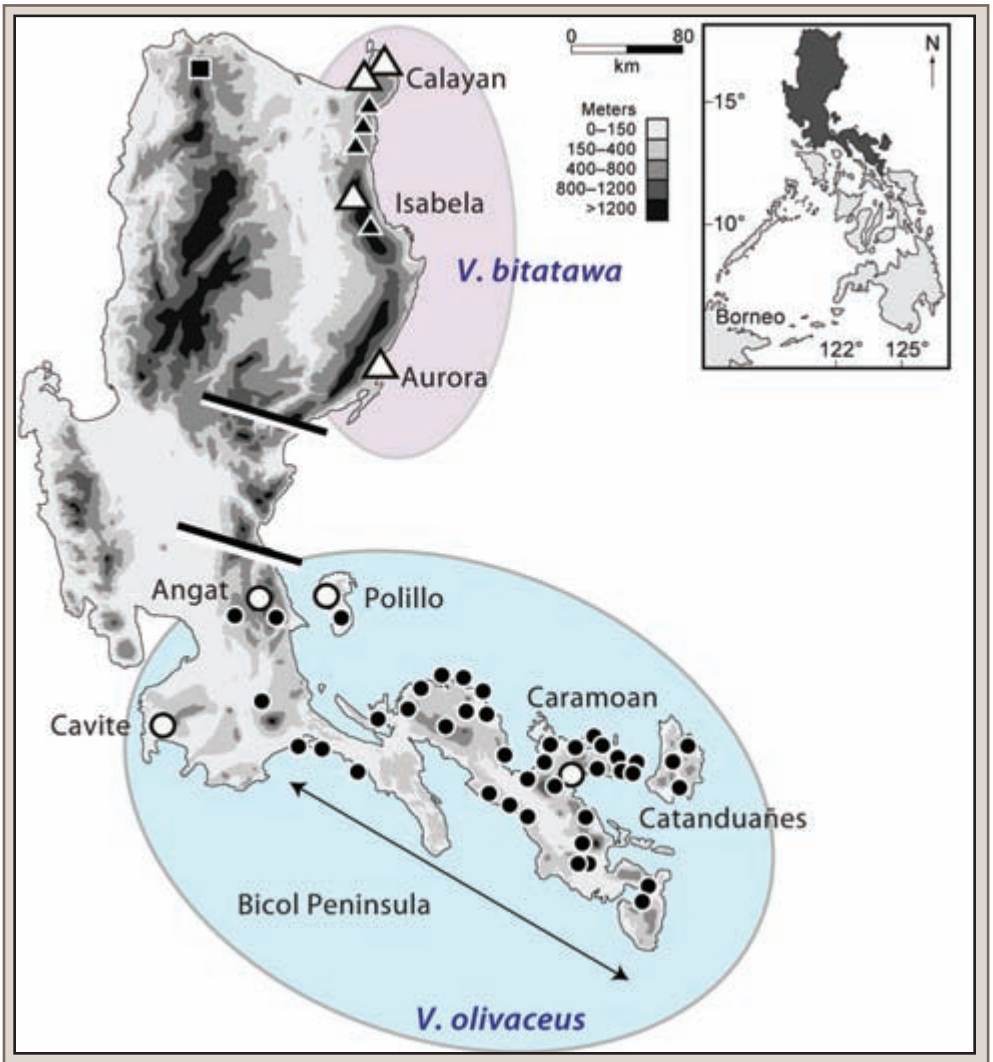

FIG. 1. Known distribution of Luzon's arboreal, frugivorous monitor lizard species. Circles denote known localities for *Varanus olivaceus*; triangles indicate vouchered localities for *V. bitatawa*. Small, closed symbols represent past records (Auffenberg, 1988; Welton, et al., 2010) and large, unshaded symbols are recent records for which genetic samples were available for the present study. The darkened square indicates the Municipality of Adams, where possible signs of an arboreal monitor lizard were observed in June 2011. Black bars indicate the approximate boundaries of the Mid-Sierra Filer Zone, as defined by Welton et al. (2010).

Results and Discussion.—Our record of *V. olivaceus* from the Angat Watershed of Bulacan Province constitutes the northernmost Luzon Island recorded occurrence for this species. Likewise the new specimen from Mt. Palay-palay, Cavite Province, represents the westernmost distributional record for *V. olivaceus*, and a major new range extension into the mountains of western Luzon, where no frugivorous or arboreal species of monitor lizard has ever been recorded (Auffenburg 1988; Devan-song and Brown 2012; Welton et al. 2010; Fig. 1). Finally, our new records of *V. bitatawa* from the Municipality of Gonzaga, Cagayan Province, constitute the northernmost records for this taxon.

Interestingly, despite targeted biodiversity surveys in the Municipalities of Maria Aurora and Mingan, Aurora Province (Siler et al. 2010), no known-locality records from within the 150 km gap, now recognized as the Mid-Sierra Filter Zone (Welton et al. 2010), have surfaced, although trade samples of uncertain provenance have been observed in markets in the town of Baler (ACD, pers. obs.). Although our new record of *V. olivaceus* from Angat Watershed narrows the distributional gap between the two species (Fig. 1), Welton et al.'s (2010) hypothesis that the Mid-Sierra Filter Zone may have led to the divergence of the two species still appears to be the best explanation for understanding the split between *V. olivaceus* and *V. bitatawa*. The coincident position of the three low-lying, arid river valleys (possibly serving as ecological barriers to dispersal for forest species; Welton et al. 2010), and the Lingayen-Dingalan geologic fault (possibly leading to physical isolation of species on different components of the Sierra Madre), within the Mid-Sierra Filter Zone (Defant et al. 1989; Yumul et al. 2003) are suggestive, but still do not provide definitive conclusions as to the exact mechanism of divergence between the two taxa.

The Mt. Palay-Palay, Cavite Province record of *V. olivaceus* was quite surprising, because no fruit-eating monitor species has ever been reported from western Luzon. This specimen could represent a natural occurrence of a population of *V. olivaceus* in

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PHOTO BY RMB

FIG. 2. Photograph in life of (above) *Varanus olivaceus* (Angat Dam Watershed Reserve, Bulacan Province) and (below) *V. bitatawa* (Municipality of Gonzaga, Cagayan Province).

PHOTO BY RMB

FIG. 3. *Varanus bitatawa* (KU 330636) as bush meat, frequently consumed by local Agta townspeoples, in Barangay Santa Clara, Municipality of Gonzaga, Cagayan Province).

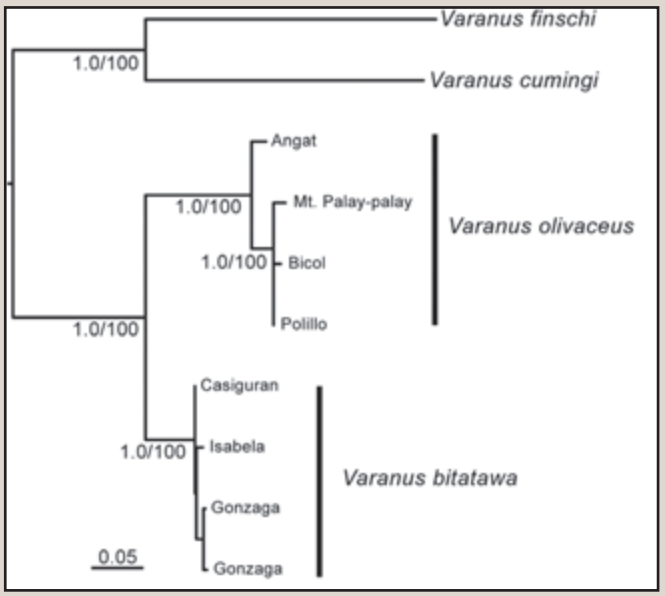

FIG. 4. Maximum likelihood phylogenetic estimate for Luzon frugivorous monitor lizards with support (Bayesian posterior probabilities/likelihood bootstraps) values plotted on selected nodes. Note presence of only minor intraspecific genetic variation within both species and the deep genetic split in *ND1* mitochondrial gene sequences between the two taxa.

the forests of southwestern Luzon, a relatively recent dispersal event (from eastern Luzon), or a human-mediated transplant. The fact that local hunters refer to *V. olivaceus* in Cavite Province with a unique common name, "Shabu," suggests to us that indigenous peoples in the area have a long cultural history with these animals. However, given the fact that illegally poached *V. olivaceus* individuals seized from pet traders have, in the past, been released in Mt. Palay-Palay National Park (C. Custodio, Protected Areas and Wildlife Bureau, Manila, pers. comm.), the possibility of an artificial transplant cannot be discounted. The lack of any appreciable genetic divergence between the Mt. Palay-Palay specimen and individuals from the Bicol faunal region and Polillo supports the interpretation of a recent dispersal event or transplant, but no strong conclusions can be derived from this study involving only a single locus and one mitochondrial gene fragment.

In the northernmost extent of the Sierra Madre Mountain Range, *V. bitatawa* is clearly a common species that constitutes an important food source for indigenous peoples' groups. During our three-week survey in the area in July–August 2010, we salvaged two specimens after they were snared in traps or hunted down by dogs belonging to Agta tribesmen (both specimens clearly were destined for immediate consumption by Agta family groups). Hunters interviewed in and around the Municipality of Gonzaga described *V. bitatawa* as a highly prized, commonly hunted, and valued trade item in the local bush meat market (Fig. 3).

To date, there are no substantiated records to suggest that arboreal, frugivorous monitor lizards are present in northwest Luzon. In 2011 we found characteristic scratch marks on fruiting *Pandanus* trees in the vicinity of Pagudpud, Ilocos Norte Province (Fig. 1; northern Cordillera Mountain Range) which suggests that *V. bitatawa* (or, possibly, some other arboreal and frugivorous species) may be present in the area (Brown et al., *in press*). Local residents at this site informed us of only one kind of *Varanus*, known locally as "Biawak," and described as a ground-dwelling species (clearly identifiable as *V. marmoratus*, the common Luzon water monitor). However, given the extreme secrecy of arboreal monitor lizards (Auffenberg 1988; Gaulke et al. 2002,

TABLE 1. Uncorrected pairwise sequence divergences (%, below diagonal) among individuals throughout the geographical ranges (sites in parentheses; see text) of *Varanus olivaceus* and *V. bitatawa*. *Varanus finschi* and *V. cumingi* were designated as outgroup in the phylogenetic analysis (Fig. 4).

		1	2	3	4	5	6	7	8	9	10
1.	*V. finschi*	—									
2.	*V. cumingi*	0.1550	—								
3.	*V. olivaceus* (Polillo)	0.1570	0.1651	—							
4.	*V. olivaceus* (Bicol)	0.1586	0.1663	0.0028	—						
5.	*V. olivaceus* (Bulacan)	0.1563	0.1642	0.0112	0.0146	—					
6.	*V. olivaceus* (Palay-palay)	0.1559	0.1697	0.0043	0.0043	0.0086	—				
7.	*V. bitatawa* (Aurora)	0.1551	0.1601	0.0374	0.0398	0.0396	0.0403	—			
8.	*V. bitatawa* (Isabela)	0.1606	0.1486	0.0622	0.0618	0.0442	0.0403	0.0034	—		
9.	*V. bitatawa* (Gonzaga–1)	0.1681	0.1486	0.0711	0.0740	0.0495	0.0389	0.0055	0.0078	—	
10.	*V. bitatawa* (Gonzaga–2)	0.1607	0.1461	0.0630	0.0650	0.0442	0.0431	0.0039	0.0061	0.0024	—

2005; Gaulke 2010; Welton et al. 2010), it remains distinctly possible that arboreal monitor lizard populations have yet to be discovered in the northern Cordillera Mountains.

Our preferred phylogenetic estimate (Fig. 4) suggests that specimens identified as *V. olivaceus* and *V. bitatawa* form clades of minimally divergent haplotypes and that the two species are sister lineages (Welton et al. 2010). Genetic divergence within each species was very low (*V. olivaceus* = 0.28–1.45; mean = 0.76%; *V. bitatawa* = 0.34–0.78; mean = 0.48%, Table 1) despite sampling from geographically distant extremes of the ranges of both species. The substantive genetic divergence between the two species (3.74–7.40; mean = 5.27%) (Fig. 4), and the topology of our inferred phylogenetic hypothesis provide further support for the recognition of two widespread, fruit-eating monitor lizard species, geographically partitioned on either side of Luzon's Mid-Sierra Filter Zone (Welton et al. 2010).

Although we have gathered important new data, bearing on the distribution, phylogeny and genetic identity of these poorly known monitor species, much work remains to be done. The IUCN currently lists *Varanus olivaceus* as "Vulnerable," with decreasing population trends "likely" (but unsubstantiated; IUCN 2011). Formal evaluations of the conservation status of *V. bitatawa* have yet to be undertaken. However, based on presumed habitat requirements (intact forest with the appropriate species of fruiting trees), and a clear conservation threat in the form of a substantial bush meat harvest, an informed, field data based, conservation status assessment for *V. bitatawa* would be desirable.

It should be emphasized, however, that for the continued existence of both species, the critical next step is actual field-based study of distribution patterns, natural history, diet, home range ecology, and habitat requirements throughout their known geographic ranges. Until these fundamental subjects receive at least some attention, effective conservation planning for these species will be very difficult, if not impossible (Brown et al., *in press*; IUCN 2011). Collection of these basic data would provide a solid foundation for an effective conservation action and management plan for Luzon's frugivorous monitor lizards and their unique forest habitats.

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Using a Species-Specif c Habitat Model Helps Identify Unprotected Populations of the Federally Threatened Red Hills Salamander (*Phaeognathus hubrichti*)

The Red Hills Salamander (*Phaeognathus hubrichti*) was listed as federally threatened by the U.S. Fish and Wildlife Service in 1976 (IUCN endangered; IUCN 2011) in response to concerns of local herpetologists regarding the impact of habitat degradation on the few known populations at the time (e.g., Jordan and Mount 1975; Mount 1975; Schwaner and Mount 1970). Since listing, research has reported that removal of canopy trees during timber harvest has a negative effect on the remaining populations of *P. hubrichti* (Dodd 1991; Godwin 2008). The federal listing of *P. hubrichti* has provided a degree of protection against the effects of timber harvest in the form of habitat conservation plans (HCPs), administered by USFWS with large landholders. Because the majority of *P. hubrichti* habitat is managed for timber production (Bailey and Means 2004), HCPs are an essential component for species persistence. However, for conservation efforts to expand, extant populations of *P. hubrichti* must be identified. Due to the fossorial life history and patchy distribution of the species, identifying populations outside of known localities is a challenging task.

In 2006, a new population of *P. hubrichti* was discovered in Wilcox County, Alabama, which was not known to harbor any salamanders (M. Bailey, pers. comm.). Prior to this discovery, it was believed that *P. hubrichti* only inhabited the Tallahatta and Hatchetigbee formations within the Red Hills (Dodd 1991). Significantly, the Wilcox County population was found in an entirely different geologic formation, the Nanafalia. The extent of additional, and unprotected, populations outside of the known range is unclear.

Identifying additional populations within Wilcox County is important to the conservation of this narrowly endemic species,

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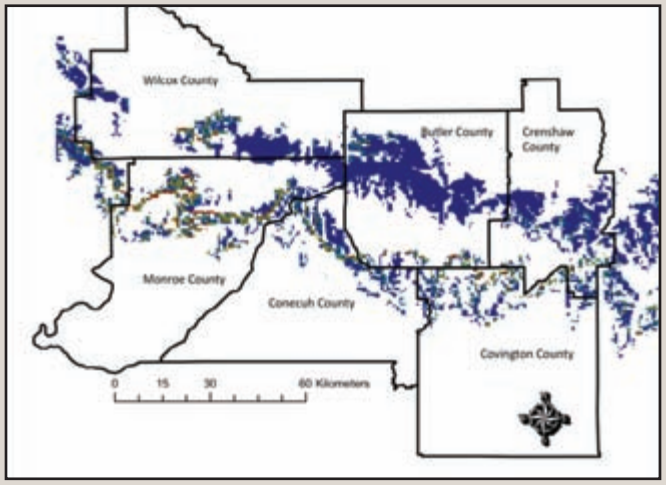

FIG. 1. Species-specific habitat model created for the Red Hills Salamander (*Phaeognathus hubrichti*). The colder colors (blue and greens) represent low model values (i.e., low quality habitat). Warmer colors (oranges and reds) represent higher model value (high quality habitat).

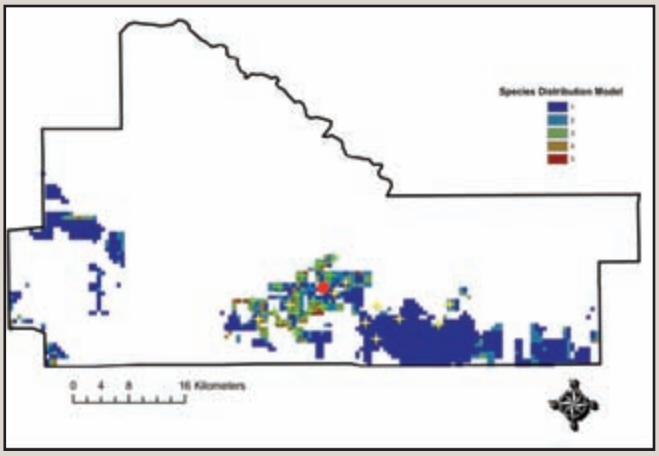

FIG. 2. Survey localities within Wilcox County, Alabama. Green symbols indicate that a population of the Red Hills Salamander (*Phaeognathus hubrichti*) was present; yellow indicates that we were not able to detect individuals or burrows. The red circle indicates the only population of the salamander identified prior to this study in Wilcox County; identified in 2006.

as the rugged terrain and steep slopes might harbor relatively large numbers of Red Hills Salamanders (Apodaca 2010). Our objective here is to identify additional populations of *P. hubrichti* in Wilcox County, Alabama with existing knowledge of habitat requirements integrated into a species-specific habitat model and to ground-truth these results with biological surveys. With this approach, we aim to bolster the conservation of the species and to refine the geographic range of this imperiled and endemic species. Additionally, we seek to demonstrate the utility of species-specific habitat models for identifying unprotected populations of imperiled species.

Methods.—*Phaeognathus hubrichti* is a monotypic plethodontid that is endemic to six counties in southern Alabama, USA. It is restricted to the Red Hills geologic formation, a narrow belt (< 5 km north/south) of Eocene-aged claystone, silt stone, and sandstone (Scott 1972). Within these formations, *P. hubrichti* are only found within mature hardwood or mixed conifer forests on steep (generally > 20°) slopes and ravines. Maintaining a closed canopy and moist forest-floor conditions are also important for population persistence (Dodd 1991; Jordan and Mount 1975). Individual salamanders spend nearly all of their time, including foraging and development of young, underground or at the entrance to their extensive burrows (Bakkegard 2002; Means 2003). Burrow entrances are found only on steep slopes and can be easily identified in the field by their smooth and circular entrance. Due to their straightforward identification, burrows are readily used to survey for *P. hubrichti* presence and population densities (e.g., Dodd 1991; Godwin 2008).

We developed a predictive habitat model based on factors important to describing where populations of *P. hubrichti* occur and combined it with ecological niche modeling to identify additional possible populations of *P. hubrichti*. We used three variables to evaluate suitability of individual grid cells including slope, habitat type, and geology.

Slope was calculated using the national elevational dataset (NED) from the U.S. Geological Survey with a resolution of 1/9 arc seconds (about 3 m). We used the ARCGIS v9.3 spatial analyst extension, which calculates slope as the maximum rate of change between each cell and its neighbors. Thus, the maximum change in elevation between neighboring cells receives the highest value, and flatter terrain receives a lower value. Because *P. hubrichti* commonly are found on steep slopes, this technique allows us to identify suitably steep areas (Dodd 1991). We categorized cells as unsuitable (<15°), poor (16–22°), suitable (22–30°), or excellent (>30°) based on how slope angle affects *P. hubrichti* densities (see Godwin 2008).

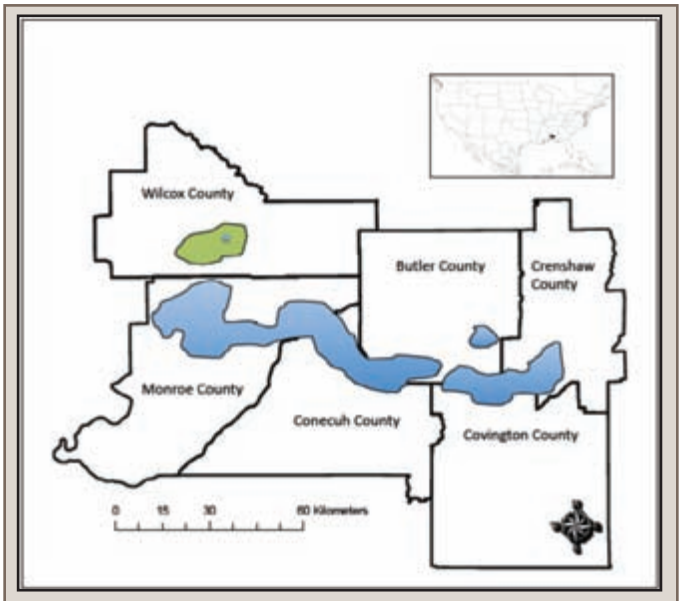

FIG. 3. Species distribution map for the Red Hills Salamander (*Phaeognathus hubrichti*). The blue polygons indicate the extent of the range known prior to this study. The green polygon represents the extent of the populations discovered in this study.

Second, we used the AL-GAP dataset (Kleiner et al. 2007) to identify suitable habitat types for *P. hubrichti*. Based on recently collected *P. hubrichti* localities and life history knowledge of the species (Apodaca 2010; Godwin 2008), we considered East Gulf Coastal Plain Southern Mesic Slope Forest (category 51) as *P. hubrichti* habitat (a detailed description of category 51 can be found at www.SEGAP.org). We assigned this category a value of 1 and all others a 0. Although it is likely that there are small patches

of suitable habitat not identified by this method, we felt they were too small or rare to support a viable population of salamanders. For the geologic formations, we used the Alabama geologic map from USGS (available online at tin.er.usgs.gov). From this data set, we selected the three geologic layers known to be used by *P. hubrichti* (Tallahatta, Hatchetigbee, and Nanafalia) (Bailey and Means 2004).

We divided the range of *P. hubrichti* and the surrounding area into grid cells of 0.005° (roughly 0.5 km^2) using ArcGIS 9.3 (ESRI, Redlands, California). Each cell was assigned a value of suitability based on the additive total of three variables described above: 1) slope, 2) proper habitat type, and 3) proper geologic layer. We eliminated cells that were outside of the climatic envelope created using environmental niche modeling (see methods below).

For the total additive model, cells were categorized using the Jenks optimization method (Jenks 1967) into four basic categories (1.unsuitable, 2.unlikely, 3.suitable, and 4.optimal). The Jenks method is also known as the goodness of variance fit, and is analogous to a one-way analysis of variance. Essentially this method seeks to maximize variance between natural breaks in the data by minimizing the squared deviations of the class means in order to best classify groups in the data.

Next, we used ecological niche modeling (ENM) to remove the areas from the predictive habitat model that are not climatically similar to known *P. hubrichti* populations using Maxent (Phillips et al. 2006). In general, Maxent uses a machine learning approach (i.e., maximum entropy) to predict the probability of occurrence of a species given an equal effort of sampling across the locality data. Maximum entropy modeling is part of a family of statistical approaches (machine learning) that typically outperforms traditional statistical approaches (e.g., generalized linear models) in complex ecological situations (Olden et al. 2008). We used a least point threshold (LPT) in order to determine the Maxent value that would serve as a cutoff for suitable climatic conditions. Although there are several threshold methods for niche modeling (see Pearson et al. 2007), the LPT is conservative and only identifies areas at least as suitable as where the species reportedly occurs. Only cells above the threshold were deemed as climatically suitable. Cells below the LPT were removed from the analysis.

To evaluate the range-wide accuracy of our distributional model we tested for a statistically significant difference between the values of the cells that contain known *P. hubrichti* localities and an equal number of randomly selected cells using an unpaired two-tailed t-test. We used the 130 unique known localities from the Alabama Natural Heritage Program (ALNHP). We then generated two sets of randomly selected cells, one set was randomly selected from the six counties known to contain *P. hubrichti* and another set that was selected just from the area within the six known counties that contained the proper geologic layers. This process evaluated whether our modeling technique identified *P. hubrichti* habitat significantly better than random.

We then used the model to identify areas within Wilcox County that may contain undocumented populations of *P. hubrichti*. We surveyed 16 localities predicted to be in high quality habitat (4.optimal), 4 localities predicted to be in suitable habitat (3.suitable), and 4 localities where the model did not predict presence (2.unlikely), but where topography was suitable for *P. hubrichti*. Since all of the predicted populations within Wilcox County is found on private land, sites were selected based on which sites we could obtain access. Exhaustive surveys were conducted by searching slope habitat for the characteristic burrows of *P. hubrichti*. Only sites with unmistakable burrows (burrows that have been smoothed down by the salamander feeding at the entrance (Godwin 2008)) or where salamanders were observed were considered to have active populations of *P. hubrichti* (see Dodd 1991).

Results.—Our model predicted the most suitable habitat for *P. hubricthti* (4.optimal) covered approximately 524 km^2 (0.54% of total model area) (Fig. 1). Suitable habitat was predicted to cover approximately 3,125 km^2 (3.24% of total model area). Low quality habitat (2.unlikely) accounted for approximately 6,042 km^2 (6.27% of total model area). The majority of the area was unsuitable habitat (89.9%).

Our model did significantly better than random when identifying suitable habitat for *P. hubrichti*. Known localities of *P. hubrichti* were found in cells that had significantly higher model values than locations drawn from random from the six counties that contain *P. hubrichti* ($t_{(129)} = 3.36$, $P < 0.001$). Additionally, known localities of *P. hubrichti* were found in cells that also had significantly higher model values than locations drawn from random from within the three geologic layers known to contain *P. hubrichti* ($t_{(129)} = 3.38$, $P = 0.003$).

Our field survey confirmed that our modeling technique was practical and effective for identifying previously undiscovered populations within Wilcox County, Alabama (Fig. 2). In total we discovered 14 previously undocumented populations of this rare endemic salamander. We found new populations in 13 out of 16 surveyed localities for the highest categories (4.optimal), 1 out of 4 in suitable habitat, and no new populations in the lowest category surveyed (2.unlikely). However, additional surveys should be completed to test this statistically.

Discussion.—Identifying unknown populations is fundamental to the conservation of threatened and endangered species. Several studies have demonstrated the utility of broad scale environmental niche modeling in conservation biology (e.g., Domínguez-Domínguez et al. 2006; Garcia 2006; Ferrier 2002; Raxworthy et al. 2003; Rissler et al. 2006). Here, we have shown that creating fine-scale species-specific models can be a useful approach for identifying areas that harbor unidentified populations of imperiled amphibians. Our model was effective at identifying areas that may harbor unknown populations of *P. hubrichti*. By applying this approach we were able to expand the total area of the known range of *P. hubrichti* by approximately 15% (Fig. 3).

The future persistence of *P. hubrichti* is dependent on the cooperation of land managers. However, proper precautions aimed at safeguarding habitat cannot be taken if populations remain unidentified. Our findings suggest that several other areas may harbor unidentified populations (Fig. 1). We only surveyed a small percentage of the predicted high-quality habitat for *P. hubrichti*, suggesting that other undocumented populations probably occur. Thus, we highly recommend that future surveys be conducted in other optimal and suitable quality habitats to improve the knowledge of the geographic distribution of this threatened species and identify additional opportunities for conservation and recovery.

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A Novel Color Morph and Additional Population of *Raorchestes akroparallagi* (Anura: Rhacophoridae) and a Second *R. chromasynchysi* Population in Karnataka, India

Both *Raorchestes akroparallagi* and *R. chromasynchysi* are recently described members of the frog family Rhacophoridae (Biju and Bossuyt 2009), endemic to the Western Ghats region of southern India. At the time of discovery, these species were considered members of the genus *Philautus*, which has since been revised after a thorough phylogenetic review of the family Rhacophoridae and erection of the genus *Raorchestes* (Biju et al. 2010). Conservation assessments of these species are not available due to a lack of data (IUCN 2011). We present findings of additional populations of these poorly-known species, the first records from Karnataka state.

Study Site and Methods.—In October 2009, we documented the presence of *R. akroparallagi* and *R. chromasynchysi* during biological surveys at Mojo Plantation, a 10-ha spice farm located approximately 10 km from Madikeri, Karnataka (12.47°N, 75.70°E). Certified organic by the Institute for Marketecology (IMO), Mojo Plantation grows a variety of native and exotic spice crops (e.g., coffee, cardamom, black pepper, vanilla) without the use of inorganic fertilizers, pesticides, or herbicides. Crops are grown in low density beneath the rainforest canopy, interspersed with patches of native vegetation. Two streams originate on the property, flowing south toward the Kaveri River. Frogs were collected on nocturnal and crepuscular surveys of this agroecosystem between 1 October and 15 November 2009. Each frog was enclosed in a terrarium, photographed, and released at the location of its capture within 48 h.

We placed each frog in a glass petri dish that was marked in ink with a 20 mm scale bar, and took digital photos at a perpendicular angle to the subject (i.e., straight above or below). We used ImageJ software (version 1.44, NIH, available from: http://rsbweb.nih.gov/ij/; Abramoff et al. 2004) to measure

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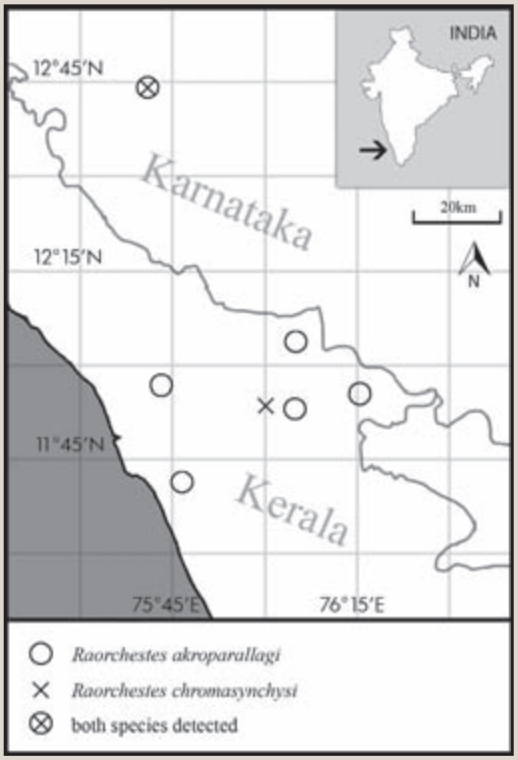

FIG. 1. Some previously known localities in northern Kerala (Biju and Bossuyt 2009) in relation to our study site near Madikeri, Karnataka, India.

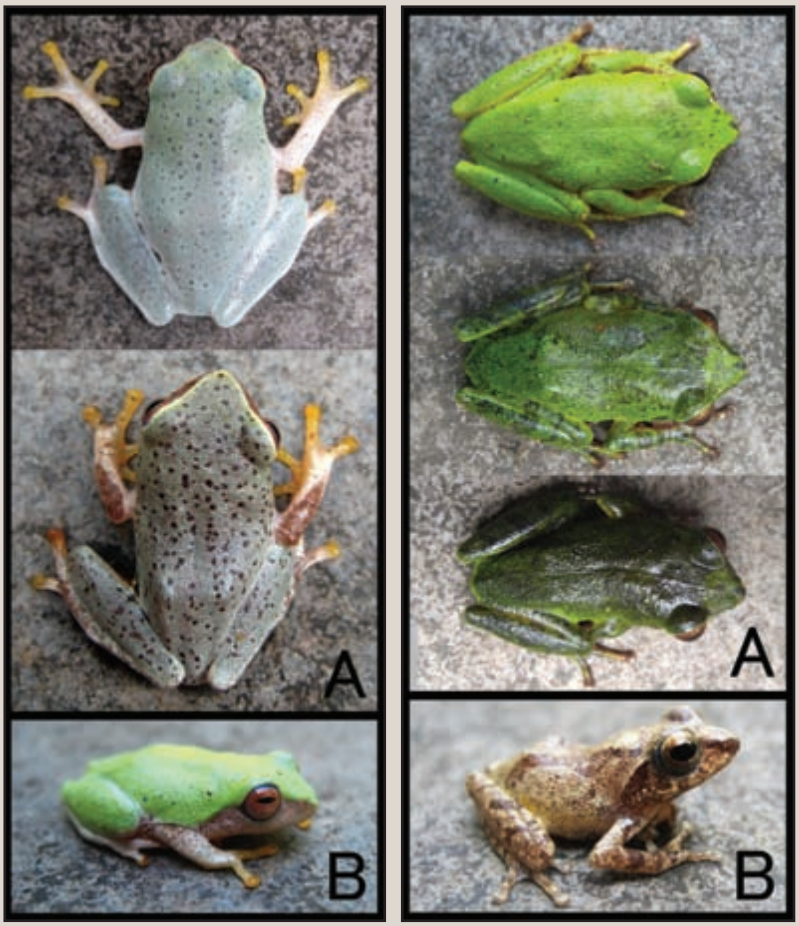

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FIG. 2 (left). *Raorchestes akroparallagi* A) color variation of a single blue morph individual due to metachrosis; B) green morph found in syntopy with blue morph.

FIG. 3 (right). *Raorchestes chromasynchysi* A) color variation of a single green morph individual due to metachrosis; B) brown morph found in syntopy with green morph.

morphometric traits from scaled digital photographs of live specimens (N = 7; Table 1) using the methodology of Antwis and Browne (2008). The following morphometrics were calculated: snout–vent length (SVL); head length (HL), measured from the rear of the mandible to the tip of the snout; head width (HW), measured at the angle of the jaws. Frogs could not be assigned to sex. Due to polymorphism and metachrosis, identification of *Raorchestes* frogs is difficult based on dorsal coloration alone (Biju and Bossuyt 2009); we documented color variation due to metachrosis by photographing individual frogs, in similar light conditions, multiple times over the duration of their captivity.

Raorchestes akroparallagi.—Biju and Bossuyt (2009) described *R. akroparallagi* from Ponmundi (8.75°N, 77.12°E), and reported populations at one site in Tamil Nadu and several sites in northern Kerala (Fig. 1). As its name implies (*akro* is Greek for "extreme," *parallagi* for "variation"), this species exhibits substantial polychromatism. Biju and Bossuyt (2009) described four color morphs from populations in Kerala: 1) grayish white, 2) light green without markings, 3) golden yellow with contrasting brown spots on dorsum and light brown bands on limbs, 4) dark green with yellowish stripe extending laterally from snout to near the vent.

We discovered an additional population near Madikeri, Karnataka, extending the range of this poorly-known species by over 75 km northward and representing a first state record. This population features a morph with a blue dorsum (Fig. 2A) in syntopy with a light green morph (Fig. 2B; similar to paratype BNHS 4388, but with small contrasting spots on the dorsum). A blue morph of this species has been previously found in Wayanad, Kerala, (S.D. Biju, pers. comm.) but has not been described in publication. The blue morph at our study site features a white line that traces the canthal ridge and anterior edge of the upper-eyelid (similar to BNHS 4392, but terminating at the posterior edge of the eyelid). This line appears in high contrast when the dorsum turns dark blue via metachrosis (Fig. 2A). Many dark spots are apparent on the dorsum and hindlimbs of both color morphs, varying in size and irregularly spaced. We collected three individuals (2 blue, 1 green) from leafy vegetation within 2 m of the ground and within 25 m of a stream. Morphometric data are lacking for one of the blue frogs, which escaped from the terrarium before scaled photos were taken.

We identified the specimens (N = 2; Table 1) as *R. akroparallagi* by comparing morphometric data to the identification criteria set forth by Biju and Bossuyt (2009): 1) small adult size (SVL = 20.6 ± 0.7 mm) is consistent with type specimens, 2) yellowish thigh and groin, 3) metachrosis of forearm, loreal and tympanic region ranges from light brown to dark brown (Fig. 2A), a trait that is found in nearly all color morphs of *R. akroparallagi* but absent in other green congeners from the Western Ghats. Blue morphs at our study site also exhibited metachrosis to a lesser extent on their feet (Fig. 2A). No other *Raorchestes* species in the region is known to exhibit this combination of traits.

Raorchestes chromasynchysi.—Biju and Bossuyt (2009) described *R. chromasynchysi* from a single locality; type specimens

TABLE 1. Morphometric measurements (in mm) of five *Raorchestes chromasynchysi* and two *R. akroparallagi* frogs found near Madikeri, Karnataka, India.

Species	Individual	Dorsum Color	SVL	HW	HL
R. akroparallagi	1	blue	21.0	8.2	7.3
	2	green	20.1	7.8	6.8
		Mean	20.6	8.0	7.1
		SD	0.7	0.3	0.4
R. chromasynchysi	1	green	29.4	11.1	9.3
	2	green	26.4	10.2	8.6
	3	green	27.0	9.8	7.1
	4	green	26.7	10.0	8.6
	5	brown	26.2	9.7	–
		Mean	27.1	10.1	8.4
		SD	1.3	0.6	0.9

were collected from a 30 km^2 area on an isolated mountain at Kurichiyarmala (11.57°N, 75.97°E). Our discovery of an additional population near Madikeri extends the range of this poorly known frog species northward by approximately 100 km, and represents the first record of this species from Karnataka state (Fig. 1). All five frogs were collected from leafy vegetation within 2 m of the ground and 10 m of a stream.

We identified all specimens (N = 5; Table 1) as *R. chromasynchysi* by comparing morphometric data to the criteria outlined in the species description (Biju and Bossuyt 2009): 1) medium adult size (SVL = 27.1 ± 1.3 mm) is consistent with type specimens, 2) spinular dorsum, 3) pointed snout, 4) canthus rostralis sharp, 5) posterior surface of thighs dark brown, and anterior surface of thighs and groin dark brown with yellow blotches, 6) dorsal metachrosis ranges from light green to dark green (Fig. 3A), or, in the brown morph, from light brown to dark brown. Four *R. chromasynchysi* frogs showed green dorsal coloration with few markings (similar to paratypes BNHS 4433, 4442), and the fifth frog (Fig. 3B) was light brown with contrasting dark brown markings in an hourglass shape on the limbs and dorsum (similar to BNHS 4438). These markings became less apparent when the dorsum turned dark brown via metachrosis.

R. chromasynchysi is also known for its polychromatism (*chroma* is Greek for "color," *synchysi* for "confusion"; Biju and Bossuyt 2009), and may be mistaken for three similar species with which it forms a monophyletic clade: *R. marki*, *R. tinniens*, and *R. signatus* (Biju et al. 2010). However, *R. chromasynchysi* is the only species of this group for which the groin and anterior thighs are dark brown with yellow blotches, a trait that Biju and Bossuyt (2009) found to be highly consistent in all polymorphs. All of our specimens match this description. Additionally, our specimens have spinular dorsums (vs. slightly granular dorsums of *R. tinniens* and *R. signatus*; Biju and Bossuyt 2009; Bossuyt and Dubois 2001) and lack a horny ridge between the eyes (as in *R. marki*; Biju and Bossuyt 2009).

There are some morphological differences between our *R. chromasynchysi* specimens and those of the Kurichiyarmala population that are worth noting (see Biju and Bossuyt 2009, figure 19): 1) both anterior and posterior thigh patterns are visible in dorsal view, as in other green *Raorchestes* of the Western Ghats (vs. patterns not visible in dorsal view), 2) toe webbing reaches the penultimate subarticular tubercle on both sides of toe IV (vs. up to the distal subarticular tubercle), 3) dorsum color does not extend onto fingers I and II. Further research may reveal these discrepancies to be artifacts of low sample size, representing variation among individuals, or unique characteristics of this population.

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Sexual Dimorphism and Color Polymorphism in the Wallum Sedge Frog (*Litoria olongburensis*)

Sexual dimorphism describes intraspecific differences in size, shape or other traits between males and females. One of the most common secondary sexual dimorphisms of anuran amphibians is a disparity in size, with adult females commonly exceeding adult males in body size (Howard 1981; Lee 2001; McGarrity and Johnson 2009; Monnet and Cherry 2002). Fecundity selection is proposed to be the driving force behind female-biased sexual size dimorphism (SSD; Darwin 1871), as clutch size and/or egg and subsequently offspring size increase with increasing female body size (Kupfer 2007; Shine 1979; Wells 2007). Selection may not only favor larger females, but also small males, as demonstrated in *Litoria xanthomera* and *L. chloris*, where smaller males used less energy when calling, had increased chorus tenure, and were more successful than larger males (Morrison et al. 2001). Sexual differences in growth, maturation, population age structure, and life history have also been suggested as possible driving forces behind SSD in some species (Howard 1981; Monnet and Cherry 2002; Shine 1979).

Many amphibians exhibit sexual differences in morphology or coloration that allow males and females to be readily distinguished (Hoffman and Blouin 2000; Wells 2007). An example of a secondary sexual characteristic of anurans is the presence of male vocal sacs, used to create advertisement calls to females during breeding events (Ryan 1991). Additionally, males of many anuran species develop nuptial pads, which are predominantly located on the inner surface of the thumb and are used for gripping a female during amplexus, and during male-male competition (Duellman and Trueb 1994). Nuptial pads are generally more developed in aquatic-breeding species (where males need to maintain a strong grip on females in rapidly flowing waters), and in species that engage in aggressive male-male encounters (Duellman and Trueb 1994). As nuptial pads are usually densely pigmented with melanin, and thus easily observed, they are commonly used to determine the sex of amphibians in the field (Duellman and Trueb 1994; Greene and Funk 2009). Additionally, some species display intersexual differences in forelimb size, allowing males to retain a firm grip on the female in amplexus (Lee 2001). Occasionally, males and females possess obvious differences in body coloration, which also facilitates sex identification (Hoffman and Blouin 2000). However, for some species, there are no obvious size or color differences and no nuptial pads, making identification of sex difficult.

The Wallum Sedge Frog, *Litoria olongburensis*, is a small (~25 mm) hylid restricted to coastal swamps of eastern Australia (Barker et al. 1995; Cogger 1995; Ingram and Corben 1975). The species is listed as vulnerable under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*, Queensland *Nature Conservation Act 1992*, New South Wales *Threatened Species Conservation Act 1995*, and by the International Union for the Conservation of Nature (IUCN 2010). *Litoria olongburensis* is known to be polymorphic for dorsal coloration, including gray-brown, beige or bright green, occasionally with dark flecking (Barker et al. 1995; Liem and Ingram 1977) (Fig. 1). However, little is known of the color and morphological differences between the sexes and field sex identification in this species can be difficult, predominantly due to their small size. Identification of sexes is essential to determine different habitat use, population sex ratios, and for captive husbandry. We examined sexually dimorphic characteristics of museum specimens and wild populations of *L. olongburensis* to expand our knowledge on the morphology of the species and sex identification in the field. We hypothesize that females will have a larger body length than males, and males will have proportionately larger forearms. Also, we hypothesize that males possess secondary sexual characteristics useful for field identification all year round, such as nuptial pads, vocal sacs, and different coloration relative to females. The results from this study may also assist with our understanding of sexual dimorphism and color polymorphism in congeneric species.

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FIG. 1. Brown (A) and green (B) color morphs of *Litoria olongburensis*.

Materials and Methods.—Male (N = 40) and female (N = 62) *Litoria olongburensis* held in the Queensland Museum (QM) and originally collected from throughout their distribution in Queensland and New South Wales (NSW), were examined. Snout–urostyle length (SUL), right tibia length (TL), and forearm length (FL) were measured with vernier calipers to the nearest 0.1 mm. Frogs were sexed by inspection of nuptial pads, vocal sac slits under the tongue, and gonads. The numbers of eggs of four preserved females were counted and the mean egg diameter (MED) of ten eggs per female was measured with digital vernier calipers. This was recorded to fill a gap in our knowledge of fecundity in this species and may be used in future comparisons with congeners. Eggs of some females had been previously removed and kept aside, and others still remained within the female's abdomen. Thus, egg numbers may be underestimated due to possible loss of eggs during preservation. As color is greatly affected by preservation, no dorsal color analysis was undertaken on museum specimens.

Measurements of male (N = 104) and female (N = 92) *L. olongburensis* in wild populations were recorded in Queensland: Great Sandy National Park (Cooloola section; N = 73), Beerburrum Scientific Area 1 and Mooloolah River NP (N = 53); and from NSW: Yuraygir NP (N = 33) and Tyagarah Nature Reserve (N = 37). These locations represent the presumed current range of the species and were utilized as four latitudes in analyses (Fig. 2). The four latitudes used in decimal degrees were 26.01, 26.78, 28.61, and 29.85 (datum: WGS 84). Frogs were measured in March, April, and November, 2010. Up to 20 frogs first observed at each site were caught and the SUL was measured as described above. The presence of nuptial pads, vocal sacs, and skin folds, as well as coloration of the dorsum, thigh, and throat, was recorded. Frogs were categorized as green or brown based on the dominant dorsal color as observed by KL. A third category of partial green included any frogs that had approximately equal proportions of green and brown dorsal coloration. Males were identified by the presence of nuptial pads (where discernible), vocal sacs, and/or folds in the throat skin. Females were identified by the presence of thick, granular throat skin (opaque in males), and a lack of nuptial pads. Additionally, any metamorphs observed were measured to ascertain size at metamorphosis. Frogs were captured using small plastic bags and were released following measurements. Bags were not re-used, and aquatic equipment was treated with Virkon (fungicide) between sites to prevent disease transmission.

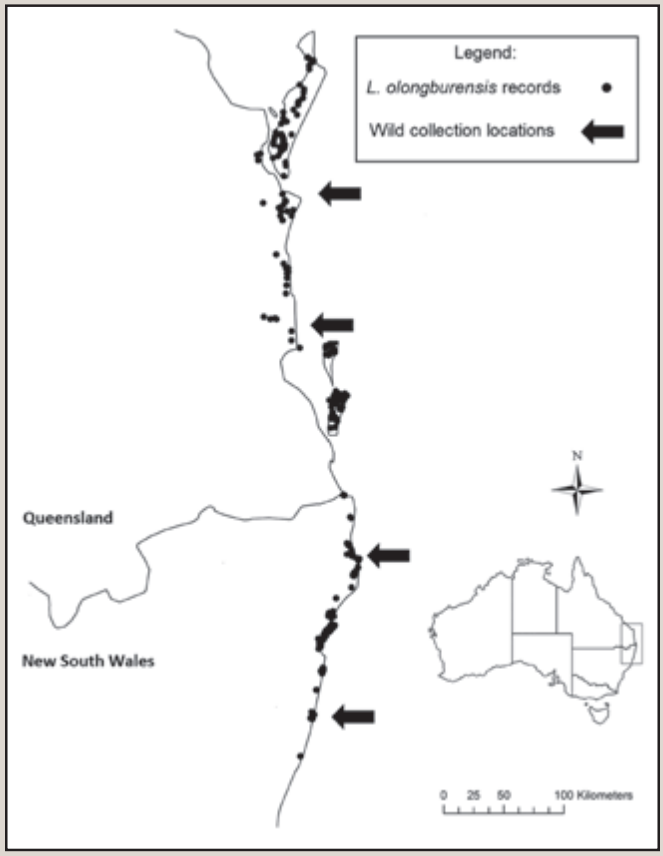


FIG. 2. Occurrence of *Litoria olongburensis* records along the east coast of Australia and the four latitudinal collection locations. Map of Australia shows enlarged area. Records sourced from the Australian Museum, Queensland Museum, South Australian Museum, Environmental Protection Agency/Queensland Parks and Wildlife Service WildNet database, New South Wales Dept of Environment and Conservation Wildlife Atlas database, and various biologists.

For museum frogs, linear regression analyses were used to analyze the relationships among SUL, TL, and FL. For both museum and wild frogs we developed a Generalized Linear Model, using a Gaussian family of SUL, with the explanatory variables sex and origin (wild or museum) as fixed factors. For wild frogs, we again used Generalized Linear Modelling, using a Gaussian family. The response variable was SUL, with the explanatory variable sex as a fixed factor, and latitude as a covariate. We also examined data to detect whether a latitudinal trend existed with SUL or SSD. Data were analyzed using PASW Statistics 18, Release Version 18.0.0 (SPSS, Inc., 2009, Chicago, Illinois, www.spss.com) and the statistical significance was set at $\alpha = 0.05$.

Results.—Both museum and wild (all latitudes) frogs displayed female biased SSD. Snout–urostyle length for each sex overlapped up to 28.7 mm, with all individuals greater than 28.7 mm being female. Female SUL (range = 20.0–34.1 mm, mean = 26.7, N = 154), was significantly larger than males (range = 19.3–28.7 mm, mean = 24.2 mm, N = 144; Wald $\chi^2 = 78.98$, P = < 0.001, Fig. 3). Origin (wild or museum) had a significant effect on SUL (Wald $\chi^2 = 14.94$, $P < 0.001$). There was no significant interaction between origin and sex (Wald $\chi^2 = 0.25$, P = 0.614; Fig. 3). Female TL (range = 11.2–18.4 mm, mean = 14.8) was also found to be significantly larger than male TL (range = 7.2–16.0, mean = 12.7; P = < 0.001); as was female FL (range = 3.9–6.8 mm, mean = 5.1) compared to male FL (range = 2.4–5.8 mm, mean = 4.6; P = < 0.01). Snout–urostyle length and TL of museum frogs were highly correlated ($P < 0.001$, $r^2 = 0.797$), as were SUL and FL ($P < 0.001$, $r^2 = 0.641$). Additionally, male and female FL and TL relative to SUL did not differ significantly (P = 0.466, P = 0.382, respectively). Thus, only SUL was recorded for frogs measured in the wild. For wild measured frogs, SUL was significantly affected by sex (Wald $\chi^2 = 4.26$, P = 0.039) and latitude (Wald $\chi^2 = 15.98$, $P < 0.001$).There was no significant interaction between sex and latitude (Wald $\chi^2 = 2.85$, P = 0.091; Fig. 4). Although latitude had a significant effect, there did not appear to be a latitudinal cline in SUL or SSD.

The smallest male with discernible nuptial pads on the inner side of the thumb had a SUL of 20.4 mm, and most males (93.2%) larger than this possessed nuptial pads (Fig. 5). Nuptial pad pigmentation was greater in the breeding periods, and occasionally indiscernible outside these periods. The average number of eggs from preserved females was 121 (range 75–160), and average MED was 1.03 mm (range 0.9–1.2 mm). The smallest size at metamorphosis recorded in the wild was 13.8 mm.

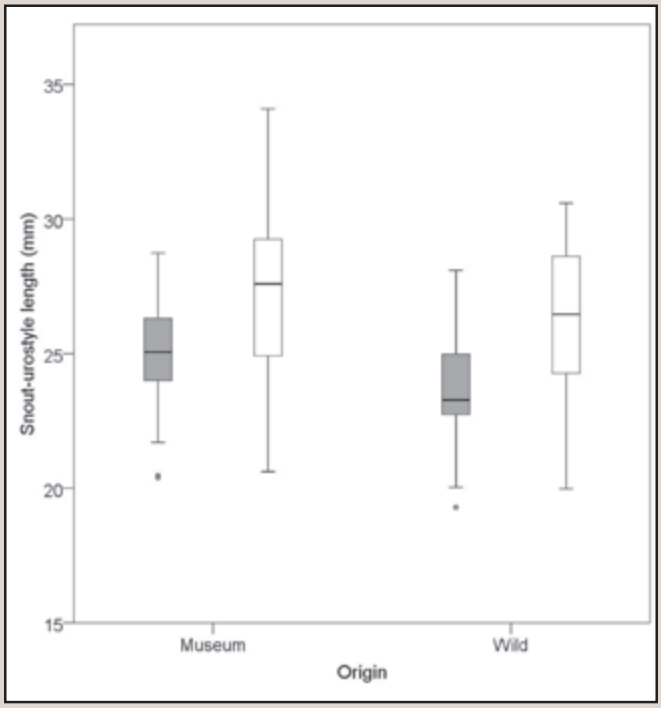


FIG. 3. Box plot of snout–urostyle length measurements of male (N = 144, gray bars) and female (N = 154, white bars) *L. olongburensis* taken from museum specimens (N = 102) and wild populations (N = 196). Significant female biased sexual size dimorphism was detected (P < 0.001), with no significant interaction between origin and sex (P = 0.614).

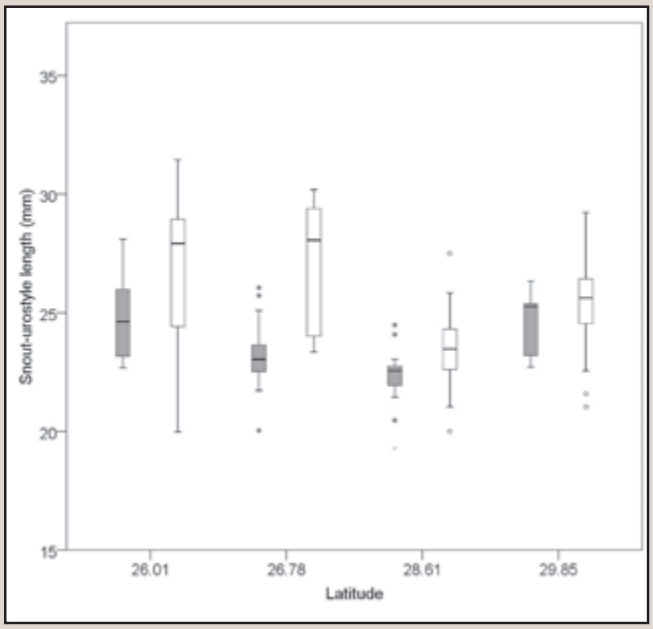


FIG. 4. Box plot of snout–urostyle length of wild male (N = 104, gray bars) and female (N = 92, white bars) *L. olongburensis* from four latitudes across the distributional range of the species (C, N = 73; MB, N = 53, T, N = 37, W, N = 33). Significant female biased sexual size dimorphism was detected (P = 0.039), with no significant interaction between origin and sex (P = 0.091)

The coloration of males and females was highly variable and there were no distinguishing color patterns for either sex (Fig. 6). For all wild frogs, dorsal coloration was measured as brown (48.3%), green (40.1%), and partial green (11.6%). The majority of frogs with green dorsal coloration were female (60.0%). Dark flecking on the dorsal surface was uncommon (four individuals). Throat color was either green (52.9%) or white/beige and the majority of frogs with green throats were female (60.04%). The largest proportion of measured frogs contained at least some blue thigh coloration (femoral streak) (59%), which was more common in frogs with green dorsal coloration (83.1%) than brown dorsal coloration (33%); and was present in both males (61.2%) and females (56.4%). However, thigh color was highly variable, including blue, orange, and brown; and combinations such as: blue/purple/orange, blue/brown/orange, blue/orange, blue/brown, brown/orange, orange/purple, and brown/purple.

Discussion.—The larger size of females (compared to males) found in *Litoria olongburensis* is consistent with the general trend in anurans (Monnet and Cherry 2002; Shine 1979). For field identification, nuptial pads and vocal sacs present in males, and the size disparity between the sexes are the best tools for sex identification. However, it must be noted that nuptial pads may be indiscernible outside the breeding periods, with differences in throat morphology becoming a more useful identification tool. Both sexes exhibited similar body coloration, thus coloration is a poor measure for sex identification. Although there were significant differences in SUL and SSD at different latitudes, we did not detect any latitudinal cline in SUL or SSD. Greater replication or more samples from along the latitudinal distribution of the species would offer more information on any latitudinal cline.

Although the selective pressures leading to SSD may be clear in some species, it may not be so obvious in others, as many selective processes mentioned in the introduction, such as fecundity selection, sexual selection and differences in life history, may occur in the same taxon (Monnet and Cherry 2002; Shine 1989). Whether there is a higher fecundity in larger females, differences in life history strategies, or selection for smaller males in *L. olongburensis* is unknown and would require further investigation.

Occasionally, male body size exceeds that of female body size, particularly in species with aggressive male encounters (Shine 1979). However, this is not true for most small species of the family Hylidae (Wells 2007), which includes *L. olongburensis*. Aggressive male-male encounters were observed in this species and appeared to be a defense of calling sites, with vocalizing males attempting to dislodge other males from a high position (KL, pers. obs.). However, it is unclear whether physical combats influence male reproductive success in this species, as no females were observed near the fighting males on these occasions.

Nuptial pads and vocal sacs were a useful characteristic for identifying males in the field. Although not quantified, we had the impression that nuptial pads were darker at the start of the breeding season. Thus, to reduce the frequency of misidentification, sex identification should occur at the beginning of the breeding season, when nuptial pad pigmentation is heightened. During the non-breeding period, when nuptial pads were indistinct, males could be identified based on faint vocal sac inflation creases or folds visible on the throat. Also, the two inner vocal sac openings were frequently visible through the outer surface of the throat. Whereas males had rather smooth and sometimes opaque skin on the throat, female throat skin was much more granular in texture and appearance. Positive identification of

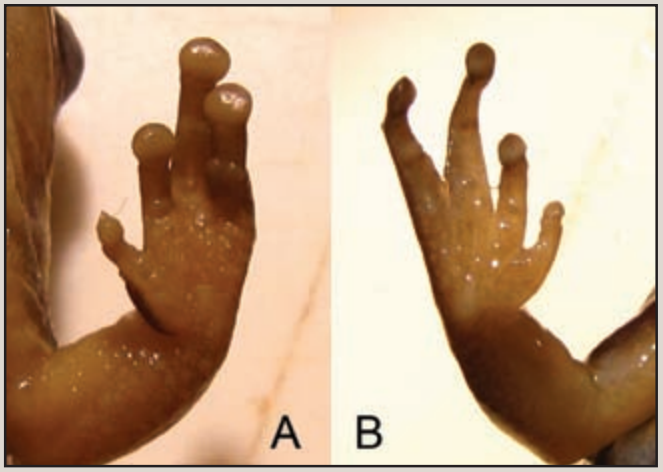
females may also be heightened during the breeding season, when eggs are more easily detected, however, outside this period, size and throat morphology are better tools for sex identification.

The majority of *L. olongburensis* in the wild had brown, or gray-brown, dorsal coloration, with a large subset having green dorsal coloration, and a small proportion with both. Although the majority of green frogs were female, there was no significant sexual color dimorphism in *L. olongburensis*. Juveniles with green dorsal coloration were occasionally observed, however, the degree of ontogenetic shift in color is unclear. Green dorsal coloration is most likely to appear after metamorphosis, but whether dorsal coloration is genetically programmed or environmentally determined, or both, remains to be examined. The majority of live specimens had some blue coloration in the thigh, characteristic of the species, but thigh coloration was highly variable, and the blue was distinctly absent in some individuals. Striking thigh coloration is thought to act as a possible anti-predator mechanism, serving to confuse an attacking predator or warn predators of the presence of toxins (Toledo and Haddad 2009). Although not quantified, field observations indicated that particularly bright dorsal and thigh coloration may be more prominent in females.

Color or pattern polymorphism has been described in many amphibians (Hoffman and Blouin 2000; Wente and Phillips 2003) and is, in some cases, due to females selecting for brightly colored males (Chunco et al. 2007; Roulin and Bize 2007; Todd and Davis 2007). However, many anuran amphibians exhibit fixed color or pattern polymorphisms in both sexes within natural populations, and some species exhibit seasonal color change (Croshaw 2005; Hoffman and Blouin 2000; Wente and Phillips 2003, 2005). Color polymorphism may be particularly advantageous in an environment consisting of spectrally heterogeneous microhabitats, and presumably makes it difficult for predators to form a reliable search image, which is more advantageous when individuals select microhabitats matching their pattern (Morey 1990; Zug et al. 2001). Indeed, *L. olongburensis* inhabits heterogeneous brown and green sedgeland microhabitats, and future studies should aim to determine whether individuals select microhabitats to match their dorsal coloration, and the extent of genetic and/or environmental influence on color polymorphism.

Disruptive coloration and patterning can also be an important component of crypsis, as blotches, stripes, bands, or spots break up the general outline of an individual (Merilaita and Lind 2005; Toledo and Haddad 2009). This may make it difficult to detect the whole animal, especially against a background containing a mixture of color (Zug et al. 2001). *Litoria olongburensis* possesses a dark brown loreal streak from eye to nostril, as well as a brown and ventrally cream streak from behind the eye to halfway down the flank (Liem and Ingram 1977). These pronounced lateral stripes may aid in breaking up the lines of the body, which may be especially suitable in the preferred sedgeland habitat of *L. olongburensis* (Lewis and Goldingay 2005). Although the closely related *L. fallax* possesses similar lateral streaking, it is less pronounced. The increased intensity of lateral streaking in *L. olongburensis* may be due to a more specialized requirement for sedgelands, whereas *L. fallax* is a more generalist species.

We have presented data that adds to our knowledge of morphology and sexual dimorphism of *L. olongburensis*. It is unclear what selective pressures may be acting to maintain different color morphs or sexual size dimorphism in *L. olongburensis* and it is likely that multiple factors may act synergistically.



PHOTOS BY K. LOWE

FIG. 5. Ventral surfaces of the hands of (A) a representative male *L. olongburenesis*, showing the pigmented nuptial pad on the inner surface of the thumb, and (B) a representative female hand for comparison. Photos are of preserved specimens from the Queensland Museum (Male, QMJ34282; Female, QMJ81483).

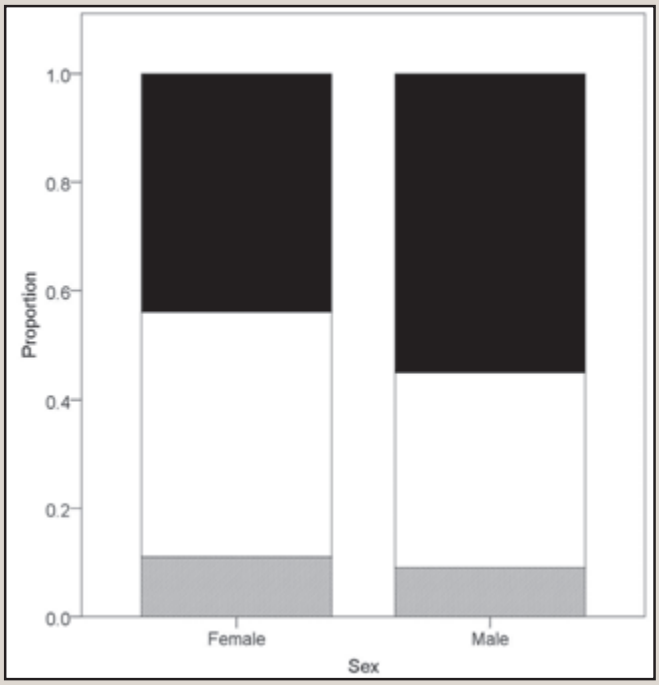


FIG. 6. The proportion of different color morphs of male (N = 93) and female (N = 79) *L. olongburensis*. Black bar, brown morph; white bar, green morph; striped bar, partial green morph.

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First Records of Limb Malformations in Wild Populations of the Endangered Balearic Midwife Toad, *Alytes muletensis*

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Limb deformities and developmental abnormalities in natural populations of amphibians have been reported for decades (Bishop 1947; Reynolds and Stephens 1984; Sessions and Ruth 1990; Woitkewitch 1961) but few reports involve deformities in rare and endangered amphibians.

The Balearic Midwife Toad *Alytes muletensis* (Sanchíz and Adrover 1977) is an endemic and threatened species of the Northeast Mallorca (Balearic Islands, Spain). Naturally, *A. muletensis* inhabits streams with vertical side walls and a bed with a stepped profile (Alcover et al. 1984). Thanks to conservation efforts, numerous anthropogenic constructions, such as fountains, and open and covered troughs, employed to provide water to livestock, have also been used as habitat for toads. These sites provide *A. muletensis* with new breeding locations, and may act as population reservoirs in the case of threats to natural

TABLE 1. Details of the malformed individuals and type of the observed malformation.

Individual	Stage	Sex	Size (mm)	Malformation Type
Cv-20	Subadult (metamorphosed)	Unknown	21.0	Bone projection
Cv-235	Adult (5 years)	Male	37.7	Syndactily
Cv-239	Adult (2 years)	Female	32.6	Polymelia
Cv-240	Subadult (metamorphosed)	Unknown	24.7	Micromelia, brachydactily and bone projection

FIG. 1. Locality 15.A, habitat of the monitored population of *Alytes muletensis*.

FIG. 2. Malformed individuals of *Alytes muletensis*: (Cv-239) Supernumerary hind limb (polymelia); (Cv-20) Small bone projection in left hind limb; (Cv-240) micromelia, brachydactyly and small bone projection in left hind limb; (Cv-235) syndactyly in third and fourth digits of the right forelimb.

populations (Román and Mayol 1995). Larval *A. muletensis* are found in permanent pools, while adults spend the day inside cracks and limestone crevices, emerging at dusk to search for food (Alcover et al. 1984). Like other species of the genus, males carry egg masses between their hind limbs until just prior to hatching, when they are laid in water.

Since its discovery as a living fossil (Mayol and Alcover 1981), *A. muletensis* has been the focus of a number of studies and conservation efforts (Román and Mayol 1997 and references therein). While the early detection and identification of the proximate causes of malformations is an important issue in managing an endangered species, no malformations have previously been reported for *A. muletensis*.

During 2005–2011, *A. muletensis* populations at six localities were monitored to determine the structure and dynamics of the adult fraction of their populations. Adults were captured, sexed, measured and a photograph of their dorsal surface was taken to identify individuals in future captures, following the methodology of Pinya and Pérez-Mellado (2009). Only one of these localities, site 15.A, had individuals with any kind of malformations. This locality is a small karstic canyon naturally excavated from limestone rocks (Fig. 1; 39.90°N, 03.01°E). The breeding pool has an approximate surface of 50 m^2 and a variable depth depending on the season (0.4–0.9 m). Vegetation around the locality is a steppe-grassland of *Ampelodesmos mauritanica* (Poaceae) spotted with *Chamaerops humilis* (Arecaceae) and *Rhamnus alaternus* (Rhamnaceae). The local population of *A. muletensis* was established in 1995, during the first recovery program for the species (Román and Mayol 1997). In 2005 the occurrence of the pathogen *Batrachochytrium dendrobatidis* was confirmed molecularly (Annis et al. 2004) in Mallorca from *A. muletensis* tadpole mouth-part samples (Oliver et al. 2008; Walker et al. 2008). The study population tested positive for *B. dendrobatidis* in 2006 with 19.05% of the samples

positive, but *B. dendrobatidis* was not detected in 2007–2010 (J. Bosch, unpubl. data).

During 19 sampling occasions from 2006 to 2011 at locality 15A, all during the peak activity period for the species (June–September), a total of 306 individuals (259 adults and 47 juveniles) were captured. All individuals were identified according to dorsal pattern and their age was determined using capture-recapture data. Four individuals had one or more malformations, with a total of five different types: polymelia, micromelia, brachydactyly, syndactyly, and bone projection (Fig. 2). The overall malformation rate was 1.31%, but was higher when each sampling occasion was treated separately. One malformed individual was captured on 9 August 2007 in a sample of 22 adults and 11 juveniles (malformation rate: 3.03%), and three were captured on 24 August 2011 from a sample of 48 adults and 7 juveniles (malformation rate: 5.45%) (Table 1).

Although there have been no previous reports of malformations in *A. muletensis*, our observations do not reveal any obvious cause. Because, *A. muletensis* is endangered, it was not possible to sacrifice living toads to check for the presence of trematode metacercarial cysts (for example of the genus *Ribeiroia*), the most commonly reported cause of this kind of limb abnormalities (Jonhson and Paull 2011). However, this parasite has not been reported in natural populations of *A.muletensis,* as previous studies have analyzed parasites only from fecal samples (Roca et al. 1998, 2004). Thus, *Ribeiroia* sp. may occur at the study sites.

Although *B. dendrobatidis* is not known to be a direct cause of malformations in adult amphibians (Altig 2007; Fellers et al. 2007; Vredenburg and Summers 2001), *B. dendrobatidis* may act synergistically with pathogens of the genus *Ribeiroia* to cause malformations (Romansic et al. 2011). In addition, possible immune system depression of tadpoles caused by environmental factors such us pollution, UV radiation or even the presence of *B. dendrobatidis* (Parris and Tommie 2004), could drive an increased susceptibility to parasites as *Ribeiroia ondatrae* and, consequently, increase malformations (Johnson et al. 1999, 2002).

It is possible that the abnormalities observed arose from mutation, developmental errors or traumatic events but these most often involve only missing digits or limb parts (Blaustein and Johnson 2003). The discovery of a concentration of gross abnormalities, with extra limb parts, raises the question of proximate causes and if these malformations are due to factors that could be considered a threat to this sensitive species.

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Diet of the Louisiana Pine Snake (*Pituophis ruthveni*)

The Louisiana Pine Snake (*Pituophis ruthveni*) is a large-bodied constrictor endemic to western Louisiana and eastern Texas (Sweet and Parker 1991). Surveys suggest that the species has declined in recent decades and is now restricted to isolated habitat patches (Reichling 1995; Rudolph et al. 2006). *Pituophis ruthveni* is listed as a Candidate Species under the Endangered Species Act by the U. S. Fish and Wildlife Service (USFWS 2011), and as a threatened species by the Texas Parks and Wildlife Department (TPWD 2011).

Ongoing fieldwork indicates that *P. ruthveni* is associated with sandy, well-drained soils with a well-developed herbaceous flora (Himes et al. 2006; Rudolph and Burgdorf 1997). Within this habitat, *P. ruthveni* is known to use the burrows of Baird's Pocket Gopher (*Geomys breviceps*) for foraging, escape from predators and fire, and hibernation (Ealy et al. 2004; Himes et al. 2006; Rudolph and Burgdorf 1997; Rudolph et al. 1998, 2002). Pocket gophers of the genus *Geomys* feed primarily on subterranean portions of herbaceous plants (Behrend and Tester 1988; Myers and Vaughn 1964). Habitat alteration, especially successional changes due to alteration of fire regimes resulting in increases in woody vegetation and declines in herbaceous vegetation, degrades habitat for *G. breviceps* with potential negative consequences for *P. ruthveni* populations. Within the range of *P. ruthveni* suitable habitat for *G. breviceps* is maintained by frequent fire that reduces competition from woody vegetation and stimulates the development of herbaceous vegetation, the primary food source for pocket gophers (Rudolph and Burgdorf 1997).

Rudolph et al. (2002) previously reported on 22 prey records of *P. ruthveni*. Small mammals were prominent in the diet (18 of 22 records) and *G. breviceps* comprised 10 of the 22 records. Based on habitat use and the close association with pocket gopher burrows, Rudolph and Burgdorf (1997) hypothesized that the decline of *P. ruthveni* in recent decades is due to habitat loss, landscape fragmentation, vehicle related mortality, and in remaining forested habitat to the alteration of fire regimes due to fire suppression. Less frequent fire return intervals allow the succession of woody vegetation to occur resulting in competitive decline of the herbaceous vegetation and ultimately of pocket gopher populations. The limited data on prey composition previously available support this hypothesis (Rudolph et al. 2002). We now report additional prey records for this rare and declining species.

Methods.—We have obtained additional prey records from fecal samples of 27 wild caught snakes obtained since 2002. Snakes were from throughout the current range of the species. These snakes were held in captivity for short periods of time during the course of other research activities. Snakes ranged from 112 to 141 cm snout–vent length (SVL). The 19 snakes sampled in Rudolph and Burgdorf (2002) also fell within this size range. Identifiable prey remains (hair, teeth, claws) were extracted from fecal samples and compared to a reference collection obtained from local species, fecal samples from captive snakes fed a known prey item, and published descriptions of mammalian hair and teeth. Prey biomass was estimated using median weights of species from Davis and Schmidly (1994). Masses for *Peromyscus* spp. and *Reithrodontomys* spp., which were not specifically identified, were estimated using values for each of the potential species present in the study area. All unidentified mammals were mouse-sized species. The value for *Peromyscus* sp., the largest mouse-sized taxon, was used for unidentified mammals. Mass of turtle eggs (presumed to be *Trachemys scripta*) was from Tucker et al. (1998).

Results.—A total of 31 additional prey records, primarily small mammals, were obtained from these 27 snakes (Table 1). Consistent with the previous report, *G. breviceps* was the most frequent prey item (18 of 31). An estimate of % biomass represented for the 53 total prey records known to date suggests that *G. breviceps* (28 of 53, 53%) comprises 75.4% of the estimated total prey biomass represented in the currently available prey sample for *P. ruthveni*. Overall, the preponderance of small mammals in the diet (47 of 53, 89%) is consistent with diets across the genus (Rodríquez-Robles 2002; Sweet and Parker 1991). The 53 prey records from a total of 46 snakes collected throughout the current range of the species provides a reliable estimate of the overall diet of *P. ruthveni*.

Discussion.—The abundance of *G. breviceps* in the known diet of *P. ruthveni* is consistent with the hypothesis presented by Rudolph and Burgdorf (1997). They hypothesized that changes in vegetation structure, i.e. the decline of herbaceous vegetation due to increasing fire-return intervals, resulted in declines of

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TABLE 1. Prey of *Pituophis ruthveni* as determined from field observations, analysis of fecal samples, and gastrointestinal tract contents.

	Rudolph et al. (2002)		This study		Total		
Species	Number	%	Number	%	Number	Estimated %	Biomass
Geomys breviceps	10	45.5	18	58.1	28	52.8	84.4
Scalopus aquaticus	4	18.2	3	9.7	7	13.2	6.7
Sigmodon hispidus	1	4.5	3	9.7	4	7.5	4.5
Peromyscus sp.	1	4.5	1	3.2	2	3.8	0.6
Reithrodontomys sp.			1	3.2	1	1.9	0.1
Unid. Mammal	2	9.1	3	4.7	5	9.4	1.5
Turtle eggs*	4	18.2	2	6.5	6	11.3	2.1
Totals	22		31		53		

*Probably *Trachemys scripta* based on egg size and habitat. A total of 20 eggs were recovered from six individual snakes.

pocket gophers and the consequent decline or extirpation of *P. ruthveni* populations.

The hypothesized dependence of *P. ruthveni* primarily on a single prey species, *G. breviceps*, may also be a factor in the reproductive biology of the species as hypothesized in Rudolph and Burgdorf (1997). *Pituophis ruthveni* has the smallest clutch size (mean = 4) and largest hatchling size (mean = 54.4 cm) in the genus (Reichling 1990). The large size at hatching may be a strategy to decrease the time required to achieve a size capable of ingesting adult pocket gophers, approximately 100 cm SVL, based on feeding trials of captive *P. ruthveni* offered live pocket gophers. Other *Pituophis* taxa with smaller hatchling sizes have a much more diverse small mammalian diet (Rodríquez-Robles 2002).

Feeding trials on captive neonates and juveniles (55–75 cm SVL) being head-started for an ongoing reintroduction effort provide additional insight on diet in this species. These captive *P. ruthveni* have refused all insect (cicadas, grasshoppers) and lizard (*Anolis carolinensis, Hemidactylus turcicus)* prey offered. They have readily accepted a variety of small mammals and birds, both live and dead, although most individuals refused shrews (*Blarina brevicauda*) and some reacted negatively to the presence of live shrews. Assuming animals in the field behave similarly, ectotherms, with the notable exception of turtle eggs, might not be a significant component of the diet of *P. ruthveni* of any size.

A number of snake species exhibit a dietary switch from ectotherms to endotherms that is based on snake size (Greene 1989; Rodríques-Robles et al. 1999; Shine and Slip 1990). A major compilation of prey records for *P. catenifer*, involving over 1000 prey records (Rodríquez-Robles 2002), found that mammals were a major component of the diet of all sizes including neonates, however lizards were only consumed by snakes less than 115 cm SVL. Only one arthropod was detected in this large data set. Our data set lacked records for snakes less than 112 cm SVL.

Specialization on a single prey species is hypothesized to have major consequences relating to the overall ecology, reproductive biology, and conservation status of the Louisiana Pine Snake. In addition, the proposed scenario is the basis of a recently initiated reintroduction program for *P. ruthveni. Pituophis ruthveni* neonates and head-started individuals are being released in habitat that has been restored by U.S. Forest Service managers primarily through restoration of a frequent fire regime using prescribed fire. The previously fire-suppressed reintroduction site currently has a well-developed herbaceous component with abundant pocket gophers and is presumably capable of supporting a *P. ruthveni* population.

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Ghost Nets Haunt the Olive Ridley Turtle (*Lepidochelys olivacea*) near the Brazilian Islands of Fernando de Noronha and Atol das Rocas

Fernando de Noronha (3.8333°S, 32.4167°W) and Atol das Rocas (3.8666°S, 33.8000°W) are Brazilian offshore islands that host breeding populations of Green Turtles (*Chelonia mydas*) and provide benthic foraging habitat for aggregations of Green and Hawksbill Turtles (*Eretmochelys imbricata*; Marcovaldi and Marcovaldi 1999) and occasionally Loggerheads (*Caretta caretta*; Bellini and Sanches 1998). The fact that Olive Ridley Turtles (*Lepidochelys olivacea*) also forage in the vicinity of these offshore islands is evidenced by carcasses found stranded on the beach and animals entangled in ghost nets, i.e., abandoned, lost, or otherwise discarded fishing gear.

From 1996 to 2011, 20 Olive Ridley Turtles were recorded by the Brazilian sea turtle conservation program (Projeto TAMAR-ICMBio), including 17 at Fernando de Noronha and 3 at Atol das Rocas. Of these, 18 were entangled in ghost nets (16 still alive and 2 dead) and another two individuals were found dead, stranded on the beach. The three turtles recorded at Atol das Rocas were alive and entangled together in the same ghost net, as were four turtles at Fernando de Noronha; all other entanglements were of single individuals. All the nets consisted of multifilament nylon, with mesh sizes of 17–22 cm (stretched mesh). The origin of these nets is unknown, neither is it clear if the nets were used in high seas or coastal fisheries or by national or international ships. Indeed, neither the scale nor magnitude of fishing activity (industrial or artisanal) in the area, or the target species, have yet been determined. Ghost nets are a well-documented threat for marine fauna including sea turtles (Halpern et al. 2008; Macfadyen et al. 2009). In spite of the fact that the origin of the ghost nets is unknown, the influence of the ocean currents seems to be clear. Atol das Rocas and Fernando de Noronha are located where the South Equatorial Current (SEC) flows from east to west (Kikuchi 2000; Renner 2004) and all recorded entanglement was east of the islands. This could indicate that ghost nets were upstream of the location where the turtles were found.

The size of nesting Olive Ridleys in Brazil ranges from 62.5 to 83.0 cm curved carapace length (CCL; Silva et al. 2007). The following size data are available for 17 of 20 turtles: seven (41.2%) were probably adults, as they measured 61–80 cm CCL; three (17.6%) were not measured but were reported to be sub-adults (Guy Marcovaldi, pers. comm.); five (29.4%) ranged from 41–60 cm CCL; and two (11.8%) were 21–40 cm CCL. Thus, they ranged in size from juveniles to adults, but most were sub-adults and adults. Nearby, in the western and central South Atlantic, Sales et al. (2008) reported a similar size distribution for incidental captures of Olive Ridley Turtles by pelagic longline fisheries. In addition, post-nesting Olive Ridleys that were satellite-tracked from the Brazilian state of Sergipe were recorded in the vicinity of areas where entanglement was recorded (Silva et al. 2011). In the western Atlantic, the main nesting populations of Olive Ridley Turtles are located in Brazil (annual nest numbers have been increasing since 1991, Silva et al. 2007; more than 6700 clutches were laid in the 2010/2011 nesting season, Projeto Tamar/ICMBio, unpubl. data), Suriname (between 150 and 200 clutches per year; with a declining trend; Kelle et al. 2009), and French Guiana (between 1716 and 3257 clutches each year, with an increasing trend; Kelle et al. 2009). In the eastern Atlantic, nesting sites are located from between Guinea-Bissau (200–300 clutches each year, with no trend discernable; Barbosa et al. 1998) and Angola (120 clutches per year, with no trend evident; Weir et al. 2007).

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Of the 20 Olive Ridley records reported here, 80% occurred between 2005 and 2011. This result may be correlated with an increase in fishing activity in the offshore waters of northeastern Brazil and at the west coast of Africa, the starting point of the SEC and where the potential fishery stocks are most likely to be found (i.e., the Benguela upwelling system; Japp and James 2003). This result could also be related to population increases observed in the two major nesting sites in the western Atlantic, Brazil (Silva et al. 2007) and French Guyana (Kelle et al. 2009).

As Fernando de Noronha Archipelago and Rocas Atoll have been monitored by Projeto TAMAR/ICMBio since 1984 and 1982, respectively (Marcovaldi and Marcovaldi 1999), the small number of *Lepidochelys olivacea* registered at both sites actually represents a low incidence of entanglement. Even in small numbers, as the occurrences were related to entanglement in ghost nets, it seems that turtles are likely to appear at these offshore islands only when something such as a ghost net takes them from their normal home range. The 18 entanglement events by ghost nets across 15 years do not seems to be a serious threat to this population, but collectively with bycatch in pelagic longline fisheries and satellite tracking data, they provide new evidence that the region plays an important ecological role for critical life stages (subadults and adults) of this species.

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TECHNIQUES

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A Technique for Field Maintenance and Transport of Cold-water Amphibians

A diverse array of amphibians have adapted to the physiological demands of cold-water environments throughout the world. Biologists are increasingly interested in studying these organisms in the laboratory, out of a desire to examine novelty under controlled conditions or because cold-water taxa occupy key phylogenetic positions (e.g., Essner et al. 2010; Pough 2007). Additionally, some cold-water amphibians are critically endangered, necessitating *ex situ* captive management (Pavajeau et al. 2008). A significant obstacle in bringing wild-caught amphibians into the laboratory is the absence of husbandry knowledge for most species (Pough 2007). Maintaining colonies of cold-water amphibians can be especially challenging due to their unusual requirements. These may include high flow rates and low pH levels, in addition to low water temperatures (~10°C recommended by Pough 2007). Laboratory husbandry protocols have been developed for some cold-water amphibians (e.g., *Ascaphus*; Essner and Suffian 2010; Held 1985). However, more proximate obstacles remain, including maintenance of cold-water amphibians in the field for extended periods during collecting activities, followed by safe transport over potentially long distances.

Field maintenance and transport of stream-dwelling cold-water amphibians, such as the Tailed Frogs, *Ascaphus* spp., are especially problematic since they are often highly stenotopic and extremely sensitive to changes in water temperature, in particular. For example, critical thermal maximums (CT_{max}), short term estimates of thermal tolerance based upon loss of righting response, for stream-dwelling forms are among the lowest recorded for amphibians (Bury 2008). The CT_{max} for adult *Ascaphus*, which inhabit torrential streams in the Pacific Northwest, ranges from 27.6 to 29.6°C (Claussen 1973). Mortality is known to occur at even lower temperatures over extended periods of time (Bury 2008). Larval *Ascaphus* (N = 48) kept at 22°C exhibited 88% mortality after 48 h, while adult frogs (N = 12) exhibited 100% mortality after 30 h (Metter 1966). Obviously, field maintenance and transport in animals for which "room temperature" is lethal, is a daunting task, requiring some forethought.

Herein, we describe a simple and inexpensive technique for maintaining cold-water amphibians, in this case, larval and adult Rocky Mountain Tailed Frogs (*Ascaphus montanus*) in the field for an extended period of time (11 days), followed by long distance transport (~3500 km) by automobile (3 days). Recently, Pramuk et al. (2011) described an effective technique for transporting another cold-water amphibian species, the Eastern Hellbender (*Cryptobranchus alleganiensis*). Their setup involved coolers filled with filtered water that was pumped through PVC plumbing to a heat exchanger filled with ice. Our setup is less elaborate, more compact and portable, and eliminates the need for ice.

Adult (N = 34) and larval (N = 16) *Ascaphus montanus* were collected by hand from streams at night with headlamps in the Coeur d'Alene National Forest, Kootenai and Shoshone Counties, Idaho, USA, from 10–20 June 2011. During collection, adults and larvae were placed temporarily in separate 740-ml plastic containers (GladWare) filled with stream water. Upon completion of collecting activities for a particular stream, individuals were transferred from temporary containers to the field maintenance and transport setup described below.

Our basic setup is illustrated in Fig. 1 and consists of the following: 1) a 12 V 38-liter thermoelectric cooler (Coleman PowerChill); 2) a 5-watt aquarium pump for aeration (Petco model #9904) with (4) air outputs, (4) airstones, (4) check valves, and ~2 m of plastic tubing (included with the pump); and 3) (4) latch containers (Sterilite; dimensions 29 cm x 18.5 cm x 7.5 cm). In addition, we added the following elements to the setup in order to provide portable power: 1) a portable power system (Statpower Technologies Portawattz PowerPAC); 2) a 12V sealed marine battery (Universal UB12900); and 3) a battery charger (Schumacher SpeedCharge).

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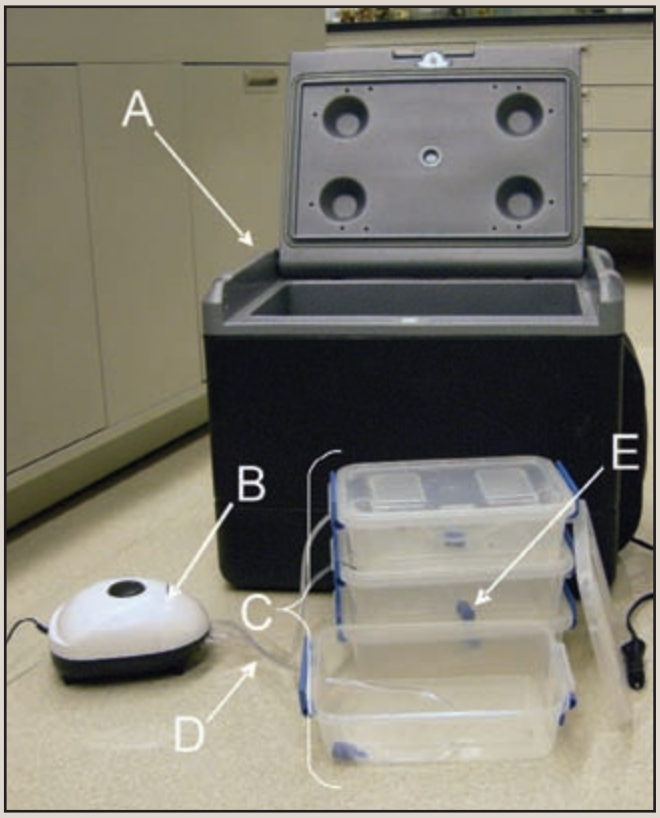

FIG. 1. Field maintenance and transport setup for cold-water amphibians. A) Thermoelectric cooler; B) air pump; C) latch containers; D) plastic tubing; and E) air stone. The thermoelectric cooler and air pump can be powered with conventional outlets when available. Alternatively, they can be plugged into a portable power system attached to a marine battery, providing cold temperatures and aeration over extended time periods.

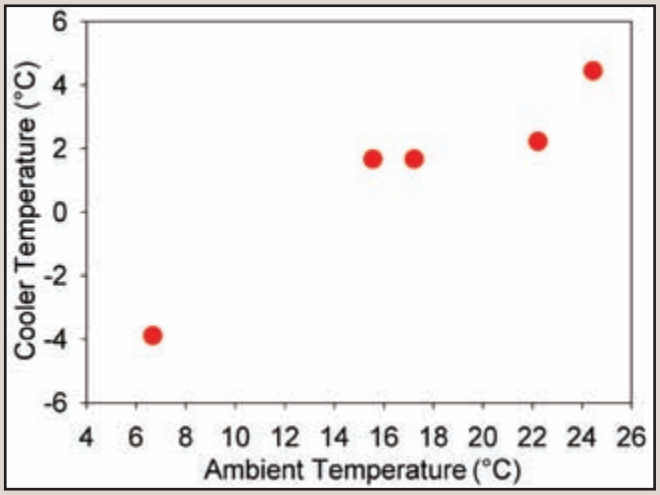

FIG. 2. Relationship between ambient temperature (T_a) and cooler temperature (T_c).

The plastic tubing was cut into (4) short sections of ~15 cm and (4) longer sections of ~35 cm. Each short section was connected to a longer section via a check valve which prevented water from back-siphoning. The open end of each longer section was connected to one of the air outputs on the pump. The open end of each shorter section was directed through a ~0.5 cm opening cut into the side of each latch container (just large enough to accommodate the outside diameter of the tubing) and attached to an air stone. Latch containers were filled halfway with stream water and stacked on top of one another inside the thermoelectric cooler. Adults were divided equally among three of the latch containers to reduce crowding, with larvae placed in the remaining container. Adult tailed frogs are highly aquatic. Since adults and larvae were collected from the same streams under the same conditions, they were treated identically in the setup. The air pump was positioned outside of the cooler, with the tubing exiting through a slight crack in the lid. The cooler and pump were powered during driving by plugging them into a two-outlet power inverter that was plugged into a cigarette lighter. When portable power was needed, the cooler and air pump were plugged into the PowerPac unit, which included its own lead acid battery and power inverter with two outlets. This device was capable of powering the cooler and air pump for ~4 h when fully charged. Connecting the PowerPac unit to the fully charged marine battery added an additional 20 h of power. The marine battery could then be recharged as needed with the battery charger.

Thermoelectric coolers rely on the Peltier effect, whereby an electric current is run across two different metals in order to create a heat pump. The manufacturer of the thermoelectric cooler used in the described setup states that it maintains temperatures up to 22°C below ambient. We tested the performance of the cooler over a range of ambient temperatures (T_a) by using a digital thermometer to measure temperatures inside the cooler (T_c; Fig. 2). The cooler was placed in a temperature-controlled room and allowed to acclimate for a minimum of 1 hour prior to recording T_c. We found that the difference between T_a and T_c did approach this level (~20°C) at typical room temperatures (22–24°C). However, this difference gradually decreased at colder temperatures. At the lowest T_a (6.7°C), T_c dropped below freezing (-4°C). Such a low temperature would jeopardize the well-being of the animals. Therefore, it is recommended that the cooler not be plugged in at T_a below 15°C.

Ambient temperature during the collecting trip never exceeded 21°C. Temperatures inside the cooler were checked frequently during daytime hours, (~6 times throughout the day), with a Fluke 179 digital multimeter for the duration of the trip. Cooler temperatures never exceeded 10°C, despite frequent disturbance due to the addition of newly captured individuals, and keeping the lid slightly cracked to accommodate the plastic tubing.

The entire setup is easy to fabricate and is relatively inexpensive (less than US $500). This approach allowed us to maintain and transport frogs over a combined 14-day period with no incidents of mortality. It should be adaptable to a variety of cold-water amphibians, keeping them at suitable temperatures without a need for ice.

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A Trial Use of Camera Traps Detects the Highly Cryptic and Endangered Grassland Earless Dragon *Tympanocryptis pinguicolla* (Reptilia: Agamidae) on the Monaro Tablelands of New South Wales, Australia

The use of remote, infrared, sensor-activated cameras (hereafter called camera traps) is becoming more widespread in wildlife research as they offer several advantages over traditional manual survey methods. Camera traps are less invasive, offer opportunities to increase detection of cryptic trap-shy fauna, and can collect data over long periods of time with minimal input (Cutler and Swan 1999; Swan et al. 2004). In Australia, much of the focus when using camera traps for threatened wildlife has been on small to large-sized native mammals (Claridge et al. 2004, 2010; Nelson 2009). Camera traps have also been used in Australia to monitor birds (Towerton et al. 2008) and introduced pests (Vine et al. 2008).

There are few publications relating to the use of camera traps for detecting reptiles in Australia. Milne et al. (2003) used video recorders on stands at known burrows to monitor burrow use by the Pygmy Blue-tongue Lizard (*Tiliqua adelaidensis*), Doody et al. (2009) used camera traps for monitoring nesting behavior of the freshwater Pig-Nosed Turtle (*Carettochelys insculpta*), and Somaweera et al. (2011) used camera traps to observe predation on the nests of the Freshwater Crocodile (*Crocodylus johnstoni*). To our knowledge, there has been no published research into the effectiveness of using camera traps to detect small and highly cryptic reptiles.

The Grassland Earless Dragon (*Tympanocryptis pinguicolla*) is a nationally listed, endangered species under the Commonwealth of Australia's *Environment Protection and Biodiversity Conservation Act 1999*. Because of the highly cryptic nature of the Grassland Earless Dragon, approaches to detecting and monitoring the species are very time consuming, labor intensive, and costly (Robertson and Evans 2009). A survey typically involves the use of artificial arthropod burrows in grids or transects, which implies a greater sampling effort since a large number of traps must be installed for a long period of time for the sampling to be effective. This methodology has been used to study the species in the Australian Capital Territory, where natural temperate grasslands lack large areas of rocky outcrop and surface rocks (Fletcher et al. 1999). In rocky landscapes, searching beneath rock (rock-turning) is also a recommended procedure (Robertson and Evans 2009).

These techniques have recently been trialled on the Monaro Tablelands of New South Wales (TM, unpubl. data). Monitoring of artificial arthropod burrows at five known locations across the Monaro Tablelands during the summer of 2010 resulted in the discovery of only two individuals at one of the five locations despite some 4253 trap days; furthermore, rock turning during the winter of 2010–2011 across the Monaro Tablelands resulted in only 15 individuals being discovered at five locations despite 73 suitable grassland sites being surveyed and > 23,000 rocks being turned (TM, unpubl. data).

This low detectability of the species using prescribed survey techniques motivated us to trial camera traps to detect one of Australia's rarest and most cryptic reptiles, the Grassland

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TABLE 1. A comparison of results from the camera trap trial and recent rock turning surveys at the study site.

	Rock turning survey 1	Rock turning survey 2	Rock turning survey 3	Camera trap trial	Rock turning survey 4
Survey date	June 2010	September 2010	April 2011	April 2011	June 2011
Number of Grassland Earless Dragons recorded	4	1	0	2	1
Total survey effort at study site	493 rocks	60 rocks	240 rocks	150 camera trap days*	20 rocks
Number of rocks turned / camera trap day to detect specimen during the survey	25, 70, 90, 120 rocks, respectively	20 rocks	0	42 and 66 camera trap days, respectively	20 rocks

* The memory cards of four of the camera traps were full upon retrieving the camera traps. The six camera traps operated on average for 25 days of the 75 days they were left on the study site (25 days x 6 camera traps = 150 camera trap days).

FIG. 1. Native temperate grassland paddock on the Monaro Tablelands of New South Wales, Australia (Travelling Stock Reserve study site within).

FIG. 2. Example of the camera trap set up used to detect the Grassland Earless Dragon in native temperate grassland of the Monaro Tablelands, New South Wales, Australia.

Earless Dragon, on the treeless basalt grasslands of the Monaro Tablelands of New South Wales.

Methods.—Six camera traps (Moultrie MFH-DGS-I60, ca. AU $360 each; www.moultriefeeders.com) were installed and set to photograph and record the Grassland Earless Dragon within a Travelling Stock Reserve (TSR) approximately 15 km S of Cooma on the Monaro Tablelands of New South Wales, Australia. Camera traps were left within the TSR for a period of 75 days between 7 April 2011 and 20 June 2011. The TSR is situated on an east-facing footslope and comprises treeless, rocky, native temperate grassland dominated by Kangaroo Grass (*Themeda australis*), spear grasses (*Austrostipa* spp.), and Red-leg Grass (*Bothriochloa macra*). The site is surrounded in three directions by extensive stretches of native temperate grassland and is generally representative of native temperate grassland across the Monaro Tablelands (Fig. 1). The study site had not previously been subject to recent standardized artificial arthropod burrow surveys in the region; however, *Tympanocryptis pinguicolla* had previously been recorded on the site through rock turning surveys (TM, unpubl. data).

Four of the six camera traps were each attached to a wooden stake approximately 20 cm above the ground at a 30-degree angle and focused on an artificial arthropod burrow which was installed approximately 40 cm away (Fig. 2). Artificial arthropod burrows are constructed from PVC tubing and designed to mimic an arthropod burrow, which are used as natural shelter sites by *T. pinguicolla* (Fletcher et al. 2009). As such, they do not trap *T. pinguicolla* because they can move in and out of them freely. The four camera traps were installed at 30-m intervals along a 120 m east to west transect. The remaining two camera traps were installed on fence posts along the northern boundary of the TSR each 30 cm from the ground and 30 m apart. All camera traps were programmed on a 24 h cycle and set to take a single photo upon each sensor trigger followed by 15 seconds of video footage. To minimize false camera trap triggers, the small section of grassland in sight of each camera trap, approximately 1 m x 1 m, was trimmed down to approximately 10 cm in height.

Results.—Camera traps took a combined total of 1296 photos and 1294 video recordings over the 75 days. Two of the camera traps were effective in capturing clear and easily identifiable photos (N = 12) and video recordings (N = 7) of the endangered

T. pinguicolla. The photos and video recordings occurred on 13 April commencing at 1120 h and 17 April 2011 at 1230 h.

There were other possible photos (N = 9) and recordings (N = 2) of *T. pinguicolla* on one other camera trap. We were not able to identify individuals on these photos or recordings due to poor focus as a result of the camera trap set up and these out of focus images could not be distinguished from other grassland lizards known to occur in the region, e.g., White's Skink (*Egernia whitti*).

The camera traps captured photos of *T. pinguicolla* at the edge of the artificial arthropod burrow and slightly overlooking the artificial arthropod burrow (Figs. 3, 4) as well as basking on a short tussock that had been trimmed beside an artificial arthropod burrow (Fig. 5). One camera trap recorded a *T. pinguicolla* basking on a nearby grassland tussock for three minutes before the lizard moved slowly to a nearby basalt rock. Another recording in this sequence showed the same lizard actively checking the inside of the artificial arthropod burrow (with its hind legs outside the burrow) until it rapidly exited the burrow. Earlier recordings on this camera trap did not show any evidence of anything entering the burrow prior to this recording. None of the *T. pinguicolla* took refuge inside the artificial arthropod burrows.

The remaining photos (N = 1275) and video recordings (N = 1285) were false trips appearing to be triggered by windblown grass, insect or arachnid activity (e.g., grasshoppers, butterflies, and wolf spiders), inquisitive Singing Bushlarks (*Mirafra javanica*), or Eastern Grey Kangaroos (*Macropus giganteus*). The study site had previously been subject to multiple rock turning surveys during the winter of 2010–2011 (TM, unpubl. data) and a comparison of the results of this trial use of camera traps with recent rock turning surveys is shown in Table 1.

Discussion.—Our trial involving the use of six camera traps at a single grassland site has proven effective in detecting the cryptic and endangered Grassland Earless Dragon. The results of this trial confirm that Grassland Earless Dragons are active on cool autumn days when temperatures reach a daily maximum of 13.2°C and 18°C and an overnight minimum of 2.6°C and -0.6°C, respectively (BOM 2011). Interestingly, the first recordings and photos of *T. pinguicolla* on 13 April occurred mid morning following the coolest night of the month which reached an overnight minimum of -1.5°C (BOM 2011). Despite not being the intent of this study, these results highlight the added bonus of using camera traps to survey for this species in that they have the potential to be used to investigate the activity periods of this highly cryptic lizard.

Despite being only a trial use of camera traps and not yet replicated, including at previously unsurveyed sites or sites with a history of non detection, the comparisons between rock turning surveys and camera traps at the site in Table 1 demonstrate the effectiveness and potential of camera traps to detect *T. pinguicolla*. Where a rock turning survey conducted during the same month as the camera trap trial (consisting of 240 rocks turned) failed to detect the species at the site, the camera traps succeeded.

There is much potential for camera traps to be a more desirable survey and monitoring technique than live trapping (Kays and Slauson 2004), and in some situations to be more effective (De Bondi et al. 2010). This trial offers insight into an innovative, less invasive and labor intensive alternative for detecting and monitoring a highly cryptic and endangered reptile across the basalt grasslands of the Monaro Tablelands of New South Wales. Furthermore this pilot study highlights the potential of camera traps for surveying other similar-sized cryptic reptiles in Australia and elsewhere.

FIG. 3. Grassland Earless Dragon approaching artificial arthropod burrow.

FIG. 4. Two minutes on, Grassland Earless Dragon overseeing artifical burrow.

FIG. 5. Four minutes on, Grassland Earless Dragon basking on a nearby tussock.

Pilot studies are a recommended means of gathering important information prior to embarking on a full survey

program using camera traps (Nelson and Scroggie 2009). A need to test other camera makes and models, appropriate camera trap distances from the burrow as well as the angle of the camera trap to burrow in order to get the best focus and therefore quality images will be required in future applications of this method. There is also the need to minimize false camera trap triggers caused by wind moving nearby vegetation and therefore allow for more extended periods of monitoring. Being a largely treeless and undulating ecosystem, some further consideration may also need to be given to the site selection, aspect, and positioning of camera traps to avoid prolonged shading of artificial arthropod burrows and increase the probability of detection. The kangaroos and birds photographed from camera traps along the fence line also suggests avoiding fence lines in future camera surveys and ensuring cameras are better stabilized.

The effective use of camera traps in this pilot study will enable us to address new and important questions that relate to use of artificial and natural burrows, activity patterns outside of key activity periods, behavioral attributes, predator-prey interactions, as well as the opportunity to investigate the effects of rock turning on the species. The ease with which camera traps can be installed and relocated across the landscape compared to the current labor intensive techniques (Robertson and Evans 2009) suggests camera traps could be ideal for improving detectability studies and implementing long term monitoring programs for the Grassland Earless Dragon.

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CONSERVATION

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Conservation Implications Following the Rediscovery of Four Frog Species from the Itombwe Natural Reserve, Eastern Democratic Republic of the Congo

The Albertine Rift (AR) of Central Africa is generally defined as the western, montane branch of the Great Rift Valley, which forms part of the Arabo-African Rift that extends from Palestine across the Red Sea to Mozambique for approximately 6,000 km (Vande weghe 2004). Plumptre et al. (2007) considered the AR to occur from ca. 30 km north of Lake Albert along the eastern border of Democratic Republic of the Congo (DRC) to the southern tip of Lake Tanganyika, including the flanks of the escarpment down to the valley. Ancient and recent historical geological processes have engendered numerous volcanoes in the AR, some of which are still active in eastern DRC (Draper 2011); Nyamulagira Volcano (near Goma) erupted as recently as November, 2011 (Thakur 2011).

Multiple studies have noted that the AR is the most species-rich area for vertebrates in continental Africa, and the rift also includes large numbers of endemic and threatened vertebrate, invertebrate, and plant species (Brooks et al. 2001; Burgess et al. 2004; Plumptre et al. 2003, 2007). Because of a substantial dearth of herpetological collecting in the AR following the violent aftermath of colonialism in the mid- to late twentieth century (Edgerton 2002; Lemarchand 2009), new species (defined herein as species new to science that require formal description) and genera of amphibians and reptiles continue to be discovered and identified, especially via the analysis of DNA sequence data (Evans et al. 2008, 2011; Greenbaum et al. 2011, 2012a, b).

The Itombwe Natural Reserve (INR, Fig. 1) is a recently established (October 2006) protected area in the AR on the western side of Lake Tanganyika. Although the exact boundaries of the reserve are not yet determined (Plumptre et al. 2010a), Doumenge (1998) defined the Itombwe Mountains as an area of appoximately 15,000 km^2 occurring between 2°40 and 4°35S, and 27°55 and 29°05E, with an elevation ranging from 900–3475 m. Vegetation and habitats of the reserve are exceptionally diverse. On the western side of Itombwe, the Congo Basin's widespread, lowland forests transition into mid-elevation forests associated with AR endemism. The mountains in Itombwe contain submontane, montane, and bamboo forests, grasslands, and subalpine vegetation (Fig. 2). The eastern side of the plateau is characterized by a steep escarpment that drops precipitously in elevation to the lacustrine plain of Lake Tanganyika, which continues to the western mountains of Burundi. Itombwe is one of very few sites in sub-Saharan Africa with a complete and continuous succession of forest types from low-elevation rainforest to montane forest, and Doumenge (1998) remarked that, "the Itombwe Mountains have the second largest, if not the largest, actual area of submontane, montane, and subalpine forests in continental Africa." Three major ecoregions converge at Itombwe, including Northeastern Congolian Lowland Forests, Albertine Rift Montane Forests and Central Zambezian Miombo Woodlands (Burgess et al. 2004). In general, precipitation varies from 3,000 mm/year in the western forests to 1600 mm/year at the highest elevations of the plateau, and 1200 mm/year in the southern and eastern savannahs, which experience a dry season lasting four months (Doumenge 1998). Temperature and rainfall in Itombwe varies considerably by ecoregion and elevation, and has been described in detail by Prigogine (1978).

In recent assessments of all well-studied AR sites, Itombwe had the most threatened species of amphibians (Stuart et al. 2008), and was tied (with Virunga National Park) for highest number of endemic amphibians (Plumptre et al. 2007). Following the description of the Itombwe-endemic pipid frog *Xenopus itombwensis* (Evans et al. 2008), Itombwe is now the most important site in the AR for amphibian diversity, which also renders it among the most important sites for amphibian conservation in continental Africa (Burgess et al. 2004). Itombwe also contains large numbers of endemic and threatened plants, butterflies, birds, reptiles, and mammals, including forest elephants and eastern lowland gorillas (Greenbaum et al. 2011; Omari et al. 1999; Plumptre et al. 2003, 2007). Prigogine (1977) discussed the avifauna of Itombwe in detail, and noted that the site contains 75% of all African forest species, including three species that are endemic to Itombwe; these data led Prigogine to suggest that

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FIG. 1. Map of east-central Africa showing the locations of the Itombwe and Kabobo Plateaus in South Kivu Province, eastern Democratic Republic of the Congo.

Itombwe is a center of montane speciation. Collar and Stuart (1988) also noted the extremely high numbers of endemic and threatened bird species at Itombwe, and Sayer et al. (1992) considered Itombwe's forests to be the most important for bird conservation on the continent of Africa.

Remarkably, Itombwe's status as a major area of endemism for African amphibians is based on relatively little fieldwork conducted in the 1940s and 1950s by Belgian herpetologist Raymond Laurent (Laurent 1950, 1951, 1955, 1964), who described several new species of frogs, including the monotypic treefrog genera *Callixalus* (Itombwe and Kabobo highlands, Rwandan highlands) and *Chrysobatrachus*, which is endemic to Itombwe's high-elevation grasslands. Tihen (1960) recognized one of Laurent's new species of dwarf toads as a monotypic Itombwe endemic genus, *Laurentophryne*. Recently, Evans et al. (2008) described a new species of clawed frog (*Xenopus*) from Itombwe, and with one additional exception (Roelke et al. 2011), there has been no taxonomic work on the Itombwe amphibian fauna since the mid-20th century, and the current status (i.e., extant vs. extinct, threatened vs. least concern) of the majority of Itombwe's amphibians is currently unknown.

In May 2011, we distributed a press release (Perez 2011; http://eligreenbaum.iss.utep.edu/lost_amphibians.htm) announcing the rediscovery of five frog species that had not been seen in the AR since 1954, including the hyperoliid treefrog *Hyperolius chrysogaster*, which was collected in montane forest near Kahuzi-Biega National Park. Herein, we focus on the remaining four species that were found at Itombwe during a brief herpetofaunal survey of several sites (Fig. 3): *Arthroleptis pyrrhoscelis* (Arthroleptidae), *Chrysobatrachus cupreonitens* (Hyperoliidae), *Hyperolius leucotaenius* (Hyperoliidae), and *Phrynobatrachus asper* (Phrynobatrachidae). Because of security limitations associated with armed militia in Itombwe, visual surveys were opportunistic and did not adhere to a consistent methodology. If the security situation in Itombwe improves in the future, additional surveys with a planned search methodology are needed at all field sites. Detailed locality information for the rediscovered Itombwe species is provided in Table 1.

Although *Phrynobatrachus asper* was listed by Behangana et al. (2009) from the AR, no detailed locality or date of collection was provided. *Chrysobatrachus cupreonitens*, *Hyperolius leucotaenius* and *Arthroleptis pyrrhoscelis* are endemic to Itombwe, but the latter species occurs at Itombwe and the Kabobo Plateau, a relatively small highland area just southeast of Itombwe (Fig. 1). Kabobo (Misotshi-Kabogo forest, *sensu* Plumptre et al. 2008, 2010a) is also considered here, because the plateau has a similar elevation, vegetation and climate to the proximate Itombwe Plateau, genetic samples from conspecific herpetofaunal populations at the two sites have minimal sequence divergence (EG unpubl. data), and Kabobo contains several endemic taxa (Table 2). Kabobo is also known to contain many rare species of birds in common with Itombwe (Prigogine 1960), and both sites contain significant populations of chimpanzees (Plumptre et al. 2008, 2009). Kabobo is also the largest tract of forest adjacent to Lake Tanganyika in DRC or Tanzania (Plumptre et al. 2008).

Our recent fieldwork suggests that the amphibian diversity of Itombwe and Kabobo is vastly underestimated. Analyses of amphibian specimens and DNA samples collected by us during expeditions in 2008–2012 identified several new species that seem to be endemic to narrow bands of elevation at the sites (< 5,000 km^2 extent of occurrence), and are thus likely to be classified as endangered under the threat criteria of the IUCN Red List (IUCN 2001). Most of these new species require additional sampling and male advertisement call recordings (anurans) for adequate species descriptions. Because our sampling of Itombwe and Kabobo has been mainly limited to forests that were not pristine, scores of additional, new amphibian species are likely to be discovered if future sampling can occur before catastrophic deforestation is complete. Moreover, chytrid fungus (responsible for global amphibian declines) has been detected (EG unpubl. data) in multiple amphibian species from Itombwe and Kabobo (including new species), creating an urgency for threat assessments of the sites' amphibian fauna (see also Greenbaum et al. 2008). We also observed that at least one Itombwe endemic amphibian species (*Phrynobatrachus asper*) is hunted for food, which is likely a consequence of its relatively large size (holotype snout–vent length = 55 mm, Laurent 1951). Given this hunting pressure, widespread destruction of Itombwe's forests, overgrazing of grasslands on the plateau and limited elevational distributions (Table 2), we recommend a critically endangered threat status (IUCN 2001) for the Itombwe endemic species *P. asper* and *Chrysobatrachus cupreonitens*, which are both currently classified by the IUCN as data deficient.

The impressive number of endemic amphibian species (Table 2), including two monotypic genera (i.e., phylogenetic relicts), suggests that Itombwe was either climatically stable over ecological and evolutionary time, or the forests are exceptionally resilient to climate-induced changes. According to Sayer et al. (1992), the Itombwe Plateau is a relict of the ancient relief that

TABLE 1. Locality data for four rediscovered species of anurans from the Itombwe Plateau, South Kivu Province, Democratic Republic of the Congo. UTEP museum catalog numbers are from the herpetology collection of the University of Texas at El Paso.

Species	Voucher No.	Locality	Habitat	Date
Arthroleptis pyrrhoscelis	UTEP 20392–20395	Near Tumungu village, 03.55873°S, 28.66603°E, 2022 m	Grassland	2 January 2011
Arthroleptis pyrrhoscelis	UTEP 20396	Near Tumungu village, 03.54172°S, 28.66970°E, 1900 m	Grassland	3 January 2011
Arthroleptis pyrrhoscelis	UTEP 20397	Near Tumungu village, 03.55594°S, 28.67029°E, 1960 m	Grassland	4 January 2011
Chrysobatrachus cupreonitens	UTEP 20398, 20403–20408	Mitamba village, 03.43184°S, 29.01411°E, 2852 m	Marsh	7 January 2011
Chrysobatrachus cupreonitens	UTEP 20399–20402	Mitamba village, 03.43153°S, 29.01164°E, 2848 m	Marsh	7 January 2011
Hyperolius leucotaenius	UTEP 20411–20413	Mikenge village, 03.74924°S, 28.74738°E, 2166 m	Marsh	30 December 2010
Hyperolius leucotaenius	UTEP 20414–20418	Elila River near Tumungu village, 03.54425°S, 28.67245°E, 1800 m	Gallery forest	1 January 2011
Hyperolius leucotaenius	UTEP 20409–20410	Near Tumungu village, 03.55370°S, 28.67422°E, 1869 m	Montane forest edge	4 January 2011
Phrynobatrachus asper	UTEP 20419–20425	Kamandende River near Mugegema village, 03.06184°S, 28.77858°E, 2675 m	Montane forest	25 May 2009
Phrynobatrachus asper	UTEP 20426–20429	Nakihomba River near Mugegema village, 03.07805°S, 28.76787°E, 2749 m	Montane forest	26 May 2009

TABLE 2. List of amphibian and reptile species that are known to be endemic to the Itombwe and/or Kabobo Plateaus. Data are taken from original species descriptions (Evans et al. 2008; Greenbaum et al. 2011; Laurent 1950, 1951, 1952, 1954, 1956), Laurent (1983), IUCN Red List (IUCN 2011) and Table 1 of this publication.

Taxon	Itombwe	Kabobo	Elevational distribution (m)	IUCN Red List Threat Status
Arthroleptis pyrrhoscelis	+	+	1900–2022	Near threatened
Arthroleptis vercammeni	+	—	1650	Data deficient
Cardioglossa nigromaculata inornata[1,2]	—	+	1900–2000	—
Chrysobatrachus cupreonitens	+	—	2400–2850	Data deficient
Hyperolius leleupi	+	—	2550–2650	Endangered
Hyperolius leucotaenius	+	+	1850–2500	Endangered
Laurentophryne parkeri	+	—	1850–1950	Data deficient
Phrynobatrachus asper	+	—	2400–2850	Data deficient
Phrynobatrachus dalcqi	—	+	1900–2000	Data deficient
Xenopus itombwensis	+	—	1800–2200	Critically endangered
Congolacerta asukului	+	—	2650–2900	—
Leptosiaphos rhodurus	+	—	1600	Data deficient
Lygodactylus angularis paurospilus[2]	—	+	1900–2000	—
Duberria lutrix currylindahli[2,3]	—	+	1900–2000	—

[1]Amiet (1972) and Blackburn (2008) noted this taxon likely represents a distinct species.
[2]These taxa likely represent distinct species, because they were described from isolated highlands that are hundreds, or even thousands of kilometers from their respective nominate species type localities.
[3]Laurent (1956) listed a specimen from "Kadjaga s/Tanganika, Urundi?" but the locality of Kadjaga in DRC or Burundi is unknown.

predates the mountains of the AR, which began forming in the Miocene 25–30 million years ago (Vande weghe 2004). This contention also supports the theory that Itombwe is in the area of the largest forest refugium (subrefugium of the AR refugium, *sensu* Prigogine 1986) in Central Africa, which likely harbored forest-endemic species throughout the Quaternary because of its ecological stability (Doumenge 1998; Sayer et al. 1992). In a discussion of the oldest forests in Africa, Lovett et al. (2005) noted that ecologically stable forests are characterized by the presence of aggregates of relictual lineages (e.g., monotypic genera), newly evolved species and ecological equilibration, where the forests are uniformly diverse over ecological gradients, thus optimizing diversity at a sustainable level. The theory behind this pattern is that long-term ecological stability depresses extinction rates, thus preserving phylogenetic relicts, and increases speciation rates, which enhances the survival of closely related variants that might be recognized as distinct species (Lovett et al. 2005).

Does Itombwe fit the pattern of an ecologically stable forest over time? Currently available data suggest the answer is yes. Although the monotypic genera *Chrysobatrachus* and *Laurentophryne* (the latter genus has not been seen since its description in 1950) have not been studied within a modern phylogenetic context, their distinctive morphology suggests they are substantially different from other closely related genera, and are likely to represent relictual genera (Laurent 1964). The monotypic genus *Callixalus* (now mostly restricted to Itombwe and Kabobo) fits this pattern as well, and the newly described genus *Congolacerta* is also a relatively ancient lineage, with one endemic species in Itombwe (Greenbaum et al. 2011). Preliminary analyses of mitochondrial DNA sequence data from multiple amphibian taxa (e.g., *Phrynobatrachus*, *Leptopelis*) suggest that Itombwe harbors several recently diverged sister taxa (< 2.5% uncorrected *p* sequence divergence) that are morphologically distinct, often with significant differences in variables of the male advertisement call (EG and F. Portillo unpubl. data). These relatively recently evolved species and several other new species that warrant recognition are mainly known from restricted geographic and elevational distributions (see Prigogine 1980 for similar patterns in birds), and support a pattern of ecological equilibration in Itombwe. If Itombwe was indeed a glacial refugium that was ecologically stable during past climatic shifts, there is hope that it could be a reservoir for its astounding biodiversity if future global climate change models are correct in predicting drastic shifts in temperature and rainfall in the 21st century. However, the mechanisms of speciation in Itombwe remain poorly understood, and further study is required.

Sayer et al. (1992) noted, "low human population density and the forest's isolation have proved, so far, to be Itombwe's best defences, but this state of affairs cannot continue forever. Despite recognition of its great value, no area of the massif is protected." Given the long history documenting the enormous conservation value of Itombwe's forests, it is surprising that concrete efforts to protect the site only commenced recently. An administration with a managing warden was established for INR in 2008. The reserve faces severe anthropogenic pressure from a growing human population that is migrating from the most heavily populated area in Central Africa (i.e., the border between DRC, Rwanda and Burundi) (Barnes and Lahm 1997), which is a result of one of the highest fertility rates in the world (Draper 2011). Reserve rangers have limited resources to ameliorate poaching, illegal mining and deforestation, which is currently not monitored. The influx of automatic weapons to Central Africa during the late twentieth century led to a sharp increase in poaching at Itombwe with accompanying, catastrophic declines in the numbers of forest elephants, gorillas and other endangered primates, and several species of ungulates (Hall et al. 1998; Mubalama et al. 2008; Omari et al. 1999; Plumptre et al. 2009). The grasslands in the highest elevations of the plateau are heavily impacted by numerous herds of domestic cattle, which are allowed to graze over vast areas. These environmental pressures will likely increase as a defunct, colonial-era road that bisects the Itombwe Plateau (between Mwenga and Fizi) is rehabilitated over the next year with funds from the European Union (CK, pers. comm.). The road will allow vehicles to extract resources (e.g., timber, gold and coltan) more efficiently and rapidly, and will likely lead to the establishment of additional human settlements with concomitant negative environmental impacts.

PHOTO BY WANDEGE M. MONINGA

FIG. 2. Photograph of the Itombwe Plateau near the village of Tumungu (ca. 1900 m), where *Hyperolius leucotaenius* was collected in montane forest (background) and *Arthroleptis pyrrhoscelis* was collected from grassland (foreground) in January, 2011.

In contrast to Itombwe, the southern extent of the Kabobo Plateau has not suffered from significant deforesation, but the site is completely unprotected, and illegal gold mining and hunting was observed by the authors in 2009. Based on positive meetings between the Institut Congolais pour la Conservation de la Nature (ICCN, i.e., Congolese Wildlife Authority), Wildlife Conservation Society (based in New York City, USA) and local chiefs and governmental leaders in 2009, plans are underway to establish Kabobo as a protected area (to be called Ngamikka National Park) with a surrounding buffer zone. However, prospecting mineral concessions were granted to several mining companies within some areas of the proposed national park, and these concessions must be annulled before conservation measures can move forward (Plumptre et al. 2010b).

Challenges to ongoing conservation efforts at INR are substantial and daunting. Preliminary conservation efforts discussed by Doumenge (1998) and Omari et al. (1999) were presumably abandoned during Africa's World War (Prunier 2009), which commenced in 1997. Since that time, at least three armed militia groups have become entrenched within the proposed boundaries of INR, and although UN programs are making some progress towards disarmament and reconciliation (CK, pers. obs.), militias continued to hamper the authors' scientific and conservation efforts as recently as January 2012. Many similar

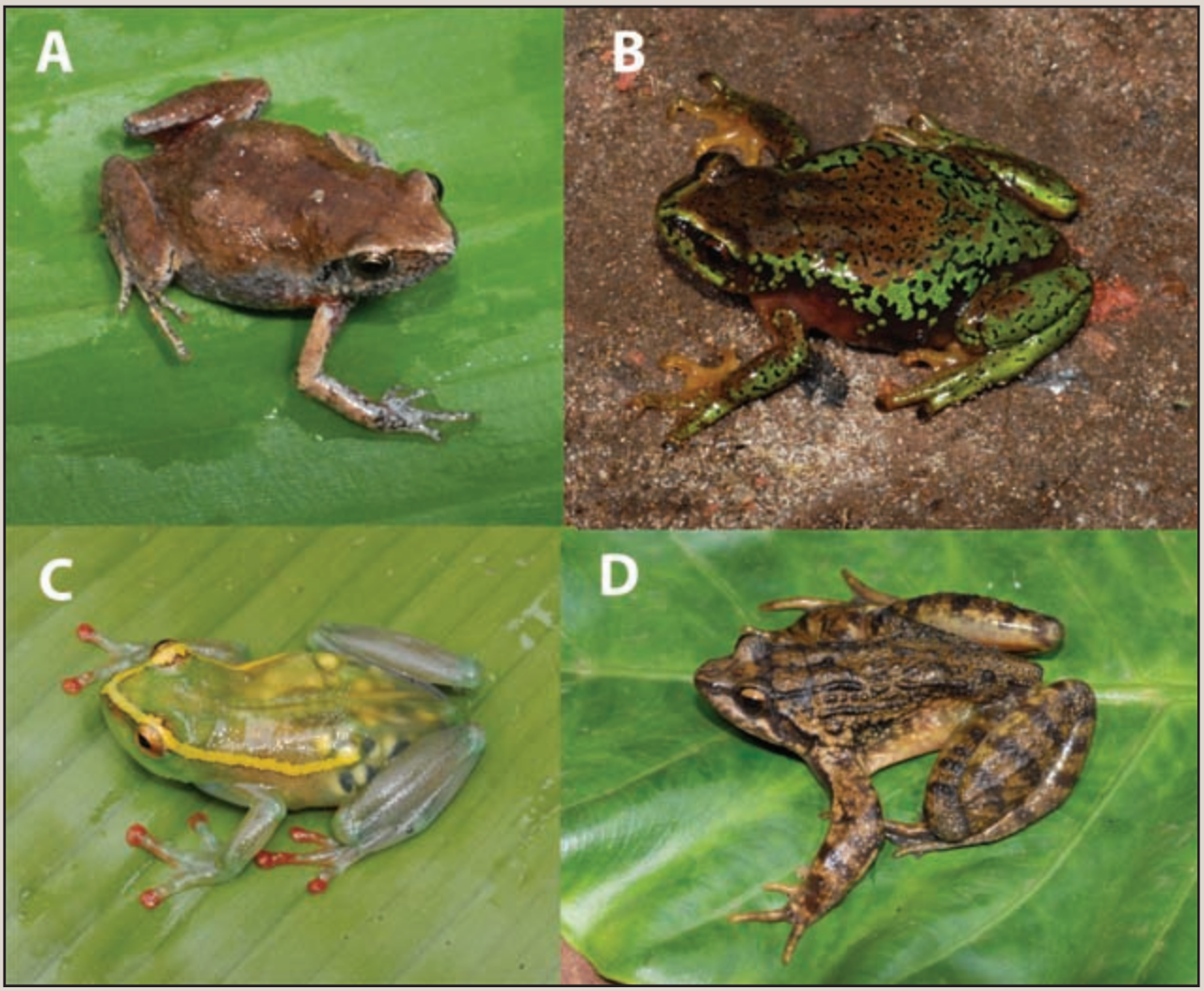

FIG. 3. Photographs of four rediscovered species of amphibians from the Itombwe Plateau. A) *Arthroleptis pyrrhoscelis*, B) *Chrysobatrachus cupreonitens*, C) *Hyperolius leucotaenius*, and D) *Phrynobatrachus asper*.

challenges occur in the more established Virunga National Park (Africa's oldest national park and a UNESCO World Heritage Site), where corruption and a lack of enforcement have allowed militias to destroy significant portions of the park's forests and wildlife (Draper 2011; Jenkins 2008). In Virunga (and presumably in INR), Ikoleki and d'Huart (2009) suggested that people living around the boundary of the park have the impression that the ICCN grants more importance to wildlife than to people, and that "objectives contributing to the promotion of socio-economic development of populations living around the protected areas" must be included in conservation activities. If peace could come to Itombwe in the future, the economic potential for ecotourism from birdwatching is enormous, given the staggering diversity of bird species that are known from the plateau. Habituation of gorillas and chimpanzees could also lead to ecotourism revenue, which is a significant source of income in neighboring Rwanda (Briggs and Booth 2006).

Despite these challenges, the rediscovery of four anuran species and discovery of at least a dozen new herpetological species at Itombwe (EG, unpubl. data) suggests that large areas of the plateau continue to harbor an impressive level of biodiversity. Several herpetological species found at Kabobo also seem to be in Itombwe (Table 2; EG, unpubl. data), suggesting the two sites were connected during geologically recent Pleistocene shifts in vegetation (but see Laurent 1983); both sites should be protected together to maximize conservation efforts and ensure that localized extirpation at one site does not result in extinction of a given species. For example, the monotypic hyperoliid genus *Callixalus pictus* is now extirpated from its type locality in Rwanda (Sinsch et al. 2011), underscoring the importance of protecting Itombwe and Kabobo, where most, if not all remaining populations occur. In conclusion, efforts to bolster INR should continue and expand to include Kabobo, predicted detrimental effects of the rehabilitated road through the Itombwe Plateau must be monitored carefully and linked to conservation benefits to local communities, and captive breeding programs must be initiated for the most vulnerable species if conservation efforts cannot improve by the end of this decade. Because additional, new herpetofaunal species await description, it is likely that the Itombwe Plateau's importance as a center of endemism and conservation concern will increase as biological exploration continues.

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HERPETOCULTURE

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Comparison of the Oral Bacteria Communities Among Five Lizard Species in a Captive Environment

The putative phenomenon of oral bacteria being part of complex predatory strategy in Komodo Dragon monitor lizards (*Varanus komodoensis*) has received considerable popular media coverage and a surprising amount of academic attention (Auffenburg 1981; Bull et al. 2011; Montgomery et al. 2002; Yogiari et al. 2001). In our experience in a zoo environment it also is evident that the general public has been convinced this is a valid phenomenon. Nevertheless, we fully concur with the review by Fry et al. (2009) that there is no direct evidence that *V. komodoensis* actually employs any such bacterial strategy in its feeding ecology. We also find it compelling that the phenomenon was entirely unmentioned in recent scholarly reviews of the ecology of *V. komodoensis,* Varanidae, or lizards in general (Bennett 1998; Ciofi 2004; King and Green 1993; Pianka and Vitt 2003).

In this study, we do not directly test the hypothesis implied by Auffenburg (1981). Rather, we present a comparison of the variation among the oral bacteria in several species of captive lizards, including Komodo Dragons, held in the same facility. Auffenberg (1981) isolated from the oral cavities of wild *V. komodoensis* four potentially pathogenic oral bacteria (*Staphylococcus* sp., *Providencia* sp., *Proteus mirabilis*, and *Morganella* [= *Proteus*] *morganii*). Montogomery et al. (2002) also found these taxa but attributed mortality of prey items from attack wounds by the lizards to the bacterium *Pasturella multocida,* which they isolated from wild-caught lizards but not from captive individuals. Examination of the oral bacterial community of a large group of *V. komodoensis* (N = 26 wild; N = 13 captive) found 57 bacteria species, with the mean number of species for wild-caught individuals being 46% higher than that of captive individuals (Montgomery et al. 2002). Gillespie et al. (2002) presented the same bacterial data as Montgomery et al. (2002), and presented preliminary observations regarding potentially effective antibiotic medicines and immune responses by *V. komodoensis* to their own bacterial flora. Yogiara et al. (2001) examined oral bacteria of 12 *Varanus* spp. (not including *V. komodoensis*) from captivity, but only reported on isolates of *Escherichia coli*. In contrast, Montgomery et al. (2002) found *E. coli* to be one of most common bacteria in wild-caught *V. komodoensis,* but absent from their captive specimens. They reported the most commonly isolated bacteria in captive animals were *Staphylococcus capitis* and *Staphylococcus caseolyticus*, which were not present in the wild-caught individuals. Considered together, these studies highlight that *V. komodoensis* harbors a wide variety of oral bacteria species, with the greater diversity appearing in wild animals and little overlap between wild vs. captive animals. Within the scope of their study, Yogiara et al. (2001) reported the possibility of cross-contamination (= transmission) of oral bacteria between individuals all held in the same captive facility and fed similar diets. Thus, transmission of oral bacteria is suspected to occur among individual lizards both in the wild and in captivity (Bull et al. 2010; Yogiara et al. 2001).

In this study, we sampled the oral bacteria of several varanid and non-varanid lizard species held in the same captive facility, to assess variation among individuals and species. Previous studies have compared only among individuals of *V. komodoensis* (both captive and wild) or have compared only varanid species (Auffenburg 1981; Montgomery et al. 2002; Yogiari et al. 2001). Our study compared oral bacteria among three species of carnivorous varanid lizards, one herbivorous scincid, and one herbivorous agamid that are maintained in the same facility and fed from the same kitchen preparation area. Our study was not designed to compare the oral bacteria of wild vs. captive animals, nor to directly address the hypothesis of oral bacteria as a predatory strategy in *V. komodoensis*.

Methods.—Species sampled included Komodo Dragon (*Varanus komodoensis*; N = 1 adult male, 1 juvenile male, 1 juvenile female), Desert Monitor (*V. griseus*; N = 1 adult male, 1 adult female), and Rough-necked Monitor (*V. rudicollis*; N = 1 adult male, 1 adult female). We additionally sampled Prehensile-tailed Skink (*Corucia zebrata*; N = 1 adult male) and Egyptian Spiny-tailed Lizard (*Uromastyx aegyptia*; N = 1 adult male, 1 adult female). Except for the adult *V. komodoensis*, all animals are maintained in the same building at Zoo Atlanta with separate enclosures for each species; individuals of the same species are maintained together or separately for variable amounts of time. The adult *V.*

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komodoensis is maintained alone in an adjacent building. All of these lizards are maintained by the same staff of keepers and all food is stored and prepared in the same kitchen. Utensils and food-preparation implements are washed and sanitized per standard precautions between uses, but no form of biosecurity protocols are in place that would prevent transfer of oral bacteria among animals in the living collection. The main building also houses a large collection of other reptile and amphibian species, plus a variety of insect cultures.

Saliva samples were collected from the oral cavity of each lizard using with two sterile cotton swabs that immediately were streaked onto two trypticase soy agar (TSA) plates and two MacConkey's agar (MAC) plates. One control swab was subsequently streaked onto one plate of each medium. As a safety precaution, saliva samples for the adult male *V. komodoensis* initially were collected on a sterile metal plate and then saliva was swabbed from the plate and the swabs streaked onto the TSA and MAC media. Plates were then sealed with parafilm and incubated at 37°C for 24–48 h. Initial isolates were chosen based on morphological assessment of the colonies. Isolation streaks were performed on clean TSA plates and MAC plates followed by incubation at 37°C for 24–48 h. Gram staining was done on samples from isolated colonies, then slides were observed using light microscopy. Gram-stain reaction and shape were recorded for each isolate. Colonies were inoculated into lysogeny broth (LB) cultures in 15-mL conical tubes.

Because DNA-sequences may offer less subjective assessment of bacterial diversity, we also extracted DNA from cultures in order to conduct a BLAST search for genetic matches of known taxa. Cultures were incubated overnight at 37°C in preparation for DNA isolation. The Wizard Genomic DNA Purification kit (Promega) was used to extract DNA from samples of the overnight cultures. Isolated DNA was stored at 2°C. Two sets of 16s rDNA primers were selected to amplify a wide range of Gram-positive and Gram-negative bacterial species. Gram-positive bacterial DNA was added to PCR tubes containing PuReTaq Ready-To-Go PCR beads (Illustra) along with fD1 and rD1 primers (Integrated DNA Technologies), and Gram-negative bacterial DNA was added with fD2 and rP2 primers (Weisburg et al. 1991). Primer controls were prepared for both primer sets. Samples underwent thirty-five cycles in a thermal cycler with each cycle consisting of one minute at 94°C for denaturing, one minute at 60°C for annealing, and one minute at 72°C for extension. Gel electrophoresis was performed at 125 volts for sixty minutes. PCR samples were applied directly onto the 0.8% agarose gel in 10µL aliquots after being mixed with 5µL of loading dye. Additionally, loading dye and 1µL of 1kb ladder was added to each gel. Primer controls allowed for the correct identification of primer dimer bands. DNA bands were excised from the gel and placed in 1.5-mL microcentrifuge tubes. The QIAquick Gel Extraction kit was used to isolate the DNA for sequencing. A Nanodrop spectrophotometer was used to measure DNA concentrations. Samples were prepared for shipment and sequencing by GENEWIZ. Sequences were compared to the nucleotide BLAST database. Comparisons of the number of culturable Gram-positive and Gram-negative bacteria observed among individuals within the species *V. komodoensis* and *U. aegyptia* were examined using the G-test of independence.

Results.—The oral flora of seven carnivorous lizards from the three varanid species consisted of 19 Gram-positive and 21 Gram-negative culturable bacterial colonies. No cultures were found on any control plates except a single colony Gram-positive cocci on the control TSA plate from the adult male dragon. However, these cocci on the control plate were aggregated into chains, and distinctively different from any other cultures appearing in other samples from the same individual; these cocci were assumed to represent contamination.

Individual variation within species was evident among the samples. For example, the adult male *V. komodoensis* did not contain any Gram-negative bacteria, though four Gram-positive species were found. Samples from the two juveniles of the same species showed different ratios ($P = 0.05$) of Gram-positive to Gram-negative bacteria, with the male having 2:1 ratio, in favor of Gram-positive bacteria, and the juvenile female had a 1:2 ratio, in favor of Gram-negative bacteria (Fig. 1). Similarly, samples from the male and female of the herbivorous *U. aegyptia* differed, with only five Gram-positive species isolated from the male and only three Gram-negative species from the female. Similarly, there was great variation among species, with the greatest numbers of morphologically distinct colonies being found in the juvenile male *V. komodoenis* and the single *C. zebrata* (nine colonies each; Fig. 2).

Results from DNA sequences discovered fewer species than were suggested by our morphological assessment of colonies (Table 1). Each lizard species possessed at least one bacterial species unique to them, and only one bacterial species

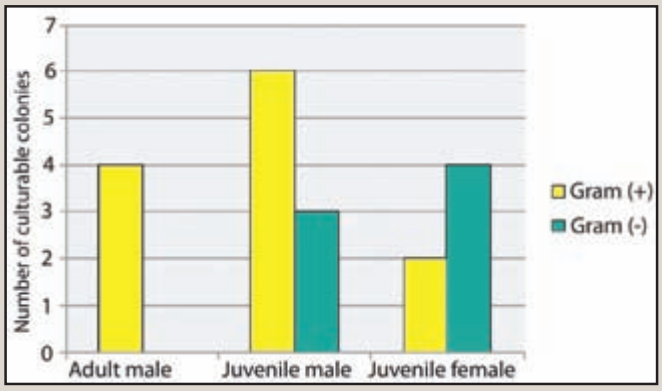

FIG. 1. Comparison of morphologically distinct culturable oral bacteria sampled from the oral cavities of three individual Komodo Dragons (*Varanus komodoensis*) in captivity. The three individuals were different ($P = 0.05$), and note that Gram-negative species were absent from the adult male.

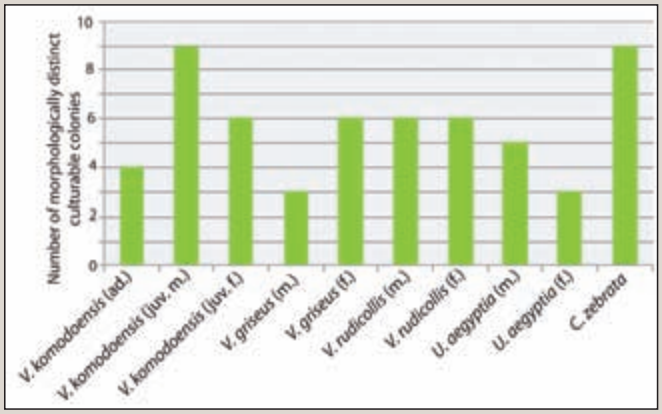

FIG. 2. Total number of morphologically distinct culturable oral bacteria sampled from the oral cavities of captive lizards (N = 1 for each entry).

TABLE 1. Bacteria species identified from oral swabs of captive lizards using DNA-sequences matched to known samples (BLAST search). Highlighted bars indicate bacteria species found in multiple individuals.

Bacteria Taxon	Maximum identification (%)	*Varanus komodoensis* (adult male)	*Varanus komodoensis* (juv. male)	*Varanus komodoensis* (juv. female)	*Varanus rudicollis* (male)	*Varanus rudicollis* (female)	*Varanus griseus* (male)	*Varanus griseus* (female)	*Uromastyx aegyptia* (male)	*Uromastyx aegyptia* (female)	*Corucia zebrata* (male)
Staphylococcus sciuri	100	X		X				X	X		X
Acinetobacter calcoaceticus	99			X							
Acinetobacter sp.	100		X								
Planomicrobium chinense	99		X	X							
Kluyvera georgiana	99		X								
Filibacter limicola	98			X							
Proteus vulgaris	99			X		X					
Aeromonas hydrophila	100				X						
Bordatella sp.	99				X						
Flavobacterium sp.	97				X	X					
Pseudomonas sp.	100					X					
Escherichia sp.	100					X					
Pseudomonas aeruginosa	100						X	X			
Streptomyces sp.	99						X	X			
Bacillus sp.	99								X		
Serratia marcescens	100									X	
Citrobacter sp.	99									X	
Morganella morganii	99									X	
Enterococcus sp.	100										X
Enterococcus sp.	100										X
Cronobacter sp.	92										X
Aeromonas punctata	94										X

(*Staphylococcus sciurii)* appeared in more than two lizard species. Samples from *V. griseus* were the least diverse among our samples, consisting only of three bacteria species between the two individuals while samples from three *V. komodoensis* were the most diverse. The herbivorous species *Uromastyx aegyptia* were the only species unique from all other species, with three unique bacteria species identified by DNA sequences. Some sequences we generated could not be allocated to species using the nucleotide BLAST database, so our results are conservative in terms of overall bacterial diversity among our sampled lizards yet are fully comparable within our study.

Discussion.—Because of the research foci of previous studies, the oral bacterial community of Komodo Dragons is the best characterized of the five lizard species we examined. Montgomery et al. (2002) examined 13 captive Komodo Dragons and found an approximate 2:1 ratio of Gram-positive bacteria (20) to Gram-negative bacteria (11), which is roughly comparable to what we found among the three individuals we sampled. We found a low number of bacteria species in Komodo dragons in our study, which is consistent with the reduced number of bacteria species that Montgomery et al. (2002) reported in captive vs. wild individuals. However, the taxonomic diversity in our captive samples is less (8 vs. 16) than that found in captive samples examined by Montgomery et al. (2002). We suggest that this difference is specifically attributable to our smaller sample size (N = 3 vs. N = 13), in a manner that is consistent across both studies. In other words, although not discussed by them, perusal of the data presented by Montgomery et al. (2002: table 1) evidences remarkable inter-individual variation in the oral flora of captive (and wild) *V. komodoensis*. For example, in their study, no bacteria species is common to more than 5 of their 13 sampled individuals (all from a single zoo), and many species were found only in single individuals. Further relevant to this point is our observation that of the eight bacterial species we discovered in our sampled *V. komodoensis*, only one (*Acinetobacter calcoaceticus*) also was found by Montgomery et al. (2002); their sample was found only in two (of 26) wild dragons, while ours was from a captive individual. In addition, we identified four novel microbial species in *V. komodoensis*: *Proteus vulgaris*, *Filibacter limicola*, *Kluyvera georgiana*, and *Planomicrobium chinense*. Similar to the results of Montgomery et al. (2002), we did not find the pathogenic species *Pasturella multocida* among our captive *V. komodoensis*.

Montgomery et al. (2002) did not compare their results from *V. komodoensis* to any other species of lizard. Yogiari et al. (2001) sampled multiple individuals and species but limited their survey to isolates of *E. coli* and did not present their data in a manner that allows evaluation of variation among their sampled individuals or species. Considered in conjunction with the results of Montgomery et al. (2001), our results suggest that oral bacterial diversity among lizards appears to be rather idiosyncratic. Although there was ample opportunity for transmission among individuals in the collection at Zoo Atlanta, we found no bacteria species to be ubiquitous among our samples. While bacterial communities were mostly distinct among host-species of lizards (i.e., some evidence for phylogenetic trends in host-bacterial relationships), we note that even pairs of individuals housed together (e.g., *V. rudicollis,* or the *U. aegyptia*) were not identical. Only a single "generalist" bacteria species (*Staphylococcus sciuri*) was found in more than a few individuals and in more than two species; we note that this same bacterium was relatively rare in the study by Montgomery et al. (2002), and was found only in their wild-caught animals. Montgomery et al. (2002:1) described their discovery of 57 bacteria species in *V. komodoensis* as a "wide variety of bacteria" but they did not emphasize that few of these bacteria species were found in more than two or three individuals, and none was ubiquitous. So, their study and our data underscore the idea that while some lizard species might be capable of hosting a wide diversity of oral bacteria, individual lizards do not appear to do so at any given time. Furthermore, evident opportunities for cross-contamination (e.g., captive individuals in the same facility) do not appear to result in widespread transmission (resulting in subsequent establishment in the oral cavity). These findings suggest that manipulative studies to investigate interaction, competition, and exclusion among bacteria species in the oral cavities of lizards might be informative. Temporal comparisons of the same individuals could reveal that bacterial colonizations are ephemeral, as was documented in snakes by Blaylock (2001).

Finally, with regards to the oral bacteria of Komodo Dragons, we suggest that because of the sensational image of such a morbid and unusual predatory strategy, the story has become quite established in popular and semi-technical accounts of the ecology of the species, including signage and oral presentations at zoos. We recommend that such messaging be carefully qualified until better evidence is presented that this phenomenon actually exists in the wild. That Auffenburg (1981) documented postbite infections from Komodo Dragons in both humans and nonnative water buffalo is wholly unsurprising. Oral bacteria are well known in squamates (e.g., Jho et al. 2011; Lam et al. 2011) and infections stemming from oral bacteria commonly are reported following bites by a broad diversity of vertebrates including sharks, birds, squamates, and mammals including humans (Abrahamaian and Goldstein 2011; Goldstein et al. 1984; Jorge et al. 1990), yet no speculation exists that oral bacteria constitute a specific predatory strategy in any of these species.

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HERPETOCULTURE NOTES

TESTUDINES — TURTLES

***CUORA GALBINIFRONS GALBINIFRONS* (Indochinese Box Turtle). POST-COPULATORY SNIFFING BEHAVIOR.** With the exception of a few species that are commonly kept and bred in captivity, relatively little is known about the breeding biology and reproductive behaviors of geomydid turtles belonging to the genus *Cuora*. In this note we describe an unusual post-copulatory behavior observed and video-recorded in an adult sexual pair of *C. galbinifrons galbinifrons* that had been introduced for breeding purposes at the Wildlife Conservation Society, Bronx Zoo.

The Bronx Zoo acquired an adult male *Cuora galbinifrons galbinifrons* from a dealer in November 1985 and an adult female in July 1986, which have been housed together for the majority of their time at the zoo. Copulation and egg laying by this pair has occurred in the past, but all eggs received to date have been non-viable. Since September 2010, the pair has been housed separately in plastic enclosures measuring 1.2 x 0.4 x 0.6 m (l x w x h). Beginning 5 November 2010, in an attempt to stimulate reproductive cycling, the pair was brumated inside their enclosures with a 25-cm deep mixture of coconut fiber and peat moss covered with leaf litter. Cork bark hides and a large water bowl were also provided.

Following a five-month-long period, during which temperatures dropped as low as 15°C, the pair was brought out of brumation on 4 April 2011, and first reintroduced in the female's enclosure for 15 minutes on 18 April. Although the male repeatedly attempted to mount the female during initial introductions, copulation was not observed until their sixth introduction on 22 May. After 16 min of unsuccessful mounting attempts by the male, the female emerged from her shell and became receptive to the male's advances. At this time, the female moved about the enclosure while manipulating her tail to reveal the cloaca. The male proceeded to mount the female, grasping the underside of the female's carapace with his hind limbs and wrapping his tail around the tail of the female. Copulation lasted for ca. 8 min. Following copulation, the male spent several minutes adjusting and retracting his penis, and the female turned to face the male. As the male turned away, the female approached the male's post-vertebral marginal scutes, lowered her head towards the male's cloacal region, and appeared to sniff the area for approximately eight seconds. Shortly thereafter, both turtles reversed their positioning and the male lowered his head and sniffed the cloacal region of the female for five seconds before turning away to charge at the observer.

Although limited to just a single observation, this account adds new information to what has been reported on the reproduction and behaviors of *C. galbinifrons* (e.g., Fiebig and Lehr 2000. Salamandra 36[3]:147–156; Fritzsche and Fritzsche 2005. Radiata 14[2]:48–49; Hiller 2005. Radiata 14[2]:44–47), and may be useful to other zoos and institutions seeking to reproduce this species in captivity. Moreover, this behavior may also provide further insight on the role of olfaction in turtles.

Cloacal sniffing has been observed in many chelonians as a precursor to copulation (see e.g., Mason 1992. *In* Gans and Crews [eds.], Biology of the Reptilia: Physiology E, pp. 114–228. University of Chicago Press, Chicago, Illinois; Halpern 1992. *In* Gans and Crews, *op. cit.*, pp. 424–532), and is currently thought to play important roles in species and gender discrimination as well as provide information on the reproductive status of females (Galeotti et al. 2007. Copeia 2007:980–985; Liu et al. 2009. Amphibia-Reptilia 29:185–195). The behavioral interactions described here for *C. galbinifrons* differ from earlier reports of sniffing behavior in that they took place after copulation had occurred, and sniffing was initiated by the female and then reciprocated by the male. Thus, this behavior in *C. galbinifrons* probably cannot be explained by previous explanations of sniffing behavior in turtles (e.g., Galeotti et al., *op. cit.*; Liu et al., *op. cit.*), but further observations are needed to understand its purpose as well as its importance in the reproduction of this species.

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SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX CONTORTRIX* (Southern Copperhead). MAXIMUM CAPTIVE LENGTH.** The current maximum documented total body length (TL) for any wild-caught form of *Agkistrodon contortrix* is 53 in. (134.62 cm) based on a specimen from White Plains, New York, USA, and reported by Ditmars (1931. Snakes of the World. MacMillan Co., New York. 207 pp.). Cagle (1968. *In* Blair et al. [eds.], Vertebrates of the United States, pp. 273–358. MacGraw Hill, New York) reported a specimen of *A. contortrix* with a total length of 57 in. (144.78 cm), although the subspecies was not indicated and a voucher specimen was not referenced.

Largest of the documented specimens of the southern form of *A. contortrix* include two Louisiana individuals, one 52 in. (132.1 cm) TL individual cited in Conant (1975. A Field Guide to the Reptiles and Amphibians of Eastern and Central North America, 2nd ed. Houghton Mifflin Co., Boston, Massachusetts. 429 pp.) and a 50.125 in. (127.3 cm) TL male measured by Douglas A. Rossman and cited in Gloyd and Conant (1990. Snakes of the *Agkistrodon* Complex: a Monographic Review. SSAR Contributions to Herpetology 6, vi + 614 pp.).

Captive specimens can clearly reach dimensions normally not obtained in wild populations; however, the following report suggests the possible body length that can occur in southern forms of *A. contortrix*. On 21 April 2001, an unsexed *A. contortrix* was captured by EC just west of CR 269, approximately 2 miles N of I-10, in Gadsden Co., Florida, USA (30.645°N, 84.820°W). No measurements were taken at the time of capture, although the snake likely was born in the fall of 2000. The specimen remained in captivity from initial capture until death, which occurred on 18 April 2012. Immediately following death, the specimen was measured by EC using a steel rule, and showed a total body length of 147.32 cm (58 in.) (Fig. 1). Sex was not determined. The specimen is believed to represent the largest documented wild-caught or captive *A. contortrix*, a voucher photograph of which has been deposited in the collection of the South Carolina State Museum, Columbia, South Carolina.

PHOTO BY ED CASSANO

FIG. 1. Record length *Agkistrodon c. contortrix* being measured following its death.

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***NERODIA SIPEDON* (Northern Watersnake). CAPTIVE LONGEVITY.** *Nerodia sipedon* is a common water snake of the northern and southeastern United States. The natural lifespan of this species is currently unknown but a longevity record of 9 years, 7 months, 24 days for a captive *Nerodia sipedon pleuralis* has been published (Slavens and Slavens 1999. Reptiles and Amphibians in Captivity: Breeding, Longevity, and Inventory. Slaveware, Seattle, Washington; Snider and Bowler 1992. Longevity of Reptiles and Amphibians in North American Collections. SSAR Herpetol. Circ. 21, 40 pp.). Here we report a *Nerodia sipedon sipedon* that attained a minimum known age of 21 years.

This snake had reportedly been captured near Traverse City, Michigan, USA in the fall of 1991 and donated to an elementary school for a class pet by the student who caught it. The student reportedly had kept the snake for some time (two or more years) before it was donated to the school, but confirming details on this point are unavailable. The snake was estimated to have been at least 45–50 cm in total length in 1993 when it came to the attention of the junior author (KR), but exact measurements were never taken. KR was given possession of the snake in 1995.

The sex of the specimen was unconfirmed but it was presumed to have been male, an assumption supported by its small relative size, as males are smaller than females in this species (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, DC. 668 pp.). Since 1995 it had been maintained in a screen-topped cage measuring 76 x 30.5 cm in horizontal dimensions, heated with a "hot rock," with bark bedding and two water dishes, and positioned near a south-facing window. It was typically fed about 12 small goldfish once per week, except during the winter months, when it would sometimes refuse food for several weeks at a time.

On 23 January 2012, after a prolonged fast, the snake was observed to have a swollen area near the tail, and was taken to a veterinarian and determined to have a "rectal prolapse" and possible septicemia. It died later that day. Although exact measurements were not made, the snake was approximately 68 cm in total length at death. It seems reasonable to assume that this Northern Watersnake was at least one year old in fall of 1991; thus its minimum attained age would be 21 years and perhaps 4–5 months (given that parturition in this species typically occurs from late July through early September in northern Michigan).

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HERPETOLOGICAL HISTORY

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Albert Patrick Blair (1913–2004) at the American Museum of Natural History

FIG. 1. Dr. Albert P. Blair, Assistant Curator, Department of Animal Behavior. Photograph taken at the American Museum in May 1946. (AMNH Photographic Archives 298739.)

A *History of Herpetology* at the American Museum of Natural History (AMNH) focused on the organization, staffing, and fieldwork of the department that was established for the museum's collection of Recent amphibians and reptiles (Myers 2000). Recently, Kraig Adler inquired whether herpetologist Albert Patrick Blair had had an AMNH connection. Adler called my attention to a newspaper obituary (*Tulsa World*, December 9, 2004), which stated that Blair had been a curator at AMNH. Indeed, the obituary was correct, A. P. "Pat" Blair (younger brother of F. W. "Frank" Blair) had held a noncollection curatorial appointment—not in Herpetology but in Animal Behavior (appointments in the Department of Animal Behavior and in the Department of Vertebrate Paleontology are not included in the *History*).

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A. P. Blair was a competent herpetologist, but, except for publications, he left few tracks in New York after finishing a fellowship at Columbia University in 1940–1941. In 1942 he may have been briefly at the New York Zoological Society (NYZS), where he was listed as "curator" in *American Men of Science* (1965, 11th ed.). That affiliation, however, could not be confirmed in NYZS Annual Report staff listings and other archival sources (M. Thompson e-mail to K. Adler, December 16, 2011). In any case, Blair came to AMNH in July of that year.

Blair was on the American Museum staff for about five years, but actually on the premises only for a year or so. The following account is based on old AMNH staff lists for Animal Behavior, correspondence in the Department of Herpetology Archives (Noble and Bogert collections), and on a one-page personnel record and an unpublished manuscript fragment in the AMNH Central Archives. This is a curious but historically interesting case.

Albert Patrick Blair (1913–2004).—"Pat" Blair was appointed Staff Assistant in the new Department of Animal Behavior in July 1942. Within weeks, he was promoted to Scientific Assistant (September 24) and then to Assistant Curator. His promotion to Assistant Curator supposedly was to be effective January 1943, but he was listed in that position in the 1942 annual report. This rapid succession of positions likely resulted from a juggling of available salary funds. Blair seems to have been considered as an Assistant Curator from the beginning but evidently could not be immediately paid at that rank.

At any rate, the 74th–77th AMNH annual reports show Blair as Assistant Curator of Animal Behavior from 1942 to 1946. The 78th ("1947") annual report mentions only his leaving the Department; he had resigned from the Museum in December 1946. (Starting in 1946 the Museum shifted from calendar-year to fiscal-year reporting—starting July 1 of one year and ending June 30 of the following year [Myers 2000: 165]).

Although Blair was formally associated with the American Museum for nearly five years, his total accumulated time spent there was only a year owing to military service in the Air Corps during World War II. It was noted in the 74th and 75th reports (1943 and 1944) that he was "on leave of absence in war service;" this note should have been repeated in the 1945 report. After getting out of the Air Corps, Blair returned to the Museum on March 15, 1946, but he left at year's end.

History Leading to Blair's AMNH Appointment.—Blair took his Ph.D. at Indiana University in 1940, under the mentorship of Alfred C. Kinsey. (It is seldom realized that Kinsey turned to studies of human sexuality only after a career as a taxonomist; he started as a systematist studying gall wasps—his huge wasp collection is at AMNH and his publications included four AMNH *Bulletins*). Blair's doctoral studies involved interrelationships of toad populations in eastern North America. On March 4, 1940, Blair wrote to G. K. Noble at AMNH saying that he hoped for a postdoctoral fellowship to work with Theodosius Dobzhansky at Columbia University in New York; he asked "is it possible that some arrangement can be worked out so that I can do part of my work with you?" Two days later, on March 6 (mail was fast in those days), Noble wrote that:

> Dr. Kinsey was very enthusiastic about your work. Unfortunately I missed seeing your demonstration at the Meetings but I heard numerous favorable comments in regard to it [re December 1939 meeting of AAAS, Columbus, Ohio, where Blair presented "an eco-genetical study of North American toads" fide 1940 *Science* 91 (2353): 118].
>
> At the present moment we are breeding *Bufo terrestris* and various *Rana* in this laboratory. We would therefore welcome a mature student like yourself who could continue work with Amphibia . . . What space, material and assistance we could give you would of course depend on the exact nature of your problem. We have had financial support for our studies on the hormonal and neural mechanisms involved in the social behavior of vertebrate animals and very much hope that we can continue to secure support for this field of study. I would be especially interested in knowing how the breeding behavior has been modified within the genus *Bufo*. In *Rana* the patterns of behavior have become enormously modified from species to species.
>
> I should like to know more of the work you intend to do at Columbia before advising you in detail . . . In general, I would say we would be very glad to welcome you in the laboratory and hope some arrangement may be made to continue your *Bufo* work into detained behavior studies.

Blair wrote back on March 26, 1940 saying that:

> I have just been notified that I have been granted a National Research Fellowship for the academic year beginning September 1.
>
> My past work has involved three main angles: (1) extensive field work, (2) subsequent analysis of field collections, and (3) experimental hybridization of the forms involved.
>
> Field work has involved approximately 20,000 miles travel in 20 states [reminiscent of his major professor Kinsey's entomological fieldwork] and has been concerned with the *fowleri-americanus-terrestris-woodhousii* group of toads. The exact determination of the western edge of the range of *fowleri* and *americanus* and of the eastern edge of the range of *woodhousii* has been given particular attention. Live material has been collected for experimental hybridization; preserved material has been accumulated until about 3,500 specimens (adult) are now at hand. Data has been collected on areas where there is apparently hybridization in nature.
>
> Laboratory analysis of field collections has been made biometric wherever possible, I have made some 25,000 caliper measurement as well as about the same number of "determinations" on less objective characters.
>
> I have experimentally hybridized *Bufo fowleri* with *B. americanus, B. americanus* with *B. woodhousii*, and *B. fowleri* with *B. woodhousii*. Pituitary injections have been used to induce breeding in a considerable percentage of the crosses. About 600 hybrids have been raised through metamorphosis. Due to limitations of space and food it has been possible to maintain only a small percentage of these.

Blair went on to detail other hybridization plans for the spring and mentioned having "some 10,000 immature toads and tadpoles" on hand. On April 3, 1940, Noble wrote that that "I shall run up to Columbia some time before long and learn what plans might be for your space and facilities."

As fate would have it, however, the 46-year-old Noble died unexpectedly on December 9, 1940 (Myers 2011: 39, 211, note 88). He died only three months after Blair's scheduled start at Columbia; it must have been a jolt to young Blair, but his budding relationship with Noble almost certainly helped pave the way for his hiring at AMNH following completion of his fellowship at Columbia.

At the time of the foregoing correspondence, Noble was curator of two AMNH Departments (the title *Chairman* was not introduced until 1942). By 1928 Noble had been offered positions at Cornell University and Columbia University (the latter to replace geneticist Thomas Hunt Morgan as full Professor of Experimental Biology). To keep him at AMNH, President Henry Fairfield Osborn and Museum Trustee (and Herpetology Research Associate) William Douglas Burden arranged for additional support and the renaming of Herpetology to the "Department of Herpetology and Experimental Biology." The last was split off as a separate department in 1934. Blair's proposed work would have meshed well with Noble's plans for Experimental Biology.

In 1942, a few years after Noble's death, the Department of Experimental Biology was renamed the Department of Animal Behavior. Its Chairman and Curator was one of Noble's Assistant Curators, Frank A. Beach—a psychobiologist who helped found the emerging discipline of behavioral endocrinology. Under Beach, the connection to herpetology was broken and Animal Behavior turned largely to studies of laboratory mammals. Nonetheless, Beach made room for herpetologist Blair, which would have pleased Noble.

Blair's AMNH Fieldwork with Charles M. Bogert.—Assistant Curator Bogert largely ran Herpetology during Curator Noble's preoccupation with Experimental Biology (Myers 2000:54–60); he continued doing so after Noble's death, becoming "Assistant Curator (In Charge)" for 1941, "Acting Curator" in 1942, "Curator" in 1943, and "Chairman and Curator" in 1944. The name of the Herpetology Department changed several times during these and other years (Myers and Zweifel 1993: 136; Myers 2000: endnotes 8, 21, 78, 82, 142, 143, and 152). Bogert and Blair had gotten friendly and certainly conversed during Blair's time at AMNH, but their archived written correspondence (1948–1964) starts after Blair had left the Museum. There is, however, an earlier (1945) letter from Bogert's Assistant Bessie Matalas [m Max Hecht], addressed to Captain A. P. Blair, Squadron "F", AAF, Pyote, Texas; she said that Bogert had left for summer teaching in California, but she provided identifications of three species of *Phrynosoma* that Blair had asked about.

A typed document from Blair in the AMNH Central Archives provides insight into Blair's postwar state of mind, and imparts some of the flavor of doing fieldwork with Bogert and colleagues.

The title is "Mexican Trip with American Museum Group." With page numbers 103–113 and a handwritten date of 1/29/93, Blair likely sent it to AMNH after extracting it from an unpublished autobiography. Some extracts from this 11-page manuscript:

> When I got out of the Air Corps in 1946 I wasn't sure whether I wanted to go back to the American Museum of Natural History and New York City or not. I wasn't even sure that I wanted to stay in biology and the academic life. I had a chance to stay with the service aviation program as a civilian employee but that didn't interest me at all. At any rate, after some agonizing I went back to the American Museum. Shortly after my return I learned that an expedition was being organized to go to Mexico in August [returning in September, 1946]. Chuck Bogert [an experienced Mexican field man] was the leader; he was the head of the Department of Amphibians and Reptiles. Rudy [Rodolfo] Ruibal, a 17-year-old Cuban in school in the U.S., was interested in herps and was a protégé of Bogert and was included. Dean Amadon of the Ornithology Department at the American Museum was another. John Moore, a research associate at the Museum was the 4th. John said to me one day, why don't you come along. I fell for it hook, line and sinker. My boss, Beach, said sure, go, and he would find some money. I was committed. . . . As transportation we had 2 surplus army vehicles, a jeep and a carryall. Both were to blow head gaskets before we got back.
>
> Finally we were rolling. About the second day, as I remember, Chuck disgustedly said he didn't see as how we couldn't ALL go to the bathroom at the same time, that he was tired of stopping for each guy as he got the urge. We stopped in Tulsa overnight and ate with my folks (fried chicken) and then went to the Illinois River overnight . . . [to] break in our camping gear. I put out a bunch of throw lines for catfish and caught the biggest string of channel cats I have ever caught. I acted like this was how many I always caught.
>
> On to Laredo where we had to clear customs. Amadon had not received his bird collecting permit nor his permit to take in a shotgun. A few pesos, about 5 as I recall, convinced the customs man that a shotgun was OK, in fact he said that a machine gun would only require 25 pesos for entrance. We entered Mexico at dusk and drove far into the night . . . We finally pulled off the road late at night . . . At morning's first light it appeared we were in a goat corral.
>
> On to Monterrey and then west. We were heading for Las Delicias [an isolated oasis at southern end of Chihuahuan Desert , Coahuila] , a tiny hamlet in a large valley surrounded by mountains with only one pass into the valley. It was far off the beaten track and we did quite a bit of wandering and asking directions. We spent a miserable night in a dry playa . . . where the dust was 6–8 inches deep. Toward evening we came to Las Delicias . . . with a half dozen primitive houses and . . . store, all of adobe. There was a pond supplied by a primitive aqueduct that carried a tiny stream of water from a spring 3 miles away at the base of a very forbidding mountain. I was so dry and dusty and half overcome by the heat that I started following the aqueduct toward the mountain to find the source. John went with me for a mile or so but turned back. I continued on alone determined to find where the water came from. Finally arriving at the spring (in a lovely canyon with great masses of maidenhair ferns along the sides) I was so overcome by heat and exhaustion that I was near collapse. I sat down in the spring with my clothes on and stayed there for maybe half an hour. The spring water was warm and actually cooled off as it ran in a tiny brook down the canyon before entering the little aqueduct for its journey to the village. I finally made up my mind to try and get back to the village. It was downhill all the way and that helped . . . Back at camp I was too ill to eat and spent the twilight hours lying on my cot beneath the enormous fig tree that provided about the only shade around. I was to climb that fig tree to feast on figs many times in the days that followed.
>
> It was terribly hot at Las Delicias and we soon learned (John and I) to do our exploring at night . . . One of John's reminiscences . . . was (he said, I don't recall it very clearly) of me returning to camp with a live rattlesnake in each hand . . . The heat didn't seem to affect the natives. Just after we arrived they had their annual mule roundup where they herded in all the mules of the valley and clipped their manes variously to indicate whose mule was whose . . . One of the cowboys came to Chuck Bogert with a large water turtle and sold it to him for 5 pesos. After the roundup was over and the cowboys had gone back to wherever in the valley they came from, the headman of the village came to Bogert and told him that the turtle hadn't belonged to the cowboy at all and he had no right to sell it. In fact, the headman said, the turtle was his wife's pet turtle. He would, however, be glad to sell it to Bogert for 5 pesos. So Bogert bought the turtle a second time.
>
> There were two species of toads around the pond so I crossed them and attempted to rear the hybrid tadpoles in some very primitive little clay pots I bought in the little "store" in the village. They were unglazed and promptly killed the toad larvae. So I put some hybrid larvae in little outdoor pools far away from camp at the spring at the base of the mountain, retrieving them after a number of days.
>
> One day a pickup truck pulled into our campground. It was K.P. Schmidt and his 2 sons. Bogert had told K.P. that we would be at Las Delicias at such and such a time but we had about given up on him finding the place, especially since we had had such a hard time finding it ourselves. K.P. was a gentle soul but I got quite mad at him one day when he went up in the canyon near the spring and ripped half the maidenhair ferns off the walls looking for a little frog which somebody (not me) had found an example of the day before . . . [Bogert's 1946 photo of Schmidt at Las Delicias was published in Myers (2000: fig. 6), although the original photo was misdated "1947."]
>
> Our next stop was on the Rio Nazas, a river that came out of the mountains and finally sank into the desert about 20 miles downstream from where we were camped . . . This is where I got mad at Amadon. I found a bird nest with mamma bird and young and told Amadon about it and he promptly went down and shot the mamma bird for a specimen.
>
> One day I told Chuck there was a *Natrix* (water snake) in the river and he said "Can't be", there's no *Natrix* within 600 miles of here, it must be a *Thamnophis* (garter snake). So that night Rudy and I went down to the river and I shot the snake and Rudy jumped in and grabbed it before it could sink. It was a *Natrix* of course . . . and it eventually got named for Bogert who was asleep on his cot when it was collected. Oh well, what the hell? [Blair had reason to be annoyed. Conant (1953) later collected additional specimens and named it *Natrix erythrogaster bogerti*, with Blair's specimen as a paratype but with collectors not given. Bogert (in litt.,

Sept. 27, 1946) had transmitted to Conant AMNH catalogue data explicitly giving Blair and Ruibal as collectors of the specimen; Conant responded (Oct. 2, 1946) that he wanted to talk about it with Blair. However, Blair went unmentioned when Conant published "named for Bogert . . . , who wrote to me from Mexico about this snake the day the first specimen was collected." As an aside, Bogert's name was *later* and improperly inserted in the catalogue as a third collector by an unknown hand.]

We came back to Monterrey and headed south, finally stopping and camping (after getting permission from Indians to camp on their ejido, a communal holding) at the Arroyo Sacahuite . . . This was jungle country with dense undergrowth stretching back from the creek. Trees were full of epiphytes . . . My nocturnal forays were concerned with a frog I had discovered the first day we camped here. It was a new species and I eventually named it for John . . . The frogs were very hard to catch, but I caught quite a few and marked them to see how far they wandered over the several days we were there . . . The last night we were at the Arroyo Sacahuite I collected all the frogs I could, about 20 as I recall . . . [see Blair 1947, for photos by Bogert and John Moore. Blair named the frog *Rana moorei*, but that name came to be preoccupied and he later (Blair 1984) provided the substitute name *Rana johni*—now *Lithobates johni* (Blair, 1965) fide Frost et al. 2006: 369.]

. . . Dean Amadon still did not have his bird collecting permit nor his permit to bring a shotgun into Mexico. After some palaver it was agreed that he and Rudy would take the jeep and go into Mexico city and try to get the permits. The carryall accompanied the jeep for a hundred miles or so before turning back . . . We drove back to the vicinity of Tamazunchale at night while the jeep went on to Mexico city. From the drive back late at night I remember a stop of the carryall while Bogert jumped out and grabbed a 6-foot fer-de-lance . . . and then a late night stumbling into a Tamazunchale motel where the shower had a big fat *Bufo marinus*, a toad, that said he got there first so please live and let live.

We (John, Chuck, me) went out to the Rio Axtla and camped waiting for Dean and Rudy to return from Mexico City . . . Amadon and Ruibal finally got back with a hair-raising tale. As they parked the jeep in Mexico city an old woman stepped out from the curb and was hit as the jeep backed up. She fell, hit her head on the curb, and died right there. Amadon was arrested and the trouble started. Amadon's statement to the police was deemed unsatisfactory and he was told (or Ruibal was told, since Amadon spoke no Spanish) that for a price he would be allowed to change his statement to something more suitable. The new statement stated that the old woman walked into the jeep, not that the jeep hit her. Once more he was allowed to change the statement, this time to the effect that the woman did not even come in contact with the jeep but simply fell down and hit her head. All this cost Amadon $600 American; he had to send home to the US and get this sum from his father. When released he was told to get out of Mexico in 30 days as the case had to be either reopened or dropped at the end of 30 days. He was bitter.

. . . Near Corpus Christi we stopped at a roadside cafe that had parking in a circle all around the establishment . . . Amadon and Ruibal came out first and didn't see the carryall and thought we had already left. So they hurried down the road to catch up with us. We realized they were ahead of us and tried to catch them, but we blew the headgasket on the carryall (the jeep headgasket had blown in Mexico) and were hours getting it replaced. We never saw the jeep again . . . At the Galveston-Port Bolivar ferry crossing they said the jeep crossed on the ferry before us. So each vehicle proceeded to NY city by itself.

Summary.—A. P. Blair had a well-founded graduate and postgraduate career with mentors Alfred C. Kinsey at Indiana University and Theodosius Dobzhansky at Columbia University. He was unfortunate in not having being able to work at the American Museum with G. K. Noble, who died shortly after Blair's arrival in New York for a fellowship at Columbia. However, Blair's initial association with Noble and the staffs of Noble's departments of Herpetology and Experimental Biology paved the way to an Assistant Curatorial appointment in the Museum's Department of Animal Behavior (new name for Experimental Biology). But Blair was able to spend little time in that post. His absence during the war seemed somehow to have dampened his spirits; he came back to the Museum unsure of what he wanted to do and soon resigned to return home to Oklahoma.

After his brief postwar return to the American Museum, Blair seemed to regain some of his earlier enthusiasm for research during his participation in a 1946 Mexican expedition, when he interacted in the field with herpetologists C. M. Bogert, J. A. Moore, R. Ruibal, and ornithologist Dean Amadon. Blair left the Museum in good standing at the end of 1946 and subsequently enjoyed a long teaching career at the University of Tulsa. His AMNH association led to five papers in the Museum's *Novitates* series (Blair 1946, 1947a, 1947b, 1947c, 1955).

A summary of Blair's life is being prepared by Adler (ms.) for volume 3 of *Contributions to the History of Herpetology*.

Acknowledgments.—I thank Kraig Adler for calling my attention to A. P. Blair's obituary in the *Tulsa World* and for sharing a communication about Blair from Madeleine Thompson, Librarian and Archivist at the Wildlife Conservation Society. I am grateful to Grace M. Tilger for archival assistance.

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A Much-Belated Obituary of an Important American Zoo Collector, with Discussion of the Type Locality for *Bogertophis subocularis* and *Lampropeltis alterna*

"Who knows the life of Meyenberg, Brown's collector?"
—Wright and Wright (1957)

In 1882, British cobbler and amateur naturalist Walter Drawbridge Crick sent Charles Darwin a beetle he had collected. The beetle had a small clam attached to its leg, and the discovery of this beetle helped to explain the mysterious migrations of freshwater bivalves from one pond to another, which was an important question at the time and also the subject of Darwin's last publication before his death. Remarkably, the collector of this beetle-hitchhiking clam indirectly linked Darwin to the discovery of the structure of DNA—Walter Drawbridge Crick was the grandfather of Francis Crick. Walter Crick died in 1903, but Darwin's rather interesting link to the co-discoverer of the DNA structure was not known until 2004 (Ridley 2004).

PHOTO COURTESY OF KRAIG ADLER

FIG. 1. Portrait of Arthur Erwin Brown, 1903.

It is unfortunate that the names and lives of amateur naturalists and collectors who make important contributions to science often remain obscure. Such is the case of another amateur naturalist and businessman, a dealer in leather products (in this instance, saddles), who in 1901 sent to Arthur Erwin Brown (Fig. 1), the second director of America's first zoo (Philadelphia), two species of snakes unknown to science at the time (Brown 1901a, b). In terms of lizard and snake species richness, the Chihuahuan Desert (source of the new snakes) is the veritable epicenter of squamate diversity in the United States, Canada, and northern Mexico (Hoekstra et al. 2010). The two undescribed species sent to Brown arguably are the two most iconic species of this region: the Trans-Pecos Ratsnake (*Bogertophis subocularis*) and the Gray-banded Kingsnake (*Lampropeltis alterna*). Both species have graced the covers, title pages, and endpapers of the many books and field guides of the region's herpetofauna. Despite his important discoveries, the collector's first name has not been known to the herpetological world for the past 111 years. Brown and others mentioned him in a number of publications only as "Mr. E. Meyenberg of Pecos, Texas."

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Undoubtedly, many students of reptiles and amphibians have read Carl Kauffeld's story of his yearnings to travel to the Chihuahuan Desert of West Texas to look for *subocularis*. Kauffeld stated that from boyhood he could recite from memory Raymond Ditmars' account of the species:

"Thus far, taken only in the Davis Mountains, southwest of Pecos, Texas…Less than a dozen specimens exist in collections." (Ditmars 1907 *in* Kauffeld 1969).

What perhaps is less generally known—and left out of the Kauffeld account—is that the very next line in Ditmars' book reads, "The collector of all these specimens, Mr. E. Meyenberg, is dead." We wanted to know more about E. Meyenberg and how he died.

Edmund Meyenberg was born to Julius Meyenberg and Kunigunde Oske Meyenberg on 25 January 1859 on a farm in Fayette County, Texas in the Bluff Community of La Grange, south of Buckner's Creek. His father, Julius, was a doctor, apothecary, and an amateur naturalist who held "one of the finest collections of insects and butterflies as is hardly equaled by the great institutions of learning in this country" (Lotto 1902: 277).

Brown reports that Edmund Meyenberg was a collector for the Zoological Society of Philadelphia. He collected and donated to the Society no less than 48 species and subspecies of reptiles from the vicinity of Pecos, Texas and also from the Davis Mountains. He collected and donated a variety of other vertebrates including multiple species of rodents, bats, passerine birds, and raptors (Brown 1902; 1903a; 1903b; 1904). Ditmars praised Meyenberg as a prolific collector of the Trans-Pecos region where he "did such good work" (Ditmars 1907). Indeed, Meyenberg supplied Ditmars and the Bronx Zoo (then the New York Zoological Park and now the Wildlife Conservation Society) with two richly colored orange-yellow and pinkish specimens of *Bogertophis subocularis* from the Davis Mountains (Brown 1903b; Ditmars 1907).

Little has been published as to the likely whereabouts of Meyenberg's collection site for the type specimens of *B. subocularis* and *L. alterna*. Suitable for the time but cryptic and outdated by today's standards of locality referencing, Brown reported that the *B. subocularis* specimens were found in "the Davis Mountains, fifty miles southwest of Pecos, near the head of Toyah Creek...Jeff Davis County" (Brown 1901a) and that the *L. alterna* specimen "came from the same locality…as the lately described [*Bogertophis*] *subocularis*" (Brown 1901b). The head of Toyah Creek rises at 30.92877°N, 103.81436°W at 1.65 miles (2.65 km) southwest

of Toyahvale in Reeves County and runs northeast for 50 miles (80.5 km) to its mouth on the Pecos River just outside of Pecos, in north central Reeves County (at 31.41301°N, 103.32725°W). Both of us (DDR and GTS) have independently come to the same conclusion—that this would likely place the type locality for these snakes in the northeastern quadrant of the Davis Mountains of Jeff Davis County in the vicinity of Madera Canyon, Little Aguja Canyon, and Big Aguja Canyon (Fig. 2), all of which flow into Toyah Creek and very close to what is now the entrance of the Buffalo Trail Boy Scout Ranch on FM 1832, roughly 11 miles (17.7 km) driving from Highway 17 in Jeff Davis County, Texas. These canyons would have been likely places for watering a horse near the headwaters of the Toyah Creek, indeed, one of the only places to do so "fifty miles southwest of Pecos" in Jeff Davis County (Brown 1901a), with the exception of San Solomon Spring (at present-day Balmorhea State Park at Toyahvale, Reeves County) which is located along the presumed route of Meyenberg's travel and approximately 40 miles (64.4 km) from Pecos.

Vernon Bailey criticized Meyenberg for not reporting reliable locality information for specimens that he allegedly found near the Guadalupe Mountains (Bailey 1905), but reported them to Brown as collected "in the neighborhood…at Pecos" (Brown 1903b). Though Meyenberg reported some of his collection localities from the vicinity of Pecos, it should be noted that his Davis Mountains collections were never questioned as to their true origins. Furthermore, both the photos and descriptions of the type specimens are characteristic of the geographic phenotypes recorded for both species from this locality. As briefly noted above, Ditmars described one of the zoological park's *B. subocularis* on display, stating, "The ground-colour was pinkish and the blotches sooty-black" (Ditmars 1907). In this part of the Davis Mountains, the terrain is strewn with Gomez Tuff, a 36.7 million-year-old layer of rhyolite composed of cemented volcanic ash, as well as basalt, which is a dark yellowish-brown, igneous rock. Weathered Gomez Tuff is dark reddish-brown or dark chocolate brown, and fresher surfaces of the tuff are pink (MacLeod 2005). There is strong natural selection for background color-matching in squamate reptiles (Norris and Lowe 1964), and dark brown, brownish-orange, pink, and reddish specimens with rich black markings have been regularly observed in several species of snakes in the northeastern Davis Mountains. These include *Crotalus lepidus* (Price 2009; Werler and Dixon 2000), *Pantherophis bairdi* (Hiatt 2005; Rhoads 2008), *B. subocularis* (Price 2006; Rhoads 2008; GTS, D. Salceies, and C. Trumbower, pers. obs.), and the *L. alterna* of this area are often of dark brown ground-color with a salmon pink or orangish blush suffused throughout (see Figs. 3 and 4; Tennant et al. 1998; also see northeastern Davis Mountains *L. alterna* examples in Merker and Merker 2005; *B. subocularis* examples in Rhoads 2008). Moreover, the type specimen of *L. alterna* collected by Meyenberg (Fig. 5) resembles the darker, busier-patterned specimens that inhabit the northeastern Davis Mountains (Fig. 3), as do also the thicker, dark H's of the type specimen for *B. subocularis* (DDR, pers. obs.).

Meyenberg was a well-connected and respected citizen in Pecos. He remained a proprietor of a saddlery in Pecos for about 10 years up until his death. He was a business owner at a time when the town had earned a reputation for violence after several gunfights occurred there. In fact, things got so rough during this time that a new slang word was coined; as one pair of historians put it: "To 'pecos' someone meant to ambush a man, steal his horse and money, kill him, and roll his body off down a

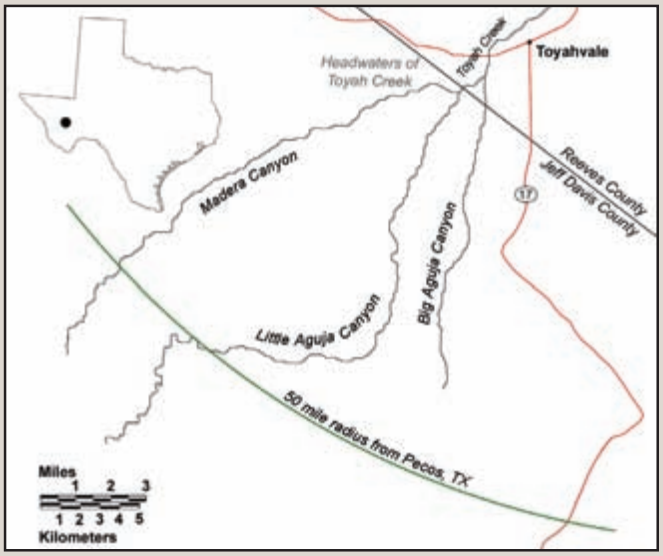


FIG. 2. Map of presumed region of the type localities for *Bogertophis subocularis* and *Lampropeltis alterna*.

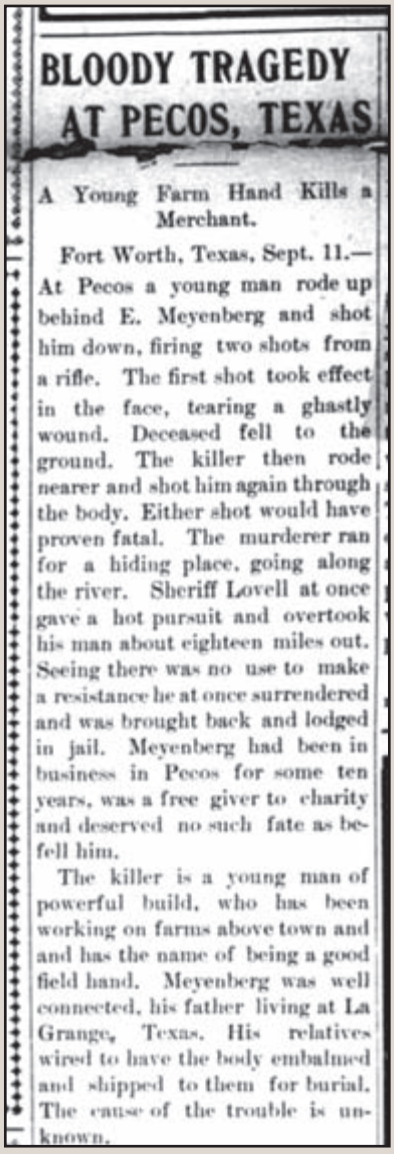
PHOTO BY MICHAEL S. PRICE

FIG. 3. *Lampropeltis alterna* adult male, Little Aguja Canyon, Davis Mountains, Jeff Davis County, Texas.

PHOTO BY MICHAEL S. PRICE

FIG. 4. *Bogertophis subocularis* adult male, from Big Aguja Canyon, Davis Mountains, Jeff Davis County, Texas.

FIG. 5. Photograph of the then-living type specimen of Gray-banded Kingsnake *Lampropeltis alterna* that Meyenberg sent to Arthur Erwin Brown, taken by R. D. Carson, Brown's photographer, in 1901, and published by Conant (1957).



BLOODY TRAGEDY AT PECOS, TEXAS

A Young Farm Hand Kills a Merchant.

Fort Worth, Texas, Sept. 11.—At Pecos a young man rode up behind E. Meyenberg and shot him down, firing two shots from a rifle. The first shot took effect in the face, tearing a ghastly wound. Deceased fell to the ground. The killer then rode nearer and shot him again through the body. Either shot would have proven fatal. The murderer ran for a hiding place, going along the river. Sheriff Lovell at once gave a hot pursuit and overtook his man about eighteen miles out. Seeing there was no use to make a resistance he at once surrendered and was brought back and lodged in jail. Meyenberg had been in business in Pecos for some ten years, was a free giver to charity and deserved no such fate as befell him.

The killer is a young man of powerful build, who has been working on farms above town and and has the name of being a good field hand. Meyenberg was well connected, his father living at La Grange, Texas. His relatives wired to have the body embalmed and shipped to them for burial. The cause of the trouble is unknown.

FIG. 6. Scanned photo of the original West Texas newspaper article reporting Meyenberg's death.

riverbank" (Galit and Simmons 2005). Another historian noted the term "a Pecos swap," which meant to steal (Wheeland 1892).

One newspaper article that we unearthed reports his death (Fig. 6). Unfortunately true to the "Old West" lawless stereotype, a young farmhand named Jim Pratt rode up behind Meyenberg and shot him down with a rifle on September 9, 1903 in, or near, Pecos, Texas (Nicholson 1903). A local law enforcement officer named Sheriff Lovell chased the killer and brought him into custody. Some three decades later, a number of Meyenberg's personal papers were gifted to herpetologist Albert Hazen Wright of Cornell University, having been incidentally purchased by Ellen Schulz Quillin, the curator and director of the Reptile Garden of the Witte Museum in San Antonio, many hundreds of miles from Pecos (Steinfeldt, undated). Among these was a copy of the 1901 description of *subocularis* that Brown had apparently personally sent to Meyenberg upon publication. Much to Wright's delight, attached to the back cover was a photograph of Meyenberg's live specimen of *L. alterna* taken by the zoo's photographer, R. D. Carson, under the direction of Brown at Philadelphia Zoo (Wright and Wright 1957). Above and below the print were handwritten compliments from either Brown or the zoo's photographer to Meyenberg. Even by this point in 1934, only this one specimen of *L. alterna* had ever been found, and though a photograph was included in the original 1901 description, this was the only other photograph of the animal known (Wright 1935).

The newspaper article reporting his death stated, "Meyenberg…was a free giver to charity and deserved no such fate as befell him" (Hamilton and Hamilton 1903). Until now, no one has endeavored to respond to the Wrights' question, "Who knows the life of Meyenberg, Brown's collector?" We hope that our report at least partially satisfies their inquiry, albeit somewhat belatedly.

Acknowledgments.—We thank Harry Greene for encouragement in publishing more on Edmund Meyenberg, Ned Gilmore (Academy of Natural Sciences) for help with information on A. E. Brown, Michael Price for representative specimen images, Damon Salceies for assistance with the map, Craig and Linda Trumbower for friendship, field support, and lodging while both of us are working in Big Bend. We also thank our respective wives, Amy and Mary, for their understanding and support of our obsessive pursuit of knowledge of our respective favorite species and the natural history of each, here linked.

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AMPHIBIAN DISEASES

Herpetological Review, 2012, 43(2), 274-278.

Geographic Variation in *Batrachochytrium dendrobatidis* Occurrence Among Populations of *Acris crepitans blanchardi* in Texas, USA

Differences in the susceptibility of amphibian species to infection by the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*), which can cause the disease chytridiomycosis, have been documented in the laboratory (Daszak et al. 2004) and among wild populations (Carey 2000; Lips 1999; Retallick et al. 2004). The severity of *Bd* infection has also been linked to climatic conditions, with temperature as a major determinant strongly affecting the outcome of infection at specific locations or seasonally (Berger et al. 2004; Bosch et al. 2007; Drew et al. 2006; Kriger and Hero 2007a, b). In addition to climatic conditions such as temperature, variability in site-specific environmental conditions also might affect the probability of infection, as indicated by large differences in abundance of *Bd* in replicate samples from the same site (Kirshtein et al. 2007), or large differences in infection of amphibians at different sites from the same area (Walker et al. 2007).

The goal of our study was to investigate the relationships of site-specific environmental conditions with the presence and the infection levels of *Bd* in amphibians. Blanchard's Cricket Frogs (*Acris crepitans blanchardi*) were selected as the focal species because it is the most abundant and conspicuous member of anuran breeding assemblages in our study area in eastern and central Texas, USA. Previously, we had detected *Bd* in *A. c. blanchardi* in central Texas, with seasonal variation in its prevalence and not accompanied by any detectable mortality or signs of chytridiomycosis (Gaertner et al. 2009). In south-central Texas, *A. c. blanchardi* occurs sympatrically with the endemic endangered Houston Toad (*Anaxyrus* [*Bufo*] *houstonensis*) at a few locations that include breeding ponds on the Griffith League Ranch (GLR) and the adjacent Welsh (WEL) property in Bastrop County. These properties are located in the Bastrop Lost Pines ecoregion and are characterized by deep sandy soils, with forest patches dominated by Loblolly Pine (*Pinus taeda*), Post Oak (*Quercus stellata*), and Eastern Red Cedar (*Juniperus virginianus*), with interspersed grassland patches and land cleared for grazing (Gaertner et al. 2010). We selected six ephemeral to semi-permanent ponds on these properties that ranged in size from ~300 to 2,400 m^2 and differed by their use in cattle ranching operations (cattle ponds C-1 GLR and D-5 GLR), overuse by feral hogs (feral hog ponds E-11 GLR and F-WEL), or lack of these practices (low use ponds A-12 GLR and B-16 GLR). The maximum distance between ponds was about 3 km.

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At these six ponds, *A. c. blanchardi* were collected by hand or net once a month over a one-year period starting February 2009. At least 20 adults were collected per pond from February to August (February to May for ponds C-1 and D-5), however, lower numbers or no captures were obtained at ponds from September to January, with drought conditions resulting in periodic drying of ponds. Animals were swabbed with sterile cotton tips with a wood handle following the method outlined in (Kriger et al. 2006b). To avoid potential cross-contamination, nets were treated with commercial bleach (final conc. 1% NaOCl) for 10 min and gloves were changed between captures. Swabs were placed in sterile 2 ml cryotubes and stored at -80°C until further processing. DNA was extracted from swabs with the Wizard Genomic DNA Purification kit (Promega Corporation, Madison, WI) following the protocol for extraction from animal tissue. DNA extracts were then tested for the presence of *Bd* using a TaqMan quantitative real time PCR (*q*PCR) assay (Boyle et al. 2004).

Temperature, total phosphorus (TP), and pH were analyzed in unfiltered water samples, while concentrations of chlorophyll *a* (Chl *a*), non-volatile suspended solids (NVSS), organic matter (OM), dissolved organic carbon (DOC), soluble reactive phosphorus (SRP), nitrate (NO_3^-), and ammonium (NH_4^+) were analyzed from filters or in filtrates of water samples. Water samples were analyzed in duplicate. In addition to water samples, a sediment core (approximately 5 cm deep) was taken at the shore-line of each pond. Sediment samples were dried, and subsequently combusted at 550°C for 4 h to determine percent sediment organic matter (SOM). Principal components analysis (PCA; SAS v.9.3) was then used to assess differences in environmental parameters among pond types and months. Environmental parameters were z-scored transformed (Krebs 1999) and

TABLE 1. Average temperature and cumulative precipitation data for the 30 days preceding sampling events at six ponds in Bastrop County, Texas, USA, during spring and summer of 2009. Values were obtained from the National Climatic Data Center and represent averages for the three closest surrounding stations (Elgin-412820, Smithville-418415, and Cedar Creek-411541). No frogs were obtained in September, October, December, and January.

Months	Feb	Mar	Apr	May	Jun	Jul	Aug	Nov
Temperature (°C)	12.1	15.4	17.1	23.8	25.4	31.2	31.2	17.9
Precipitation (mm)	21	55	35	82	61	3	42	14

TABLE 2. Percentage of Blanchard's Cricket Frogs (*Acris crepitans blanchardi*) infected with *Batrachochytrium dendrobatidis* during the spring and summer of 2009 (± 95% confidence interval) at six ponds in Bastrop County, Texas, USA. No frogs were collected in September, October, December, and January, and all frogs collected in November tested positive (pond A-12, N = 10 and pond B-16, N = 7; pond C-1, N = 1; pond D-5, N = 1). Nd represents times when no frogs were obtained.

Pond	February	March	April	May	June	July	August	Average
A-12	58 (± 22) N = 19	100 N = 20	65 (± 21) N = 20	100 N = 20	80 (± 18) N = 20	95 (± 10) N = 20	75 (± 19) N = 20	88
B-16	100 N = 20	85 (± 16) N = 20	85 (± 16) N = 20	90 (± 13) N = 20	65 (± 21) N = 20	Nd	94 (± 11) N = 17	89
C-1	90 (± 13) N = 20	100 N = 4	88 (± 23) N = 7	100 N = 6	Nd	Nd	Nd	90
D-5	100 N = 20	100 N = 8	85 (± 16) N = 20	100 N = 20	Nd	Nd	Nd	89
E-11	Nd	92 (± 16) N = 12	86 (± 26) N = 7	85 (± 16) N = 20	80 (± 18) N = 20	100 N = 20	100 N = 20	88
F-WEL	95 (± 10) N = 19	93 (± 13) N = 14	75 (± 42) N = 4	100 N = 13	100 N = 7	100 N = 20	88 (± 16) N = 16	73
Average	89	94	80	95	78	98	89	89

the appropriate number of principal components to retain in the model was determined using a scree plot as a guide.

Further analyses used a linear mixed-effects model (Program R v.2.9.1) to test for differences ($\alpha = 0.05$) among pond types and months in the number of *Bd* genome equivalents (GE) per individual. Number of *Bd* GE per individual were $\log_{10}$ (N+1) transformed to improve assumptions of the linear model. Interaction between pond type and months lacked sufficient replication and was therefore not tested. To further explore the factors associated with *Bd*-GE differences among months and pond type, the cumulative precipitation and mean temperature of the 30 d preceding sampling dates were downloaded from the National Climatic Data Center (Table 1). Because no station is available for Bastrop, daily values from the three surrounding stations (Elgin-412820, Smithville-418415, and Cedar Creek-411541) were averaged. Months were converted to day of collection (e.g., Julian date) and diagnostic plots were used to assess interactions between time and pond type on *Bd* GE per individual. In the absence of any apparent interaction, regression models were used to predict $\log_{10}$ (N+1) transformed *Bd* GE per individual from Julian date, air temperature, and precipitation across pond type.

Bd was detected on 89% (N = 572) of *A. c. blanchardi* collected. The overall monthly percentage of infected *A. c. blanchardi* ranged from 78% (N = 67) in June to 100% (N = 19) in November (Table 2). Although the percent of infected *A. c. blanchardi* were the same for each pond during November (100% of individuals tested were positive at ponds A-12, B-16, C-1, and D-5), percentages varied for different ponds within the same month by as little as 15% (pond C-1 [100%] and pond B-16 [85%] in March) to as much as 42% (pond D-5 [100%] and pond A-12 [58%] in February) (Table 2). These results confirm the occurrence of *Bd* in central Texas where it has been detected in different *Eurycea* species (Gaertner et al. 2008) and in an urban population of *A. c. blanchardi* (Gaertner et al. 2009). In the latter study, 83% of individuals tested positive for *Bd* in one sampling event, with none of the infected individuals showing clinical signs of infection during handling (e.g., lethargy, lack of righting reflex, excessive sloughing of skin), as was also the case in this study.

The number of *Bd* genome equivalents (GE) detected on *A. c. blanchardi* ranged from 0 to up to 3×10^5 GE per individual with an overall mean of 2,400 GE per individual. The highest values exceeded lethal levels reported for other species (Vredenburg et al. 2010), however, most values were within ranges obtained in other studies (Kriger and Hero 2007a, b). Although small variations in numbers of *Bd* GE were noted on *A. c. blanchardi* collected within ponds with a minimum of 15 individuals during some sampling events (e.g., 0–54 GE for *A. c. blanchardi* from pond A-12 in February and 0–153 GE for *A. c. blanchardi* from pond E-11 in June), differences as large as four orders of magnitude were not uncommon (e.g., $0–3 \times 10^4$ GE for *A. c. blanchardi* from pond F-WEL in March) (Table 3). Large seasonal variation in numbers of *Bd* GE were detected on *A. c. blanchardi* throughout

TABLE 3. Average number of genomic equivalents of *Batrachochytrium dendrobatidis* on individuals of Blanchard's Cricket Frogs (*Acris crepitans blanchardi*) from six ponds located in Bastrop County, Texas, USA during the spring and summer of 2009 (± 95% confidence interval). No frogs were obtained in September, October, December, and January, and average number of genomic equivalents of *Bd* (± 95% confidence interval) on individuals collected in November were: pond A-12, 370 (± 570); pond B-16, 71(± 24); pond C-1, 18 (N = 1); and pond D-5, 2,500 (N = 1). Nd represents times when no frogs were collected.

Pond	February	March	April	May	June	July	August	Average
A-12	12 (± 6)	2,100 (± 1,400)	1,600 (± 850)	170 (± 36)	40 (± 20)	120 (± 36)	210 (± 65)	870
B-16	1,300 (± 980)	9,100 (± 10,000)	13,000 (± 12,000)	360 (± 340)	100 (± 63)	Nd	160 (± 47)	3,800
C-1	270 (± 120)	780 (± 1,000)	670 (± 790)	5,500 ± 9,600	Nd	Nd	Nd	1,200
D-5	150 (± 67)	270 (± 170)	120 (± 57)	85 (± 47)	Nd	Nd	Nd	180
E-11	Nd	6,600 (± 7,400)	1,300 (± 850)	3,300 (± 3,100)	38 (± 17)	180 (± 26)	200 (± 40)	1,600
F-WEL	2,200 (± 2,100)	30,000 (± 43,000)	1,500 (± 2,600)	2,400 (± 2,700)	280 (± 310)	220 (± 23)	140 (± 55)	5,200
Average	760	9,400	4,000	1400	85	174	180	2,400

the study, with monthly average intensities peaking in March at 9,400 *Bd* GE per individual and decreasing in the summer to a minimum of 85 *Bd* GE per individual in June (Table 3). Our previous studies documented seasonal changes in infection rate but not in intensity, which was not previously analyzed, with high infection rates in spring and no *Bd* detections during summer when one cured individual was identified (Gaertner et al. 2009). Although these previous results seem to contradict our current investigation with high rates of *Bd* detection throughout the year, differences among infection rates are most likely attributable to different sensitivities of the detection methods. The *q*PCR detection method developed by (Boyle et al. 2004) has widely been accepted and used as adequate detection and quantification method for *Bd* (e.g., Kirshtein et al. 2007; Kriger et al. 2006a, b; Walker et al. 2007), with a sensitivity about 2–5 times higher than the nested PCR approach applied in our previous study (Gaertner et al. 2009). The low numbers detected during summer by *q*PCR in the current study (i.e., usually less than 10 GE) might therefore not have been detectable by nested PCR in our previous study (Gaertner et al. 2009).

Our PCA analysis of relationships between *Bd* and environmental characteristics demonstrated that ponds differed along two primary environmental gradients (Fig. 1). The first Principal Component explained 31% of the variation in *Bd* occurrence and described a gradient from relatively deep ponds with consistently lower nutrient levels to ponds that were shallow and thereby more prone to nutrient loading including organic matter (OM), total phosphorus (TP), and non-volatile suspended solids (NVSS). The second Principal Component explained 19% of the variation and contrasted aquatic habitats dominated by high respiration (high ammonium, nitrate, and pH) to those of high primary production (high dissolved organic carbon and chlorophyll *a*). Low-use ponds (ponds A-12 and B-16) were, on average, deeper (2.3–2.5 m) and had lower average concentrations of OM (10–27 mg l^{-1}), TP (80–110 µg l^{-1}), ammonium (36–133 µg l^{-1}), and nitrate (260–270 µg l^{-1}), whereas cattle ponds (C-1 and D-5) and those used by feral hogs (E-11 and F-WEL) were generally shallower (0.46–1.1 m) with high concentrations of OM (15–50 mg l^{-1}), TP (210–370 µg l^{-1}), ammonium (175–1,600 µg l^{-1}), and nitrate (385–1,100 µg l^{-1}).

The number of *Bd* GE per individual did not differ among low-use ponds, cattle ponds, or feral hog ponds ($F_{2, 3} = 3.8$, $P = 0.14$), but differences were apparent among months ($F_{7, 25} = 3.8$, $P < 0.01$). Whereas an association between numbers of *Bd* GE per individual and precipitation was not detected ($F_{1,36} = 0.6$, $P = 0.46$), we found that across pond type, numbers of *Bd* GE per individual were inversely related to day ($F_{1,36} = 7.4$, $P = 0.01$) and air temperature ($F_{1,36} = 6.7$, $P = 0.01$) (Fig. 2). Seasonal variation has been documented for *Bd* occurrence on amphibian hosts with peak prevalence of disease levels at temperatures less than 19.4°C (Kriger and Hero 2007b) and 21.6°C (Gaertner et al. 2009). These temperatures are in agreement with those in our study; for all sites, we found that the monthly peak in overall intensity of infection occurred in March (15.4°C) and April (17.1°C) (Table 1).

Air temperatures are often auto-correlated with water temperature. However, whereas all ponds warmed at the same general rate despite differences in size (not depicted), the strongly negative correlation for *Bd* GE for temperatures greater than 25°C was not observed for all ponds. Two of the ponds had relatively more stable year-round environmental conditions, likely a result of the larger volume of water for those sites (low use ponds A-12 and B-16). The seasonality of infection by *Bd* was fairly predictable in these ponds with the average intensity of infection rising to a peak in March and April and then declining through the summer months. These ponds showed negative correlations between *Bd* GE and water temperature (Figure 2). The remaining ponds were characterized by much more dynamic environmental characteristics. This included two ponds (cattle ponds C-1 and D-5) in which the greatest total *Bd* GE detections occurred at temperatures above 25°C. Admittedly, those *Bd* GE values were not notably high for either pond when scaled against all ponds, reaching only ~5,500 GE and ~275 GE, respectively. It is possible

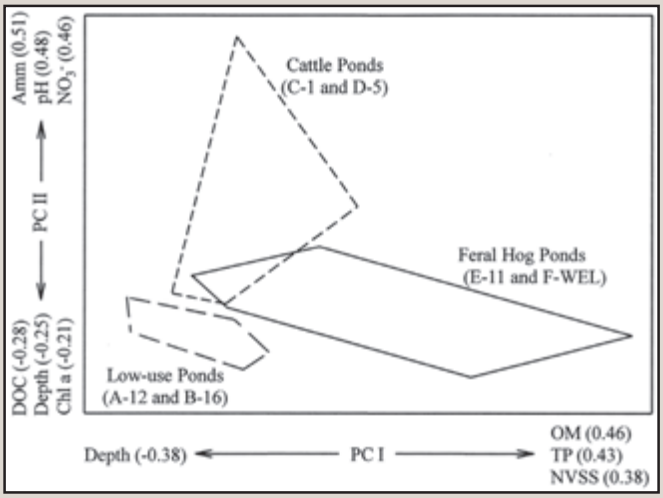

FIG. 1. Plot of sample scores from six sites, enveloped by pond type, on principal component axis I and II of environmental data (H+ [*pH*], ammonium [*Amm*], nitrates [NO_3^-], soluble reactive phosphorus [*SRP*], non-volatile suspended solids [*NVSS*], total phosphorus [*TP*], water temperature [*WaterTemp*], organic matter [*OM*], chlorophyll *a* [*Chla*], soil moisture [$SoilH_2O$], soil organic matter [*SOM*], dissolved organic carbon [DOC], and depth [*Depth*]) collected monthly from ephemeral to semi-permanent ponds located in Bastrop County, Texas.

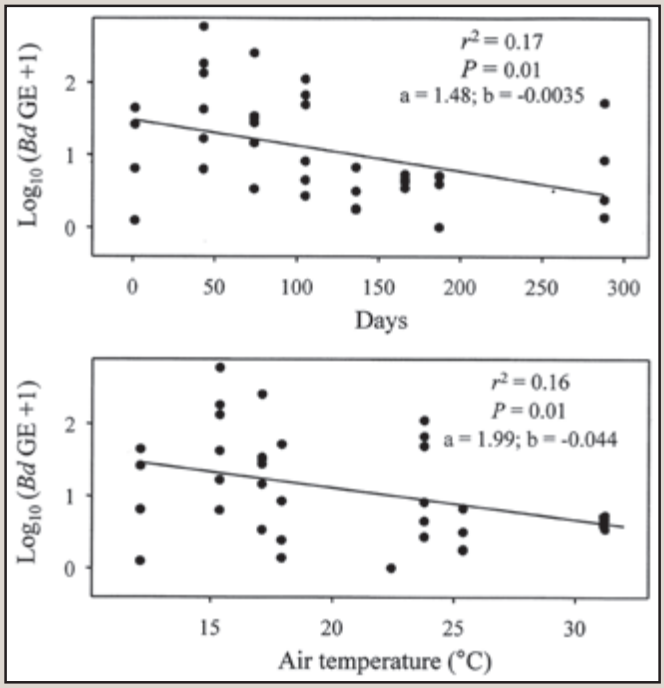

FIG. 2. Relationships between *Batrachochytrium dendrobatidis* genome equivalents (*Bd* GE) per individual *Acris crepitans blanchardi* and Julian date (starting February 1 and ending November 15) (top panel) and between *Bd* GE per individual *A. c. blanchardi* and air temperature averaged from 30 d preceding each sampling date (bottom panel) collected from ephemeral to semi-permanent ponds located in Bastrop County, Texas.

that the overall lower *Bd* GE rates for these two sites reflected their more ephemeral nature when compared with the other ponds examined here.

It also may be possible that the frogs sampled in the later, warmer periods at those two sites were migrants from larger, cooler ponds rather than residents and this could also explain the increased *Bd* GE values despite the seemingly unsuitable temperatures. We consider these more dynamic patterns of *Bd* prevalence to be consequent of their smaller size and the concomitant effect of evaporation and precipitation events (ponds C-1and F-WEL). The environmental variables measured in these ponds fluctuated widely between monthly sampling events as did the intensity of infection by *Bd*. Aside from temperature, we did not detect a strong trend among alternative environmental parameters for these ponds in association with the level of infection over time. None of the water quality assessment measures appeared to influence the prevalence or occurrence of *Bd* at those sites. Overall, the seasonal pattern in abundance was more pronounced in deeper ponds than in shallow or ephemeral ponds and was correlated with consistently lower nutrient levels in deeper ponds.

Bd has been found to be more prevalent in amphibians occurring in flowing rather than in standing waters, and more individuals of amphibians were infected with *Bd* and at higher levels in permanent water bodies than in ephemeral water bodies where detection of *Bd* was extremely rare (Kriger and Hero 2007a). Since the aquatic zoospore of *Bd* cannot survive desiccation (Johnson et al. 2003), desiccation may prevent *Bd* from causing significant infections at sites without standing water despite there being enough moisture to support amphibian populations. Impoundment construction and modifications of ephemeral ponds into permanent livestock water sources have increased the number of permanent water bodies over the last century with some negative potential impacts to rare amphibians (Gaston et al. 2010). Since central Texas has a large number of endangered and endemic amphibian species (Brown et al. 2012; Chippindale et al. 2000), an increase of permanent water sources might consequently result in an increase of the abundance and transmission of *Bd*, and might thus have detrimental effects on the amphibian assemblages in the area.

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Surveys for Frog Diversity and *Batrachochytrium dendrobatidis* in Jamaica

Jamaica is home to the world's second most endangered frog assemblage, with 16 of 21 (76%) endemic species recognized as threatened (IUCN 2011). There are 17 endemic *Eleutherodactylus* (Hedges 1989), five endemic *Osteopilus*, one of which is unnamed and thus has not been assessed by the IUCN (Moen and Wiens 2008; S. B. Hedges, unpubl. data) and four invasive anurans on the island (Mahon and Aiken 1977). We conducted the first large-scale assessment of the island's amphibians since the 1980s while sampling for the amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*). Prior to our work, *Bd* was known from all of the other Greater Antillian islands (Burrowes et al. 2004; Diaz et al. 2007; Joglar et al. 2007), several of the Lesser Antillian islands (Alemu et al. 2008; Garcia et al. 2009), and mainland North, Central and South America (Carnaval et al. 2006; Longcore et al. 1999; Fisher et al. 2009), but was not confirmed in Jamaica.

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Given the documented extinctions and population declines in congeners to Jamaica's frogs from chytridiomycosis in Puerto Rico (Burrowes et al. 2004; Longo et al. 2010) and Central America (Lips et al. 2004; Puschendorf et al. 2006), we were concerned about the conservation implications of epidemic outbreaks of *Bd* to Jamaica's amphibians. As of September 2010, 6 of Jamaica's 21 described endemic species had not been recorded in over two decades (Hedges and Diaz 2011). The timeframe of their last sighting was similar to that of some chytridiomycosis-related extinctions and extirpations elsewhere in the Caribbean (Burrowes et al. 2004). We conducted this project to investigate the occurrence of *Bd* per species and location, assess the status of Jamaican frog species, and to provide information to focus future conservation efforts directed at extant endemic species.

We sampled for amphibians across Jamaica, spending at least one person-day in the field in the known ranges of every endemic species on the island (Fig. 1; Table 1). We conducted our field work between October 2010 and June 2011. We defined a

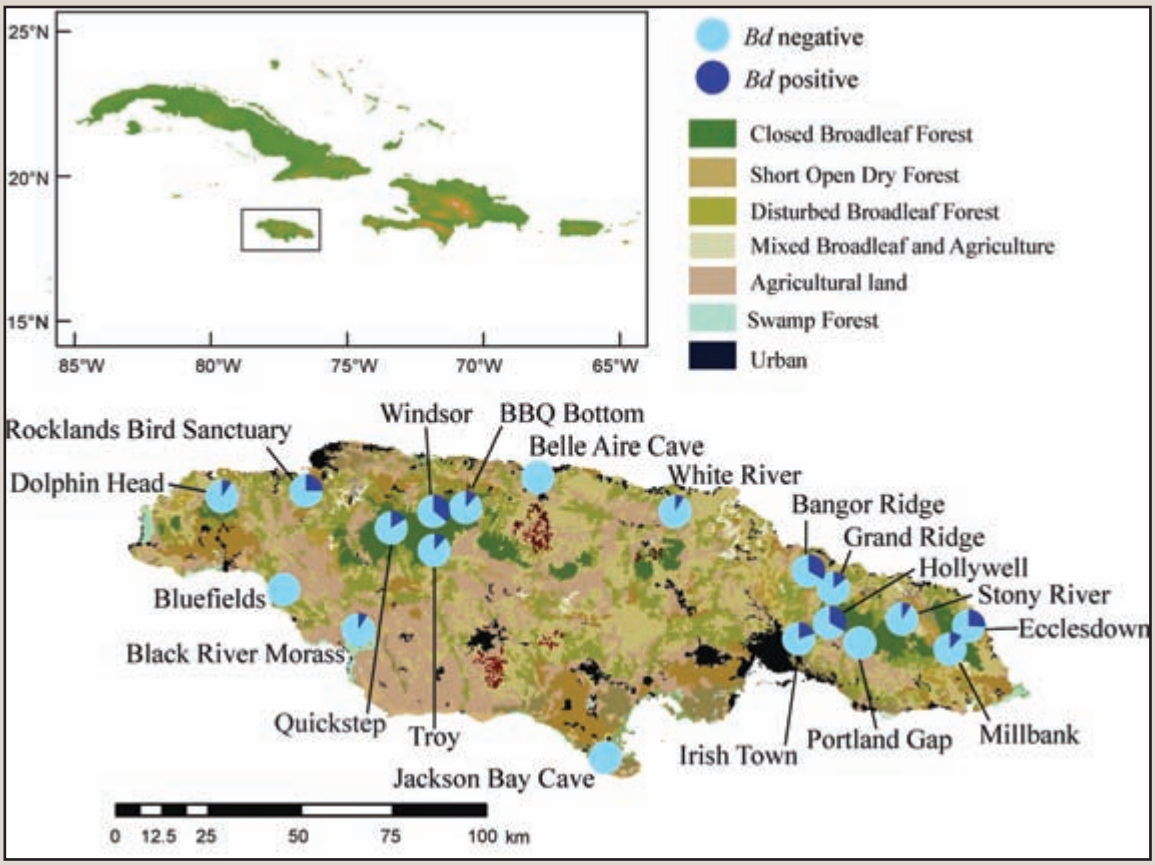

FIG. 1. Distribution of sampling locations in Jamaica for the amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*). Proportion of *Bd*-positive and *Bd*-negative individuals are indicated per site. Primary land cover types are shown (from Forestry Department, Jamaica: http://www.forestry.gov.jm/maps_data_page.htm [accessed 3 June 2011]).

person-day as the search effort of one person within a 24-h period, generally 2–5 h/day. We sampled closed broadleaf, disturbed broadleaf, short open dry, and swamp forest habitats, as well as mixtures of disturbed broadleaf and small plantations, and suburban habitats and caves. Our field sites ranged from sea level swamp and dry forests to elfin forest at 2250 m on top of Jamaica's highest peak.

We used visual/audio encounter surveys beginning at sunset and lasting 2–5 h per site. Frogs were caught by hand using an inverted plastic bag and were housed overnight in the bag. We recorded capture location using a Garmin Global Positioning System Map 60CS in the WGS84 datum. We identified captures to species, and swabbed them ten times on the bottom of each foot, under each thigh, along the stomach, and under the drink patch. We examined frogs for skin sloughing, unusual posture, and other known chytridiomycosis symptoms (Berger et al. 1998; Berger et al. 2005). Frogs that were not collected as voucher specimens were released at their capture location after processing. We thoroughly disinfected all of our gear between each sampling site with a 10% bleach solution, followed by air drying in direct sunlight. We stored the swabs dry at ambient temperature in the field and refrigerated them immediately on return to the laboratory (Hyatt et al. 2007; Skerratt et al. 2008). We extracted the total *Bd* genome, as well as any DNA

TABLE 1. Amphibian sampling locations in Jamaica (latitude/longitude; WGS 84 datum). Elevation is approximate average search elevation (m).

Site number	Location	Northing	Easting	Elevation
1	Ecclesdown	18.0533	-76.3497	600
2	Millbank	18.0302	-76.3671	600
3	Stony River	18.0858	-76.5149	250
4	Portland Gap	18.0481	-76.5842	1540
5	Hollywell	18.1911	-76.7274	1200
6	Irish Town	18.0745	-76.6919	900
7	Grand Ridge	18.0922	-76.6577	1100
8	Bangor Ridge	18.1694	-76.6808	300
9	White River	18.3651	-77.0484	130
10	Jackson Bay Cave	17.7349	-77.2224	20
11	Belle Aire Cave	18.4558	-77.3679	10
12	BBQ Bottom	18.3750	-77.5466	250
13	Windsor	18.3583	-77.6508	115
14	Troy	18.2639	-77.5991	550
15	Quickstep	18.2978	-77.7167	350
16	BLRM	18.0675	-77.8248	5
17	Rocklands Bird Sanctuary	18.4558	-77.9412	260
18	Bluefields	18.1662	-78.0092	40
19	Dolphin Head	18.3691	-78.1741	530

TABLE 2. *Batrachochytrium dendrobatidis* (*Bd*) occurrence on frogs in Jamaica. No. *Bd*–positive individuals/total no. individuals sampled per species and location are provided. For site names see Table 1. Genera are: O = *Osteopilus*; E = *Eleutherodactylus*; R = *Rana*; L = *Lithobates*. 0/0 indicates that the sampling location was in a species' range, but the species was not detected. A dash (–) indicates that the sampling area was outside of the species' range, and the species was not found. Bold numbering indicates that the species was found outside its known range. Asterisks indicate invasive species.

	Location																			
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Totals (%)
O. brunneus	1/3	1/16	0/6	–	–	0/0	–	0/0	1/5	–	–	0/0	0/0	0/5	2/5	0/0	1/2	0/12	0/0	6/54 (11.00)
O. crucialis	–	–	–	–	–	–	–	–	–	–	–	0/0	0/0	0/0	0/0	–	–	–	–	0/0 (0)
O. marianae	–	–	–	–	–	–	–	–	–	–	–	–	0/0	0/0	0/0	–	–	–	–	0/0 (0)
O. wilderi	–	–	–	–	–	–	–	0/0	–	–	–	0/1	0/0	0/1	0/0	–	–	–	0/0	0/2 (0)
O. sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0/5	–	–	–	–	0/5 (0)
E. alticola	–	–	–	0/1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0/4 (0)
E. andrewsi	1/3	0/0	–	0/3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1/6 (16.70)
E. cavernicola	–	–	–	–	–	–	–	–	–	0/2	–	–	–	–	–	–	–	–	–	0/2 (0)
E. cundalli	–	–	–	–	–	–	–	–	0/1	–	0/4	3/15	0/0	0/0	1/9	–	0/0	0/0	0/0	4/29 (13.80)
E. fuscus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2/8	2/8 (25.00)
E. glaucoreius	7/17	0/0	1/4	0/0	1/3	3/5	0/1	0/0	0/3	–	–	–	–	–	–	–	–	–	–	12/33 (36.36)
E. gossei	0/8	2/7	1/5	–	–	12/63	–	0/1	2/19	–	–	0/9	2/5	0/4	0/0	1/2	0/1	–	–	20/124 (16.13)
E. grabhami	–	–	–	–	–	–	–	–	–	–	–	–	–	0/0	0/0	–	–	0/0	–	0/0 (0)
E. griphus	–	–	–	–	–	–	–	–	–	–	–	**0/11**	–	–	0/14	–	–	–	–	0/25 (0)
E. jamaicensis	0/0	0/0	–	–	–	–	–	–	–	–	–	0/0	0/0	0/0	0/0	–	–	–	0/0	0/0 (0)
E. junori	–	–	–	–	–	–	–	–	–	–	–	–	–	0/0	–	–	–	–	–	0/0 (0)
E. luteolus	–	–	–	–	–	–	–	–	–	–	–	**0/9**	–	–	4/16	–	–	0/5	0/4	4/34 (11.76)
E. nubicola	–	–	–	0/0	1/3	–	1/3	–	–	–	–	–	–	–	–	–	–	–	–	2/6 (33.33)
E. orcutti	–	–	0/0	0/0	0/0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0/0 (0)
E. pantoni	–	–	–	–	–	–	–	–	–	–	–	**4/15**	0/6	3/33	6/33	–	–	–	1/27	14/114 (12.28)
E. pentasyringos	1/5	0/0	0/6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4/26 (15.38)
E. sisyphodemus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0/0	–	–	–	–	0/0 (0)
*E. johnstonei**	–	0/1	–	0/1	–	1/13	–	1/2	0/3	–	–	–	2/2	3/8	–	1/8	0/1	–	1/2	10/43 (23.26)
*E. planirostris**	–	–	–	–	–	–	–	–	–	–	–	–	1/1	–	–	–	–	–	–	1/1 (100%)
*L. catesbeianus**	–	–	–	–	–	–	–	–	0/1	–	–	–	–	–	–	–	–	–	–	0/1 (0)
*R. marina**	–	0/1	0/1	–	–	–	–	–	–	–	–	–	–	–	–	0/12	–	–	–	0/14 (0)
Totals (%)	13/51	3/25	2/22	0/4	2/6	16/81	1/7	1/3	3/33	0/2	0/4	7/60	5/14	6/51	13/82	2/22	1/4	0/17	4/41	
(%)	(25.49)	(12.00)	(9.09)	(0.00)	(33.33)	(19.75)	(14.29)	(33.33)	(9.09)	(0.00)	(0.00)	(11.67)	(35.71)	(11.76)	(15.85)	(9.09)	(25.00)	(0.00)	(9.76)	

present from frog skin cells or other frog skin microbiota, from the swabs using the standard PrepmanUltra protocol (Hyatt et al. 2010). We ran quantitative PCR tests at the Cornell University Life Sciences Core Laboratories Center, Ithaca, New York. We ran samples in singlicate at a 1:10 dilution of the starting stock on an Applied Biosystems ViiA7 machine. All voucher specimens are stored in the Herpetology Laboratory, University of the West Indies, Kingston, Jamaica.

Site-specific *Bd* infection rates ranged from 0–33% (Table 2). All but four sites had at least one *Bd*-positive frog. The four *Bd*-negative sites included two caves and a high-elevation cloud forest, each with low sample sizes, and a relatively dry, disturbed coastal broadleaf forest in western Jamaica. The site with the highest *Bd* prevalence (5/14 frogs infected) was in central Jamaica, at the intersection of small-scale agricultural land and disturbed broadleaf forest. With these exceptions, little geographical pattern is apparent in infection rates. When *Bd* infection rates per species were pooled across all sites at which each species occurred, most species showed rates between 10 and 20%. Although *Bd* was not detected on *Eleutherodactylus griphus*, *Osteopilus wilderi*, *O.* sp. (S.B. Hedges, unpubl. data), and *E. cavernicola*, due to low sample sizes (Skerratt et al. 2008), we cannot reliably draw the conclusion that their infection rates differed from other species sampled. *Eleutherodactylus glaucorieus* had the highest infection rate at 36% (12/33). All frogs examined were adults, except a very recently metamorphosed *O. wilderi* sampled in Troy. We were limited to examining leaf litter, caves, and low vegetation, hence canopy-dwelling species (the *Osteopilus*) were not well represented in our sample. We found no dead or moribund animals, and saw no disease symptoms on the animals we sampled.

We were unable to locate seven endemic species during our surveys (Table 2). Two of these species, *E. orcutti* and *E. jamaicensis*, have not been observed since the 1980s, and are the island's only two semi-aquatic *Eleutherodactylus*: *E. orcutti* is a stream specialist; and *E. jamaicensis* a bromeliad tank specialist. Because *Bd* is often transmitted aquatically, semi-aquatic species may be more at risk of *Bd* infection than terrestrial species (Kilpatrick et al. 2009). We spent considerable search effort on these species, including visiting the type localities of both. We spent 71 person-days (with 2–5 h/day of sampling) searching in the historical range of *E. jamaicensis* and 27 person-days in the historical range of *E. orcutti* without seeing an individual or hearing a call of either species, raising concerns about the continued existence of these species. *Eleutherodactylus jamaicensis* searches were conducted in November 2010 and January, February, March, May, and June of 2011, whereas searches in *E. orcutti*'s range were carried out in January, March, April, May, and June of 2011. The other non-sampled *Eleutherodactylus* are of less concern, as they are highly cryptic terrestrial species. Although the *Osteopilus* share the semi-aquatic life history strategy with *E. jamaicensis,* we heard calls from these species while in their ranges.

Although we quantified *Bd* loads in our positive samples, we do not report those data here. Many of the swabs were not refrigerated for up to a week after sampling, due to the remoteness of our sampling sites. We stored the swabs dry in the field at ambient temperature, which was generally between 20 and 30°C. Storage at ambient temperature does not increase the risk of false negatives, but may reduce the detectable *Bd* zoospore load by up to 67% when temperatures are above 23°C (Skerratt et al. 2008; Van Sluys et al. 2008). Given that our samples were exposed to ambient temperatures for variable amounts of time, between several minutes and seven days, and that our study sites had considerably different ambient temperatures, our measured loads may be inconsistent representations of actual loads. However, we found no loads above 3,000 zoospore equivalents, and the majority of the infected individuals showed less than 100 zoospore equivalents. Even if these measurements represent an average of one third of the original load, they indicate that the frog populations we sampled may not be in immediate danger of chytridiomycosis-related decline (Vredenburg et al. 2010), at least under current environmental conditions and with the current (as yet not genotyped) strain of *Bd* on the island. Further habitat loss and the introduction of other diseases or more virulent *Bd* strains are ongoing threats to this highly endangered frog community. Additional sampling is warranted for endemic species which were undetected during this survey.

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Occurrence of *Batrachochytrium dendrobatidis* Among Populations of *Lithobates clamitans* and *L. pipiens* in Wisconsin, USA

Continued efforts to sample for *Batrachochytrium dendrobatidis* (*Bd*), the fungus that causes amphibian chytridiomycosis, in the U.S. have begun to provide a more complete understanding of its distribution (Longcore et al. 2007; Muths et al. 2009). In fact, some have even questioned the relevancy for additional non-targeted sampling and have suggested targeting gaps in our understanding of *Bd* distribution such as in the northern regions of the U.S. (Muths et al. 2009). One such significant northern gap is the state of Wisconsin.

The earliest reported detection of *Bd* in Wisconsin was from specimens preserved in 1969 and 1984 (Ouellet et al. 2005). Since then sampling for *Bd* has been performed along the Mississippi and St. Croix rivers bordering Wisconsin and Minnesota, detecting its occurrence at numerous localities. Sampling also was performed in southwestern Wisconsin but *Bd* was not detected there (Sadinski et al. 2010). Although states neighboring Wisconsin have been more thoroughly sampled for *Bd* (Minnesota [Rodriguez et al. 2009; Woodhams et al. 2008], Iowa [Loda and Otis 2009; Steiner and Lehtinen 2008], Illinois [Steiner and Lehtinen 2008], and Michigan [Steiner and Lehtinen 2008; Zellmer et al. 2008; Zippel and Tabaka 2008]), Wisconsin is largely separated from these by geologically and biologically significant borders. To the north and east, Wisconsin is bordered by Lake Superior and Lake Michigan, respectively, and to the west the Mississippi and St. Croix Rivers. Additionally, the state contains one of the highest concentrations of freshwater lakes in the world. Clearly, Wisconsin is not simply a biologically-arbitrary political designation, but rather corresponds to a biologically unique area within which an understanding of the distribution of *Bd* is important for a more complete documentation of this amphibian pathogen in the U.S. Herein we report the findings of broad-scale sampling for *Bd* across Wisconsin.

We sampled during fall 2009 (5–26 September) and summer 2010 (21 June–9 July) opportunistically at localities within each of the 24 Geographical Management Units (GMU's; Fig. 1) of the Wisconsin Department of Natural Resources. GMUs were used to assure a broad distribution of sampling across the state and because they are based on a mixture of hydrologic basins, county boundaries, and DNR regional boundaries for the purpose of managing water resources: *Bd* occurrence by GMU is potentially important information for future water resource management decisions. Ten arbitrarily chosen GMU's were sampled during Fall 2009 whereas the remaining 14 (plus two that were sampled

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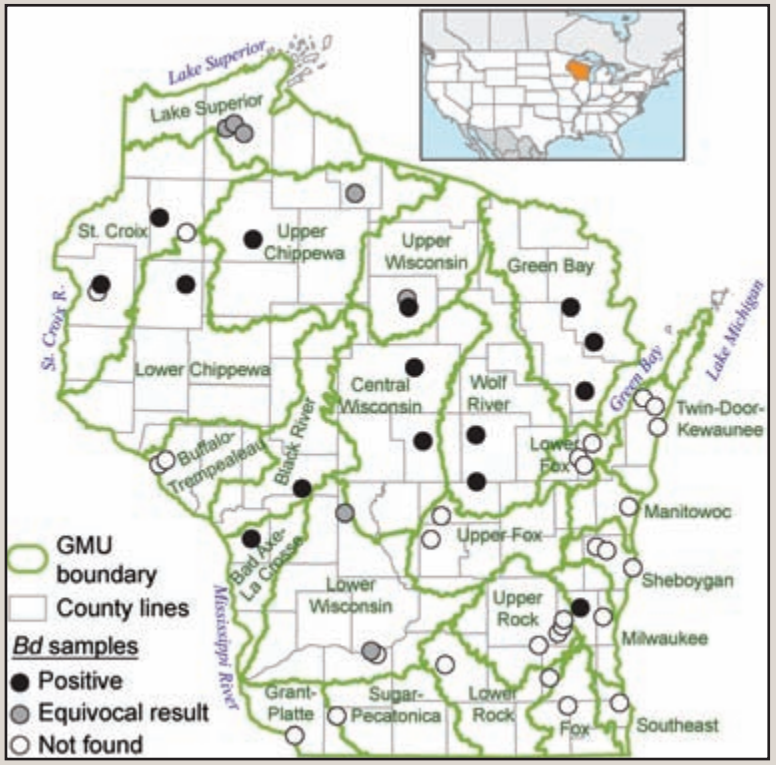

FIG. 1. *Batrachochytrium dendrobatidis* (*Bd*) sampling locations in Wisconsin, USA. Green lines indicate Geographical Management Units delineated by the Wisconsin Department of Natural Resources and used for our sampling design.

in fall) were sampled during summer 2010. From one to four localities were sampled within each GMU, depending partly on the size of the GMU and partly on the success of finding sufficient specimens at localities. Sampling focused on *Lithobates clamitans* and *L. pipiens*, two frogs common throughout Wisconsin and also known to be susceptible to infection by *Bd*. Sampling was performed following procedural suggestions of Brem et al. (2007), including swabbing each frog with a high quality medical swab on each rear foot, ventral surface of each thigh, and the ventral abdominal area. The swab was then stored in ethanol in a pre-filled vial until testing. After swabbing, frogs were measured and their health noted, and then they were released at the site of capture. The goal was to sample seven to fourteen individuals (split between the two species) from each GMU, depending upon the size of the GMU.

Upon completion of sampling, swabs were sent to the Real-time PCR Facility at Washington State University where DNA from swabs was extracted using Qiagen DNeasy Blood & Tissue Kits and quantitative real-time PCR (qPCR) was used to estimate the amount of fungal DNA present in swabs. Primers and MGB probe were generated from generally conserved areas of the ITS-1 and 5.8S regions of chytrid fungus rDNA; see methods in (Boyle et al. 2004). Twenty-five µl reactions containing 12.5 µl 2 × Taqman Master Mix (Applied Biosystems, Foster City, California, USA), PCR primers at a concentration of 900 nM, the MGB probe at 250 nM and 5 µl of DNA and run on an ABI 7300 Thermocycler (Applied Biosystems). PCR conditions are as follows: 2 min at 50°C, 10 min at 95°C, followed by 15 sec at 95°C and 1 min at 60°C for 50 cycles (Boyle et al. 2004). For PCR assays, samples were pooled to minimize cost yet still address our primary objective of a broad survey across the state using the GMU's as sampling units (Hyatt et al. 2007). Thus, pooled samples included samples from 3–8 individuals of the same species from the same GMU and usually from the same locality; pooling of individuals from multiple localities was done with individuals that remained after pooling within localities. Pooled samples never included samples from both species of frogs or frogs from multiple GMU's. Each pooled sample was run in triplicate and if the standard error of any unknown sample (across the triplicate wells) was > 0.2, the outlier was removed and quantification was estimated by using the remaining two replicates. If this did not produce a standard error <0.2, the sample was rerun. If only one replicate was positive, the sample was rerun. Two pooled samples that gave marginal results (Green Bay locality 10, Milwaukee River pooled localities 25 and 26) were subsequently analyzed by individual. Since pool sizes varied, mean zoospore quantity was divided by the number of specimens included in the pool to give an average spore count per frog as a standard to facilitate comparison across pools and with other studies.

A total of 233 frogs were sampled (199 *Lithobates clamitans*, 34 *L. pipiens*) from 50 localities across the 24 GMU's. None of the frogs exhibited any symptoms of chytridiomycosis. Swab samples were combined into 47 pools for PCR analyses. Analyses detected *Bd* at sites in 12 of 24 (50%) GMU's in Wisconsin (Fig. 1). Among those testing positive are all of the largest GMU's in the state, occupying approximately two-thirds of the geographic area of Wisconsin, and primarily in the northern half of the state (Fig. 1). Among the 50 individual localities, 14 (28%) were positive, 29 (58%) negative, and seven (14%) could not be unequivocally determined. However, given the small sample sizes from each locality (1-7 individuals) the probability of Type II error rates (false negatives) can be considerable and the true prevalence, not considering the equivocal results, could be 23 (46%) to 37 (74%), (upper CI = 0.35 for samples of N = 7, and CI = 0.78 for N = 1; Brem et al. 2007).

Twenty-one (45%) of the PCR sample pools tested positive for *Bd* with mean zoospore quantity ranging from 29.3883 to 0.0024, for an average spore count per frog of 5.2337 to 0.0005 (Table 1). The majority of these indicated extremely low quantities of *Bd* zoospores (Table 1) with only three of 47 pooled assays exceeding a mean of 5.0 zoospores or a per frog average spore quantity greater than 1: Bad Axe-LaCrosse1 = 29.3883 (average spore count per frog = 4.1983); Upper Wisconsin2 = 15.7012 (5.2337); and Lower Chippewa1 = 5.1748 (1.0350).

Since samples pooled for PCR analysis never included mixed species, and in most cases the presence or absence of *Bd* at a given locality for either species can be determined from the pooled samples (i.e., only a few cases had positive results for a pool of two or more localities), results for differences in prevalence of *Bd* between *Lithobates clamitans* and *L. pipiens* can be interpreted. Of the 50 localities sampled across all GMU's, 41 had only *L. clamitans* present, of which five were equivocal; of the remaining 36, 13 (36%) tested positive. Five localities had only *L. pipiens* present, all of which returned negative results. The remaining four sites had both species present, with *L. pipiens* testing negative at all four sites and *L. clamitans* testing positive at one, negative at another, and equivocal at two. Thus when unequivocal results could be obtained, *L. clamitans* tested positive

TABLE 1. Comprehensive listing of all localities where anurans were sampled (#1–50) for *Batrachochytrium dendrobatidis* (*Bd*) in Wisconsin, USA, grouped by Geographic Management Unit (GMU) and arranged roughly north to south. Indicated are the number of *Lithobates clamitans* (*lc*) sampled at each locality, the grouping of *L. clamitans* samples for qPCR assays (single locality or remainder pooled from multiple localities) including the resultant average spore count per frog, and whether they were *Bd*-positive (+), *Bd*-negative (-), or equivocal (?) results relative to *Bd* presence. NA = not applicable as no *L. clamitans* were sampled at locality. Because all *L. pipiens* tested negative, their presence at a locality is indicated by an asterisk followed by the sample size.

GMU	Locality No.	Locality Description	Coordinates	No. *lc*	Single locality analyses	Pooled analyses of remaining samples	*Bd*
Lake Superior	12	Bayfield Co.: Bass Lake: Small man-made pool ~ 5 m from lake at ~0.25 mi S on West Bass Lake Rd from jct with County Rd. H.	46.513069°N 91.379853°W	7	0.0000 (N = 5)		?
	13	Bayfield Co.: Marshy wetland ~0.25 mi S of Ruth Lake Rd. (at ~0.5 mi S jct of Ruth Lake Rd. and County Rd. H) on unknown logging road.	46.513244°N 91.385703°W	1		0.0005 (N = 5)	?*[1]
	14	Bayfield Co.: Delta: White River near parking lot at end of White River Reserve Rd. ~ 0.25 mi from jct with Delta-Drummond Rd.	46.453333°N 91.277400°W	7	0.0000 (N = 5)		?
St. Croix	31	Polk Co.: St. Croix Falls: wetland just west of 170th St. at 0.4 mi N jct with 140th Ave.	45.416122°N 92.510574°W	0	NA		NA*[2]
	32	Polk Co.: Loveless Lake: Boat landing, ~0.2 mi from jct of 160th St. and South Loveless Lake Lane.	45.435303°N 92.490506°W	5	0.3040 (N = 4)	0.0437 (N = 4)	+
	33	Washburn Co.: Little Bass Lake: Little Bass Lake Road less than ~0.1 mi S of jct with County Rd. E.	45.910514°N 92.009013°W	7	0.0381 (N = 4)		+
	34	Washburn Co.: Crystal Lake: wetland at SE corner of jct of Wohlford Dr. and State Hwy 70.	45.812239°N 91.697500°W	0	NA		NA*[4]
Upper Chippewa	39	Sawyer Co.: Ojibwa: Ojibwa Community Park Boat Landing N shore of Chippewa River at County Rd. G bridge.	45.798864°N 91.117756°W	7	0.0656 (N = 5)	0.0113 (N = 5)	+
	40	Iron Co.: Turtle-Flambeau Flowage: Springstead Landing off Flowage Landing Rd.	46.073367°N 90.173794°W	3			?*[4]
Upper Wisconsin	47	Lincoln Co.: Tomahawk: Road Lake: Big Moose Supper Club -N8796 County Rd. S (= W Grand Ave.), waters edge 77 m from parking lot.	45.435317°N 89.697106°W	3		0.0328	?
	48	Lincoln Co.: 3 ft to the east of State Hwy 107 at 0.15 mi S of jct with Hillcrest Rd.	45.397561°N 89.693119°W	4	5.2337 (N = 3)	(N = 4)	+
Green Bay	10	Marinette Co.: Governor Thompson State Park: Caldron Falls Reservoir Boat Landing #13, 1.4 mi from jct Boat Landing #13 Rd. and Fabian Ln.	45.344979°N 88.248635°W	7	0.0058 (N = 7)		+
	11	Oconto Co.: Stiles: Machickanee Flowage Public Boat Access off Chicken Shack Road 0.3 mi W of jct with State Hwy 141.	44.856731°N 88.055369°W	7	0.1155 (N = 3) 0.0137 (N = 4)		+

TABLE 1. Continued.

GMU	Locality No.	Locality Description	Coordinates	No. *lc*	Single locality analyses	Pooled analyses of remaining samples	*Bd*
Lower Chippewa	15	Chippewa Co.: Bloomer: Marsh Miller Lake: Birch Point, 210th Ave. boat landing and swampy area.	45.147117°N 88.049994°W	7	1.0350 (N = 5)	0.4333 (N = 5)	+
	16	Barron Co.: Rice Lake: Near Moon Lake, small culvert drainage SE corner of jct of Camelot Cir. And Camelot La.	45.469344°N 91.729178°W	7	0.0260 (N = 4)		+
Buffalo-Trempealeau	3	Buffalo Co.: Mississippi River: wetland at Rieck's Lake Park along Hwy 35, 2.5 mi N Alma.	44.354542°N 91.931783°W	0	NA		NA*[2]
	4	Buffalo Co.: pond 5 m off County Rd. I, 0.5 m N on I from jct with State Hwy 35.	44.361839°N 91.929417°W	2	0.0000 (N = 2)		-*[4]
Black River	2	Jackson Co.: Millston: Lee Lake 15: sandy swimming beach just off Woodland Rd., ~50 m SE jct of Woodland Rd. and County Hwy O.	44.188317°N 90.652158°W	7	0.1554 (N = 7)		+
Central Wisconsin	5	Portage Co.: Stevens Point: Wisconsin River: river bottom wetland along west shore, 0.6 mi NW (upstream) of parking area at S end of Mead Park.	44.530122°N 89.606533°W	7	0.0000 (N = 5)	0.0000 (N = 4)	-
	6	Marathon Co.: Wausau: Scholfield Park, ~100 m from the parking lot to the south and ~100 m from jct with E. Randolph St. to the north.	44.979803°N 89.630817°W	6	0.0010 (N = 4)		+*[1]
Wolf River	49	Waupaca Co.: Iola: Iola Veterans Memorial, off Main St.	44.515743°N 89.130317°W	7	0.1670 (N = 7)		+
	50	Waushara Co: Twin Lake, Twin Lake Campground.	44.237208°N 89.145175°W	7	0.0152 (N = 3) 0.0000 (N = 4)		+
Lower Fox	17	Brown Co.: DePere: 0.18 mi NE of jct S Broadway and State Hwy 172.	44.477817°N 88.051589°W	2			-
	18	Brown Co.: DePere: Apple Creek Campground, N3831 County Rd. U, fishing pond.	44.356472°N 88.190633°W	2		0.0000 (N = 7)	-
	19	Brown Co.: Wrightstown: 0.1 mi SW jct State Hwy 96 and Washington St. on shore of Fox River at end of Dock St., Brown Co. Parks System.	44.324856°N 88.165131°W	3			-
Twin-Door-Kewaunee	36	Door Co.: Brussels: 9245 Lovers Lane, Quietwoods South Camping Resort, permanent catch and release fishing pond, sandy beach area.	44.776753°N 87.591292°W	2			-
	37	Door Co.: Forestville: Forestville Flowage: Forestville Dam Park, 475 Mill Road.	44.693308°N 87.490239°W	1		0.0000 (N = 7)	-
	38	Kewaunee Co.: Algoma: Hwy 42 Olson Park at confluence of Silver Creek and Ahnapee River.	44.617789°N 87.444325°W	4			-

TABLE 1. Continued.

GMU	Locality No.	Locality Description	Coordinates	No. *lc*	Single locality analyses	Pooled analyses of remaining samples	*Bd*
Bad Axe-La Crosse	1	La Crosse Co.: West Salem: Veteran's Memorial Park ~100 m NW of bridge in park.	43.898639°N 91.115689°W	7	4.1983 (N = 7)		+
Lower Wisconsin	21	Juneau Co.: narrow trench along cranberry marsh perpendicular to Country Rd. H ~50 m SW from jct County Rd. H and Mulloney Road.	44.063664°N 90.291183°W	7		0.2401 (N = 8)	?
	22	Iowa Co.: Spring Green: Helena Unit Lower Wisconsin State Riverway off State Hwy 14 at S shore of Wisconsin River.	43.168492°N 90.040628°W	1			?
	23	Iowa Co.: wetland 0.15 mi NW jct of State Hwy 14 and County Rd. C.	43.162833°N 90.026442°W	6	0.0000 (N = 6)		-
Upper Fox	41	Marquette Co.: Westfield: On west shore of Westfield Pond 9, S side of County Rd. E bridge.	43.883081°N 89.495658°W	1		0.0000 (N = 4)	-
	42	Waushara Co.: Ice Age Trail Mecan Segment: Mecan River: ~0.1 mi NE from jct of 9th Ave. and State Hwy 21.	44.030117°N 89.444119°W	6	0.0000 (N = 3)		-
Manitowoc	24	Manitowoc Co.: Hartlaub Lake, ~125 m SE of jct Hartlaub Lake Rd. and Lakewood Lane.	44.047678°N 87.739278°W	7	0.0000 (N = 7)		-
Sheboygan	27	Sheboygan Co.: Kohler-Andrae State Park, Woodland Dunes Nature Trail.	43.652147°N 87.727619°W	1			-
	28	Sheboygan Co.: Elkhart Lake: Elkhart Lake Boat Ramp off County Rd. P.	43.830014°N 88.037453°W	3		0.0000 (N = 7)	-
	29	Sheboygan Co.: Elkhart Lake: Little Elkhart Lake Boat Ramp at end of Lauretta Ct., 100 m W of jct with Schwaller Drive.	43.806261°N 87.984175°W	3			-
Fox	7	Waukesha Co.: Waterville: Henrietta Lake off Waterville Rd. ~ 0.25 mi SW of jct Waterville Rd. and State Hwy 18 (= Sunset Dr.).	43.018578°N 88.442464°W	6		0.0000 (N = 7)	-
	8	Walworth Co.: Potter Lake just off County Hwy. L at ~0.25 mi SW of jct County Rd. L and Stone School Rd (near jct with Shorewood Dr.).	42.814069°N 88.341122°W	1			-
Milwaukee River	25	Ozaukee Co.: Saukville: permanent pond at 2644 Bach St. off Cedar Sauk Rd.	43.369039°N 87.996928°W	1		0.0138 (N = 7)	-
	26	Washington Co.: West Bend: Silver Lake: Henschke Hillside Lake Access 5607 Peter's Dr., 0.25 mi from jct Peter's Dr. and W Paradise Dr.	43.393217°N 88.213642°W	6			+
Grant-Platte	9	Grant Co.: Paris: Banfield Bridge Recreation Area off Indian Creek Road & W. Banfield Road, boat landing on west shore north of bridge.	42.630919°N 90.653014°W	0	NA		NA*[7]

TABLE 1. Continued.

GMU	Locality No.	Locality Description	Coordinates	No. *lc*	Single locality analyses	Pooled analyses of remaining samples	*Bd*
Sugar-Pecatonica	35	Lafeyette Co.: Belmont: Lake Joy: Lake Joy Campground 24192 Lake Joy Lane.	42.776214°N 90.296214°W	7	0.0000 (N = 7)		-
Lower Rock	20	Dane Co.: Madison: UW-Madison: shallow temporary pool midway between Walnut St. and Easterday La. and just N of Observatory Dr.	43.076906°N 89.423033°W	0	NA		NA*[7]
Upper Rock	43	Dodge Co.: Ixonia: Harnischfeger Park, W3048 Crawfish Rd.	43.210069°N 88.543700°W	1			-
	44	Washington Co.: Kettle Moraine State Forest Pike Lake Unit: Pike Lake: 0.75 mi S of State Hwy 60 on Kettle Moraine Rd.	43.309683°N 88.322783°W	2		0.0000 (N = 7)	-
	45	Washington Co.: Kettle Moraine State Forest Pike Lake Unit: Black Forest Nature Trail off Powder Hill Rd., 0.5 mi S State Hwy 60.	43.317328°N 88.309711°W	1			-
	46	Washington Co.: Druid Lake Boat Landing on N shore of Druid Lake off Clearwater Beach Rd.	43.281006°N 88.409072°W	3			-
Southeast	30	Racine Co.: Yogi Bear's Jellystone Camp Resort (near jct State Hwy 38 and 7 1/2 Mile Rd.): far NE corner @ Boo Boo's fishing pond & dock.	42.838219°N 87.908597°W	7	0.0000 (N = 7)		-

at 14 of 38 localities (37%) and *L. pipiens* tested negative at all nine (100%) localities where it occurred. Thus, these data indicate that no *L. pipiens* tested positive even in one case when they were sampled from a locality where *L. clamitans* did test positive. However, sample sizes for *L. pipiens* ranged from 1 to 7 individuals giving the probability of a Type II error (false negative) being from 0.78 to 0.35 (upper CI = 0.35 for samples of N = 7, and CI = 0.78 for N = 1; Brem et al. 2007).

The detection of *Bd* throughout much of Wisconsin is not surprising considering similar findings in other upper-Midwest states including Minnesota (Rodriguez et al. 2009; Woodhams et al. 2008), Iowa (Loda and Otis 2009; Steiner and Lehtinen 2008), Illinois (Steiner and Lehtinen 2008), and Michigan (Steiner and Lehtinen 2008; Zellmer et al. 2008; Zippel and Tabaka 2008). Likewise, the absence of any symptoms of chytridiomycosis in the presence of *Bd* is similar to results from previous studies (e.g., Oullet et al. 2005; Rodriguez et al. 2009; Woodhams et al. 2008). However, our results need to be interpreted cautiously because our sample sizes were small and our results potentially were biased by our seasonal sampling. All but one of the ten GMU's sampled in the fall 2009 tested positive for *Bd*, whereas only three of 14 GMU's tested in the summer 2010 tested positive, and, with a few minor exceptions, this seasonal sampling roughly corresponded to the north in fall 2009 and the south in summer 2010. This north-south, fall-summer sampling correspondence was an unintended flaw in our sampling design, and a more balanced sampling design is needed to address whether this was indeed a seasonal pattern in *Bd* detection, although such a seasonal pattern has been reported previously (Kinney et al. 2011; Oullet et al. 2005). Furthermore, our pooling of swabs, often from multiple localities within the same GMU, confounded any detection at finer spatial scales.

The apparent greater detection of *Bd* among *Lithobates clamitans* than among *L. pipiens* may simply be a result of false negatives from our small sample sizes. However, other factors cannot be eliminated. For example, it is possible that *L. pipiens* resists *Bd* zoospore attachment more than *L. clamitans*, although *Bd* has been detected on both previously (Loda and Otis 2009; Oullet et al. 2005; Woodhams et al. 2009). Also, *L. pipiens* calls and breeds early in the spring and thus tadpoles are more likely to metamorphose by the fall of that year and over-winter as juvenile frogs. In contrast, *L. clamitans* calls and breeds later during the summer months and their tadpoles are known to overwinter prior to metamorphosis. Thus, determining the time of the year when *Bd* is most infectious and the life cycle stages when these frog species are most vulnerable (e.g., Oullet et al. 2005), particularly in Wisconsin, could begin to help explain the results obtained herein, but clearly more work remains to further understand where *Bd* occurs and its effects in Wisconsin and elsewhere.

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Batrachochytrium dendrobatidis in Peru

The amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), has been well-studied in Australia, North and Central America, and Europe, but relatively little information is available concerning the status of this pathogen in South America. This is especially disturbing given that South America contains the highest diversity of amphibian species in the world (Vié et al. 2009).

In Peru, sampling for *Bd* has been especially sparse, with only six studies in localized regions conducted to date (Table 3). The first record of *Bd* in Peru came from several dead *Atelopus patazensis* collected in 1999 (Venegas et al. 2008). Although recent surveys have shown that this species continues to persist, it is currently listed as critically endangered by the IUCN due to the combined effects of *Bd* and water pollution (IUCN 2011). Reliable data are not available on the status of other *Atelopus* species in Peru, though many appear to be declining (Venegas et al. 2008; von May et al. 2008), a trend seen throughout the range of this genus (La Marca et al. 2005). Population surveys for *A. pulcher* in northern Peru have not detected any adults in localities where they were once abundant, and one of the last individuals seen was found dead and later tested *Bd*-positive (Lötters et al. 2005). Another study in northern Peru failed to detect *Bd* in 23 individuals tested using histopathological analysis (Enciso et al. 2008). In southern Peru, the first record of *Bd* came from 3 of 4 *Telmatobius marmoratus* collected in 2002 in the Cordillera Vilcanota (Seimon et al. 2005). A later study in this region reported a range expansion in *Bd* to the highest altitude yet recorded (5348 m), which Seimon et al. (2007) posit might be due to the recent deglaciation and subsequent host population expansion in the region. Additionally, it appears *Bd* might be contributing to declines in one of the two host species in this study (Seimon et al. 2007). Most recently, Catenazzi et al. (2011) discovered dramatic declines in montane amphibian species richness and abundance in southern Peru between surveys from 1999 and 2008–2009. They attributed these declines to chytridiomycosis rather than habitat loss because *Bd* is widespread in the region and declines occurred within the well-protected zone of Manu National Park (Catenazzi et al. 2011).

Recently, it has been shown that the global trade of amphibians is a major contributor to the worldwide dispersal of *Bd* (Farrer et al. 2011; Fisher and Garner 2007). In Peru, trade of amphibians is fairly common; especially in large cities such as Lima and Cusco where Andean frogs (predominantly *Telmatobius* and *Batrachophrynus* species) are frequently sold in restaurants and markets as a protein source or for their perceived medicinal properties (Angulo et al. 2008). Investigations have shown that many of these frogs are *Bd*-positive (Catenazzi et al. 2010), indicating

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TABLE 1. Summary of amphibian study sites in Peru sampled for *Batrachochytrium dendrobatidis* (*Bd*). Surveys were performed during the dry seasons (June–August) 2007 and (May–July) 2008.

Locality	Latitude	Longitude	Altitude (m)	N	*Bd* Positive	Prevalence
2007						
Ahuashiyacu	-6.4578	-76.30843	722	15	2	0.13
Allpahuayo Mishana	-3.75067	-73.28228	102	1	0	0.00
Bocatoma	-6.4585	-76.34968	426	43	0	0.00
Chacos Valley and Llamaquizú	-10.61583	-75.35056	1800-2100	4	1	0.25
Chazuta	-6.5692	-76.12622	235-355	42	0	0.00
Huallaga River	-6.58899	-75.91939	171-232	36	0	0.00
Iquitos Km 23	-3.9586	-73.375	149	37	0	0.00
Iquitos Km 71	-3.75067	-73.33228	122	15	0	0.00
Lamas	-6.38493	-76.51527	645	1	0	0.00
Nanay River	-3.68572	-73.2835	96	17	1	0.06
Pampa Hermosa	-10.9925	-75.43278	1200-1550	10	0	0.00
Pond near Tunnel	-6.43118	-76.30882	846	16	0	0.00
Pongo de Cainarachi	-6.29388	-76.23598	190-220	58	0	0.00
San Jose	-6.4194	-76.2901	470-589	58	0	0.00
Santa Rosa	-5.4406	-78.55473	1234-1270	11	1	0.09
Sapasoa	-6.89635	-76.82817	315-416	32	0	0.00
Sauce	-6.72453	-76.25318	622	5	0	0.00
Seco River	-8.59656	-76.08714	771	20	0	0.00
Tahuayo	-4.17703	-73.15365	115	26	0	0.00
2008						
Aguaytia	-9.05734	-75.66543	429	6	0	0.00
Chacos Valley and Llamaquizú	-10.61583	-75.35056	1800-2100	2	0	0.00
CICRA Station	-12.56861	-70.09917	250-270	83	1	0.01
Cueva de las Lechuzas	-9.32867	-76.02715	656	19	1	0.05
Huampal	-10.18825	-75.57519	968	6	0	0.00
Ivochote	-12.46317	-72.96740	471-481	32	0	0.00
Lake Milagros	-9.14174	-75.99635	671-691	17	0	0.00
Lake Yarinachocha	-8.32561	-74.59022	188	29	0	0.00
Manu Learning Center	-12.78926	-71.39175	463	51	2	0.04
Oxapampa	-10.54556	-75.35835	2355	12	0	0.00
Pilcopata	-12.90997	-71.42281	480-525	49	0	0.00
Pozuzo	-10.04908	-75.54059	692	10	0	0.00
Puente Maranura	-12.96498	-72.66568	1068	22	0	0.00
Puerto Bermudez	-10.27102	-74.93673	243-309	37	0	0.00
Puerto Inca	-9.36759	-75.00175	202-229	23	0	0.00
San Pedro Market, Cusco*	-13.52384	-71.97128	3363	2	1	0.50
Satipo	-11.27665	-74.64673	719	23	0	0.00
Shima Venzo	-11.11832	-74.22433	394-474	37	0	0.00
Tambopata Research Center	-13.13333	-69.60000	350	61	0	0.00
Wayqecha	-13.17956	-71.60561	2623-3240	15	1	0.07

*Specimen purchased from market

that they are likely contributing to spread of the disease throughout Peru as they are moved from capture sites to markets.

The aim of our investigation was to conduct a systematic survey of the current distribution of *Bd* in amphibian populations throughout Peru. Our main goal was to obtain a "snapshot" of the current distribution of the infection to aid in planning future research and management of the disease.

Field surveys of *Bd* prevalence were conducted during June–August of 2007 and May–July of 2008, coinciding with the dry season. We surveyed 39 sites along the eastern slopes of the Andes, providing a collection of samples along both latitudinal (3.68572°S, 73.28350°W to 13.17956°S, 71.60561°W) and altitudinal gradients (90–3240 m; Fig. 1). Coordinates of each locality were determined using a portable GPS unit (Garmin *E*trex Vista). Sites were surveyed using the visual encounter technique (Lips et al. 2001). For each site, two surveyors performed a time-constrained survey for 4 h. The primary goal of each survey was to capture as many individuals and species as possible. During each survey, all amphibians encountered were captured by hand and a new plastic bag was used each time to eliminate the possibility of cross contamination between individuals. For ease of species identification, only post-metamorphic individuals were sampled. After capture, all specimens were kept in individual plastic bags and stored in a cool place until each transect was completed. Appropriate measures were taken to prevent cross-contamination between sites (i.e., disinfection of equipment and footwear between sites, clean clothing, etc.).

During processing, a new pair of latex gloves was worn for each individual, and all equipment was disinfected between animals. Processing consisted of: species identification, clinical examination for abnormalities (i.e., retained shed skin, reddening of skin) and collection of digital photographs of the dorsum

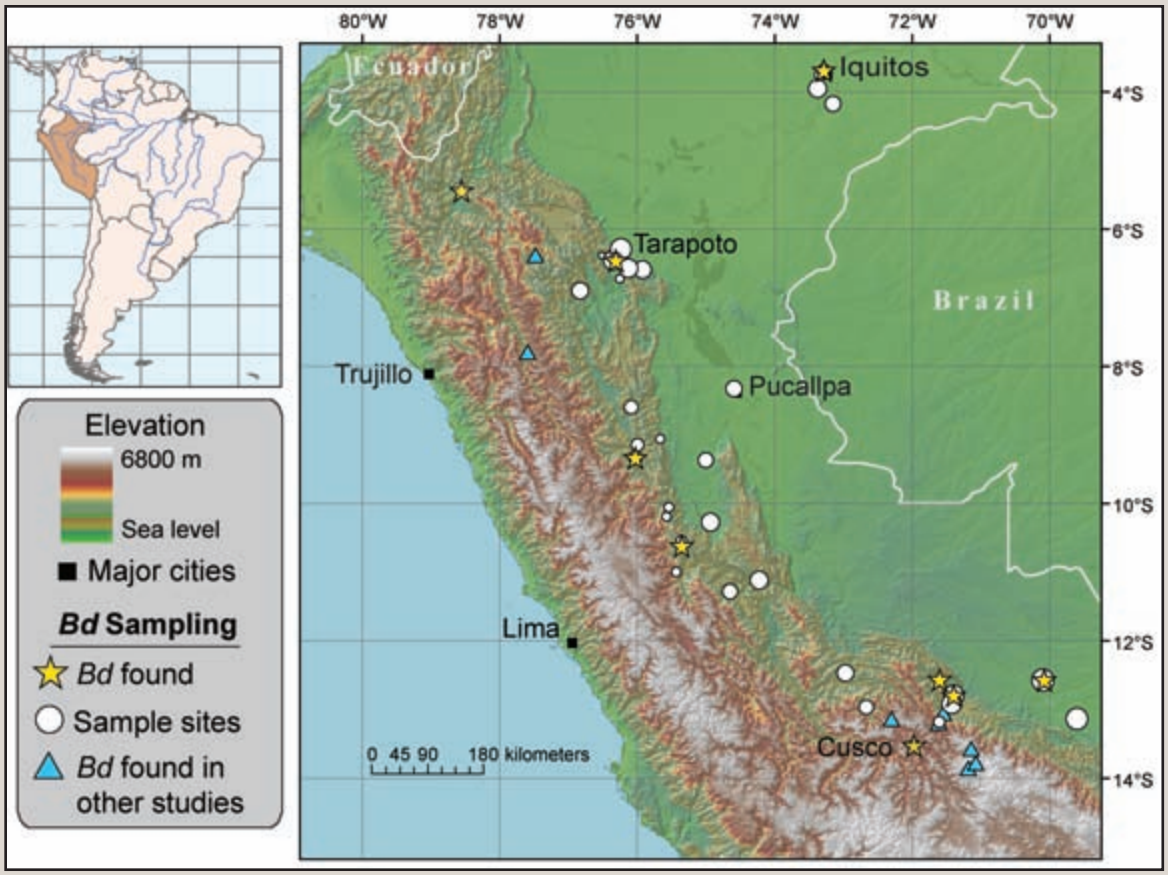

FIG. 1. Study sites in Peru sampled for *Batrachochytrium dendrobatidis (Bd)*. Circles = sample sites with circle diameter proportional to number of samples; stars = sites where *Bd* was detected, and triangles = *Bd*-positive sites reported by others (see Table 3).

and venter. The epidermis was swabbed using a dry sterile swab (Medical Wire and Equipment). Swabbing consisted of: running the swab 10 times over the dorsum, sides, venter, undersides of each thigh, and 5 times on the underside of each foot; for a total of 80 swab runs/animal (Kriger et al. 2006). After processing, all specimens were released within 2 m of their capture site (with the exception of the frogs purchased at the San Pedro Market which were euthanized after processing). Swabs were preserved at room temperature in individually labeled vials containing 95% ethanol.

DNA extractions for swabs were performed in the winter of 2008. The samples from 2007 were extracted in 2008 due to a delay in obtaining permits. During this time these samples were stored at the Museum of Natural History in Lima at room temperature. Upon arrival in the US, all samples were immediately placed at 5°C until DNA extraction. DNA extraction was performed using the PrepMan Ultra Sample Preparation Reagent (ABI), following methods outlined in Boyle et al. (2004). Samples were then analyzed using a highly sensitive endpoint PCR *Bd* assay (minimum sensitivity of 1 zoospore /ml) developed in our laboratory (unpublished), which uses *Bd*-specific primers developed by Annis et al. (2004; Bd1a: 5'-CAGTGTGCCATATGTCACG-3', Bd2a: 5'-CATGGTTCATATCTGTCCAG-3'). The reaction recipe was: 1.25 µl of DNA Gold Buffer (10x, ABI), 1.0 µl of $MgCl_2$ (16.7 µM), 2.4 µl of GeneAmp dNTP mix with dTTP (1000 µM, ABI), 0.5 µl of forward and reverse primers (5 µM, Invitrogen), 0.06 µl of AmpliTaq Gold with GeneAmp (5 units/µl, ABI), 4.29 µl of DNA grade water (Fisher Scientific), 2.0 µl of sample for a total reaction volume of 12 µl. Reactions were loaded into a 96-well plate and placed in the PTC-200 Thermal Cycler (Peltier). Initially all samples were run in duplicate (i.e., two separate PCR's/ sample/ plate) along with positive (previously amplified *Bd* DNA from culture) and negative controls (PCR master mix and H_20). Inhibition controls were not used. The thermal cycler program we utilized was: 1) 5 min at 95°C, 2) 45 sec at 93°C, 3) 45 sec at 60 °C, 4) 1 min at 72°C, 5) repeat steps #2–4, 44 more times, and 6) 10 min at 72°C. After thermal cycling, 8 µl resulting product was mixed with 1 µL of loading dye (6X; Apex) and loaded into a gel (8 ml of 1x TBE Buffer, 1.2 g of agarose; Apex). Additionally, one well per row was loaded with 100 bp DNA ladder (Promega), so that the size of the PCR amplicons could be estimated. Gels were then immersed in 1x TBE Buffer and run at 120 volts approximately 40 min, after which gels are examined and photographed using a UV viewing apparatus. The number of true positives and false negatives were determined by scoring the presence/absence of 300 bp bands on electrophoresis gels. For ambiguous samples, further PCR analyses were conducted. The data for each locality were summarized in terms of prevalence of infection (total number of infected individuals/total number of individuals sampled).

Over a two-year period, a total of 983 amphibian skin swabs were collected from 39 sites throughout Peru. We collected samples from 36 genera of amphibians belonging to 14 families (Table 2; Fig. 2). The results of our PCR assay showed that 11 of 983 individuals sampled were positive for *Bd* (overall prevalence = 1.0%; Table 1). *Bd* was detected in amphibians at 9 of 39 sites across a broad range of altitudes (96–3240 m; Fig. 1). Among-site

TABLE 2. Summary of study amphibian taxa tested for *Batrachochytrium dendrobatidis* (*Bd*) in Peru.

Family	N	*Bd* Positive	Prevalence	*Bd*-positive species
Aromobatidae	8	1	0.13	*Allobates marchesiansus*
Bufonidae	166	0	0.00	
Caeciliidae	1	0	0.00	
Centrolenidae	4	0	0.00	
Ceratophryidae	3	1	0.33	*Telmatobius cf. marmoratus**
Dendrobatidae	242	1	0.01	*Hyloxalus shuar*
Hemiphractidae	16	1	0.06	*Gastrotheca excubitor*
Hylidae	212	4	0.02	*Osteocephalus buckleyi, Hyloscirtus cf. phyllognatus, Scinax garbei, Hypsiboas melanopleura*
Leiuperidae	12	1	0.08	*Engystomops petersi*
Leptodactylidae	139	2	0.01	*Leptodactylus cf. andreae, Leptodactylus petersii*
Microhylidae	21	0	0.00	
Plethodontidae	4	0	0.00	
Ranidae	1	0	0.00	
Strabomantidae	154	0	0.00	

*Specimen purchased from market

FIG. 2. Three species that tested positive for *Batrachochytrium dendrobatidis* (*Bd*) in this study in Peru: A) *Hyloscirtus cf. phyllognatus*, B) *Telmatobius cf. marmoratus*, and C) *Gastrotheca excubitor*.

prevalence ranged from 0 to 25% (Table 1; only results from natural populations were used in this analysis, therefore results from San Pedro market were excluded). *Bd* was detected in 11 species of anurans from 7 families (Table 2).

The majority of *Bd*-positive individuals had reproductive modes associated with permanent bodies of water (6/11; *Allobates marchesiansus, Hypsiboas melanopleura, Hyloscirtus cf. phyllognatus, Hyloxalus shuar, Osteocephalus buckleyi, Telmatobius cf. marmoratus*) and/or had an aquatic tadpole stage (9/11; *A. marchesiansus, Engystomops petersi, Hypsiboas melanopleura, Hyloscirtus cf. phyllognatus, Hyloxalus shuar, Leptodactylus petersii, O. buckleyi, Scinax garbei, T. cf. marmoratus*). Five of the 11 *Bd*-positive individuals are known to utilize streams for reproduction *(Allobates marchesiansus, Hyloscirtus cf. phyllognatus, Hyloxalus shuar, O. buckleyi, T. cf. marmoratus)*. The family with the highest number of infected individuals was Hylidae with 4 infected individuals (Table 2). *Bd* was not detected in any of the *Atelopus* that we sampled (3 *A. pulcher*, 20 *A. cf. andinus*). One of the *Bd*-positive samples came from two *Telmatobius marmoratus* purchased at San Pedro Market in central Cusco (of unknown origin) where they were being sold for human consumption. Obvious clinical abnormalities consistent with possible signs of the disease chytridiomycosis were only detected in 3 of 983 individuals (all *Gastrotheca excubitor*), which had retained shed skin on their toe pads. One of these 3 individuals tested positive for *Bd* with the PCR assay.

The results of this and previous studies indicate that *Bd* is widespread throughout Peru, and from our limited data it appears that *Bd* presence may not be as tightly linked with altitude as suggested by others (Fig. 1; e.g., Bielby et al. 2008; Brem and Lips 2008; Lips et al. 2008). This adds to the growing body evidence (e.g., Kriger and Hero 2008; Walker et al. 2010) that altitude may not have as strong an influence on disease prevalence as originally believed. In this study, the majority of *Bd*-positive individuals had reproductive modes associated with permanent bodies of water and/or an aquatic tadpole stage, characteristics that are have been shown to be associated with high transmission and prevalence of chytridiomycosis (Kriger and Hero 2007; Lips et al. 2003). Of these species, five are known to utilize streams for reproduction, a characteristic associated with susceptibility and declines in other regions (Catenazzi et al. 2011; Kriger and Hero 2007; Lips et al. 2003). There was a greater frequency of *Bd*-positive individuals in the family Hylidae. Other researchers have reported a higher frequency of chytridiomycosis in this family (e.g., Stuart et al. 2004), which may be linked to reproductive mode (Lips et al. 2003) and/or evolutionary history (Corey and Waite 2008). Contrary to our expectations, we did not detect *Bd* in any of the *Atelopus* that we sampled. Although this is the first time that a population of *A. cf. andinus* has been sampled for *Bd*, this disease has been previously detected in other Peruvian *Atelopus* (*A. pulcher*; Lötters et al. 2005; *A. patazensis:* Venegas et al. 2008). Our data showing *Bd* in 1 of 2 *Telmatobius marmoratus* tested from the San Pedro market further supports the idea suggested by Catenazzi et al. (2010), that the trade of amphibians in Peru is contributing to the dispersal of *Bd* throughout the country.

The *Bd* prevalence we found among sites was lower than we expected, especially in mid-elevation regions where previous studies in other countries have reported high frequencies of infection (e.g., Sánchez et al. 2008). Other studies in Peru have reported among-site prevalence ranging from 0 to 100% (Table 3). In fact, Catenazzi et al. (2011) reported *Bd* prevalence as high 64–100% (in *T. marmoratus*) from some of the same sites that we visited in the department of Cusco. There are several possible reasons for this. First, our surveys were conducted in the dry season when climatic conditions may be less conducive to disease transmission and progression (but see Burrowes et al. 2004). Second, our within-site sample sizes may not have been large enough to detect the disease (mean sample size = 26 individuals; 95% CI = 0 to 55). Statistical modeling has shown that at least 30

TABLE 3. Studies of *Batrachochytrium dendrobatidis* (*Bd*) in Peru conducted to date.

Locality	Department	Study Year(s)	Altitude (m)	N	Prevalence	Citation
Provincia de Pataz	Piura	1999	2620	3	0.67	Venegas et al. 2008
Sibinacocha watershed	Cusco	2002	4450	4	0.75	Seimon et al. 2005
Sibinacocha watershed	Cusco	2003	4422–5244	24	0.21	Seimon et al. 2007
Cainarachi valley	San Martín	2003	600	1	1.00	Lötters et al. 2005
Sibinacocha watershed	Cusco	2005	5348	2	0.50	Seimon et al. 2007
Abra Huallahualla	Cusco	2008	3100–4550	65	0.26	Catenazzi et al. 2011
Abra Malaga	Cusco	2008	3300–4050	8	0.13	Catenazzi et al. 2011
Kosnipata Valley	Cusco	2007, 2008	1250–3700	1097	0.12	Catenazzi et al. 2011
Privada Huiquilla	Amazonas	2007, 2008	2800	23	0.00	Encisco et al. 2008

individuals need to be swabbed per locality in order to detect at least one positive individual at a site if the disease prevalence is 10% (Cannon and Roe 1982). As it was not always possible for us to collect 30 individuals per locality due to time limitations, this may explain the lower frequencies we observed. Lastly, although we know that the *Bd* assay that we used is equally sensitive to *Bd* detection techniques published by others (e.g., Hyatt et al. 2007; unpubl. data, laboratory comparisons of *Bd* assay performed by T. Kosch), another possibility for our lower number of *Bd* detections may be due to the presence of PCR inhibitors which were not accounted for in our assay and have been known to contribute to incorrect reporting of false negatives (Garland et al. 2009).

Another interesting observation from this investigation is that only 3 of 983 individuals had any obvious clinical abnormalities consistent with the disease chytridiomycosis, and we did not observe any die-offs or moribund individuals. This is may be because chytridiomycosis is difficult to detect by clinical examination (Green et al. 2002; Kriger et al. 2006), but may also indicate that the infection is not progressing to an advanced state, possibly due to host immunity or low virulence (especially if *Bd* has been present in Peru for long enough for adaptation to occur). Unfortunately, we are unable to distinguish between these possibilities with our limited data.

Although the results of this and previous studies demonstrate that *Bd* is widespread in South America (e.g., Brazil: Carnaval et al. 2006; Venezuela: Sánchez et al. 2008; Argentina: Barrionuevo and Ponssa 2008), the consequences of this disease are still relatively unknown due to the near complete absence of general population monitoring and *Bd* studies in these countries. In Peru, significant declines have been reported in multiple high-elevation species in southern Peru (Catenazzi et al. 2011), and several *Atelopus* and *Telmatobius* species are believed to already be extinct (Venegas et al. 2008; von May et al. 2008). Peru contains some of the highest amphibian diversity on record and the loss of this diversity could have severe consequences. This makes the lack of knowledge on *Bd* and population status of Peru's amphibians especially alarming.

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Further Presence of Ranavirus Infection in Amphibian Populations of Tennessee, USA

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An estimated 43% of amphibian species across the globe are in decline (Stuart et al. 2004). These declines have been attributed to various diseases and anthropogenic impacts such as habitat destruction (Daszak et al. 1999; Price et al. 2006). Of particular interest to this study are ranaviruses, which are known to be a causal factor in amphibian die-offs worldwide (Cunningham et al. 1996; Fox et al. 2006; Green et al. 2002). Gray et al. (2009a) suggested that ranaviruses can have detrimental effects on localized populations, potentially leading to species declines.

In the eastern United States, ranavirus infections have been documented in 33 amphibian species (Miller et al. 2011). In Tennessee, ranavirus has been found in plethodontid salamanders in the Southern Appalachian Mountains (Gray et al. 2009b) and in various species of anurans in farm ponds (Gray et al. 2007; Hoverman et al. 2011a). To date, ranavirus infection in amphibians has not been reported in western Tennessee. Our objective

TABLE 1. Prevalence and 95% confidence intervals of ranavirus infection in larval amphibians inhabiting four ponds located at the Milan Army Ammunition Plant, Milan, Tennessee, USA, April 2010. Pond coordinates are withheld as these locations are on U.S. Department of Defense property.

	Pond Prevalence and 95% Confidence Interval			
Species	Pond NC1	Pond NC3	Pond NC6	Pond NC9
Ambystoma maculatum		0.33 0.06–0.79	1.0 0.21–1.0	0.5 0.33–0.67
A. opacum		0 0–0.66		
A. talpoideum		0.1 0.02–0.40		
Hyla chrysoscelis / *H. versicolor* complex		0.06 0.01–0.26	0.04 0.01–0.18	0.43 0.16–0.75
Lithobates clamitans			0 0–0.43	
L. sphenocephalus	0.18 0.08–0.34			

was to test for the occurrence of ranavirus in larval amphibian populations at one site in western Tennessee.

We conducted our study at the Milan Army Ammunition Plant (MLAAP) in Milan, Tennessee, USA (35.911977°N, 88.702903°W). The MLAAP was established in 1941 with over 9124 hectares in Carroll and Gibson counties (Brew and Markol 2001). Although herpetological research has been conducted at the MLAAP, none has focused on amphibian pathogens.

We opportunistically captured amphibian larvae from four fishless ponds on the MLAAP during April 2010 using dip nets. Upon capture, larvae were rinsed with aged tap water, placed in separate containers, and transported to Austin Peay State University (APSU). In total, we captured 136 larvae of the following species: *Ambystoma maculatum* (N = 32), *A. opacum* (N = 2), *A. talpoideum* (N = 10), *Hyla chrysoscelis/H. versicolor* complex (N = 53), *Lithobates clamitans* (N = 5), and *L. sphenocephalus* (N = 34). Before moving between ponds, all field personnel disinfected boots, waders, and field collection equipment with a 5% sodium hypochlorite (bleach) solution (Bryan et al. 2009). At APSU, amphibian larvae were euthanized by complete immersion in 80% ethanol after sedation in a 5% ethanol bath. Approximately 50% of the liver was collected for ranavirus testing. The liver is a known site of ranavirus infection in North American amphibians (St-Amour and Lesbarrères 2007), and commonly used in surveillance studies (e.g., Hoverman et al. 2011a). Sterilized instruments and different gloves were used between each animal to prevent cross contamination.

We isolated genomic DNA using standard phenol-chloroform techniques. Liver samples were initially incubated in 100 µl of 1 mg/ml collagenase (Sigma-Aldrich Chemical Company, St. Louis, Missouri, USA) in phosphate buffered saline for 4 hours at 37°C followed by an additional incubation using 100 µl of proteinase K for 16 hours at 37°C. After incubation, the digested tissue samples were triturated to disrupt cellular matrixes, and an equal volume of a 1:1 ratio of phenol:chloroform was added. The sample was vortexed thoroughly for 10 seconds and set at room temperature for approximately 5 minutes. The sample was then centrifuged at 10,000 x g for 5 minutes, and the top aqueous layer was moved to a new tube. Approximately 5 volumes of 100% ethanol and 100 µl of 3 M sodium acetate were added to the sample for DNA precipitation. Samples were placed in a -80°C for at least 15 minutes then centrifuged at 10,000 x g for 10 minutes. The resulting DNA pellet was washed once in 80% ethanol and subsequently centrifuged at 10,000 x g for 5 minutes. The DNA pellet was vacuum-dried, resuspended in 20 µl of molecular grade water, and stored frozen for future ranavirus testing.

We tested for the presence of *Ranavirus* DNA in duplicate for each sample using polymerase chain reaction (PCR) with primers specific for the major capsid protein of the virus (Mao et al. 1997). We used the PCR primers for *frog virus 3* (FV3) published in Mao et al. (1997), which is the type species of *Ranavirus*. These primers have been shown to be reliable for detecting FV3-like ranaviruses in Tennessee amphibians (Gray et al. 2007). The PCR amplified products were visualized on a 0.84% agarose electrophoresis gel, which was stained with ethidium bromide. DNA sequence analysis of PCR samples amplified using the aforementioned primers revealed a greater than 98% DNA sequence identity to NCBI's genomic database for the FV3 major capsid protein gene with an accession number of JQ771299. The PCR amplified products were purified using a Promega Wizard PCR clean-up kit and sent to Vanderbilt University for genomic sequencing.

The major capsid protein of *Ranavirus* was detected in 29 specimens, including a first detection in a wild population for *A. talpoideum*. Percent positives ranged from 0–43% (Table 1), with the highest percentage of infection in *Hyla chrysoscelis/versicolor* complex. Infection was not detected in *A. opacum* and *L. clamitans*.

We detected FV3-like ranaviruses in four amphibian species, with a first species detection in *A. talpoideum* (Miller et al. 2011). Interestingly, Hoverman et al. (2011b) were unable to cause infection in this species when challenged in the laboratory with two strains of FV3-like ranaviruses. One of the highest percent infections was in *A. maculatum*, which are frequently associated with ranavirus die-offs in eastern North America (Brunner et al.

2011; Gahl and Calhoun 2010; Green et al. 2002; Petranka et al. 2003; Todd-Thompson 2010). In the laboratory, Hoverman et al. (2011b) reported that *A. maculatum* larvae had relatively low susceptibility to ranaviral disease. We also documented infection in larval *H. chrysoscelis/H. versicolor* complex and *L. sphenocephalus*, which has been reported previously (Miller et al. 2011). Our findings support previous surveillance and laboratory studies demonstrating that ranaviruses can infect multiple species in an amphibian community (Brunner et al. 2011; Duffus et al. 2008; Hoverman et al. 2010; Schock et al. 2008). Given that ranaviruses are common pathogens in North America that can result in disease emergence in amphibian, reptile, and fish populations (Gray et al. 2009a), state and federal natural resource agencies should consider establishing ranavirus surveillance programs.

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GEOGRAPHIC DISTRIBUTION

CAUDATA — SALAMANDERS

***AMBYSTOMA BARBOURI* (Streamside Salamander).** USA: OHIO: Lawrence Co.: Hamilton Township (38.57403°N 82.77565°W, WGS84). 21 February 2011. Jeffrey V. Ginger. Verified by Herman Mays (based on DNA analysis). Cincinnati Museum Center (CMC 12206). New county record (Pfingsten and Matson 2003. Ohio Salamander Atlas. Ohio Biological Survey Misc. Contribution No. 9, Columbus).

The breeding site was a flooded ditch used as a breeding pool on Back Road. Collected from a ditch that was being used as a breeding pool instead of a first or second order stream, the typical habitat for the species (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.).

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***AMBYSTOMA MACULATUM* (Spotted Salamander).** USA: GEORGIA: Hall Co.: Elachee Nature Center (34.245842°N, 83.832004°W; WGS 84). November 2011. Daniel Thompson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50154 photo voucher); New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp).

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***AMBYSTOMA OPACUM* (Marbled Salamander).** USA: INDIANA: Fountain Co.: Portland Arch Nature Preserve (40.219310°N, 87.337699°W; WGS 84). 05 May 2007. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50137 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***CHIROPTEROTRITON CHONDROSTEGA* (Gristle-headed Salamander).** MÉXICO: MÉXICO: Municipality of Santiago Tianguistenco: Ahuatenco (19.127083°N, 99.464389°W; NAD 27), 2605 m elev. 13 August 2011. Eduardo Mendoza-Almazan and Abraham Jardón-Perea. Colección de Vertebrados (Anfibios y Reptiles), Universidad Autónoma del Estado de México (CAREM-0000225). Verified by Aleida Cruz. First record for the State of Mexico (Smith and Taylor 1948. U.S. Nat. Mus. Bull. 194:i–iv, 1–118) and a 175 km SE (airline) range extension from the closest known locality, Los Reyes, Acaxochitlán, Hidalgo (fig. 1. in Ramírez-Bautista et al. (2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Univ. Autó. Estado de Hidalgo, CONABIO, Lito Impresos Bernal, S. A., Pachuca, Hidalgo, México. x + 104 pp.). The salamander was found in pine-oak forest.

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***EURYCEA CHAMBERLAINI* (Chamberlain's Dwarf Salamander).** USA: ALABAMA: Covington Co.: Conecuh National Forest; Mossy Pond (31.13922°N 86.60119°W; WGS 84). 05 June 2011. C. Thawley and S. Graham. Verified by Craig Guyer. AUM 39521. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn, 347 pp.). Specimens of *Eurycea quadridigitata* reported from this county previously (Mount 1975, *op. cit.*) were collected before the description of *E. chamberlaini* and may instead be attributable to this taxon. However, populations of *E. quadridigitata* (sensu stricto) are found ca. 100 km to the E of this site in Houston Co., Alabama (Graham et al. 2008. Herpetol. Rev. 39:476), and populations of a possible undescribed dwarf salamander species (e.g., Jensen et al. 2008. The Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.) are also present within Conecuh National Forest in Covington and Escambia counties, Alabama (Graham et al. 2008, *op. cit.*). AUM 39521 is morphologically consistent with *E. chamberlaini*, suggesting that all three species may occur in close proximity and/or sympatrically in southern Alabama.

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***EURYCEA CIRRIGERA* (Southern Two-lined Salamander).** USA: INDIANA: Carroll Co.: Lake Freeman (40.709353°N, 86.754642°W; WGS 84). 25 May 2008. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50152 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***EURYCEA GUTTOLINEATA* (Three-lined Salamander).** USA: GEORGIA: Franklin Co.: Victoria Bryant State Park (34.297397°N, 83.159190°W; WGS 84). 24 September 2012. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50161 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***NECTURUS BEYERI* (Gulf Coast Waterdog).** USA: TEXAS: San Jacinto Co.: ca. 9 air km W of Shepherd, in Big Creek 2.8 km S of SH 150 on 217 (30.506447°N, 95.088408°W; WGS 84). 27 December 2009. John T. Williams, Brandon C. Bowers, Scott A. Wahlberg, Matthijs Hollanders. Verified by Toby J. Hibbitts. Texas Cooperative Wildlife Collections, TCWC 94289–24290. New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. University of Texas A&M Press, College Station. viii + 421 pp.).

Liberty Co.: in Menard Creek ca. 1 km N of FM 787 on County Road 2650 (30.455858°N, 94.738247°W; WGS 84). 11 December 2010. Brandon C. Bowers, John T. Williams, Scott A. Wahlberg, Matthijs Hollanders. Verified by Toby J. Hibbitts. TCWC 95131–95132. New county record (Dixon 2000, *op. cit.*). Menard Creek also flows through Hardin Co., where *N. beyeri* has been vouchered.

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***NECTURUS MACULOSUS* (Mudpuppy).** USA: TENNESSEE: Wayne Co.: Fortyeight Creek, 107 m upstream from US Highway 64, just above the Old Highway 64 Bridge. Accessed from Fortyeight Creek Rd. (35.341944°N, 87.660556°W, NAD 27). 4 April 2011. Michael C. Fulbright and Matthew D. Wagner. Austin Peay State University Museum of Zoology, APSU 19120. Verified by A. Floyd Scott. One adult caught via electrofishing. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. [Hard copy and Internet versions, the latter of which includes links to information on Tennessee amphibians having appeared since 1996, http://www.apsu.edu/amatlas/, accessed 28 September 2011]).

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***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt).** USA: ILLINOIS: Kane Co.: Bliss Woods Forest Preserve (41.788133°N, 88.4388°W; WGS 84; elev. 219 m). 1 April 2010. K. Huschart and C. Milne-Zelman. Verified by Chris Phillips. Illinois Natural History Museum (INHS 21683). New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Natural History Survey Manual. 285 pp.). Scientific Research Permit issued to C. Milne-Zelman by Forest Preserve District of Kane County.

We thank Tom Anton and William Graser for field assistance.

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ANURA — FROGS

***ACRIS CREPITANS* (Northern Cricket Frog)** USA: ALABAMA: Crenshaw Co.: Blue Creek, N of Crenshaw County Rd. 30, 500 m W of Petrey (31.84672°N W 86.21233°W; WGS 84). 29 May 2011. S. Graham. Verified by John Jensen. AUM AHAP-D 307 (digital audio file). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 347 pp.). Chorus of males recorded calling in swamp.

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***ANAXYRUS AMERICANUS* (American Toad).** USA: INDIANA: Carroll Co.: Lake Freeman (40.709353°N, 86.754642°W; WGS 84). 14 April 2008. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50151 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***ANAXYRUS AMERICANUS* (American Toad).** USA: TENNESSEE: Jefferson Co.: ~13 km W of Jefferson City (36.08435°N, 83.62905°W; WGS 84). 14 May 2009. Ted M. Faust and Mark Mayfield. Verified by Floyd A. Scott. Austin Peay State University Museum of Zoology (APSU 19083 [color photo]). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 31 December 2011] including links to data on amphibians in Tennessee that have appeared since 1996). An individual was found crossing Beaver Creek Road at 2240 h during a downpour.

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***ANAXYRUS FOWLERI* (Fowler's Toad).** USA: INDIANA: Boone Co.: Starkey Park (39.951389°N, 86.322500°W; WGS 84). 14 June 2010. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50148 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***CERATOPHRYS JOAZEIRENSIS* (Caatinga Horned Frog).** BRAZIL: RIO GRANDE DO NORTE: Municipality of Santa Maria: 5.854°S, 35.701°W (datum WGS84, 137 m elev.). 10 April 2010. J. S. Jorge. Coleção Herpetológica da Universidade Federal do Rio Grande do Norte, Natal Rio Grande do Norte, Brazil (CHBEZ 3633, female 7.55 cm SVL; and 3776, male 9.35 cm SVL). Verified by U. Caramaschi. This species was previously known for the states of Bahia, municipality of Juazeiro (type locality; Mercadal 1986. Amphibia-Reptilia 7[4]:313–334), Paraíba and Rio Grande do Norte (Vieira et al. 2006. Check List 2[2]:28–29), and Pernambuco (Moura et al. 2011. *In* Moura [org.], Herpetologia no Estado de Pernambuco, pp. 51–85. Ministerio do Meio Ambiente, Brasilia). Second record for the state of Rio Grande do Norte, extending the distribution of the species ca. 110 km NW from municipality of Passa e Fica, Rio Grande do Norte state, Brazil (Vieira et al., *op. cit.*). This is the first record for the Agreste region, a transitional area between the Caatinga and Atlantic rainforest ecosystems.

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***CRAUGASTOR OCCIDENTALIS* (Taylor's Barking Frog)**. MÉXICO: ZACATECAS: Municipality of Juchipila: Sierra Morones, 7.74 km WSW of Juchipila (21.39961°N, 103.18785°W; WGS84), 1847 m elev. 13 September 2009. Zaira Yaneth González-Saucedo, Rubén Alonso Carbajal-Márquez, José Carlos Arenas-Monroy, and José Jesús Sigala-Rodríguez. Verified by Lee Grismer. LSUHCDPC 6125 photo voucher. First municipality record, second record for Zacatecas, extending the known distributional range of the species ca. 49 km (airline) ESE from the type locality, La Hacienda, Municipality of Florencia de Benito Juárez, Zacatecas (Taylor 1941. Proc. Biol. Soc. Washington 54:87–94). The frog was found on ground leaf litter in the ecotone between tropical deciduous forest and oak forest.

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***ELEUTHERODACTYLUS CYSTIGNATHOIDES* (Rio Grande Chirping Frog)**. MÉXICO: HIDALGO: Municipality of Tecozautla: 1.62 km E La Paila (20.56925°N, 99.5843333°W; WGS84), 1724 m. elev. 31 May 2009. Víctor Vite Silva. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB-UAEH 2109). First municipality record, extending the range in the state ca. 31.76 km E from its closest reported locality at Arbolado, Municipality of Tasquillo on a nut farm (Morales 2010. Herpetofauna de Dos Ambientes Contrastantes del Municipio de Tasquillo. Tesis, Universidad Autónoma del Estado de Hidalgo. Mineral de la Reforma. 84 pp.). It is also the first record in Hidalgo from xerophytic scrub vegetation, as the species has previously been reported only from cloud forest (Canseco-Márquez et al. 2004. *In* Luna et al. [eds.], Biodiversidad de la Sierra Madre Oriental, pp. 417–437. Las Prensas de Ciencias, México, D.F.).

Fieldwork was funded by CONACyT- 95828 and CONABIO GT002.

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***ELEUTHERODACTYLUS NITIDUS* (Shiny Peeping Frog)**. MÉXICO: HIDALGO: Municipality of Tecozautla: 1.31 km E La Paila (20.56652778°N, 99.61519444°W; WGS84), 1665 m. elev. 29 May 2009. Adriana López Mejía. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB-UAEH 2116). First municipality record, extending the range in the state ca. 98.34 km SW from its closest reported locality in Acayuca, Municipality of Molango (Ramírez-Bautista et al. 2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Universidad Autónoma del Estado de Hidalgo, CONABIO. x + 104 pp.) The frog was found in xerophytic scrub, but the only previous record of this species in Hidalgo was in cloud forest (Ramírez-Bautista et al. 2010, *op. cit.*) Fieldwork was funded by CONACyT- 95828 and CONABIO GT002.

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***ELEUTHERODACTYLUS PLANIROSTRIS* (Greenhouse Frog)**. USA: FLORIDA: Desoto Co.: Arcadia, Dee Oaks Nursery, 150 m S of Owens School Rd. and 250 m W of County Rd. 661 (27.17896°N, 81.93542°W; WGS84). 19 July 2010. C. Thawley. UAHC 16425. Verified by Leslie J. Rissler. New county records (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final Report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). This introduced species has now been reported from approximately two-thirds of counties from peninsular Florida, suggesting that it is likely distributed across the entire peninsula.

Thanks to Walter E. Meshaka, Jr. for assistance and review of localities.

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***FEJERVARYA NEPALENSIS* (Nepal Cricket Frog)**. INDIA: UTTARAKHAND: Haridwar, Jhilmil Jheel Conservation Area (29.80556°N, 78.2277°E, WGS 84; 245.97 m elev.; 29.8722°N, 78.1882°E; WGS 84; 273.40 m elev.). J. P. Sati. 10 March 2011 (ZSI NRC 861). HARYANA: Yamuna Nagar, Kalesar National Park & Wildlife Sanctuary (30.3467°N, 77.5167°E; WGS 84; 332.237 m elev.) S. J. S. Hattar. 15 July 2007 (ZSI NRC 775). All verified by Karan Shah. First records for Uttarakhand and Haryana states. Previously known from Arunachal Pradesh, Assam, and Nagaland (Ao et al. 2003. Zoo Print J. 18:1117–1125; Mathew and Sen 2010. Pictorial Guide to Amphibians of North East India. Zoological Survey of India, Kolkata. xii + 144 pp.); and central and eastern midlands of Nepal (Anders 2002. *In* Schleich and Kästle [eds.], Amphibians & Reptiles of Nepal. Biology, Systematics, Field Guide, pp. 133–348. ARG Gantner Verlag K.G., Ruggell).

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***HOPLOBATRACHUS CRASSUS* (Jerdon's Bullfrog)**. BANGLADESH: NILPHAMARI DISTRICT: Koya Golahut, Saidpur (25.801969°N, 88.900531°E; WGS 84; 41.15 m elev.). 27 August 2011. Md. Abdur Razzaque Sarker. Verified by Ghazi S. M. Asmat. Museum of Herpetology Laboratory, Ichamati College, Dinajpur, Bangladesh (MHLB-HC01). First record from Nilphamari District, northern Bangladesh; previously recorded from Chittagong (Asmat et al. 2003. Univ. Rajshahi J. Zool. 22:141–143). Near Saidpur Bypass Road > 2 km N from Saidpur and > 17 km S from Nilphamari. Adults collected beside paddy field. Habitat includes *Cynodon dactylon* and *Bambusa arundinacea* plantations.

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***HYLA AVIVOCA* (Bird-voiced Treefrog)** USA: ALABAMA: Crenshaw Co.: Blue Creek, N of Crenshaw County Rd. 30, 500 m W of Petrey (31.84672°N W 86.21233°W; WGS 84). 29 May 2011. S. Graham. Verified by John Jensen. AUM AHAP-D 308 (digital audio file). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 347 pp.). Chorus of males recorded calling in swamp

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***HYLA BISTINCTA* (Mexican Fringe-limbed Treefrog)**. MÉXICO: MÉXICO: Municipality of Valle de Bravo: Velo de Novia (19.166072°N, 100.139875°W; NAD 27), 1895 m elev. 12 June 2010. M. Guadalupe López-Garduño. Colección de Vertebrados (Anfibios y Reptiles), Universidad Autónoma del Estado de México (CAREM 0000226–227). Verified by Gil Martínez. First record for Valle de Bravo, positioned 38 km S of the other reported locality in Estado de México, 19 km W of Villa Victoria (Duellman 2001. Hylid Frogs of Middle America, Vol. 2. SSAR Contrib. Herpetol. 18: x + 695–1159; Smith and Taylor 1948. U.S. Nat. Mus. Bull. 194: i–v, 1–118). The frog was found in a pine-oak forest (*Pinus* sp. and *Quercus sartorii)*.

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***HYLA VERSICOLOR* (Gray Treefrog)**. USA: INDIANA: Boone Co.: Stonegate Neighborhood (39.951389°N, 86.322500°W; WGS 84). 8 May 2009. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50146 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***HYLARANA TYTLERI* (Yellow-striped Frog)**. BANGLADESH: NILPHAMARI DISTRICT: Berakuthi, Barua (25.822194°N, 88.827708°E; WGS 84; 43.89 m elev.). 30 September 2011. Md. Abdur Razzaque Sarker. Verified by Ghazi S. M. Asmat. Museum of Herpetology Laboratory, Ichamati College, Dinajpur, Bangladesh (MHLB-HT01). First record from Nilphamari District, northern Bangladesh; described from Dhaka District (Theobald 1868. J. Asiatic Soc. Bengal 37:7–88), and recorded from Chittagong District (Asmat et al. 2003. Univ. Rajshahi J. Zool. 22:141–143), and Barisal District (Howlader 2010. Russian J. Herpetol. 17:255–256). Near Primary High School, Berakuthi, Barua, Bangladesh, >14 km S from Nilphamari. Adults collected in late morning on pond. Habitat includes pond with *Eichhornia crassipes*, paddy fields, and *Musa acuminata* plantations.

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HYPSIBOAS NYMPHA. BRAZIL: AMAZONAS: Municipality of Coari: 4.38388889°N, 64.73694444°W (WGS 84; 73 m elev.). 13 December 2006. R. de Fraga and V. T. de Carvalho. Coleção de Anfíbios e Répteis, Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil (INPA-H 18303, SVL 34.7 mm; body mass in life 1.9 g; collected in Terra Firme Forest). Verified by J. Faivovich. *Hypsiboas nympha* is distributed in the western Amazon Basin, and is known from the northern and southern regions of eastern lowland Ecuador and from northeastern Peru at elevations below 600 m, and from lowlands of Colombia around Leticia (Faivovich et al. 2006. Herpetologica 62:96–108). This record is the easternmost limit known for this species, and the first Brazilian record, extending the known distribution 630 km E of the nearest record in Leticia, Colombia (Faivovich et al., *op. cit.)*

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***INCILIUS OCCIDENTALIS* (Pine Toad)**. MÉXICO: HIDALGO: Municipality of Tecozautla: 0.84 km E La Paila (20.56325°N, 99.61002778°W; WGS 84; 1617 m elev.). 30 May 2009. Nallely Morales Capellán. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH-CIB 2111, 2113). First municipality record, extending the range in the state ca. 33 km SW from its closest reported localities at Puerto del Angel and Puerto Colorado, Zimapán (Huitzil-Mendoza 2007. Herpetofauna de Dos Localidades en la Región Norte de Zimapán, Hidalgo. Tesis, Universidad Autónoma del Estado de Hidalgo. Mineral de la Reforma. 92 pp.). It is also the first record from xerophytic scrub in Hidalgo. Previous reports in the municipalities of Agua Blanca and Tepehuacán de Guerrero were from cloud forest and pine-oak forest in Cuautepec de Hinojosa (Ramírez-Bautista et al. 2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Universidad Autónoma del Estado de Hidalgo, CONABIO. x + 104 pp.). However, the species has been observed in xerophytic scrub in Querétaro (Dixon et al. 1972. Southwest. Nat. 16:225–237), Aguascalientes (Vázquez and Quintero 2005. Anfibios y Reptiles de Aguascalientes. CONABIO. México, D.F. 318 pp.), and México and Distrito Federal (Ramírez-Bautista et al. 2009. Herpetofauna del Valle de México: Diversidad y Conservación. UAEH y CONABIO. México, D.F. 213 pp.). Fieldwork was funded by CONACyT- 95828 and CONABIO GT002.

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***LITHOBATES BLAIRI* (Plains Leopard Frog)**. USA: NEBRASKA: Gosper Co.: 4.0 km S, 2.6 km W Bertrand (40.4893°N, 99.6634°W; NAD83). 19 July 2011. Alyx R. Lingenfelter and Keith Geluso. Verified by Curtis J. Schmidt. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas (FHSM 15851, 15852). First county record (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. University of Nebraska, Lincoln. vi + 158 pp.). Fills gap in south-central parts of the state. Nearest prior records include all surrounding counties including Dawson, Frontier, Furnas, and Phelps. Frogs were captured along a waterway in the Peterson Federal Waterfowl Production Area.

ALYX R. LINGENFELTER (e-mail: lingenfeltar@lopers.unk.edu) and **KEITH GELUSO** (e-mail: gelusok1@unk.edu), Department of Biology, University of Nebraska at Kearney, Kearney, Nebraska 68849, USA; **JEFF L. DRAHOTA**, Rainwater Basin Wetland Management District, U.S. Fish and Wildlife Service, Funk, Nebraska 68940, USA

***LITHOBATES CLAMITANS* (Green Frog)**. USA: INDIANA: Boone Co.: Starkey Park (39.940888°N, 86.268396°W; WGS 84). 22 April 2007. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50140 photo voucher). New county (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***LITHOBATES PALUSTRIS* (Pickerel Frog)** USA: ALABAMA: Jefferson Co.: Small tributary of Turkey Creek, 1 km S of Morris (33.72478°N 86.82260°W; WGS 84). 11 February 2012. S. Graham. Verified by Craig Guyer. AUM AHAP-D 499. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 347 pp.). Found in leaf litter along the tributary.

Funding for this collection trip was provided by a National Science Foundation grant (IOS-1051367, DEB- 0949483) to Tracy Langkilde.

SEAN P. GRAHAM, Department of Biology, The Pennsylvania State University, 208 Mueller Laboratory, University Park, Pennsylvania 16802, USA (e-mail: szg170@psu.edu).

***LITHOBATES PALUSTRIS* (Pickerel Frog)**. USA: INDIANA: Montgomery Co.: Pine Hills Nature Preserve (39.938073°N, 87.058497°W; WGS 84). 23 July 2009. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50153 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***LITHOBATES PALUSTRIS* (Pickerel Frog)**. USA: TENNESSEE: Jefferson Co.: ~13 km W of Jefferson City (36.08489°N, 83.62999°W; WGS 84). 14 May 2009. Ted M. Faust and Mark Mayfield. Verified by Floyd A. Scott. Austin Peay State University Museum of Zoology (APSU 19086 [color photo]). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 31 December 2011] including links to data on amphibians in Tennessee that have appeared since 1996). An individual was found crossing Beaver Creek Road on a rainy night at 2235 h.

TED M. FAUST, Clinch River Environmental Studies Organization, Clinton, Tennessee 37716, USA (e-mail: tmfaust21@gmail.com); **MARK MAYFIELD**, Daisywood Drive, Knoxville, Tennessee 37932, USA (e-mail: mrmayf eld.mm@gmail.com).

***LITHOBATES PIPIENS* (Northern Leopard Frog)**. USA: INDIANA: Boone Co.: Starkey Park (39.940888°N, 86.268396°W; WGS 84). 18 April 2009. Georgia Museum of Natural History (GMNH 50141 photo voucher); Clinton Co.: Camp Cullom Park (40.312808°N 86.632811°W; WGS 84). 15 March 2008. GMNH 50139 (photo voucher). Specimens found by Todd Pierson and verified by Elizabeth McGhee. Both are county records (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***LITHOBATES SPECTABILIS* (Showy Leopard Frog)**. MÉXICO: HIDALGO: Municipality of Tecozautla: 1.52 km E La Paila (20.559722222°N, 99.61591667°W; WGS 84), 1646 m. elev. 18 June 2008. Julián Bueno Villegas. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB-UAEH 1545). First municipality record, extending the range in the state ca. 31.28 km E from its closest reported locality in Arbolado, Municipality of Tasquillo (Morales 2010. Herpetofauna de Dos Ambientes Contrastantes del Municipio de Tasquillo. Tesis, Universidad Autónoma del Estado de Hidalgo. Mineral de la Reforma. 84 pp.). The frog was found next to a stream surrounded by xerophytic scrub vegetation. Fieldwork was funded by CONACyT - 95828 and CONABIO GT002.

ADRIANA LÓPEZ-MEJÍA (e-mail: alamo_87@hotmail.com) and **IRENE GOYENECHEA** (e-mail: ireneg28@gmail.com), Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A. P. 1-69 Plaza Juárez, Pachuca, Hidalgo, México.

***LITHOBATES SPHENOCEPHALUS* (Southern Leopard Frog)**. USA: TENNESSEE: Grainger Co.: ~13 km W of Jefferson City (36.10105°N, 83.63563°W;WGS 84). 15 May 2009. Ted M. Faust and Mark Mayfield. Verified by Floyd A. Scott. Austin Peay State University Museum of Zoology (APSU 19084 [color photo]). An individual was found on McBee Island along the bank of the Holston River at 1030 h. New county record (Redmond and Scott. 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 31 December 2011] including links to data on amphibians in Tennessee that have appeared since 1996).

TED M. FAUST, Clinch River Environmental Studies Organization, Clinton, Tennessee 37716, USA (e-mail: tmfaust21@gmail.com); **MARK MAYFIELD,** Daisywood Drive, Knoxville, Tennessee 37932, USA (e-mail: mrmayf eld.mm@gmail.com).

PHYLLOMEDUSA BAHIANA. BRAZIL: BAHIA: Municipality of Jeremoabo: Raso da Catarina Ecological Station (9.916944°S, 38.698611°W, datum SAD-69; elev. 444 m). 28 March 2011. C. R. dos Santos Silva. Verified by F. Acuña Juncá. Herpetological collection, Feira de Santana State University, Feira de Santana, Bahia, Brazil (MUEFS 3712) and the Federal University of Sergipe, São Cristovão, Sergipe, Brazil (CHUFS 1737, 1738). The Raso da Catarina is the driest region in the Brazilian state of Bahia, and is composed of a mosaic of semi-deciduous forest habitats on sandy soils (Sick et al. 1987. Rev. Bras. Zool. 3[7]:441–463). The species is found in the municipalities of Aurelino Leal, Camacan, Conceição de Feira, Feira de Santana, Lençóis, Maracás, Miguel Calmon, Morro do Chapéu, Mucugê, Muritiba, Palmeiras, Rui Barbosa, Senhor do Bonfim, Salvador, and Uruçuca in Bahia (Brunes et al. 2010. Mol. Phyl. Evol. 57:1120–1133; Juncá 2008. *In* IUCN 2011. IUCN Red List of Threatened Species.Version 2011.2. on <www.iucnredlist.org>. Downloaded 29 January 2012) and Capela in Sergipe (Morato et al. 2011. Checklist 7[6]:756–762). The present record represents a new northern limit for the

distribution of the species, extending its range 175 km directly NE of Senhor do Bonfim, Bahia. In addition, this record is important for the conservation of the species in the Caatinga, given that it refers to a federal conservation unit.

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***POLYPEDATES LEUCOMYSTAX* (Common Tree Frog)**. BANGLADESH: NILPHAMARI DISTRICT: Berakuthi, Barua (25.822231°N, 88.834361°E; WGS 84; 47.24 m elev.), 15 November 2011. Verified by Ghazi S. M. Asmat. Md. Abdur Razzaque Sarker. Museum of Herpetology Laboratory, Ichamati College, Dinajpur, Bangladesh (MHLB-PL01). First record from Nilphamari District, northern Bangladesh; previously recorded from Chittagong Division, including Cox's Bazar District, Chokoria, Malumghat; Bandarban District, Bandarban, Milonchari; Rangamati District, Kaptai, Kaptai Village; Dhaka Division, Dhaka District, Savar (Mahony et al. 2009. Hamadryad 34:80–94). Near Saidpur Bypass Road >13 km S from Nilphamari. Adults collected on mango tree (*Mangifera indica*) at primary forest edge. Habitat includes *Cynodon dactylon, Azadirachta indica, Curcuma longa, Areca catechu,* and *Bambusa arundinacea* plantations.

MD. ABDUR RAZZAQUE SARKER (e-mail: razzaqsciencebd@gmail.com), and **MOHAMMAD SAJID ALI HOWLADER** (e-mail: sajidpabc@gmail.com), Herpetology Laboratory Bangladesh, Society for Research and Development, House No. 28/5 (2nd f oor), Shonatangar, Jigatola, Dhanmondi, Dhaka 1209, Bangladesh.

***PSEUDACRIS BRACHYPHONA* (Mountain Chorus Frog)**. USA: NORTH CAROLINA: Clay Co.: 14 March 2011. Lori A. Williams. Adult male frogs (N = >5) calling from Payne Branch and surrounding riparian and wet meadow habitat. Digital audio recordings were made from Pine Log Road (SR 1104) at junction with Payne Road (SR 1182), 3.3 km airline SSE of Brasstown (35.009987ºN, 83.94716ºW;WGS 84) and on Pine Log Road, 0.2–0.3 mi S of Payne Road, 3.6 km airline S of Brasstown (35.006115°N, 83.95076°W; WGS 84). Verified by Jeffrey C. Beane. North Carolina State Museum of Natural Sciences (1274 audio recordings). New county record (North Carolina Natural Heritage Program 2011. Biotics Database. Department of Environment and Natural Resources, Raleigh, North Carolina). Closest previous historical record in North Carolina is in Cherokee Co., 3.2 km airline NW (North Carolina Natural Heritage Program 2011, *op. cit.*).

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***PSEUDACRIS CRUCIFER* (Spring Peeper)**. USA: INDIANA: Clinton Co.: Camp Cullom Park (40.312808°N 86.632811°W; WGS 84). 16 March 2009. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50138 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***RHINELLA CRUCIFER* (Striped Toad)**. BRAZIL: ALAGOAS: Municipality of Maceió: Serra da Saudinha (9.366667°S, 35.750000°W; WGS84; 150 m elev.) 18 February 2005. F. A. C. Nascimento and others. Setor de Zoologia, Coleção Herpetológica do Museu de História Natural, Universidade Federal de Alagoas, Maceió, Brazil (MUFAL 3892, 3894, 3895; collecting license IBAMA/RAN #184/05). Verified by S. T. Silva. This frog is known to occur in the Atlantic Forest of the Brazilian states of Ceará, Paraíba, Pernambuco, Sergipe, Bahia, Minas Gerais, Espírito Santo, and Rio de Janeiro (Baldissera Jr. et al. 2004. Arquivos do Museu Nacional 62[3]:255–282; Marques et al. 2006. Herpetol. Rev. 37[1]:98; Silveira et al. 2009. Biotemas 22[4]:231–235). First state record, extending the known distribution of species about 156 km SSE from the closest locality known (Municipality of Caruaru, Pernambuco state), filling a distributional gap between the states of Sergipe and Pernambuco.

BARNAGLEISON SILVA LISBOA (e-mail: bslgleison@gmail.com), and **FILIPE AUGUSTO CAVALCANTI DO NASCIMENTO** (e-mail: f lipe.bio@gmail.com), Setor de Zoologia, Museu de História Natural, Universidade Federal de Alagoas, Av. Aristeu de Andrade, 452, Farol, CEP: 57051-090, Maceió, Alagoas, Brazil.

***SCAPHIOPUS HOLBROOKII* (Eastern Spadefoot)**. USA: OHIO: Muskingum Co.: Wayne Township. Duncan Falls (39.88409°N, 81.90944°W; WGS 84). 09 September 2011. Richard Green. Verified by John W. Ferner. Cincinnati Museum Center (CMC 12317). New county record. (Davis and Menze 2000. Ohio Anuran Atlas, Ohio Biological Survey, Columbus). Fills a gap of approximately 94 km in the Eastern Spadefoot's distribution in the Muskingum River valley. Nearest records are approximately 52 km north in Coshocton County and 42 km south in Morgan County.

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); **RICHARD GREEN,** Philo High School, 4000 Millers Lane, Duncan Falls, Ohio 43734, USA (e-mail: r.green@prodigy.net).

***SCAPHIOPUS HOLBROOKII* (Eastern Spadefoot)**. USA: TENNESSEE: Jefferson Co.: ~13 km W of Jefferson City (36.08389°N, 83.62811°W; WGS 84). 14 May 2009. Ted M. Faust and Mark Mayfield. Verified by Floyd A. Scott. Austin Peay State University Museum of Zoology (APSU 19082 [color photo]). New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 31 December 2011] including links to data on amphibians in Tennessee that have appeared since 1996). Two individuals were found crossing Beaver Creek Road on a rainy night at 2230 h.

TED M. FAUST, Clinch River Environmental Studies Organization, Clinton, Tennessee 37716, USA (e-mail: tmfaust21@gmail.com); **MARK MAYFIELD**, Daisywood Drive, Knoxville, Tennessee 37932, USA (e-mail: mrmayf eld.mm@gmail.com).

***UPERODON GLOBULOSUS* (Balloon Frog)**. BANGLADESH: NILPHAMARI DISTRICT: Berakuthi, Barua (25.825753°N, 88.829083°E; WGS 84; 44 m elev.), 8 September 2011. Md. Abdur Razzaque Sarker. Verified by Ghazi S. M. Asmat. Museum of Herpetology Laboratory, Ichamati College, Dinajpur, Bangladesh (MHLB-UG01). First record from Nilphamari District, northern Bangladesh; previously recorded from Dhaka Division, including Savar and Gazipur districts, also Tangail District, Rasulpur, Madhupur forest (Mahony et al. 2009. Hamadryad 34:80–94). Near Berakuthi > 13 km S from Nilphamari. Adults collected

from roadside paddy field. Habitat includes *Cynodon dactylon* and *Musa acuminate* plantations.

MD. ABDUR RAZZAQUE SARKER (e-mail: razzaqsciencebd@gmail.com), **MOHAMMAD SAJID ALI HOWLADER** (e-mail: sajidpabc@gmail.com); and **MD. ASHRAFUL KABIR** (e-mail: ashraful_wb@yahoo.com), Herpetology Laboratory Bangladesh, Society for Research and Development, House No. 28/5 (2nd f oor), Shonatangar, Jigatola, Dhanmondi, Dhaka 1209, Bangladesh.

***XENOPHRYS PARVA* (Concave-crowned Horned Toad)**. BANGLADESH: SYLHET DIVISION: Sylhet District: Khadimnagar National Park (24.9527°N, 91.9458°E; WGS 84; 65 m elev.). 9 July 2011. Animesh Ghose and Jay Prakash Ray. Photographic voucher, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 1.38a–c). Verified by Guin Wogan. First record from Sylhet Division as well as northeastern Bangladesh, previously known from Chittagong and Chittagong Hill Tracts (Asmat et al. 2003. Univ. Rajshahi J. Zool. 22:141–143). Nearest records from Manipur, India (Bordoloi and Ningombam 2007. Zoo's Print J. 22:2688–2690), ca. 100 km E of Khadimnagar National Park and ca. 300 km N of Chittagong (Asmat et al. 2003. Univ. Rajshahi J. Zool. 22:141–143).

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TESTUDINES — TURTLES

***APALONE FEROX* (Florida Softshell)**. USA: FLORIDA: Monroe Co.: Big Pine Key, Blue Hole, National Key Deer Refuge (24.70536°N, 81.38044°W; WGS84). 28 November 2008. R. Powell. Verified by K. L. Krysko. Florida Museum of Natural History, University of Florida (UF) 166147 (image voucher only). First record of the species in the Florida Keys (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final Report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee).

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***APALONE SPINIFERA* (Spiny Softshell)**. USA: INDIANA: Boone Co.: Starkey Park (39.940888°N, 86.268396°W; WGS 84). 2 August 2009. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50147 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***CHELYDRA SERPENTINA* (Snapping Turtle)**. USA: INDIANA: Boone Co.: Starkey Park (39.940888°N, 86.268396°W; WGS 84). 23 April 2006. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50149 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***CHRYSEMYS PICTA* (Painted Turtle)**. USA: GEORGIA: Franklin Co.: Starr's Bridge Road near GA-51 (34.322426°N 83.183005°W; WGS 84) 24 September 2012. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50163 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***CHRYSEMYS PICTA* (Painted Turtle)**. USA: INDIANA: Boone Co.: Starkey Park (39.940888°N, 86.268396°W; WGS 84). 18 April 2006. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50150 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***CHRYSEMYS PICTA* (Painted Turtle)**. USA: OHIO: Muskingum Co.: Muskingum Township, Powelson Wildlife Area (a reclaimed strip mine pond) along County Road 49, ca. 0.6 km W of the intersection with Northpointe Drive (40.05112°N, 82.03005°W; WGS 84). 15 June 2011. Jeffrey E. Dawson and Cheri L. Dawson. Verified by Jeffrey G. Davis. Photo vouchers in Cincinnati Museum Center, Geier Collections and Research Center (CMC HP 6029–6030). First published county record and updates a 45-year-old specimen with incomplete collection data. Fills a distributional gap in eastern Ohio. The species is documented in adjacent Coshocton, Guernsey, Licking, Morgan, Noble, and Perry counties (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas. Ohio Biol. Surv. Misc. Contr. No. 10, Columbus. iv + 81 pp.). There is an unpublished museum record (CM 88997) from Muskingum County collected "about 2 mi N Zanesville" on 18 May 1965 by David M. Sever. The locality of this record is ca. 8 km S of our record. Data on the historical record were initially obtained through the HerpNET data portal (http://www.herpnet.org; accessed 18 November 2011), verified by Stephen P. Rogers, and provided with the permission of Carnegie Museum of Natural History.

JEFFREY E. DAWSON, Reptiles/Shores Region, Columbus Zoo and Aquarium, Powell, Ohio 43065, USA and Department of Biology, University of Nebraska-Kearney, Kearney, Nebraska 68849, USA (e-mail: dawsonje@lopers.unk.edu); **CHERI L. DAWSON,** 2599 Bristol Road, Columbus, Ohio, 43221, USA.

***DEIROCHELYS RETICULARIA* (Chicken Turtle)**. USA: FLORIDA: Clay Co.: Melrose, SR 21, 0.23 km S of 5th Avenue (29.72804°N, 82.04752°W; WGS84). 24 January 2012. Benjamin K. Atkinson. Florida Museum of Natural History (UF 166509). Verified by Max A. Nickerson. First Clay Co. record in >110 years, and the second specimen vouchered for the county (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final Report, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Gravid female (195 mm SCL) found dead on road at 1000 h EST. Observation of shelled eggs in January (UF 166509) is not surprising given the species' winter nesting season in northern Florida (Jackson 1988. Florida State Mus., Biol. Sci. 33:113–158).

Herbert Hutchinson Brimley, accomplished naturalist and former Director of the North Carolina Museum of Natural Sciences (Cooper 1979. Brimleyana 1:1–14) donated the previous voucher, of unknown collection date, to the Milwaukee Public Museum (MPM 215) in April 1900. This sub-adult (101 mm SCL)

female (based on size of maturity, in Jackson 1988, *op. cit.*) was collected in Green Cove Springs, Florida (ca. 45 km NE of UF 166509).

Although Chicken Turtles are probably common in Clay Co., given the number of ephemeral wetlands (the species' preferred habitat: Ewert et al. 2006. *In* P. Meylan [ed.], Biology and Conservation of Florida Turtles, pp. 249–259. Chelon. Res. Monogr. No. 3), they do not readily enter baited traps (Jackson 1996. Chelon. Conserv. Biol. 2:105–108), rendering encounters by herpetologists sporadic and likely explaining the paucity of records.

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***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle).** USA: INDIANA: Boone Co.: Starkey Park (39.940888°N, 86.268396°W; WGS 84). 18 July 2008. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50145 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***GRAPTEMYS OUACHITENSIS* (Ouachita Map Turtle).** USA: OHIO: Morgan Co.: Windsor Township. Muskingum River (39.52733°N, 81.74521°W; WGS 84). 05 June 2011. Lynn Barnhart. Verified by John W. Ferner. Cincinnati Museum Center Herpetological Photodocumentation Collection (CMC HP 5949–5951). New county record (Wynn and Moody 2006. Ohio Turtle, Lizard, and Snake Atlas, Ohio Biol. Surv. Misc. Contrib. No. 10, Columbus). Adult female was found moving over land probably to or from a nesting site. Specimen represents the second record from the Muskingum River drainage (Davis and Krusling 2010. Herpetol. Rev. 41[3]:391–392). Nearest record is from approximately 70 km upstream in the Muskingum River.

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***HYDROMEDUSA TECTIFERA* (South American Snake-necked Turtle).** ARGENTINA: BUENOS AIRES: Partido de Tornquist: Sierra de la Ventana: near Río Sauce Grande (38.130633°S, 61.793490°W, WGS84; 250 m elev.). 12 March 2012. D. Di Pietro. Herpetological Collection of Museo de La Plata, Buenos Aires, Argentina (MLP R 5717 hatchling turtle, 32 mm carapace length, road-killed during a heavy rain). Verified by P. Bona. Species previously known from Uruguay, eastern Paraguay, southeastern Brazil, and northeastern and central Argentina (Cabrera 1998. Las Tortugas Continentales de Sudamérica Austral. Córdoba, Argentina, Privately printed, 108 pp., 6 pls.; Fritz and Havaš 2007. Vert. Zool. 57:149–368). Southernmost locality for the species and extends its known distribution ca. 495 km airline SW from Roberto Pairó, Partido de Magdalena, Buenos Aires province, which was the previous nearest known locality (Cabrera 1998, *op. cit.*).

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***INDOTESTUDO ELONGATA* (Elongated Tortoise).** VIETNAM: DAK LAK PROVINCE: Buon Don District: Yok Don National Park (12.8599°N, 107.7054°E; WGS 84; 195 m elev.). 1 July 2004. Mark R. Bezuijen. Verified by Brian Horne. Photographic voucher deposited in Zoological Reference Collection, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC [IMG] 2.161a–c). Adult, straight carapace length 22 cm, in dry dipterocarp forest along Dak Ken, a vegetated perennial stream; caught by residents (Ede ethnic minority), encountered with turtle at capture site, 1500 h. Measured and released. First record for Dak Lak Province (Nguyen et al. 2009. Herpetofauna of Vietnam. Edition Chimaira, Frankfurt am Main. 768 pp.). Most turtle records from Indochina are of specimens in commercial trade; few published wild records are available (Stuart and Platt 2004. Asiatic Herpetol. Res. 10:129–150).

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***MESOCLEMMYS RANICEPS* (Amazon Toad-headed Turtle).** BRAZIL: AMAZONAS: Municipality of Beruri: 1) Piagaçu-Purus Sustainable Development Reserve, Tucumã Stream (4.75°S, 62.7°W; WGS84), Purus River in the Solimões River Basin. 26 September 2004. D. C. Balensiefer and R. C. Vogt. Collection of Amphibians and Reptiles, Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil (INPA-H 12482 inmature male captured in a trammel net in 2.5 m of water, 239 mm straight-line carapace length [CL], 180 mm carapace width, 80 mm carapace height, 210 mm plastron length, 41 mm femoral scute length [FML], and 54 mm head width [HW]. 2) Tapera, Rio Negro (0.14456°S, 64.10242°W; WGS84). Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 2640). 3) Canutama, Rio Purus, (6.5°S, 64.33333°W; WGS84) (MZUSP 2834, 2838). 4) Municipality of Barcelos: City of Barcelos, hand collected in a drainage ditch, (0.93333°S, 62.98333°W; WGS84), in the Negro River Basin. 4 January 2004. R. C. Vogt. (INPA-H 11672, female of 287 mm CL, 210 mm CW, 90 mm CH, 235 mm PL, 43.5 mm FML, and 66.7 mm HW).

Specimens from MZUSP verified by P. A. Vanzolini, and specimens from INPA verified by R. Bernhard. Species known from the Amazon and upper Orinoco river basins, from Venezuela to Bolivia, including Colombia, Ecuador, Peru, and Brazil (Rueda-Almoncid et al. 2007. Las Tortugas y los Cocodrilianos de los Países Andinos del Trópico. Conservación Internacional, Andes CBC, Bogata. 537 pp.). In Brazil it is known from 20 dispersed localities in the following states: Acre (1), Amapa (1), Amazonas (13), Para (2), and Rondonia (3), with many gaps between the localities. INPA-H 12482 is a new municipality record and fills a gap in the known distribution of this species to the southwest between specimen MZUSP 2640 ca. 352 km to the north and MZUSP 2834 and 2838 ca. 496 km to the south. INPA-H 11672 is new municipality record, 396 km upstream from Manaus.

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. USA: GEORGIA: Hall Co.: Elachee Nature Center (34.245842°N, 83.832004°W; WGS 84). 16 October 2011. Daniel Thompson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50156 photo voucher); New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. USA: GEORGIA: Stephens Co.: Yonah Dam Road (34.664497°N, 83.308047°W; WGS 84). 23 June 2010. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50144 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp).

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***TRACHEMYS SCRIPTA* (Pond Slider)**. USA: INDIANA: Boone Co.: Starkey Park (39.947679°N, 86.255742°W; WGS 84). 16 July 2007. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50142 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***TRACHEMYS SCRIPTA SCRIPTA* (Yellow-bellied Slider)**. USA: GEORGIA: Whitfield Co.: Mill Creek at Heritage Point Park, (4.790655°N, 84.942505°W). 21 May 2010. Chris Manis and John Patrick. Verified by John Jensen. University of Tennessee at Chattanooga Museum of Natural History (UTC Digital Collection-4669TPW-GMU). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Specimen was captured in a hoop net baited with sardines packed in soybean oil.

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SQUAMATA — LIZARDS

***ANOLIS CAROLINENSIS* (Green Anole)**. USA: GEORGIA: Franklin Co.: Victoria Bryant State Park (34.297397°N, 83.159190°W; WGS 84). 24 September 2012. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50159 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***ANOLIS CAROLINENSIS* (Green Anole)**. USA: GEORGIA: Taylor Co.: Fall Line Sandhills Wildlife Management Area (32.57815°N, 84.27017°W; WGS 84; elev. ~207 m). 02 February 2012. Robert L. Hill. UTADC 7413. Verified by John Jensen. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.). Specimen observed moving on a fallen tree near the edge of a large ephemeral pond at ~1700 h, photographed, and released.

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***ANOLIS CAROLINENSIS* (Green Anole)**. USA: GEORGIA: Tift Co.: Tifton (31.480529°N, 83.507719°W; WGS 84). 23 November 2011. Malavika Rajeev and Meenakshi Rajeev. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50157 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***ANOLIS PETERSII* (Peters's Anole)**. MÉXICO: PUEBLA: Municipality of Xicotepec de Juárez: Xicotepec de Juárez-Itzatlán (20.34217°N, 97.95876°W; WGS84), 370 m elev. 20 August 2007. Jesús Hernández-Ortega. Verified by Luis Canseco-Márquez. UTADC 7195–7197. First record for Puebla, extending its known range from the closest reported locality 137 km (air line) NW of Mirador, Veracruz (Smith and Taylor 1950. U.S. Nat. Mus. Bull. 199:1–253; Lieb 2001. *In* J. D. Johnson et al. [eds.], Mesoamerican Herpetology: Systematics, Zoogeography, and Conservation, pp. 53–64. Centennial Mus., Spec. Publ. No. 1, University of Texas at El Paso, El Paso, Texas). The lizard was found on a tree in rain forest.

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***ANOLIS SAGREI* (Brown Anole)**. USA: TEXAS: Kleberg Co.: city limits of Kingsville, 1217 Lawndale Street, .06 km SW of Carlos Truan Blvd. (27.504161°N, 97.852633°W; WGS84). 11 June 2011. Robert W. Rabe, Cheryl J. Claunch, Eric O. Montalvo, Randy L. Powell. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 85065, male). New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M Univ. Press, College Station. 421 pp.). The collection site is ca. 8.25 km from Nueces/Kleberg county line. *Anolis sagrei* is an introduced species to the United States with established populations throughout several southern states including Texas (Kraus 2009. Alien Reptiles and Amphibians: A Scientific Compendium and Analysis. Springer Publ., New York. 576 pp.).

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***ANOLIS YOROENSIS*.** HONDURAS: COPÁN: Quebrada Las Piedras (15.128583°N, 88.90025°W; WGS 84), 1450 m elev. 21 April 2011. James R. McCranie and Leonardo Valdés Orellana. SMF 93369. San Isidro (15.122028°N, 88.933556°W; WGS 84), 1050 m elev. 15 November 2008. James R. McCranie and Leonardo Valdés Orellana. SMF 91311. Both are first records for Copán.

CORTÉS: Finca Naranjito (15.516667°N, 88.15°W; WGS 84), 1000 m elev. 15 April 1979 and 11 August 1993, respectively. James R. McCranie. SMF 91309–10. First records for Cortés. SANTA BÁRBARA: Nuevo Joconales (15.059583°N, 88.519056°W; WGS 84), 1150 m elev. 17 April 2011. James R. McCranie and Leonardo Valdés Orellana. SMF 93353. Quebrada de las Minas (15.061417°N, 88.490528°W; WGS 84), 1080 m elev. 17 April 2011. James R. McCranie and Leonardo Valdés Orellana. SMF 93354–58. Quebrada Las Cuevas (15.053444°N, 88.517056°W; WGS 84), 1150 m elev. 18–19 April 2011, respectively. James R. McCranie and Leonardo Valdés Orellanda. SMF 93359–61. All represent first records for Santa Bárbara. All anoles listed above verified by Gunther Köhler. These records extend the known distribution of this Honduran endemic 80–160 km W from the closest published locality on Cerro Pajarillos, Montaña de Pijol, Yoro (McCranie et al. 2002 [2001]. Amphibia-Reptilia 22:465–473). Santa Bárbara specimens were collected in slightly disturbed broadleaf forest, whereas Copán and Cortés lizards were found in highly disturbed broadleaf forests that had been converted to coffee and other types of agricultural fields. All lizards were active on low tree trunks by day and were sleeping in low vegetation at night.

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***BARISIA IMBRICATA IMBRICATA* (Imbricate Alligator Lizard)**. MÉXICO: GUERRERO: ca. 4 air km NW Taxco, Sierra Taxco (18.5813°N, 99.6453°W, NAD27), 2403 m elev. 17 June 2009. Jason M. Jones, Christoph Grünwald, and Robert W. Bryson, Jr. Verified by Edmundo Pérez Ramos. MZFC 26333. First record for Guerrero, extending the known range ca. 50 km S of records near Nevado de Toluca, Estado de México (Guillette and Smith 1982. Trans. Kansas Acad. Sci. 85:13–33). The lizard was found under a log near a cornfield in humid mixed oak forest.

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***BRACHYMELES CEBUENSIS* (Cebu Slender Skink)**. PHILIPPINES: CEBU ISLAND: CEBU PROVINCE: Municipality of Argao: Barangay Tabayag, Mt. Suyak (9.891°N, 123.514°W, WGS84; 700 m elev.). 12 December 2011. C. H. Oliveros. Verified by L. J. Welton. University of Kansas Natural History Museum (KU 331835). Adult specimen, collected by local farmer on ground under leaf litter. New municipality record, southernmost record, and third known locality (Siler et al. 2011. Herpetol. Monogr. 25:76–112), extending distribution 26.64 km S of type locality in Barangay Tapal, Municipality of Carcar. Previously recognized on basis of 12 specimens from two localities, and a recognized distribution spanning < 70 km of deforested eastern coast of Cebu Island, Philippines. Although currently classified as Critically Endangered (CR) by IUCN, observed at three locations, surviving in heavily disturbed, dry, deforested habitat. We therefore have re-evaluated this species against IUCN criteria for classification, and find that it qualifies for status of Vulnerable, VU, based: VU B2ab(iii); D2 (IUCN, 2011. Red List of Threatened Species. Ver. 2011.2. http://www.iucnredlist.org. Accessed 2 Mar 2012).

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***CHAMAELEO CHAMAELEON* (Common Chamaeleon)**. MOROCCO: ATLANTIC SAHARA: Mijk (23.705°N, 15.707°W, WGS 84; 70 m elev.). 18 November 2011. Franck Chevalier. Institut de Recherche pour le Développement at Dakar (IRD TR-4142). Verified by Jean-François Trape and Sébastien Trape. Also observed at Imlili sebkha (23.276°N, 15.915°W, WGS 84; 43 m elev.). Franck Chevalier (sight records, no voucher specimen). First records for Dakhla District, Atlantic Sahara region (Morocco), and southernmost records for Africa. These records extend the range on coastal areas of Sahara Desert 220 and 280 km SW from nearest record in Lamjayibir, 87 km S of Boujdour, Atlantic Sahara (Geniez et al. 2006. The Amphibians and Reptiles of the Western Sahara. Edition Chimaira, Frankfurt an Main. 228 pp.; Sindaco and Jeremcenko 2008. The Reptiles of the Western Palearctic. Edizioni Belvedere, Latina. 579 pp.).

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***CTENOSAURA HEMILOPHA* (Cape Spiny-tailed Iguana)**. MÉXICO: BAJA CALIFORNIA SUR: Municipality of Loreto: Isla Monserrat (25.663425°N, 111.6557194°W; WGS 84), 22 December 2007. William López Forment. Verified by José Alberto Cruz Silva. CNAR-IBH 25425 (almost complete skeleton with skin). First record from Isla Montserrat, extending its known range 49.4 km SE of Loreto (Grismer 2002. Amphibians and Reptiles of Baja California: Including its Pacific Islands and the Islands in the Sea of Cortez. Univ. California Press, Berkeley. xiv + 399 pp.).

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: TEXAS: Johnson Co.: Cleburne: 1009 Willow Creek Road (32.3336°N, 97.3997°W; WGS 84). 03 August 2011. Collected by Robert J. Allen. Verified by Toby J. Hibbitts. Texas Cooperative Wildlife Collection (TCWC 95592). New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M Univ. Press, College Station. 421 pp.). The specimen was collected from an exterior wall at a residence. Numerous individuals were observed at the collection site. The nearest documented populations are to the north in Tarrant Co., Texas, northeast in Dallas Co., Texas (Dixon 2000, *op. cit.*), and to the east in Ellis Co., Texas (McCluney 2003. Herpetol. Rev. 34:166).

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***HOLBROOKIA LACERATA LACERATA* (Northern Spot-tailed Earless Lizard)**. USA: TEXAS: Mason Co.: on the mid-section of the Captain Mike Hall Way Road, 30.4 km SW of the intersection of U.S. Hwy. 87 and State Hwy. 29 in Mason, Texas on the Blue Mountain Peak Ranch (30.559152°N, 99.458558°W; NAD 83, elev.

629 m). 24 May 2010. Wesley M. Anderson and Robert L. Gundy. Verified by Travis LaDuc. Texas Natural History Collection (TNHC 74704). New county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 421 pp.; Dixon et al. 2007. Texas Herpetol. Soc. Publ. 2007[1]:1–56). The subspecies was previously known from 25 counties in central Texas. The new locality in Mason Co. is 6.7 km NE of the nearest previously known locality in Kimble Co. (WTSU 10739). Both records occur on Tarrant Complex soils and the Low Stony Hill ecological site, which are contiguous between the two localities (USDA Natural Resources Conservation Service. 2009. Soil Survey Geographic Database. http://soils.usda.gov/survey/geography/ssurgo/), therefore the occurrence of the subspecies at the new locality was not unexpected. *H. lacerata* has been extirpated from much of its historical range (Duran and Axtell 2010. A rangewide inventory and habitat model for the spot-tailed earless lizard, *Holbrookia lacerata*. Final Report to the Texas Parks and Wildlife Dept. 37 pp.). On 24 May 2011 the U.S. Fish and Wildlife Service issued a 90-day finding that listing the species as threatened or endangered may be warranted.

We thank Richard Taylor for allowing us to conduct surveys over several years on his Blue Mountain Peak Ranch.

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***LEPIDODACTYLUS LUGUBRIS* (Mourning Gecko)**. COLOMBIA: DEPARTAMENTO DE ANTIOQUIA: Municipio de Nariño: Vereda Puente Linda (5.571888°N, 75.123777°W, WGS 84), 655 m elev. 4 February 2010. Collected by Population Ecology Students 2009-2. Museo Herpetológico de Antioquia, Medellín, Colombia (MHUA-R 12031–12061 collected in a building construction site at 1900 h, approx. 20 m from the edge of premontane forest). Municipio de Medellín (6.190167°N, 75.581778°W, WGS 84), 1505 m elev. March 2010. (MHUA-R 12241–12246). L. C. Rubio-Rocha and E. Alzate. Verified by Eric N. Smith. This species is native to the western Pacific, and has probably been present in Panama and Ecuador from the mid-19th century (Smith and Grant 1961. Herpetologica. 17:68; Mechler 1968. Rev. Suisse Zool. 75:305–371) and has since then been reported in Nicaragua, Costa Rica, Suriname, and on the Caribbean island of Guadeloupe (Bauer et al. 2007. Appl. Herpetol. 4[1]:84–85; Henderson et al. 1976. Herpetol. Rev. 7:173; Lorvelec et al. 2011. Herpetol. Notes 4:291–294; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. University of Chicago Press, Chicago, Illinois. 486 pp.). Its presence is suggested in Brazil and Peru, but the reliability of the Brazilian records has been questioned (Lorvelec et al., *op. cit.*). Early records of this species in Colombia were from along the Pacific Coast in Departamento de Nariño, municipality of Tumaco in 1942, and it was later reported in Departamento de Cauca, Isla Gorgona in 1961 and Departamento de Valle del Cauca, Municipality of Buenaventura, in 1965 (Medem 1979 *In* Von. Prahl et al.1979. Gorgona. Universidad de los Andes, Bogotá, Colombia) near the main ports. It is thought to have arrived by maritime shipping and to have subsequently spread to other municipalities of Departamento de Nariño, Departamento de Cauca, and Departamento de Valle del Cauca (Ayala 1986. Caldasia 15:555–571; individuals collected between 1971 and 1976). It has been found more recently in northern Colombia in Departamento de Boyacá and Departamento de Córdoba in 1981 and 2000, respectively (Moreno-Arias et al. 2006. Herpetol. Rev. 37[1]:100–101). First records for Departamento de Antioquia, extends range 170 km E and 140 km NE of the Rio Cabí at Quibdó, Departamento de Chocó, (García et al. 2006. Rev. Inst. Univ. Tecnol. Chocó D. L. C. 25:47–55) and are located 350 km S of the northernmost record and 298 km W of the most eastern record for the species (Moreno-Arias et al. 2006, *op. cit.*).

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***LEPIDOPHYMA GAIGEAE* (Gaige's Tropical Night Lizard)**. MÉXICO: HIDALGO: Municipality of Tecozautla: 1.62 km E La Paila (20.57175°N, 99.59725°W; WGS84), 1696 m. elev. 14 March 2009. Judith T. Pampa Ramírez. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CIB-UAEH 1948). First municipality record, extending the range in the state ca. 52.88 km W from its closest known record at El Atajo, Municipality of Zimapán (in pine-oak forest) (Ramírez-Bautista et al. 2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Universidad Autónoma del Estado de Hidalgo, CONABIO. x + 104 pp.). This species is recorded for the first time in Hidalgo from xerophytic scrub, as it normally occurs in pine-oak forest associations (Ramírez-Bautista et al. 2010, *op. cit.*), although it has been reported in such within Querétaro (Dixon et al. 1972. Southwest. Nat. 16:225–237; González 1995. Herpetol. Rev. 26:15–17. Fieldwork was funded by CONACyT - 95828 and CONABIO GT002.

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***SCINCELLA LATERALIS* (Little Brown Skink)**. USA: GEORGIA: Tift Co.: Tifton (31.480529°N, 83.507719°W; WGS 84). 30 October 2011. Todd Pierson and Malavika Rajeev. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50158 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp).

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***UROSAURUS ORNATUS* (Ornate Tree Lizard)**. MÉXICO: SONORA: Isla Pájaros (27.88798°N, 110.84722°W, NAD 27), 10 m elev. 10 July 2007. J. Ventura-Trejo. Verified by Bradford D. Hollingsworth. San Diego Natural History Museum Herpetological Photo Collection (SDNHM-HerpPC 5205–5207). First record for the island, with the closest mainland locality being 6 km NE near Guaymas, Sonora, and the fourth insular locality for *U. ornatus* in the Sea of Cortés (Rorabaugh 2008. J. Arizona-Nevada Acad. Sci. 40:20–65). The lizards were common on rocky substrates.

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yahoo.com.mx); **JESUS VENTURA TREJO,** Proteccion de Flora y Fauna de las Islas del Golfo de California SEMARNAT-CONANP Of cina Regional Guaymas, Guaymas, Sonora, México (e-mail: jventurat@yahoo.com.mx).

SQUAMATA — SNAKES

***COLUBER CONSTRICTOR* (North American Racer)**. USA: NEBRASKA: Buffalo Co.: 4.5 km N, 3.4 km E Odessa (40.7420°N, 99.21594°W, NAD83, elev. 695 m). 18 June 2011. R. Aric Buerer. Verified by Curtis J. Schmidt, Sternberg Museum of Natural History, Fort Hays State University, Hays Kansas (FHSM 15858). First county record. Fills distributional gap in south-central Nebraska (Ballinger et al. 2010. Amphibians and Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. University of Nebraska, Lincoln. vi + 158 pp.). Species is known from adjacent Hall Co. to the east, Dawson Co. to the west, and Kearney Co. to the south (Fogell 2010, *op. cit.)*. Individual was captured in funnel trap in an upland grassland grazed by cattle.

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***CONTIA LONGICAUDAE* (Forest Sharp-tailed Snake)**. USA: CALIFORNIA: Del Norte Co.: Siskiyou National Forest, along USFS Rd. 4904 (Takilma Rd.) ~25 m S of Oregon border, and ~100 m SE of Dunn Creek and East Fork Illinois River confluence (41.999607°N, 123.622459°W; NAD 83). 11 October 2011. Bradford R. Norman and Alan D. Barron. Verified by Jens V. Vindum. Department of Herpetology, California Academy of Sciences (CAS 250101). First county record and northwestern-most record in California (Feldman and Hoyer 2010. Copeia 2010:254–267). Specimen fills a gap in the distribution of *C. longicaudae* in the Coast Ranges along the far northwest of California (Feldman and Hoyer 2010, *op. cit.*). The nearest specimen records are: 92 km NW, near South Fork Elk River, Curry Co., Oregon (UTA 24547, 24548), and 76 km S, at Fish Lake, Humboldt Co., California (HSU 470) (Feldman and Hoyer 2010, *op. cit.*; Hoyer et al. 2006. Northwest. Nat. 87:195–202). There is also reliable site record (no voucher) only 10 km N of the Oregon border (but 48 km WNW of CAS 250101), outside of Harbor, Curry Co., Oregon (Hoyer et al. 2006, *op. cit.*).

Along the western slope of the Coast Ranges, *C. longicaudae* typically occupies mixed evergreen forest dominated by Douglas Fir (*Pseudotsuga menziesii*) and Coast Redwood (*Sequoia sempervirens*), but can also be found in relatively open woodlands and forest clearings with mixed conifer and oak (*Quercus* sp.) overstories (Feldman and Hoyer 2010, *op. cit.*). Such habitat is common in northwestern California, suggesting the range of *C. longicaudae* is contiguous in this region.

Voucher specimen collected under California Department of Fish and Game license #D-0000628290-7 (to BRN); photographs of the specimen alive (by ADB) are hosted at http://www.californiaherps.com/snakes/pages/c.longicaudae.html.

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***CROTALUS HORRIDUS* (Timber Rattlesnake)**. USA: GEORGIA: Baldwin Co.: Browns Crossing Road NW (33.074277°N 83.377750°W; WGS84). 8 September 2011. Dennis Parmley. GCH 5429. Verified by John Jensen. Within expected range, but first county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). Single adult collected DOR on road flanked by pine/deciduous forest.

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***DIADOPHIS PUNCTATUS* (Ring-Necked Snake)**. USA: INDIANA: Fountain Co.: Portland Arch Nature Preserve (40.219310°N, 87.337699°W; WGS 84). 05 May 2007. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50143 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***FARANCIA ABACURA* (Red-bellied Mudsnake)**. USA: ALABAMA: Crenshaw Co.: DOR on Crenshaw County Rd. 59, 6 km N of Luverne at Turkey Creek (31.77430°N, 86.21927°W; WGS 84). 06 June 2011. S. Graham. Verified by Craig Guyer. AUM 39513. New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 347 pp.).

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***GEOPHIS DUGESI* (Chihuahuan Earth Snake)**. MÉXICO: SONORA: Municipio de Bacadéhuachi: Sierra Bacadéhuachi, Rincón de Guadalupe, Arroyo Campo los Padres (Río Riíto drainage), 16.5 km (by air) ENE of Bacadéhuachi (29.844444°N, 108.976944°W; NAD 27), 1680 m elev. 5 September 2011. David Bygott and Robert A. Villa. Verified by Erik F. Enderson. UAZ 57369-PSV. First record for the municipality and third for the state, extending the known range 166 km NNW of the closest known locality at Yécora (Recchio et al. 2007. Herpetol. Rev. 38:103–104). The snake was foraging at ca. 2300 h in a rocky montane canyon on a rocky road cut next to a stream, after sporadic daytime rains, in a sycamore-Arizona Cypress riparian forest surrounded by pine-oak forest.

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***IMANTODES LENTIFERUS* (Blunt-Headed Tree Snake, Dormideira)**. BRAZIL: ACRE: Sena Madureira, BR-364 highway, km 124, Ramal do 15, km 03, Fazenda Matão (9.151528°S, 68.543167°W, WGS84; elev. 154 m). 28 October 2011. P. R. Melo-Sampaio and J. M. L. Maciel. Herpetological Collection, Universidade Federal do Acre, Rio Branco, Acre, Brazil (UFAC 0372 found moving on branches, above small temporary pond in forest edge 2200 h). Verified by M. B. Souza. Species previously known from Iquitos, Peru (Dixon and Soini 1986. The Reptiles of the Upper Amazon Basin, Iquitos Region, Peru. Milwaukee Public Museum, Milwaukee. 154 pp.), eastern Pará, Brazil (Cunha and Nascimento 1978. Ofídios da Amazônia. Mus. Par. Emílio Goeldi Publ. Avuls. 31:1–218), and Rondônia state, Brazil (Jorge-da-Silva 1993. Herpetol. Nat. Hist. 1:37–86). First state record extends the known distribution to Acre state ca. 570 km W from Samuel – Rondônia (Jorge-da-Silva, *op. cit.*).

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***LAMPROPELTIS GETULA* (Common Kingsnake)**. USA: GEORGIA: Taliaferro Co.: GA-22 (33.604346°N, 82.923750°W; WGS 84). 21 October 2010. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50135 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***LAMPROPELTIS GETULA* (Common Kingsnake)**. USA: GEORGIA: Whitfield Co.: Heritage Point Park, (37.794705°N, 4.936594°W). 10 May 2010. Chris Manis. Verified by John Jensen. University of Tennessee at Chattanooga Museum of Natural History (UTC Digital Collection-4668TPW-GMU). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***NERODIA SIPEDON* (Northern Watersnake)**. USA: GEORGIA: Franklin Co.: Victoria Bryant State Park (34.297397°N, 83.159190°W; WGS 84). 24 September 2012. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50160 photo voucher); New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp).

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***OPHEODRYS AESTIVUS* (Rough Green Snake)**. USA: TENNNESSEE: Maury Co.: Chickasaw Trace County Park on Santa Fe Pike at approximately trail mile 3.5 (35.667739°N, 87.080534°W; WGS 84). 20 October 2011. Nicole Foster. Verified by A. Floyd Scott. Austin Peay State University (APSU 19184). New county record (Scott and Redmond 2008 [latest update: 08 November 2011]. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available at http://apsu.edu/reptatlas/, accessed 20 October 2011).

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***PORTHIDIUM VOLCANICUM* (Costa Rican Hog-nosed Pitviper)**. PANAMÁ: CHIRIQUÍ: Distrito Boquete: Boquete Equestrian Club, 15 km S Boquete (8.694857°N, 82.4496567°W; WGS 84), ca. 1000 m elev. 8 June 2010. Jessica Van den Burgh. Verified by J. A. Campbell. UTADC 6801–6806 (single specimen). First verified record from Panama, extending the range ca. 125 km SE of the closest known locality, Ujarrás de Buenos Aires, Costa Rica (Solórzano 1994. Rev. Biol. Trop. 42:695–701). According to Campbell and Lamar (2004. The Venomous Reptiles of the Western Hemisphere, 2 vols. Comstock Publ. Assoc., Cornell Univ. Press, Ithaca, New York. xviii + 870 pp.), old records representing *P. lansbergii* from Chiriquí, Panamá probably represent *P. volcanicum*. The snake was inadvertently killed by a weed whacker.

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***RAMPHOTYPHLOPS BRAMINUS* (Brahminy Blindsnake)**. USA: FLORIDA: Clay Co.: Keystone Heights, Jasmine Avenue near Keystone Lake (29.781319°N, 82.03615°W, WGS84; elev. 37 m). Benjamin K. Atkinson. 8 February 2012. Florida Museum of Natural History (UF 166510). Verified by Max A. Nickerson. New county record, expanding the known distribution of this fossorial, nonnative, parthenogenetic species. Extends the range 30 km NE of the nearest known locality in Alachua Co., Florida (Meshaka 2011. A Runaway Train in the Making: The Exotic Amphibians, Reptiles, Turtles, and Crocodilians of Florida. Monograph 1. Herpetol. Conserv. Biol. 6:1–101) and 70 km SW of a solitary record in Duval Co., Florida (Krysko et al. 2011. Atlas of Amphibians and Reptiles in Florida. Final report, Project Agreement 08013, Florida Fish and Wildlife Conservation Commission, Tallahassee. 524 pp.). Adult female found alive on residential sidewalk at 1200 h.

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***REGINA SEPTEMVITTATA* (Queen Snake)**. USA: GEORGIA: Franklin Co.: Starr's Bridge Road near GA-51 (34.322426°N, 83.183005°W; WGS 84) 24 September 2012. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50162 photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp).

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***REGINA SEPTEMVITTATA* (Queensnake)**. USA: INDIANA: Boone Co.: Lion's Park (39.948807°N, 86.255936°W; WGS 84). 12 May 2011. Todd Pierson. Verified by Elizabeth McGhee. Georgia Museum of Natural History (GMNH 50136 photo voucher). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. xiv + 404 pp.).

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***RHADINAEA LAUREATA* (Crowned Graceful Brownsnake)**. MÉXICO: CHIHUAHUA: Municipio de Bocoyna: near km 86 on Hwy 25 N of Creel (27.789694°N, 107.651972°W; NAD 27), 2355 m elev. 12 July 2008. Robert W. Bryson, Jr. and Mike Torocco. UAZ 57331-PSV. Municipio de Guadalupe y Calvo: ca.1 km N of Baborigame (26.425975°N, 107.268522°W; NAD 27), 1800 m elev. 10 October 2008. Ricardo Ramírez-Chaparro and Jesús Enrique-Fuentes. UAZ 57321-PSV. Both specimens verified by Irene Goyenechea and Charles W. Myers. These are first records for Chihuahua and their respective municipalities and are located ca. 154 longitudinal km from each other; UAZ 57331-PSV is the northernmost record for the species. They are positioned 460 and 312 straight-line km, respectively, NW from the closest known locality at Laguna del Progresso, Durango (Myers 1974. Bull. Am. Mus. Nat. Hist. 153:1–262). Both snakes were found in pine-oak woodlands on the Sierra Madre Occidental.

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RHADINAEA MONTANA **(Nuevo León Graceful Brown Snake)**. MÉXICO: TAMAULIPAS: Municipality of Gómez Farías: road from La Gloria-Las Palmas (23.0710°N, 99.1420°W; WGS84), 1900 m elev. 8 July 1996. Fernando Mendoza-Quijano. MZFC 8528. Verified by Luis Canseco-Márquez. First state record, extending its known range ca. 103 km (airline) NW from the closet locality at Sierra Nevada, Municipality of Zaragoza, Nuevo León, México (Lazcano et al. 2004. Bull. Chicago Herpetol. Soc. 39:181–187). The snake was found under a fallen tree trunk in pine forest.

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SIBYNOPHIS COLLARIS **(Collared Black-headed Snake)**. BANGLADESH: SYLHET DIVISION: Moulovibazaar District: Lawachara National Park (24.330963°N, 91.801120°E; WGS 84; ca. 50 m elev.). Two individuals found during day on leaf litter in mixed evergreen forest. 10 August 2011 and 5 November 2011. Five roadkilled individuals also found on former Dhaka-Sylhet highway, dissecting Lawachara National Park. Verified by Gernot Vogel. Herpetology Laboratory, Department of Environmental Science and Managment, Independent University of Bangladesh (SESM 003). First country record for Bangladesh. Nearest populations recorded from Bumdeling Wildlife Sanctuary, Bhutan (Wangyal 2011. Herpetol. Rev. 42:117–122; Meghalaya, India (Gray 1853. Ann. Mag. Nat. Hist. [2] 12:386–392); and Assam, India (Ahmed at al. 2009. Amphibians and Reptiles of Northeast India. A Photographic Guide. Aaranyak, Guwahati. 168 pp.).

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SISTRURUS CATENATUS TERGEMINUS **(Western Massasauga)**. USA: TEXAS: Taylor Co.: 58 km SW of Abilene (32.113805°N, 100.125419°W; WGS 84). 28 July 2004. Thomas E. Lee, Jr. Abilene Christian University Natural History Collection (ACUNHC 01521). Verified by Allen Landwar. New county record (Dixon 2000. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas. 260 pp.). This record fills a gap in the distribution of Southern Rolling Plains Western Massasauga among the most proximal counties: Jones, Runnels, Coleman, Shackelford, and Nolan. The Taylor Co. specimen was taken from a pocket gopher burrow in sandy soils.

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STORERIA OCCIPITOMACULATA **(Red-bellied Snake)**. USA: INDIANA: Pike Co.: Pike State Forest: (38.344827°N, 86.162614°W; NAD 83). 6 June 2010. Michael Lodato. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2012a). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed. Indiana Academy of Science. vii + 404 pp.). Gravid female found on secondary road traversing mature forest.

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TANTILLA CORONATA **(Southeastern Crowned Snake)**. USA: GEORGIA: Talbot Co.: Found under a rock on top of an unnamed ridge, 1.5 km S of State Rt. 208, 3 km W of Talbotton (32.67420°N, 84.58326°W; WGS 84). 15 February 2012. S. Graham and D. Olive. Verified by Craig Guyer. AUM AHAP-D 498 (digital photo voucher). New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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THAMNOPHIS CYRTOPSIS **(Black-necked Gartersnake)**. USA: ARIZONA: Navajo Co.: Petrified Forest National Park (PEFO), (34.812093°N, 109.868271°W; NAD 83). 29 Aug. 2006. M. Wilkerson. University of New Mexico, Museum of Southwestern Biology (MSB 79534). A second specimen (MSB 79527) was found in the park in 2011. Both verified by Tom Giermakowski. First records for the species in PEFO (Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 150 pp.).

Although there are scattered records from the lower edge of the Colorado Plateau these specimens constitute the first records for the species in PEFO. The park has been heavily surveyed for herpetofauna for over 15 years and in an area where there is little to no persistent water (Drost et al. 2001. *In* Proceedings of the Fifth Biennial Conference of Research on the Colorado Plateau, pp. 83–102. U.S. Geological Survey Report Series USGSFRESC/COPL/2001/24). Both specimens were juveniles collected DOR during night-time road cruising surveys on the main park loop road.

Both specimens were collected by PEFO Resource Management personnel and are on loan to the MSB under accession number PEFO-00922, and catalog numbers PEFO 36599 and 36600.

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THAMNOPHIS RADIX **(Plains Gartersnake)**. USA: NEBRASKA: Gosper Co.: 5.0 km S, 1.0 km W Bertrand (40.4803°N, 99.6448°W; NAD 83). 14 July 2011. Alyx R. Lingenfelter, Dustin J. Casady, and Mallory Irvine. Verified by Curtis J. Schmidt. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas (FHSM 15853). First county record. Fills in gap in south-central parts of the state with the nearest published records from Dawson, Frontier, and Phelps counties (Ballinger et al. 2010. Amphibians and

Reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona. 400 pp.; Fogell 2010. A Field Guide to the Amphibians and Reptiles of Nebraska. University of Nebraska, Lincoln. vi + 158 pp.). Captured in a funnel trap set near a waterway in the Peterson Federal Waterfowl Production Area dominated by Smooth Brome (*Bromus inermis*) with scattered milkweed (*Asclepias* spp.), Dogbane (*Apocynum cannabinum*), and ragweed (*Ambrosia* spp.).

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***THAMNOPHIS RUFIPUNCTATUS* (Narrow-headed Gartersnake).** USA: ARIZONA: Yavapai Co.: Prescott National Forest, Verde River (34.87971°N, 112.30856°W, NAD 83). 9–10 September 2010 and 10 August 2011. Iain D. Emmons and Erika M. Nowak. Verified by George Bradley. University of Arizona Museum of Natural History. Digital photo vouchers (UAZ 57396-PSV, 57397-PSV, 57398-PSV). Range extension (Holycross et al. 2006. Surveys for *Thamnophis eques* and *Thamnophis rufipunctatus* in the Gila River Watershed of Arizona and New Mexico. Final report to Arizona Game and Fish Department). These specimens represent a new western boundary of the known geographic distribution of *T. rufipunctatus*, and extend the range 10 km SW of the closest unvouchered sightings and 24 km W of the last vouchered sighting from the upper Verde River watershed in 2001 (ASU HP-00016).

One adult female was captured in a Gee minnow trap on the edge of the main river channel, and one neonate male was captured by hand on the edge of a backchannel pool in 2010. One subadult female was captured in a Gee minnow trap on the edge of a river side channel, and one neonate was seen but not captured on the edge of the main river in 2011.

Thamnophis rufipunctatus has suffered dramatic population declines and fragmentation throughout its range (Holycross and Brennan 2006. Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 150 pp.; Hibbitts et al. 2009. Southwest. Nat. 54:461–467) and the species is currently undergoing a status review pursuant to federal listing by the U.S. Fish and Wildlife Service. Recent surveys of historical localities in the upper Verde River watershed have failed to produce any sightings (Holycross et al. 2006, *op. cit.*; Emmons et al. 2011. 2010 Riparian Herpetofauna Surveys. Unpubl. final report to Prescott National Forest). Recent genetic analysis suggests divergence between disjunct populations in the United States and Mexico (Wood et al. 2011. Mol. Ecol. 20[18]:3856–3878). In this conservation context, the range extension provides a significant distribution record for the species.

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***THAMNOPHIS SAURITUS* (Eastern Ribbonsnake).** USA: NORTH CAROLINA: Haywood Co.: Canton (35.4322°N, 82.8121°W; WGS 84; elev. 898 m). 18 September 2011. Candace Little. Verified by Jeff Beane. North Carolina State Museum Natural Sciences (12717, photo voucher). New county record (Palmer and Braswell 1995. Reptiles of North Carolina. University of North Carolina Press, Chapel Hill, North Carolina. xiii + 412 pp.). This record extends the range 36 km N of nearest record in Transylvania Co. (Palmer and Braswell 1995, *op. cit.)*.

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***THAMNOPHIS SIRTALIS* (Eastern Gartersnake)** USA: ALABAMA: Crenshaw Co.: AOR on U.S. Hwy 29, 3 km SW Dozier (31.47312°N, 86.38808°W; WGS 84). 29 May 2011. S. Graham. Verified by Craig Guyer. AUM AHAP-D 306 (digital photo voucher). New county record (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Printing Co., Auburn. 347 pp.).

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***UROTHECA GUENTHERI* (Striped Glass-tailed Snake).** PANAMÁ: PANAMÁ: Distrito de Panamá: Cerro Azul, Parque Nacional Chagres, in backyard of Autoridad Nacional del Ambiente field station (ca. 9.195328°N, 79.401664°W; WGS 84), 680 m elev. 28 July 2009. Ángel Sosa and Jorge Guerrel. Verified by Gerardo Chaves Cordero. MVUP 2092. First record for the Province of Panamá, extending its distributional range approximately 100 km (airline) NE from La Mesa area, trail to Las Minas, El Valle, Coclé. Previously known only from four specimens in different localities of western Panamá (Lotzkat et al. 2010. Herpetol. Rev. 41:520–523; Myers 1974. Bull. Amer. Mus. Nat. Hist. 153:1–262). The snake was found at night in an open grassy area.

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The Second Known Contact Zone Between *Plethodon websteri* and *P. ventralis*, and Additional Records for Bibb County, Alabama, USA

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Bibb County, Alabama is situated at an interesting physiographic crossroads, and as a result has a rich and diverse herpetofauna (Mount 1975). The northern half of the county is the southwestern terminus of the Ridge and Valley physiographic province, and the southern half is below the Fall Line and is comprised of Coastal Plain soils and sandhills. Bibb County has experienced extensive herpetological collections, which have documented interesting disjunct populations of species associated with the lower Coastal Plain (e.g., *Micrurus fulvius*, *Pseudacris ornata*, *Anaxyrus quercicus*). We conducted a bioblitz competition (see Graham et al. 2007) to obtain additional records. Most searching took place within the Cahaba River National Wildlife Refuge (CRNWR) or Talladega National Forest (TNF). While researching this note, we discovered specimens in the AUM collections that represent unpublished, noteworthy records, and include them here.

Attempts were made to extend the range of species known from other areas of the Ridge and Valley and Cumberland Plateau (e.g., *Eurycea lucifuga*, *Aneides aeneus*, *Lithobates palustris*). Despite extensive searching, presence of appropriate habitat (limestone outcrops and crevices), and moist conditions, we were unable to locate these species. We also attempted to assess the current status of Bibb County Coastal Plain disjuncts, particularly the inhabitants of Ashby Pond, an historical collection site for *Ambystoma tigrinum*, *Pseudacris ornata*, and *Anaxyrus quercicus* (AUM collections). This pond was located and sampled thoroughly, but we failed to confirm the presence of any of these species.

All new records were verified by Craig Guyer or confirmed by molecular methods. Unless otherwise noted, all GPS datums are WGS 84.

CAUDATA — SALAMANDERS

***DESMOGNATHUS AENEUS* (Seepage Salamander).** FS 726/FS 715 intersection in TNF; gum swamp and beaver pond 400 m SW of intersection (32.906922°N, 87.392005°W). 04 April 2009. AUM 34910–34912. The presence of *D. aeneus* in Bibb County was previously questionable. Mount (1975) illustrates a locality on the Bibb County/Tuscaloosa County line. Mount's range maps for *Desmognathus* sp. were largely derived from Folkerts (1968), so this locality was presumably based on specimens contained in the CMNH, since no specimens from Bibb County are found in any other museum that Folkerts consulted (Folkerts 1968). Harrison (1992) and Harrison (2005) did not include Bibb County within the range of *D. aeneus*, possibly due to the lack of precise locality data for the CMNH specimens (Herpnet query). We include this as a valid county record to eliminate ambiguity.

***PLETHODON VENTRALIS* (Southern Zigzag Salamander).** CRNWR; seepage in ravine 400 m W of Cahaba River (33.065079°N, 87.087198°W). 04 April 2009. S. Graham. AHAP-D 218; GENBANK accession # GQ 464404 (See below for method of verification).

***PLETHODON WEBSTERI* (Webster's Salamander).** CRNWR; ravine E of Cahaba River (33.071646°N, 87.073708°W). 21 March 2009. S. Graham and K. Gray. AHAP-D 219; GenBank accession # GQ464403. The presence of a small *Plethodon* species in Bibb County was noted by Mount (1975), who treated it as *P. dorsalis*. Specimens from this county were not examined by Highton in his description of the cryptic species *P. websteri* (Highton 1979), and therefore specimens from this county are not currently assignable to either species. Specimens collected in different areas (~ 1.5 km apart) of CRNWR appeared different morphologically and we therefore undertook efforts to utilize molecular confirmation of their species assignment. Specimens were verified using the mitochondrial marker *cytochrome b* (~850bp) and compared against GenBank sequence data for small *Plethodon* species (DQ994903, DQ994904, DQ994913, DQ994930 DQ994980, DQ994981, DQ994982, DQ994993, DQ994994, DQ994996; Wiens et al. 2006). Results conclude that samples collected from different localities within the CRNWR are in fact two different species, *P. ventralis* and *P. websteri*. This locality represents the second known zone of sympatry for *P. websteri* and *P. ventralis*. The other known contact zone is ~ 80 km NE in adjacent Jefferson County, an interesting site in which the species exhibit character displacement in color pattern and have a similarly narrow contact zone (< 1 km; Highton 1985). Although

we found no firm evidence of character displacement at CRNWR (most specimens appeared to be striped morphs), we found that specimens identified as *P. websteri* occurred on the east side of the Cahaba River, and specimens of *P. ventralis* occurred on the west side. More work is needed to confirm if this is another case of a *Plethodon* species pair found at a contact zone with a stream as a geographical barrier (e.g., Highton 1995).

TESTUDINES — TURTLES

***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)**. Cahaba River below Centreville. No date. J. Dobie. AUM 29574.

***MACROCHELYS TEMMINCKII* (Alligator Snapping Turtle)**. Cahaba River near Centreville. No date; 1996. J. Godwin. AUM 37814.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. Trapped in slough along Harrisburg Rd. E of bridge over Cahaba River (32.855105°N, 87.196347 °W). 03 April 2009. S. Graham. AHAP-D 212–213.

***TERRAPENE CAROLINA* (Eastern Box Turtle)**. CRNWR, intermittent stream W of Cahaba River (33.091849°N, 87.066746°W). K. Nelson. 21 March 2009. AHAP-D 245.

***TRACHEMYS SCRIPTA* (Pond Slider)**. Trapped in pond at Cahaba River Park in Centreville (32.950533°N, 87.138352°W). 03 April 2009. S. Graham. AHAP-D 216.

SQUAMATA — LIZARDS

***ASPIDOSCELIS SEXLINEATUS* (Six-lined Racerunner)**. CRNWR; E side of Cahaba River near abandoned strip mine (33.082142°N, 87.060367°W). 04 April 2009. M. Connell and D. Steen. AHAP-D 215.

SQUAMATA — SNAKES

***AGKISTRODON PISCIVORUS* (Cottonmouth)**. CRNWR; 100 m N of Bibb County Rd. 24 (33.099975°N, 87.061766°W). 21 March 2009. K. Gray. AHAP-D 211. Found decapitated.

***CARPHOPHIS AMOENUS* (Eastern Wormsnake)**. CRNWR; Mesic slope NE of Caffee Creek, 0.3 km W of Cahaba River (33.079353°N, 87.073791°W). 21 March 2009. M. Connell. AHAP-D 210.

***PANTHEROPHIS GUTTATUS* (Red Cornsnake)**. TNF; Hilltop 0.16 km S of FS 718, 0.66 road km E of intersection with FS 726. (32.919167°N, 87.386944°W). 04 April 2009. K. Nelson. AHAP-D 209. NE corner of wildlife food plot, under fallen bark at base of dead pine snag.

***THAMNOPHIS SAURITUS* (Eastern Ribbonsnake)**. TNF; beaver pond 1.5 km SW of FS 726/FS 715 intersection along FS 715 (32.903290°N, 87.402926°W). 04 April 2009. S. Graham and K. Gray. AHAP-D 214.

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New and Updated County Records for Amphibians and Reptiles in Minnesota

The following entries are either new county records or updates of previously reported specimens collected prior to 1961 as cited in Oldfield and Moriarty (1994), Moriarty (1996), and Gamble and Moriarty (2006). A new state record is reported for Minnesota, *Sternotherus odoratus*. *Sternotherus odoratus* could naturally occur in Minnesota, including the Zumbro River (Casper 1996, 1997; Oldfield and Moriarty 1994). However, the circumstances surrounding the two specimens found in Rochester make the notion of their natural origins seem unlikely. They were located near an area where *Trachemys scripta* was introduced, and I have witnessed *Sternotherus odoratus* for sale at

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local area pet retailers. All records are photo vouchers deposited in the James Ford Bell Museum of Natural History (JFBM) and all accession numbers are preceded by the letter "P." All photos were verified by Ben Lowe.

CAUDATA — SALAMANDERS

***AMBYSTOMA LATERALE* (Blue-spotted Salamander).** Carver Co.: Minnesota Landscape Arboretum (44.85697°N, 93.60948°W; WGS 84). 5 May 2007. New county record. Julia L. Bohnen and Matt Schuth. JFBM P320.

***NOTOPHTHALMUS VIRIDESCENS* (Eastern Newt).** Beltrami Co.: Lindgren Lake (47.66724°N, 94.54599°W; WGS 84). 5 July 2002. New county record. Jeffrey B. LeClere. JFBM P321a,b.

ANURA — FROGS

***ANAXYRUS (= BUFO) AMERICANUS* (American Toad).** Beltrami Co.: near County Road 22 N of Bemidji (47.59539°N, 94.86926°W; WGS 84). 2 July 2002. Updated county record. Jeffrey B. LeClere. JFBM P322.

***HYLA VERSICOLOR* (Gray Treefrog).** Beltrami Co.: County Road 22 near jct with 15 (47.59890°N, 94.88226°W; WGS 84). 3 July 2002. Updated county record. Jeffrey B. LeClere. JFBM P323.

***LITHOBATES (= RANA) PIPIENS*. (Northern Leopard Frog).** Beltrami Co.: Tower Rd NE near Turtle Lake (47.63435°N, 94.85591°W; WGS 84). 3 July 2002. Updated county record. Jeffrey B. LeClere. JFBM P324

***LITHOBATES (= RANA) SEPTENTRIONALIS*. (Mink Frog).** Beltrami Co.: Fox Lake (47.59891°N, 94.84497°W; WGS 84). 5 July 2002. Updated county record. Jeffrey B. LeClere. JFBM P325.

***LITHOBATES (= RANA) SYLVATICUS* (Wood Frog).** Beltrami Co.: On County Road 22 near jct with 15 (47.59891°N, 94.88152°W; WGS 84). 3 July 2002. Updated county record. J. B. LeClere. JFBM P327.

TESTUDINES — TURTLES

***CHRYSEMYS PICTA* (Painted Turtle).** Beltrami Co.: near County Road 22 N of Bemidji (47.59524°N, 94.86856°W; WGS 84). 5 July 2002. New county record. Jeffrey B. LeClere. JFBM P328.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)** Olmsted Co.: Two specimens trapped in the Zumbro River close to Silver Lake in downtown Rochester (44.03018°N, 92.45730°W; WGS 84). July 2003. Quarry Hill Nature Center staff. JFBM P329a,b. New state record, likely introduced.

***TRACHEMYS SCRIPTA* (Pond Slider).** Olmsted Co.: Quarry Hill Nature Center (44.03227°N, 92.42530°W). May 2004. Quarry Hill Nature Center staff. JFBM P330a,b. First state record. Introduced. Hennepin Co.: Webber Park Pond (45.03432°N, 93.29215°W). Introduced. 1 August 2008. Jared Rypka-Hauer. JFBM P331.

SQUAMATA – SNAKES

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake).** Isanti Co.: 2 mi N of Isanti next to Rum River (45.52418°N, 93.25332°W; WGS 84). 12 July 2009. Updated county record. Thomas K. Boysen. JFBM P332a-f.

***PANTHEROPHIS VULPINUS* (Western Foxsnake).** Rice Co.: Riverbend Nature Center in Faribault (44.27894°N, 93.24083°W; WGS 84) 6 June 2008. Updated county record. Jamie Pastika. JFBM P334.

***STORERIA OCCIPITOMACULATA* (Red-bellied Snake).** Beltrami Co.: just N of Fox Lake (47.61489°N, 94.84476°W; WGS 84). 5 July 2002. Updated county record. Jeffrey B. LeClere. JFBM P335.

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New Amphibian and Reptile County Records for Eight Counties in East Tennessee, USA

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The following is a report for new county records for eight counties in East Tennessee. There are several counties in this region that lack distribution records for common and rare amphibian and reptile species. Since 2004, biologists from the Tennessee Wildlife Resources Agency (TWRA) have been conducting nongame surveys across the state collecting species occurrence data on public and private lands. Several TWRA Wildlife Management

Areas (WMAs) were intensively inventoried following protocols written in the State Wildlife Action Plan (SWAP). Specimen localities were determined by using a Garmin or Magellan handheld global positioning unit (GPS) based on map datum WGS 84 with the decimal degree position format. Photo vouchers were verified by A. Floyd Scott and deposited in the Austin Peay State University (APSU) collection in Clarksville, Tennessee. The taxonomy used here follows Crother et al. (2008). All specimens are new county records based on Redmond and Scott (1996, 2008). Collector was Sterling D. Daniels unless otherwise noted.

CAUDATA — SALAMANDERS

***AMBYSTOMA OPACUM* (Marbled Salamander)**. Campbell Co.: Titus Creek drainage of the North Cumberland WMA, 80 m below Rector Cemetery (36.36695°N, 84.25163°W). 5 November 2008. APSU 19090. Adult specimen found under a wooden coverboard.

***AMBYSTOMA TIGRINUM* (Eastern Tiger Salamander)**. Jefferson Co.: Henderson Island Refuge at the end of Nichols Ferry Road, Dandridge (35.99426°N, 83.42632°W). 26 February 2008. Sterling D. Daniels, Scott A. Dykes, Tony Hickle, Chris Ogle, Bob Robertson, and R. L. Pete Wyatt. APSU 19114. Specimen was collected in the larger impoundment on the island adjacent to the drain. Twenty other adult individuals were captured.

***ANEIDES AENEUS* (Green Salamander)**. Union Co.: Whites Creek Road on Chuck Swan State Forest in Union County (36.33308°N, 83.92843°W). 28 May 2008. APSU 19115.

***EURYCEA LUCIFUGA* (Cave Salamander)**. Hancock Co.: Cave 20 m from the Clinch River off of Joe Alder Road on Kyles Ford WMA (36.56297°N, 83.04114°W). 10 October 2007. APSU 19158.

***NOTOPHTHALMUS VIRIDESCENS VIRIDESCENS* (Red-spotted Newt)**. Hancock Co.: Pond 500 m from the Clinch River on Kyles Ford WMA (36.58084°N, 83.01827°W). 10 October 2007. APSU 19093. Specimen was captured with a dip net.

***PLETHODON DORSALIS* (Northern Zigzag Salamander)**. Jefferson Co.: Henderson Island Refuge at the end of Nichols Ferry Road, Dandridge (35.99186°N, 83.42758°W). 25 October 2007. APSU 19088. This specimen was found under a log below a small permanent pond. Hancock Co.: 60 m from Joe Alder Road on Kyles Ford WMA (36.56297°N, 83.041114°W). 30 March 2009. APSU 19151. Found under a rock adjacent to a barn.

***PLETHODON GLUTINOSUS* (Northern Slimy Salamander)**. Hancock Co.: 100 m from Joe Alder Road on Kyles Ford WMA (36.56297°N, 83.041114°W). 30 March 2009. APSU 19097. This specimen was captured under a piece of tin.

***SIREN INTERMEDIA NETTINGI* (Western Lesser Siren)**. Campbell Co.: Cove Lake State Park 80 m from Old Hwy 63 (36.30405°N, 84.22266°W). 2 April 2009. Sterling D. Daniels, Scott A. Dykes, Randy Wolfe, R. L. Pete Wyatt. APSU 19104. 24 adults and 6 juveniles were collected.

ANURA — FROGS

***ANAXYRUS AMERICANUS* (American Toad)**. Claiborne Co.: Pond 15 m from Little Creek Road on private land (36.57699°N, 83.53673°W). 10 October 2007. APSU 19095. Hancock Co.: 150 m from the W side of Horton Ford Road on Kyles Ford WMA (36.58084°N, 83.01827°W). 14 April 2009. APSU 19111. Specimen was captured in a mitigation zone after it was heard calling.

***GASTROPHRYNE CAROLINENSIS* (Eastern Narrow-mouthed Toad)**. Greene Co.: 500 m from Oakwood Road on Lick Creek WMA (36.58084°N, 83.01827°W). 8 October 2007. APSU 19094.

***HYLA CHRYSOSCELIS* (Cope's Gray Treefrog)**. Hancock Co.: 150 m from the W side of Horton Ford Road on Kyles Ford WMA (36.58084°N, 83.01827°W). 14 April 2009. APSU 19113.

***LITHOBATES CATESBEIANUS* (American Bullfrog)**. Campbell Co.: Vernal pool 150 m from Old Hwy 63 on North Cumberland WMA (36.36801°N, 84.23833°W). 15 July 2008. APSU 19087.

***LITHOBATES CLAMITANS MELANOTA* (Northern Green Frog)**. Claiborne Co.: Pond 15 m from Little Creek Road on private land (36.57699°N, 83.53673°W). 10 October 2007. APSU 19092. Hancock Co.: Pond 500 m from the Clinch River on Kyles Ford WMA (36.58084°N, 83.01827°W). 10 October 2007. APSU 19091.

***LITHOBATES SYLVATICUS* (Wood Frog)**. Claiborne Co.: Pond 200 m from Forge Ridge Road on private land (36.5801°N, 83.53017°W). 4 March 2008. APSU 19089.

***PSEUDACRIS CRUCIFER* (Spring Peeper)**. Hancock Co.: 150 m from the W side of Horton Ford Road on Kyles Ford WMA (36.58084°N, 83.01827°W). 14 April 2009. APSU 19112.

TESTUDINES — TURTLES

***CHRYSEMYS PICTA PICTA* (Eastern Painted Turtle)**. Greene Co.: Pond 500 m from South Mohawk Road on Lick Creek WMA (36.159115°N, 83.074530°W). 20 August 2009. APSU 19142. Three individuals were captured by hoop traps.

***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)**. Hancock Co.: Beneath Highway 70 Bridge on the Clinch River on Kyles Ford WMA (36.56935°N, 83.04093°W). 9 June 2010. APSU 19141

***GRAPTEMYS PSEUDOGEOGRAPHICA* (False Map Turtle)**. Hawkins Co.: 3.3 km upstream from Berry's Island Ecological Study Area at the end of Berry's Drive (36.31155°N, 83.19542°W). 4 November 2010. John Hammonds and Steve Henegar. APSU 19098. Specimen was caught by a TWRA fisheries crew in a trap net while sampling Cherokee Reservoir.

***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. Campbell Co.: Cove Lake State Park 80 m from Old Highway 63 (36.30405°N, 84.22266°W). 2 April 2009. Sterling D. Daniels, Casey Pittman, and Randy Wolfe. APSU 19143.

SQUAMATA — LIZARDS

***SCINCELLA LATERALIS* (Little Brown Skink)**. Campbell Co.: 300 m from Flatwoods Road on the Ollis Creek Trail on the North Cumberland WMA (36.37487°N, 84.22261°W). 12 April 2010. APSU 19108. Specimen was captured under a coverboard. Hawkins Co.: Spring ca. 300 m W of Kyle Valley Road on Kyles Ford

WMA (36.55151°N, 83.01342°W). 5 May 2009. APSU 19107. Specimen was found under a log.

SQUAMATA — SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead)**. Campbell Co.: Titus Creek drainage W of Interstate 75 on the North Cumberland WMA (36.36148°N, 84.23528°W). 26 June 2008. APSU 19099. Specimen was captured using a reptile funnel box located in a native warm season grass field. Hancock Co.: Hwy 63 just prior to Mulberry Gap (36.57438°N, 83.25282°W). 20 October 2009. APSU 19101. Unicoi Co.: adjacent to Flint Creek off of Rocky Fork Road on Rocky Fork WMA (36.07740°N, 82.56989°W). 19 May 2010. Sterling D. Daniels and Scott A. Dykes. APSU 19100.

***COLUBER CONSTRICTOR* (North American Racer)**. Hancock Co.: 100 m NE of Joe Alder Road on Kyles Ford WMA (36.56147°N, 83.04761°W). 15 April 2009. APSU 19146.

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. Campbell Co.: Titus Creek drainage W of Interstate 75 on the North Cumberland WMA (36.36148°N, 84.23528°W). 30 June 2008. APSU 19102. Hancock Co.: Hwy 33 S of Sneedville (36.49003°N, 83.32644°W). 8 October 2009. APSU 19103.

***LAMPROPELTIS GETULA* (Common Kingsnake)**. Claiborne Co.: Intersection of Hill Road and Little Creek Road (36.55569°N, 83.57195°W). 10 July 2010. APSU 19140.

***PANTHEROPHIS GUTTATUS* (Red Cornsnake)**. Hancock Co.: Intersection of Horton Ford Road and Hwy 70 on Kyles Ford WMA (36.56894°N, 83.03818°W). 20 October 2009. APSU 19106. Adult found in the roadway.

***PANTHEROPHIS SPILOIDES* (Gray Ratsnake)**. Hancock Co.: 100 m NE of Joe Alder Road on Kyles Ford WMA (36.56147°N, 83.04761°W). 14 April 2009. APSU 19144.

***STORERIA OCCIPITOMACULATA OCCIPITOMACULATA* (Northern Red-bellied Snake)**. Hancock Co.: Harris and Green Cemetery near Short Mountain (36.52036°N, 83.30878°W). 2 July 2011. Sterling D. Daniels, Dan Gibbs, and Ricky Harris. APSU 19145.

***THAMNOPHIS SIRTALIS SIRTALIS* (Eastern Gartersnake)**. Campbell Co.: Flatwoods road ca. 800 m past the Ollis Creek trail E of Interstate 75 on the North Cumberland WMA (36.30405°N, 84.22266°W). 10 July 2009. APSU 19105. Specimen was caught in an old field using a funnel trap.

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New County Records for Reptiles and Amphibians from South and Southeast Texas

The reptiles and amphibians of the state of Texas have been extensively studied (Dixon 2000; Werler and Dixon 2000). Nonetheless, there are still regions within Texas containing counties that have poorly documented herpetofauna (Dixon 2000). Herein we report 11 new county records for reptiles and amphibians from south and southeast Texas. Most of these records fill distributional gaps for common species.

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Our new findings indicate that *Eleutherodactylus cystignathoides* has a greater distribution in Texas than currently suggested in the scientific literature. This frog is thought to be native to the Rio Grande Valley in south Texas, but has been reported from geographically disjunct localities elsewhere in the state (Conant and Collins 1998; Dixon 2000). Because the county records we document for Jim Wells, Duval, and Kleberg counties are close to their native range, they may reflect recent range expansion, or a more widespread original distribution. A phylogeographic analysis of this species may prove useful for determining the limits of their native range and where they are invasive.

The following specimens were collected during March 2011. Geographic coordinates (WGS84) were obtained from a Garmin eTrex® handheld geographic positioning (GPS) unit. Specimens were deposited in the University of Texas at Arlington Amphibian and Reptile Diversity Research Center and all identifications were verified by Carl J. Franklin.

ANURA — FROGS

***ELEUTHERODACTYLUS CYSTIGNATHOIDES* (Rio Grande Chirping Frog)**. Duval Co.: town of San Diego (27.76846°N, 98.24720°W). 14 March 2011. Found under trash around an abandoned building. Christian L. Cox. UTA A 61031. New county record. Goliad Co.: ranch near town of Goliad (28.64176°N, 97.35498°W). 12 March 2011. Found under railroad ties in pasture adjacent to dry creek bed. Ruben U. Tovar. UTA A 60959–60961. New county record. Jim Wells Co.: town of Alice (27.72249°N, 98.09340°W). 14 March 2011. Found under trash in an abandoned lot. Utpal Smart. UTA A 61026–61028. New county record. Kleberg Co.: town of Kingsville (27.52993°N, 97.88897°W). 13 March 2011. Found in folds of plastic sheet near an abandoned building. Paul N. Pasichnyk. UTA A 60962–60963. New county record. Live Oak Co.: town of George West (28.32994°N, 98.11401°W). Found under board next to an abandoned trailer. 12 March 2011. Matthew A. Moseley. UTA A 60956–60958. New county record.

SQUAMATA — LIZARDS

***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. Duval Co.: town of San Diego (27.76846°N, 98.24720°W). 14 March 2011. Found on outskirts of town under bark on a fallen log. Christian L. Cox. UTA R 59354. New county record.

***ANOLIS CAROLINENSIS* (Green Anole)**. Bee Co.: town of Beeville (28.38935°N, 97.77164°W). 12 March 2011. Found under board leaning on an abandoned building. Christian L. Cox. UTA R 59351. New county record.

SQUAMATA — SNAKES

***SALVADORA GRAHAMIAE* (Eastern Patch-nosed Snake)**. Bee Co.: town of Beeville (28.38935°N, 97.77164°W). 12 March 2011. Found under trash in vacant lot in Beeville. Paul N. Pasichnyk. UTA R 59352. New county record.

***STORERIA DEKAYI* (DeKay's Brownsnake)**. Goliad Co.: ranch near town of Goliad (28.64176°N, 97.35498°W). 12 March 2011. Found under a board at the edge of a pasture next to a creek bed. Teddy Angarita-Sierra. UTA R 59353. New county record.

***TANTILLA GRACILIS* (Flat-headed Snake)**. Live Oak Co.: town of George West (28.32994°N, 98.11401°W). 20 January 2011. Found under boards next to a creek bed. Christian L. Cox. UTA-R 59301–59302. New county record.

***VIRGINIA STRIATULA* (Rough Earthsnake)**. Bee Co.: town of Beeville (28.38935°N, 97.77164°W). 12 March 2011. Found under an abandoned vacuum cleaner next to a burned field in outskirts of Beeville. Matthew A. Moseley. UTA R 59350. New county record.

Acknowledgments.— Our sincere appreciation is extended to Brett Mueller (Hensley Dos Ranch) for lodging and land access. We thank Carl J. Franklin for verifying identifications and curatorial assistance. We thank Toby J. Hibbitts for literature support in confirming county records, and Jeffrey W. Streicher for editorial assistance. All specimens were collected under the TPWD Permit SPR-0709-303 to Corey E. Roelke (C. L. Cox, sub-permittee). This trip was partially funded by an East Texas Herpetological Research Grant to C. L. Cox.

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New Geographic Distribution Records for Amphibians and Reptiles from Arkansas, USA

Since the publication of Trauth et al. (2004), a plethora of new geographic distribution records have been documented for various Arkansas herpetofauna. We here report 11 additional geographic (new county) records for two amphibians and eight reptiles from sites in Arkansas. Specimens were verified by Stanley E. Trauth, and vouchers were deposited in the Arkansas State University Herpetological Museum (ASUMZ), State University, Arkansas. Geocoordinates are based on datum WGS 84 and current common names follow Crother (2008).

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CAUDATA — SALAMANDERS

***AMBYSTOMA OPACUM* (Marbled Salamander)**. Pope Co.: 3.2 km SW of Pelsor off St. Hwy. 123 (35.773258°N, 93.073082°W). 20 April 2010. D. Allen. ASUMZ 31727. New county record that fills a distributional gap in the Arkansas River Valley.

ANURA—FROGS

***GASTROPHRYNE CAROLINENSIS* (Eastern Narrow-mouthed Toad)**. Baxter Co.: Junction of St. Hwy. 201 & 341 on 201

(36.224334°N, 92.289276°W). 16 April 2011. C. T. McAllister. ASUMZ 31728. Off county road 73 (Culp Road), vic. Culp (36.105976°N, 92.214287°W). 16 April 2011. C. T. McAllister. ASUMZ 31729. New county record that fills a hiatus between Fulton, Izard, Marion, and Stone counties. In addition, ASUMZ 31728 is a female measuring 38 mm in snout–vent length (SVL); this measurement equals a maximum SVL for *G. carolinensis* (Conant and Collins 1998; Trauth et al., *op. cit.*).

TESTUDINES — TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle)**. Johnson Co.: Clarksville, Clark Road (35.461833°N, 93.490733°W). 15 April 2010. J. Kremers. ASUMZ 31730 (photographic voucher). New county record that helps fill a distributional gap in the Arkansas River Valley.

SQUAMATA — LIZARDS

***PLESTIODON ANTHRACINUS* (Coal Skink)**. Baxter Co.: Off county road 73 (Culp Road), vic. Culp (36.105976°N, 92.214287°W). 16 April 2011. C. T. McAllister. ASUMZ 31735. New county record that fills a hiatus among Fulton, Izard, Marion, and Stone counties.

SQUAMATA — SNAKES

***AGKISTRODON PISCIVORUS LEUCOSTOMA* (Western Cottonmouth)**. Scott Co.: 3.2 km E of Waldron off St. Hwy. 80 (34.893816°N, 94.049149°W). 11 May 2010. E. Basehart. ASUMZ 31731. New county record filling a distributional gap in the western Ouachitas of the state.

***CARPHOPHIS VERMIS* (Western Wormsnake)**. Searcy Co.: 1.6 km NW of Leslie off US 65 (35.833263°N, 92.571144°W). 10 May 2010. J. Griffin. ASUMZ 31732. Yell Co.: Briggsville (34.933982°N, 93.494357°W). 27 April 2010. J. Kremers. ASUMZ 31733. New county records partially filling distributional gaps just north and south of the Arkansas River Valley, and among Newton and Stone counties, respectively.

***CEMOPHORA COCCINEA COPEI* (Northern Scarletsnake)**. Johnson Co.: Clarksville, 2019 Clark Road (35.461833°N, 93.490733°W). 5 May 2010. J. Kremers. ASUMZ 31736. New county record along the Arkansas River Valley.

***NERODIA RHOMBIFER RHOMBIFER* (Northern Diamond-backed Watersnake)**. Lincoln Co.: off St. Hwy 293 (Sorrels Ferry Rd.) at Cane Creek Lake (33.915123°N, 91.74983°W). 9 April 2011. C. T. McAllister. ASUMZ 31769 (photographic voucher). New county record in southeastern part of state among Desha and Jefferson counties.

***PANTHEROPHIS (=SCOTOPHIS) OBSOLETUS* (TEXAS RATSNAKE)**. Hot Spring Co.: off US 270 at Jones Mills, Smoky Ridge Rd. (34.437903°N, 92.875392°W). 15 June 2010. C. T. McAllister. ASUMZ 31792 (photographic voucher). New county record in central Arkansas among Garland and Grant counties; this snake has now been documented from 72 of 75 counties of the state (Robison 2006; Trauth et al., *op. cit.*).

***STORERIA DEKAYI WRIGHTORUM* (Midland Brownsnake)**. Johnson Co.: Clarksville, 2019 Clark Road (35.461833°N, 93.490733°W). 15 April 2010. J. Kremers. ASUMZ 31736. New county record between Franklin and Logan counties of the Arkansas River Valley.

Acknowledgments.—Thanks to S. E. Trauth (ASUMZ) for curatorial assistance and specimen verification, and J. Kremers for providing several vouchers. Specimens were collected under the authority of Arkansas Scientific Collecting Permits issued to CTM and HWR by the Arkansas Game and Fish Commission.

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NATURAL HISTORY NOTES

CAUDATA — SALAMANDERS

***PLETHODON CINEREUS* (Eastern Red-backed Salamander). MORPHOLOGY.** *Plethodon cinereus* is one of the most common salamanders in the Maritime Provinces of eastern Canada (Cook 1984. Introduction to Canadian Amphibians and Reptiles. National Museum of Natural Sciences, Ottawa. 200 pp.; Gilhen 1984. Amphibians and Reptiles of Nova Scotia. Nova Scotia Museum, Halifax. 162 pp.). There are three recognized color morphs: a deep red-striped back with black sides referred to as red-backed; a black pigmented back and sides, referred to as lead-backed; and the rarest of the three morphs, red with varying degrees of black mottling referred to as erythristic (Fig. 1). Morph frequencies in this species, which seem to be influenced by temperature, have attracted growing interest as a proxy for monitoring local and large-scale climate change (Gibbs and Karraker 2005. Conserv. Biol. 20:913–917). The lead-back morph is more closely associated with warmer, drier climates than the red-backed morph and erythristic individuals are reported to replace lead-back individuals at higher elevations (Gilhen 1984, *op. cit.*) There are apparently very few reports of the three morphs co-occurring (one site among 50 reported by Lotter and Scott 1977. Copeia 1977:681–690) and none from Maritime Canada (Cook and Bleakney 1961. Can. Field Nat. 75:53; Gilhen 1984, *op. cit.*). Recently, an area was discovered on 29 April 2011 with all three morphs in the Connecticut Audubon Society Croft Preserve in Goshen, Connecticut, USA (41.8926°N, 73.1914°W) (pers. comm., T. Leenders).

Odell Park is a 160-ha area of mature mixed hardwood and conifer forest situated in the city of Fredericton, New Brunswick, Canada, 20–100 m elev. Here all three morphs co-occur. Among 103 individuals observed in Odell Park between 6 May 2010 and 18 Sept 2011, red-backed morph was the most common (N = 85, 82.5%), followed by the erythristic morph (N = 11, 10.7%), with the lead-backed morph the least prevalent (N = 7, 6.8%). Four voucher specimens were collected from Odell Park and have been deposited in the New Brunswick Museum: two red-backed morphs (NBM 009072, 74), one lead-back morph (NBM 009073), and one erythristic morph (NBM 009071).

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***PLETHODON SERRATUS* (Southern Red-backed Salamander). CICADA BURROW USE.** *Plethodon serratus* is a lungless, terrestrial salamander that is dependent upon ambient moisture for its survival. When surface substrates dry, such as during the summer months or during drought periods, these salamanders must seek refuge in microhabitats with higher moisture content, including soils deeper underground. Although some salamanders have the capacity to dig their own burrows (Semlitsch 1983. Can. J. Zool. 61:616–620), this does not appear to apply to *Plethodon* salamanders (Heatwole 1960. Ecology 41:661–668). Instead, they utilize burrows created by other organisms (e.g., worms and beetles; Ransom 2011. Oecologia 165:745–754), or, as described by Heatwole (1960, *op. cit.*), use their heads as a wedge and force their bodies into cracks or small openings in the substrate by pushing with their feet, and in some instances, their tails.

The spring of 2011 was an emergence year for Brood XIX of the 13-year periodical cicada (Hemiptera: Cicadidae: *Magicicada* sp.) in south central Missouri. Cicada nymphs feed on tree roots at depths that can exceed 60 cm. They excavate and maintain underground burrows, which they abandon when they emerge at the soil surface and disperse in the late spring (Williams and Simon 1995. Annu. Rev. Entomol. 40:269–295), leaving behind abundant access to subterranean microhabitats at about the time *P. serratus* begin to seek underground refuge for the summer (Herbeck and Semlitsch 2000. J. Herpetol. 34:341–347). Annual, or "dog day" cicada nymphs (Hemiptera: Tibiceninae:

PHOTO BY TWAN LEENDERS

FIG. 1. The three morphs of *Plethodon cinereus*: red-backed, lead-backed, and erythristic.

FIG. 1. Adult *Plethodon serratus* encountered in a periodical cicada (*Magicicada* sp.) burrow during the Brood XIX emergence in May 2011 in south central Missouri, USA.

Tibicen sp.) emerge annually in late July and August, not long before *P. serratus* are detected utilizing surface habitats in the late summer/fall (Herbeck and Semlitsch 2000, *op. cit.*).

While conducting leaf litter surveys in the Ozark Mountains for terrestrial salamanders on 25 May and 27 Sept 2011 in the Sinkin Experimental Forest (US Forest Service), Dent Co., Missouri, USA, we encountered adults of *P. serratus* in burrows constructed by cicada nymphs. The salamander encountered in May slipped deeper into the periodical cicada burrow soon after detection, so we were unable to collect morphological data. The salamander encountered utilizing an annual cicada burrow in September was an adult male, 42 cm SVL (Fig. 1). Periodical cicada burrow densities in the spring ranged from 0.3–4.7/m^2 (mean = 1.5/m^2) and cicada burrow densities in the fall ranged from 0–3.1/m^2 (mean = 0.6/m^2) (Drake et al., unpubl. data).

We hypothesize that periodical cicada burrows greatly increase access to deeper subterranean microhabitats for terrestrial salamanders, and that greater access to more hospitable underground habitat via these burrows during inclement periods, such as seen in the summer or dry periods during other seasons, may result in increased survival into the fall.

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***PLETHODON WELLERI* (Weller's Salamander). NESTING LOCATION.** Few nests of *Plethodon welleri* have been found and all observations have been on Whitetop Mountain and Mount Rogers, Virginia, USA, at elevations ≥ 1585 m. Nests were located in surface crevices of downed, decaying logs of *Picea rubens* (Red Spruce) immediately below a layer of moss. Those with eggs were discovered in mid-August while nests with hatchlings were found in late August and early September. The number of eggs or hatchlings in nests ranged from 4–11 (Organ 1960. Copeia 1960:287–297; Hoffman et al. 1948. J. Washington Acad. Sci. 38:106–108).

We report a novel nest location from the north slope of Whitetop Mountain, Virginia at 1494 m. On 1 July 2011 we found a nest of *P. welleri* located in leaf litter composed of *Betula alleghaniensis* (Yellow Birch), *Fagus grandifolia* (American Beech), and *Acer pensylvanicum* (Striped Maple) 4.5 cm beneath the leaf litter surface. Eggs were found in leaves that had fallen from the previous year and were immediately above a layer of decomposed leaves. The nest was 3.5 cm from a downed, decaying Yellow Birch log that was 21 cm in diameter. A female *P. welleri* (35 mm SVL and 67 mm total length) was coiled around two eggs. The embryos had small limb buds.

Our observation documents the first nest of *P. welleri* in a location other than moss covered logs and provides support for the importance of leaf litter for this species. This nest had fewer eggs than had been previously documented. Embryos exhibited mid-term development indicating that deposition was complete and either egg predation had occurred or only two eggs were deposited (Organ 1960, *op. cit.*). Embryo development also suggests that the eggs were likely deposited in mid-June. Egg deposition dates have not been determined but have been suggested to occur in May or June and our observation provides evidence for this time period (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 587 pp.). This nest was 91 m lower than previously documented nests and in an area without *Picea rubens* which were the only logs in which Organ (1960, *op. cit.*) found nests.

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ANURA — FROGS

***ELEUTHERODACTYLUS CUNEATUS*. PREDATION.** During a one-year study of *Eleutherodactylus cuneatus* (Fong et al. 2010. Biotropica 42:348–354) we recorded three predation events by two different predators: crabs and spiders. The observations were made along a tributary of the Indio River (20.0°N, 75.6°W; NAD 27 Cuba datum) at La Gran Piedra, Santiago de Cuba province, Cuba.

On 18 Aug 2003 at 2024 h, we found a female freshwater crab (*Epilobocera cubensis* carapace length = 46 mm, carapace width = 68 mm) inside a burrow in the bank, on dry land, actively feeding on an adult *Eleutherodactylus cuneatus* (ca. 49.7 mm SVL). When discovered, the crab was pulling out pieces of the frog body, which was approximately half consumed. There was a large laceration on the frog's abdomen and the internal organs; the snout tip, one hind limb, and a half of other two limbs were missing. At 2000 h, water temperature was 20.0°C, air temperature was 21.1°C, and humidity was 94%. The frog was collected and deposited in the herpetological collection of the Centro Oriental de Ecosistemas y Biodiversidad (BIOECO), Santiago de Cuba (BSC.H 3460).

Later that night (at 0040 h), we witnessed a second freshwater crab (62 mm carapace width) consuming another adult *E. cuneatus* (>25 mm SVL). The crab was on dry land, 70 cm from the water's edge. The head of the frog had been eaten and the crab was grasping the prey with a chela and pulling out pieces of the frog with the other chela. The water temperature was 19.0°C, air temperature was 19.6°C, and humidity was 93%.

Although it was not possible to determine whether the frogs had been killed or merely scavenged by the crabs, injuries were consistent with crab predation and no other dead frogs were observed in ca. 8 h of survey in this stream. Predation by crabs is known in other anuran species, and includes egg, tadpole, and adult life stages (Gray and Christy 2000. Crustaceana 73:1023–1025; Hayes 1983. Biotropica 15:74–76;Ryan et al. 1981. Behav. Ecol. Sociobiol. 8:273–278). Considering the scarcity of papers reporting this event, it seems that crabs are opportunistic frog predators.

On 18 March 2004 at 1350 h, a female ctenid spider (*Ohvida vernalis*; 16.3 mm cephalothorax + abdomen length) was sighted motionless and camouflaged in the leaf litter, 137 cm away from the stream's edge, holding and biting a juvenile *E. cuneatus* (ca. 10 mm SVL). While we attempted to collect the spider, it released its prey and the frog escaped, taking refuge in the leaf litter before we could collect it. At 1524 h, the water temperature was 18.5°C, the air temperature was 20.7°C, and humidity was 89%. The spider was collected and deposited in the herpetological collection of the Centro Oriental de Ecosistemas y Biodiversidad (BIOECO), Santiago de Cuba (without a catalog number).

Frogs are common prey for spiders, as documented in recent reviews (Armas 2001. Rev. Ibérica Aracnología 3:87–88; Menin et al. 2005. Phyllomedusa 4:39–47; Toledo 2005. Herpetol. Rev. 36:395–400), but this is only the second record of spider predation on a Cuban frog (see Novo et al. 1985. Misc. Zool. 28:1–2).

Among the families of spiders, Ctenidae is one of the most frequently reported as an anuran predator (Menin et al. 2005, *op. cit.*); ctenids are ambush predators that catch prey on the ground (A. Sánchez, pers. comm.) hence increasing the opportunity of encounters with terrestrial frogs such as *E. cuneatus*.

This is the first study reporting predators of *E. cuneatus*, although Valdés de la Osa and Ruiz García (1977. Misc. Zool. 6:4) reported cannibalism in captive specimens of *E. cuneatus* (possibly *E. riparius*) and other workers have mentioned predators of other Cuban *Eleutherodactylus* (see revision in Armas 2001, *op. cit.*). It would be interesting to examine the relationship between predator abundance and *E. cuneatus* density.

We thank A. Sánchez for identifying the spider, and R. Viña, B. Lauranzón, and Y. Rivera for providing field assistance. S. Scherlowski kindly carried field equipment to Cuba. Financial support for the field work was from a Seed Grant from the Declining Amphibian Population Task Force (DAPTF). The Centro Oriental de Ecosistemas y Biodiversidad (BIOECO) provided permits and logistic facilities.

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***ELEUTHERODACTYLUS MONENSIS* (Coquí de Mona). REPRODUCTION.** *Eleutherodactylus monensis* is a medium-sized frog (49.4 mm max SVL for females), endemic to Mona Island, Puerto Rico. Females and males are found on the forest floor, leaf litter, fallen vegetation, and bromeliads. Males call from lower vegetation up to 1.0 m above the ground (Joglar 1998. Los Coquíes de Puerto Rico: Su Historia Natural y Conservación. Editorial de la Universidad de Puerto Rico, San Juan. 232 pp.). This is the first report on reproduction in this species and includes information on nesting site, clutch and egg size, and SVL of hatchlings. The clutch (Fig. 1) was found on 17 Sept 2011 in the Sardinera area on the western side of Mona Island. The clutch contained nine eggs ($\bar{x}$=4.62 mm diameter; range 4.0–5.2; N = 9) and was found on a *Cocos nucifera* palm frond buried ca. 28 cm deep within a pile of vegetation and debris that was 0.5 m high. While digging through the mound we observed an adult male (25.8 mm SVL) very close to the clutch, although we have no evidence of parental care at this point. On 25 Sept 2011, eight days after the clutch was discovered, 8 of the 9 eggs hatched and the SVL at birth was measured ($\bar{x}$= 6.28 mm SVL; range 6.0–6.5; N = 8). The hatchlings were deposited in the herpetology collection of the Museo de Biología, Universidad de Puerto Rico–Río Piedras as UPRRP V-00783345.

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***HEMISUS MARMORATUS* (Marbled Snout-Burrower). DEFENSIVE BEHAVIOR.** The Sub-Saharan African Hemisotidae includes nine species in the genus *Hemisus* (Frost 2011. Amphibian Species of the World: An Online Reference. v5.5. American Museum of Natural History, New York). The group is distinguished by the possession of sharply pointed snouts, modified shoulder girdles, well-developed forelimb muscles, and expanded metatarsal tubercles, all of which are adaptations for rapid, head-first burrowing (Channing 2001. Amphibians of Central and Southern Africa. Comstock Publ. Assoc., Ithaca and London. 470 pp.). One of the most widespread species is *Hemisus marmoratus*, which occurs in non-rainforest habitats from Senegal to Eritrea, and south to South Africa (Frost 2011, *op. cit.*). Although various aspects of the species' natural history and behavior have been described (Rödel 2000. Herpetofauna of West Africa. Vol. I. Amphibians of the West African Savanna. Edition Chimaira, Frankfurt am Main. 332 pp.; Schmidt and Inger 1959. Explor. Parc Nat. Upemba, Mission G. F. de Witte 56:1–264), large gaps remain, especially in poorly known populations from Central Africa.

Duellman and Trueb (1986. Biology of Amphibians. Johns Hopkins Univ. Press, Baltimore and London. 670 pp.) noted that several groups of heavy-bodied Neotropical anurans inflate their lungs in an attempt to appear larger to predators. This behavior is often coupled with elevation of the posterior part of the body and flexion of the head downwards in the direction of the predator. Such behavior has been noted in the African hyperoliid *Phlyctimantis verrucosus*, which is known to have aposematic coloration on the flanks and legs, and secretes a noxious latex-type liquid (Channing and Howell 2006. Amphibians of East Africa. Comstock Publishing Associates, Ithaca, New York.

FIG. 1. Egg clutch of *Eleutherodactylus monensis* photographed on top of a fallen *Cocos nucifera* palm frond on 17 Sept 2011 in the Sardinera area on the western side of Mona Island, Puerto Rico.

FIG. 1. Adult *Hemisus marmoratus* (UTEP 20347) in defensive inflate-and-bow display.

418 pp.). Channing (2001, *op. cit.*) referred to the latter display as the "unken reflex." However, Duellman and Trueb (1986, *op. cit.*) and Lillywhite (2008. Dictionary of Herpetology. Krieger Publ. Co., Malabar, Florida. 376 pp.) defined unken reflex as a warning display in which the back is arched, the hind legs are raised over the body with the soles upward, and the head is pulled back to display aposematic coloration. The unken reflex is typically associated with salamanders and the Asian frog genus *Bombina*. To avoid confusion with the unken reflex, we define the behavior described above for *Phlyctimantis* as the inflate-and-bow display. De Witte (1941. Inst. Parcs Nat. Congo Belge 33:xvii–261) illustrated, but did not discuss, a female *H. guineensis* engaged in this latter "emotional" display in Virunga (formerly Albert) National Park in northeastern Democratic Republic of the Congo (DRC). Herein, we report an identical defensive behavior for *H. marmoratus*.

At 1530 h (45°C air temperature) on 21 Jan 2010, we collected a single adult (32.4 mm SVL) *H. marmoratus* from a large, muddy pit on the road south of Nyunzu, Katanga Province, DRC (6.5122°S, 28.0564°E; elev. 799 m). This area is in the Central Zambezian Miombo Woodlands Ecoregion of Burgess et al. (2004. Terrestrial Ecoregions of Africa and Madagascar: A Conservation Assessment. Island Press, Washington, Covelo and London. 501 pp.). The animal was placed in a plastic container until the following morning, when it was photographed. During this process, the frog was handled repeatedly to prevent escape, and to remove debris from its skin. In response to this handling, the frog inflated its lungs, elevated the posterior half of its body with its hind limbs, and lowered the head in the direction of the individual who was handling it (Fig. 1). The frog maintained this position for ca. 1 min before lowering the posterior half of its body, and allowing its lungs to deflate. The specimen was deposited in the herpetological collection of the Laboratory for Environmental Biology at the University of Texas at El Paso (UTEP 20347).

Previous studies noted that *H. marmoratus* typically tries to escape predators by hopping towards water or burrowing rapidly (Noble 1924. Bull. Amer. Mus. Nat. Hist. 49:147–347; Wager 1986. Frogs of South Africa: Their Fascinating Life Stories. Delta Books, Craighall. 183 pp.). Our observations represent the first record of the inflate-and-bow defensive behavior in this species. Considered together with the published illustrations of *H. guineensis* (De Witte 1941, *op. cit.*), our observations suggest the inflate-and-bow display might be widespread among the Hemisotidae.

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***KALOULA KALINGENSIS* (Narrow-Mouthed Frog). PARENTAL CARE.** The microhylid *Kaloula kalingensis* was observed to exhibit bi-parental care on 18 Aug 2011 on Mt. Banahao in Luzon, Philippines (14.0932°N, 121.4912°E) at an elevation of 1100 m. An adult male (2.8 cm SVL; 2.7 g) was found guarding a clutch of 14 tadpoles in a phytotelm (water-filled cavity) of a tree 0.91 m above the ground. The phytotelm was 4.5 cm wide by 6.5 cm tall with a depth of 8 cm. The adult remained at the bottom of the cavity where it would emerge periodically to the surface to breathe (Fig. 1). The tadpoles continued to surface for air every couple of minutes as well. The adult male was collected and removed from the phytotelm. Two days later the phytotelm was resurveyed and an adult female (3.49 cm SVL; 4.7 g) was found guarding the remaining tadpoles, thus confirming that this species exhibits bi-parental clutch guarding. Other frogs (e.g., *Playmantis montanus*) in this area have been documented guarding direct-developing eggs but few species with tadpoles have been shown to exhibit parental care from the site of a phytotelm, as well as having both parents contribute to care of the tadpoles.

FIG. 1. *Kaloula kalingensis* (see arrow) in a phytotelm with tadpoles.

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***LEPTODACTYLUS ALBILABRIS* (Caribbean White-Lipped Frog). CALLING SITE.** Frogs are known to use burrows of a diverse array of animals as calling or retreat sites. Here I report the use of an active crab burrow as a calling site for *Leptodactylus albilabris*. A diverse array of invertebrate burrows are used by frogs as retreat sites, for example tarantulas (Blair 1936. Copeia 1936:115; Hunt 1980. Nat. Hist. 89:48–53; Powell et al. 1984. Salamandra 20:273–274; Cocroft and Hambler 1989. Biotropica 21:2–8), termites (Loveridge 1976. Zool. Afr. 11:319–333), scorpions (Rödel and Braun 1999. Biotropica 31:178–183), or crabs (McIntyre 2003. Herpetol. Rev. 34:52–53). Only one other anuran, the leptodactylid *Lithodytes lineatus*, is known to call from invertebrate dug burrows, calling from within the nests of leafcutter ants (*Atta* spp.) (Lamar and Wild 1995. Herpetol. Nat. Hist. 3:135–142). While *Leptodactylus albilabris* has previously been reported calling from crevices or burrows (Narins 1990. BioScience 40:268–274), which may play a role in the seismic communication reported for this species (Lopez et al. 1988. Anim. Behav. 36:1295–1308), the nature of these burrows or crevices was not described and other occupants were not reported.

I observed a single *Leptodactylus albilabris* calling at the mouth of an active crab burrow on three nights in August 2011 in El Combate, Puerto Rico. Other than the focal individual no other individuals of *L. albilabris* were audible during the observation period. The burrow was in a residential area between two outbuildings and under a pile of scrap plywood. The burrow measured ca. 15–20 cm in diameter at the opening and was always inhabited by a single Blue Land Crab (*Cardisoma guanhumi*)

with a carapace width of ca. 10 cm. The depth of the burrow was not determined, although it was filled with water to within 12 cm of the top. *Cardisoma guanhumi* is primarily herbivorous, although occasionally eating carrion, including frogs (Wolcott and Wolcott 1987. Physiol. Zool. 60:262–268). It is possible the crab was not perceived as a predator despite its considerably larger size. This crab was observed in the burrow both day and night, while the *L. albilabris* was only observed after dark. On each night of observation I removed the plywood after the frog began calling to confirm its location. The frog always retreated away from the burrow either under another piece of plywood or the concrete slab of the outbuilding (on the first night of observations the frog was captured to confirm identification before it retreated in this manner). The frog returned to approximately the same location each night to call suggesting that this location was preferred as a calling site but not as a retreat site.

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***LEPTODACTYLUS FRAGILIS* (White-lipped Foamfrog). DISTRESS CALL.** Although anurans produce a wide array of vocalizations, most studies have focused on studying advertisement calls with other call types receiving little attention. Additional types of vocalization include territorial, courtship, fighting, and defensive calls (Duellman and Trueb 1994. Biology of Amphibians. McGraw-Hill, New York. 670 pp.). Distress calls are defensive calls triggered by dangerous circumstances such as being captured by a predator (Hödl and Gollmann 1986. Amphibia-Reptilia 7:11–21). Although their function is unclear, it has been suggested that distress calls act as a defensive mechanism to reduce the chances of predation. Distress calls occur in numerous species of anurans but only recently these calls have been carefully characterized in a growing number of species (de Toledo and Haddad 2009. S. Am. J. Herpetol. 4:25–42). Several species in the family Leptodactylidae produce distress calls, but it is unclear how widespread this anti-predatory strategy is in this clade. Here I describe the defense call of *L. fragilis*. The observations took place in the canal area, Gamboa, Panama (9°07.0'N, 79°41.9'W).

During the evening of 12 July 2010 I captured a female *L. fragilis* (36.4 mm SVL) that was motionless by a breeding puddle. As it was captured, the frog produced an open-mouth vocalization strikingly different in acoustic structure from the mating call of the species (Fig. 1A). She produced over 35 distress calls (34 were recorded and 33 analyzed) and arched her body backwards two times between calls as if she was playing dead. The defensive calls were easily triggered by holding the frog from the rear legs or allowing it to escape and capturing it again. The distress calls are short (0.636 ± SD 0.17s), high frequency cries (dominant frequency: 11.32± SD 1.22 kHz) that are rich in harmonics, and can have from one to three notes (Fig. 1B). Most calls, however, have two notes (75.6%). The first note is longer than the other two that are similar in duration and structure (note 1: 0.297 ± SD 0.13s; note 2: 0.127 ± SD 0.02; note 3: 0.126 ± SD 0.01). This acoustic structure differs strikingly from the mating call of this species, which consists of a short and low-pitched upward sweep whistle with few harmonics (Ibañez et al. 1999. The Amphibians of Barro Colorado Nature Monument, Soberania National Park and Adjacent Areas. Editorial Mizrachi & Pujol, Panama).

During12 July–11 Aug 2011, I captured 16 *L. fragilis* (12 males and 4 females) and recorded when they produced a distress call. Only two individuals produced distress calls, the female mentioned above and a male (32.7 mm SVL) found on 28 July 2010.

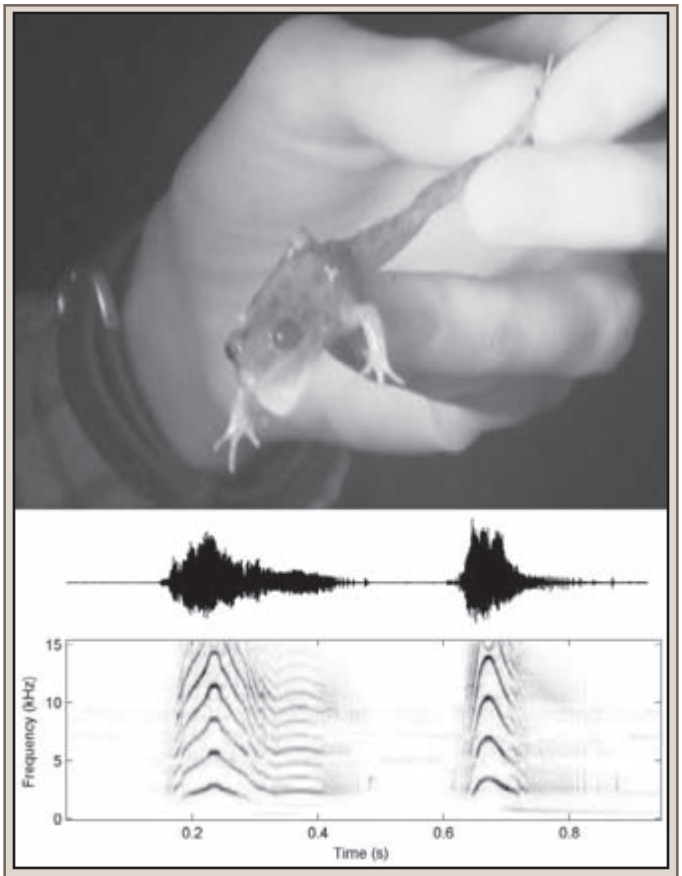

FIG. 1. (A) Female *Leptodactylus fragilis* producing distress calls with her mouth open. (B) Oscillogram (above) and spectrogram (below) of representative distress calls produced by a female *L. fragilis*.

When captured, the male also arched his body backwards between producing distress calls. In both cases, the distress calls were emitted with the frog's mouth open as has been observed for distress calls emitted by most anuran species studied (de Toledo and Haddad 2009, *op. cit.*, but see Figueiredo-de-Andrade et al. 2010. Herpetol. Notes 3:37–39). Distress calls in this species, as has been reported for other species, are not consistently triggered by humans handling the frogs.

The distress call of *L. fragilis* is similar in its general acoustic structure to the distress calls described for species in the *fuscus* and *pentadactylus* group (De Toledo and Haddad 2009, *op. cit.*: *L. pentadactylus*, *L. savage*, *L. mystacinus*, *L. fuscus*, *L. troglodytes*, and *L. vastus*; Toledo et al. 2005. Herpetol. Bull. 2005:29–31: *L. labyrinthicus*). Despite the large differences in advertisement calls among those species, the release calls are relatively similar, consisting of short, high-pitched screams. The characterization of the distress calls of *L. fragilis* reported here builds upon recent studies describing defensive calls in anurans. A robust set of descriptions of distress calls will allow further investigations to examine the function and evolution of this call type.

This observation was possible thanks to the support of Texas Tech University. I am thankful to L. Beaty who helped record the video of the female producing distress calls and to the Smithsonian Tropical Research Institute for help and logistics.

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***LEPTODACTYLUS FUSCUS* (Rufous Frog). PREDATION.** *Leptodactylus fuscus* is distributed in the neotropical region from

Panamá to Argentina, and to the eastern edge of the Andes Mountains. The species occupies open habitats and colonizes river edges and recently modified habitats in forested regions (Heyer and Reid 2003. Ann. Brazil. Acad. Sci. 75:39–54; Wynn and Heyer 2001. Tropical Zool. 14:255–285).

On 3 March 2010 we collected a DOR adult Burrowing Owl (*Athene cunicularia*). During examination of the stomach contents, a *Leptodacylus fuscus* was found along with 5 orthopterans, 5 coleopterans, and some unidentified material. Only the legs of the frog were well digested. The almost intact head and sacral region allowed identification. The owl was run over at km 46.7 at 0750 h on the route ES-060, a highway located in the Municipality of Guarapari, State of Espírito Santo, Brazil.

Athene cunicularia is a terrestrial species, with nocturnal and diurnal-crepuscular habits that occurs from Canada to Tierra del Fuego (Argentina). They live in fields, pastures, and salt marshes; populations are thought to be expanding due to increasing destruction of the forest landscape (Gervais et al. 2003. J. Wildl. Manag. 67:155–164; Sick 1997. Ornitologia Brasileira. Ed. Nova fronteira, Rio de Janeiro, Brazil. 862 pp.). The species inhabits holes in the ground. Several studies have shown this species has a generalized diet, consisting of arthropods and vertebrates (amphibians, reptiles, and mammals) (Martins and Egler 1990. Rev. Brasil. Biol. 50:579–584; Sick 1997, *op. cit.*; Motta-Júnior 2006. Ararajuba: Rev. Brasil. Ornitol. 14:359–377; Vieira and Teixeira 2008. Bol. Mus. Biol. Mello Leitão (n. Sér.) 23:5–14). This is the first report of *Leptodactylus fuscus* in the diet of *Athene cunicularia*.

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***LEPTODACYLUS AFF. MARMORATUS.* ALBINISM.** *Leptodacylus* aff. *marmoratus* is a frog widely distributed in the Atlantic Forest of northeastern Brazil (Freitas and Silva 2005. A Herpetofauna da Mata Atlântica Nordestina, Pelotas: Editora USEB). Here, we report an adult albino *L.* aff. *marmoratus* (17.2 mm SVL) collected on 14 June 2011 at 1530 h in the Parque Estadual de Dois Irmãos, municipality of Recife (8.002665°S, 34.942679°W, WGS 84) Albinism in adult anurans is rare in nature (Rodrigues and Oliveira Filho 2004. Herpetol. Rev. 35:373–373). This report is the first record of an albino *Leptodacylus* aff. *marmoratus*. The specimen was deposited in herpetological collection at the Universidade Federal Rural de Pernambuco/Unidade Acadêmica de Serra Talhada - UFRPE/UAST (CHUFRPE 1100), Serra Talhada, Pernambuco, Brazil.

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***LITHOBATES AREOLATUS CIRCULOSUS* (Northern Crawfish Frog). THWARTED PREDATION.** Heemeyer (2011. Thesis, Dept. Biology, Indiana State Univ.) has shown that snakes are major predators of Crawfish Frogs, but that frogs in burrows are 11.7 times less likely (deaths/day) to be preyed upon than frogs exhibiting breeding migrations or ranging behaviors. What is not clear is whether Crawfish Frogs in burrows are simply avoiding snakes, or whether burrows allow Crawfish Frogs to successfully defend themselves. When not breeding, Crawfish Frogs spend most of their time (up to 11 mo/yr) in or immediately adjacent to crayfish burrows (Heemeyer 2011, *op. cit.*). Crawfish Frogs will generally use the same burrow throughout the year unless forced to abandon it, for example, due to flooding (Heemeyer and Lannoo 2011. Herpetol. Rev. 42:261–262). This fidelity to specific burrows has allowed us to follow individual frogs for long periods of time using Cuddeback® (Non Typical Inc.) wildlife cameras set to photograph at 1-h intervals (the minimum interval programming allows; Hoffman et al. 2010. Bioscience 60:829–834). This monitoring effort has serendipitously allowed us to address the question of Crawfish Frog defense. On its feeding platform, a Crawfish Frog will typically position itself facing its burrow entrance, and when frightened will jump into the burrow, crawl a short ways down the burrow, then turn around to face the burrow entrance. Frogs in this position are usually within 7.5–15.0 cm of the soil surface (Thompson 1915. Sci. Pap. Univ. Michigan 10:1–7).

On 4 July 2011, Cuddeback® images showed that Frog 26 (110 mm SVL, 128 g) was out of its burrow most of the morning and early afternoon, through 1400 h (Fig. 1A). One hour later a Black Racer (*Coluber constrictor*) was photographed working the burrow entrance (Fig. 1B). One hour after that, the frog had not re-appeared (Fig. 1C), and in fact did not appear for another four hours, until 2000 h, when it assumed the same position it held at 1400 h (Fig. 1D). Black Racers will prey on Crawfish Frog adults and juveniles (Heemeyer 2011, *op. cit.*). A 110 cm total length Black Racer took a 97 mm SVL Crawfish Frog on 5 June 2010, and a 85 cm SVL Black Racer took a 105 mm SVL Crawfish Frog on 10 August 2010. From these data we suspect that the snake in Fig. 1 was large enough to have eaten Frog 26. Skin secretions from numerous dorsal granular glands of Crawfish Frogs exhibit antimicrobial properties (Ali et al. 2002. Biochim. Biophys. Acta 1601:55–63) rather than antipredatory properties, but see Heemeyer et al. (2010. Herpetol. Rev. 41:475). Altig (1972. Quart. J. Florida Acad. Sci. 35:212–216) has shown Crawfish Frogs

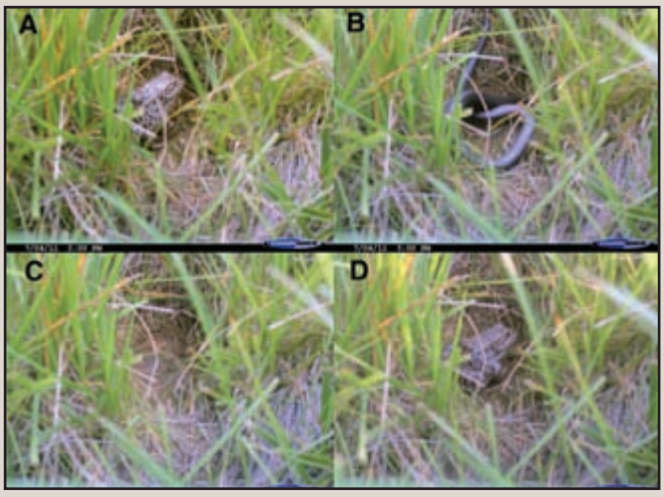

FIG. 1. Crawfish Frog number 26 on 4 July 2011. A) On its feeding platform at 1400 h; B) being attacked by an Eastern Black Racer at 1500 h; C) fate unknown; D) emerged from its burrow unharmed at 2000 h. When threatened Crawfish Frogs quickly jump into their burrow, turn around to face the threat, lower their heads, then inflate their bodies to forcibly press themselves against their burrow walls.

exhibit a defensive display, where they inflate their bodies and lower their heads. We have observed similar defensive displays in Crawfish Frogs inhabiting burrows. When inflating their bodies, adult Crawfish Frogs wedge themselves against their burrow walls (Engbrecht and Heemeyer 2011. Herpetol. Rev. 41:197) making extraction difficult (Heemeyer and Lannoo 2010. Herpetol. Rev. 41:168–170). Crawfish Frogs in burrows appear vulnerable to snake predation when lifting their head, which allows the snake to grab their jaws and gain purchase (Engbrecht and Heemeyer 2011, *op. cit*). With this exception in mind, it is clear from this sequence of photographs that crayfish burrows can assist Crawfish Frogs in defending themselves. Absent this protection, it is unlikely a Crawfish Frog would survive a snake attack such as the one recorded here.

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***PELOPHYLAX LESSONAE* (Pool Frog). PREDATION and REINTRODUCTION.** During surveys to monitor the reintroduction of the northern clade of *Pelophylax lessonae* at a site in Norfolk, UK (Buckley and Foster 2005. Reintroduction Strategy for the Pool Frog *Rana lessonae* in England. English Nature Research Report 642, Peterborough, UK) a male Grass Snake (*Natrix natrix*; 615 mm TL, 52 g) with a large prey bulge was captured (2 Aug 2009) and placed in a cloth bag, whereupon it regurgitated an adult male *P. lessonae* (58 mm SUL). The distal part of the left hind leg and most of the right hind leg had been digested, so body weight could not be measured directly. However, northern clade *P. lessonae* of this SUL weigh ca. 20 g (J. Buckley and J. Foster, unpubl. data), a relative prey mass of 0.38.

Natrix natrix feed primarily on amphibians, taking species depending upon availability (Gregory and Isaac 2004. J. Herpetol. 38:88–95). The frogs in this reintroduction program originate from Sweden where *N. natrix* also occur and presumably prey on this species. Nevertheless, at the present site anurans were scarce prior to the reintroduction of Pool Frogs. The current observation indicates that *N. natrix* there are able to exploit this new prey species, as they have done at a site in southeast England where they feed on the congeneric *P. ridibundus*, an introduced non-native species (Gregory and Isaac, *op. cit.*).

Grass Snakes are abundant at the reintroduction site but their impact on the Pool Frog program is unknown. The frog ingested was a relatively large male: mean SUL for males = 52 mm, range = 42–63, N = 54; females are a little larger, mean SUL = 54 mm, range = 42–74, N = 61 (J. Buckley and J. Foster, unpubl. data). Grass Snakes at this site are relatively small, although large adults in the population grow to 700–800 mm TL (unpubl. data), presumably large enough to prey on all sizes of *P. lessonae*.

I am grateful to Amphibian and Reptile Conservation, Anglian Water and Natural England for funding the Pool Frog reintroduction program.

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***PHYSALAEMUS ERIKAE*. DEFENSIVE BEHAVIOR.** One of the most common defensive strategies performed by some species of the family Leiuperidae is the elevation of the pelvic region, during which large dark inguinal glands are shown to potential predators (Duellman and Trueb 1994. Biology of Amphibians. McGraw-Hill Publ. Co., New York. 670 pp).

Physalaemus erikae is endemic to southern Bahia, Brazil and can be found on the borders of Atlantic Rainforest fragments, clearings, and cacao plantations (Cruz and Pimenta 2004. J. Herpetol. 38[4]:480–486). This species also shows inguinal glands, however these are much smaller than in other species that show the above described defensive display.

On 10 Oct 2009, in the municipality of Uruçuca we collected three *P. erikae* in a temporary pond near a cacao plantation. During a photo session in the laboratory one of the frogs (MZUESC 8417) assumed a defensive posture, lifting the body and opening its mouth when we pointed a finger in its direction. In most cases, the frog opened its mouth at the approach of the finger and closed it soon after, but in some cases the frog kept the mouth open even after the finger was removed. This behavior lasted about 90 seconds and was not displayed again by any of the collected frogs.

This behavior has been described for other amphibian species, but generally the behavior is more complex than the one related here. *Hemiphractus fasciatus* shows its orange tongue during the mouth opening display and may try to bite a predator; notably this species has a pair of odontoids on the lower jaw that are able to pierce human skin (Myers 1966. Herpetologica 22:68–71). When threatened, *Calyptocephalella gayi* inflates the lungs, raises its body, opens its mouth, emits loud vocalizations, and may even jump towards the potential predator (Veloso 1977. Herpetologica 33:434–442).

The defensive behavior observed in *P. erikae* is less complex, as the frog only adopted a threatening pose without any aggressive action towards the possible predator. This behavior is similar to that observed in species of the genus *Leptopelis* (Perret 1966. Zool. Jahrb. Syst. 93:289–464). Our report is the first case of this type of behavior in a species of the family Leiuperidae.

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***PROCERATOPHRYS AVELINOI, CYCLORAMPHUS ACANGATAN*. DEFENSIVE BEHAVIOR.** Frogs in the family Cycloramphidae exhibit defensive behaviors including thanatosis, contraction, chin-tucking, crouching down, inflating the body, and cloacal discharge (Toledo et al. 2010. J. Nat. Hist. 44:31–3.; Toledo et al. 2011. Ethol. Ecol. Evol. 23[1]:1–25).

Herein we report two species of the family Cycloramphidae performing the defensive behavior of contraction (sensu Toledo et al. 2010, *op. cit.*). The first observation occurred in the Parque das Perobas (23.483333°S, 51.983333°W) in the municipality of Maringá, state of Paraná, Brazil. Four *Proceratophrys avelinoi* were collected in pitfall traps on 9 Aug 2007, and when handled during removal from the bucket remained immobile for about two minutes, with hands and arms slightly raised at the side (Fig. 1A, B). The same behavior was observed on 2 Feb 2008, in a residual forest in the municipality of Embú-Guaçu (23.883333°S, 46.816666°W), state of São Paulo, Brazil. An adult *Cycloramphus acangatan* was caught in a pitfall trap, and when handled during removal from the bucket it remained motionless for three minutes with hands and arms slightly raised at the side (Fig. 1C, D). All individuals observed remained in this position for more than two minutes. After returning to the normal position, individuals of both species repeated the behavior after being handled again. Contraction is a defensive behavior exhibited by toxic species (Sazima 1974. J Herpetol. 8[4]:376–377). *Proceratophrys avelinoi* has a characteristically colored ventral region which might signal

FIG. 1. *Proceratophrys avelinoi* after being removed from a pitfall trap exhibiting contraction behavior; A) dorsal view, B) ventral view. Below *Cycloramphus acangatan* after being removed from a pitfall trap in a contracted position; C) dorsal view, D) ventral view.

toxicity. *Cycloramphus acangathan* is known to exhibit cloacal discharge (Toledo et al. 2011, *op. cit.*), although contraction has not been reported until now. This is the first record of contraction for the genus *Cycloramphus* and the first report for *P. avelinoi*.

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***PSEUDACRIS CRUCIFER* (Spring Peeper). PREDATION.** Cold tolerance and early emergence from hibernation may reduce overlap between breeding *Pseudacris crucifer* and ophidian predators. Nonetheless, *P. crucifer* is preyed upon by several species of snakes that forage in wetlands, including natricines (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. Univ. Oklahoma Press, Norman. 438 pp.; Carpenter 1952. Ecol. Monogr. 22:235–258; Test 1958. Copeia 1958:151–152). Despite moving long distances overland to forage in isolated ephemeral wetlands for amphibian prey (Roe et al. 2003. Biol. Cons. 188:79–89), *Nerodia erythrogaster* was not reported to prey upon *P. crucifer* by Gibbons and Dorcas (1994, *op. cit.*). Herein I provide observations of *N. erythrogaster* preying upon adult *P. crucifer* in breeding wetlands near Vicksburg, Warren Co., Mississippi, USA.

At ca. 1915 h, 13 March 1986, I observed a juvenile *N. erythrogaster* (28 cm total length) in an ephemeral wetland swallowing a gravid adult female *P. crucifer*. Several eggs had discharged through the frog's abdomen wall where pierced by the snake's teeth. Between 2030 and 2055 h, 13 April 1986, I observed five *N. erythrogaster* foraging in a borrow-pit pond in the floodplain of Hatcher Bayou. Upon capture, one snake disgorged an adult *P. crucifer* (sex not recorded).

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***RANA BOYLII* (Foothill Yellow-legged Frog). UPLAND MOVEMENT.** *Rana boylii* is primarily a stream-dwelling species that may make modest migrations along stream corridors (Fellers 2005. *In* M. Lannoo [ed.], Amphibian Declines: the Conservation Status of United States Species, pp. 534–536. Univ. California Press, Berkeley, California). It is usually found near water (Nussbaum et al. 1983. Amphibians and Reptiles of the Pacific Northwest. Univ. Press Idaho, Moscow, Idaho; Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., Boston, Massachusetts. 533 pp.) and rarely more than a meter from the shoreline (Storer 1925. Amphibia of California. Univ. California Press, Berkeley California). However, Nussbaum et al. (1983, *op. cit.*) reported finding small *R. boylii* over 50 m from a river. As this frog is considered a stream-dwelling species, the effect of the loss of adjacent uplands has not been well studied. Here we describe frequent observations of *R. boylii* far from a natal stream and in an urban setting.

We conducted evening road surveys during rainfall and other ad hoc visual encounter sampling in the vicinity of the perennial Sulphur Creek, east of Ukiah, California, USA. We also conducted egg mass surveys along a 0.8 km reach of Sulphur Creek. This study reach of the creek is surrounded by residential development on the south side consisting of over 70 houses with manicured lawns and/or landscaping accessed by two-lane asphalt roads that parallel Sulphur Creek. Most of our observations were on roads separated from the creek by one or more rows of residential houses. Piecemeal developments and a two-lane paved road parallel the creek on the north side.

We found a total of 60 juvenile *R. boylii* in the residential study area during spring and fall from 2008 to 2011. Fifty-six were found on residential roadways with 7 of these frogs apparently killed by vehicles. We also found two crushed *R. boylii* beneath a boat cover on a concrete driveway in front of a residential house and two more frogs in nearby landscaping. The largest single-evening observation was 40 *R. boylii* on 11 Oct 2011. Most observed frogs appeared to be moving away from the creek. Although not recorded, we observed frogs on roadways for several years prior to 2008. The distance of *R. boylii* observations from Sulphur Creek ranged from 16 m to 331 m with an average distance of 71.3 m. On 1 May 2011 we found 27 egg masses and two juvenile *R. boylii* in Sulphur Creek indicating that the study reach is a natal stream for the species. Other amphibians detected on roadways and front yards included California Newts (*Taricha torosa*), Western Toads (*Anaxyrus boreas*), and Pacific Chorus Frogs (*Pseudacris regilla*).

These findings suggest that *R. boylii* may use upland habitat far more than previously reported. Also, the loss of creek habitat and alterations to hydrology are major conservation concerns (Fellers 2005, *op. cit.*). Our observations of road mortality and other dead frogs suggest that *R. boylii* are susceptible to indirect impacts from urbanization.

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TESTUDINES — TURTLES

***CHELYDRA SERPENTINA* (Snapping Turtle). DIET.** *Chelydra serpentina* is an omnivorous species known to consume a wide variety of plants and animals (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.). In Florida, *C. serpentina* has been reported to eat *Colocasia esculenta*, *Elodea* sp., *Lemna* sp., *Najas* sp., *Nelumbo lutea*, *Nymphaea* sp., *Sagittaria* sp., *Spirodela polyrhiza*, *Typha* sp., *Utricularia* sp., and *Vallisneria* sp. (Aresco et al. 2006. *In* P. A. Meylan [ed.], Biology and Conservation of Florida Turtles, pp. 44–57. Chelonian Res. Monogr. No. 3; Punzo 1975. J. Herpetol. 9:207–210). Herein is the first report of *C. serpentina* feeding on Hydrilla (*Hydrilla verticillata*), an invasive aquarium species (originally from southern India) that has been established throughout Florida since the 1970s (Langeland 1996. Castanea 61:293–304).

On 3 April 2011 at approximately 2000 h, we observed an adult male *C. serpentina* (straight midline carapace length = 365 mm, mass = 10.25 kg) at Naked Spring, Gilchrist Co., Florida, USA (29.82993°N, 82.68124°W; WGS84; elev. 8 m) consuming *H. verticillata* continuously for approximately five minutes. Hydrilla is abundant in this spring and grows too rapidly to be controlled by the foraging activities of all resident animal populations at this site, but it may at least provide some nutritional value to *C. serpentina*.

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***EMYDOIDEA BLANDINGII* (Blanding's Turtle). RECORD CLUTCH SIZE.** Nesting activity in a population of *Emydoidea blandingii* in Algonquin Provincial Park, Ontario has been monitored annually since 2007. On 17 June 2011, an unmarked female was found nesting at 2100 h on a gravel road, and she laid 25 eggs. The female weighed 1920 g post-oviposition, and had a straight-line carapace length of 244 mm. A predator exclusion cage was buried over the top and down the sides of the nest to prevent predation of the eggs. Beginning in August, the nest was monitored daily for emerging hatchlings. On 17 September 2011, after 92 days of incubation, four hatchlings were observed on the ground surface under the cage. Upon excavation, another 21 hatchlings were found hatched and alive within the nest chamber (Fig. 1). This nest experienced 100% hatching success, defined as the proportion of eggs laid that hatched. Hatchling body mass ranged from 8.0 to 10.2 g (mean ± SE = 9.50 ± 0.09 g) and straight-line carapace length ranged from 31.1 to 36.2 mm (34.1 ± 2.2 mm). Hatchlings from this nest were similar in size to those emerging from nests with smaller clutch sizes (N = 91; mass: 8.74 ± 0.08 g, range 6.5–10.2 g; straight-line carapace length: 32.8 ± 0.1 mm, range 27.3–35.8 mm) at our study site.

Previously reported clutch sizes for *E. blandingii* range from 3 to 24 eggs (Ernst and Lovich 2009. Turtles of the United States and Canada, 2nd ed. Johns Hopkins University Press, Baltimore, Maryland. 827 pp.; Rowe 1992. Can. J. Zool. 70:1690–1695; Ruane et al. 2008. Copeia. 2008:771–779). As the clutch we observed is greater by one egg than the previous maximum of 24 eggs, our observation serves as a new record for the largest reported Blanding's Turtle clutch size. Our clutch size observation is from a population near the northern range limit for the species, where both female body size and clutch sizes may reach their maximum (Iverson et al. 1993. Can. J. Zool. 71:2448–2460).

PHOTO BY BETH McLAREN

FIG. 1. Hatchlings (N = 25) of *Emydoidea blandingii* in Algonquin Provincial Park, Ontario from a clutch of 25 eggs emerged on 17 September 2011.

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***GLYPTEMYS INSCULPTA* (Wood Turtle). AGGRESSIVE BEHAVIOR.** Male *Glyptemys insculpta* are believed to form linear dominance hierarchies which are enforced by ritualistic fighting (biting, lunging, and mounting) and may determine access to females (Kaufmann 1992. Herpetol. Monogr. 6:1–25). Dominance has apparently not been reported for female *G. insculpta* (or any freshwater turtle). However, Walde et al. (2007. Herpetol. Conserv. Biol. 2:49–60) reported that female *G. insculpta* bypassed suitable nesting beaches used by conspecifics. The observations reported below suggest that dominance relationships may exist among female *G. insculpta* competing for preferred nesting sites.

On 17 June 2009 I observed three female *G. insculpta* digging (presumably testing potential nest sites) on a 15 x 10 m gravel bar along the Ontonagon River in the western Upper Peninsula of Michigan, USA. At approximately 2130 h, I observed one female (Turtle 1) on this nesting beach digging in the gravel with her front feet. At 2131 h another female (Turtle 2) emerged from the river, crawled onto the nesting beach, and started digging about a 1.5 m from Turtle 1. At 2133 h, a third female (Turtle 3) emerged from the river, approached, then bit and lunged toward Turtle 1. Turtle 1 moved to another spot on the beach. Turtle 3 moved toward Turtle 2 and repeated the behaviors that she had just directed toward Turtle 1. Turtle 2 moved to a different spot on the beach as well. Both of the turtles that retreated moved to areas of the beach

that were lower and closer to the river, and then resumed digging. Turtle 3 started digging at 2140 h at the point where Turtle 1 had been digging at 2130 h. These turtles stayed in these positions until dark (~ 23 h) when I could no longer observe them.

The aggressive/ submissive behaviors of female *G. insculpta* reported here may represent competition for favored nest sites. Nest sites on higher ground may be favored over lower areas on the beach due to the chance of periodic flooding. Fighting over nest sites may be advantageous when they are a limited resource. While there appeared to be ample suitable nest sites on this particular gravel bar, the quality of a nest site from the standpoint of a nesting turtle is likely based on a number of variables. Substrate, soil temperature and moisture, elevation, and aspect are potentially important factors in nest site selection (Buech et al. 1997. *In* J. Van Abbema [ed.], Proceedings: Conservation, Restoration, and Management of Tortoises and Turtles—An International Conference, pp. 383–391. New York Turtle and Tortoise Society, New York; Hughes et al. 2009. Northeast. Nat. 16:321).

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***KINOSTERNON SUBRUBRUM* (Eastern Mud Turtle). OVERWINTERING.** *Kinosternon subrubrum* is one of a few freshwater turtle species that will reportedly overwinter on land or under water. Intriguingly, within a population, a few turtles may choose to overwinter in water, while most choose terrestrial environments (Ultsch 2006. Biol. Revs. 81:339–367). In an effort to determine the overwintering sites of a *K. subrubrum* population in the Coastal Plain of Maryland, we radio-tracked turtles during two consecutive overwintering seasons (November–February 2008–2010).

All turtles selected terrestrial overwintering sites in deciduous forests at distances of 55–224 m (N = 8; 2008–2009) and 61–190 m (N = 7; 2009–2010) from the wetland's edge. Turtles excavated burrows with mean depths of 13.2 ± 1.6 cm (10.4–15.3 cm, N = 6) in 2008–2009, and 12.1 ± 6.4 cm (7.0–25.0 cm, N = 7) in 2009–2010. These data suggest that Maryland *K. subrubrum* may use deep burrowing to avoid freezing temperatures. In contrast, the depth of terrestrial burrows was shallow (2–11 cm) and uncorrelated with the time of year in 27 South Carolina *K. subrubrum* (Bennett et al. 1970. Ecology 51:738–740). *Kinosternon subrubrum* appear to construct deeper overwintering burrows at higher latitudes as we report a maximum depth of 25 cm in Maryland, which is comparable to 24 cm in New York (Wetmore and Harper 1917. Copeia [45]:56–59). Our conclusions are preliminary and require validation through comparisons of burrowing depths at different times of year (i.e., summer versus winter). Also, habitat variables need to be accounted for. Nonetheless, these observations should be informative to future studies of overwintering strategies in kinosternid turtles.

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***TERRAPENE CAROLINA CAROLINA* (Eastern Box Turtle). MOVEMENT AFTER HURRICANE.** On 27–28 August 2011, Hurricane Irene passed through Abingdon, Maryland, USA (wind gusts = 80 km/h, precipitation = 11 cm). Most of the rainfall occurred on the evening of 27 August. The high winds continued into the morning of 28 August, but by the evening, it was calm and sunny. On 29 August, between 1200 and 1500 h, radio telemetry was used to locate eight *Terrapene c. carolina* (four males, four females) at the Anita C. Leight Estuary Center (Abingdon). Seven of these turtles were walking, and the one stationary female was sitting almost fully exposed in a pile of leaves (only the rear of her carapace was covered). Also, three additional box turtles (two males, one female) which did not have transmitters were randomly encountered; all three were walking.

This high level of activity is unusual for several reasons. First, turtles have been tracked at the Estuary Center since 2005 (2 in 2005 and 2006, 4 in 2007 and 2008, 13 in 2009, 11 in 2010, and 8 in 2011), but prior to 29 August 2011 we had never observed such a large number moving simultaneously. Generally, only a small proportion of telemetered turtles are active, while the majority are buried under leaves or hiding in bushes (even during and immediately following rainstorms). Second, at the Estuary Center, it is rare to randomly encounter three turtles within three hours, and previous instances have nearly always been during or immediately following a rainstorm. Third, it is well documented that box turtles are most active during rain (presumably for foraging), however, the forest floor was dry at the time that the above observations were made, and the sky was sunny and clear (31°C) (Strang 1983. J. Herptol. 17:43–47). There is typically relatively little turtle activity on days with these climatic conditions. Finally, we have observed (and it has been reported for other subspecies) that *Terrapene c. carolina* is typically active in the morning and late afternoon and is usually largely inactive during the afternoon (Dodd 2001. North American Box Turtles: A Natural History. Univ. Oklahoma Press, Norman, Oklahoma. 231 pp.).

It seems possible that *Terrapene c. carolina* may spend additional time exploring its home range immediately following large climatic disturbance events. This may enable the turtles to become familiar with changes that have taken place. Multiple studies have shown that box turtles have an excellent spatial memory, and the memorization of food-rich locations seems to play an important role in their foraging behavior (McKnight 2011. Herpetol. Notes. 4:97–102; Parker 1982. Southwest. Nat. 27:365). A large storm (such as Hurricane Irene) which knocks down many trees could potentially destroy key foraging areas (or create new ones), create barriers which prevent turtles from accessing foraging sites, or force turtles to take new routes to these sites. Therefore, after major storms, box turtles may benefit from quickly relearning attributes of their home ranges. Though admittedly speculative, this factor might explain, in part, the unusually high activity levels observed the day after Hurricane Irene.

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CROCODYLIA—CROCODILIANS

***CAIMAN CROCODILUS* (Spectacled Caiman). HOMOSEXUAL BEHAVIOR.** On 24 March 2011, I captured a *Caiman crocodilus* for a biological study in the Orinoco Llanos region, Natural Reserve Palmarito, Casanare, Colombia (4.820956°N, 71.635661°W). The caiman was measured (SVL = 103.4 cm), sexed as male by cloacal inspection (Brazaitis 1968. Brit. J. Herpetol. 4:54–58), marked with a metallic tag (No. AV005) and released at the point of capture, a small stream called caño Las Palomas, 4 m wide and

FIG. 1. Two *Caiman crocodilus* males in copulatory position during the dry season at Natural Reserva Palmarito, Casanare, Colombia.

1.2 m deep at that point. Once in the water, AV005 grunted softly several times and immediately another *C. crocodilus* swam towards him from 3 m away and stood on his back. During a period of 8 min. (from 1307 h to 1315 h), the second caiman tried to get into a latero-ventral position by grabbing AV005 with its hind leg and tail toward his body. This behavior has been described as the step prior to mating in *C. crocodilus chiapasus* in México (Álvarez del Toro 1974. Inst. Mex. de Recursos Renovables, 70 pp.) and for *C. crocodilus crocodilus* in Venezuela (Staton and Dixon 1977. Wildlife Research Report 5, U.S. Fish and Wildlife Service). During this time no aggression was observed and no sounds were emitted by the caimans. AV005 swam slowly twice for no more than 3 meters. He did not try to escape at any moment. As the size and behavior of the second caiman suggested that it was also a male and it was clear that it was trying to copulate, I asked the person providing field assistance (a local cowboy) to rope in the caiman. The second caiman was captured (SVL = 101 cm) and also was sexed as a male, as determined by the presence of a penis.

There is no doubt regarding the sex of either caiman, due to the presence of a penis and SVL measured >90 cm (Ayarzagüena 1983. Doñ. Act. Vert. 10[3], 136 pp.; Antelo, unpubl. data), nor is there doubt about the intent of copulation.

Homosexual behavior has been described for at least 470 species (for a review see Bagemihl 1999. Biological Exuberance: Animal Homosexuality and Natural Diversity. St. Martin's Press, New York. 751 pp.), including lizards (Cole and Townsend 1983. Anim. Behav. 31:724–728; Werner 1980. Zeitschrift für Tierpsychol. 54:144–150), but to my knowledge, this is the first observation of homosexual behavior for any species of crocodilian.

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SQUAMATA — LIZARDS

***AMEIVA AMEIVA* (Common South American Green Lizard). PREY AND FEEDING BEHAVIOR.** *Ameiva ameiva* is one of the most common teiid lizards found both in open and forested areas in South America, occurring from northern Argentina to the Amazon and northeastern Brazil (Vitt and Colli 1994. Can. J. Zool 72:1986–2008). Many ecological studies on this species exist (e.g., Colli 1991. Copeia 1991:1002–1012; Vitt and Carvalho 1995. Copeia 1995:305–329; Vitt and Colli 1994, *op. cit.*). *Ameiva ameiva* is known to prey mainly on insects, especially small beetles (Vitt and Colli 1994, *op. cit.*), however, feeding behavior and the relationship between body size of the lizard and its prey species remain poorly known. During a survey on 23 March 2009 conducted at Porto Trombetas, Oriximiná municipality, Pará State, Brazil (1.46333°S, 56.37083°W), an adult female *A. ameiva* (ca. 15 cm SVL) was observed preying on a large adult cerambycid beetle (total length >6 cm), the body of which was more than twice the width of the lizard's head. The skill shown by the lizard to kill and eat the beetle was remarkable and documented herein. The lizard was observed actively foraging in a grassland area at 1200 h. When the beetle was found within the grass, it was bitten by the lizard between the head and thorax, the lizard struggling to sever the head from the body. At this moment, the beetle was displaying defensive behaviors, opening its elytra and trying to bite the lizard. The insect's wing movements made manipulation difficult by the predator (Robinson 1968. Psyche 75:195–207), and cerambycid beetles also have strong maxillae that they use to cut wood and to provide protection against predators or conspecifics (Ray et al. 2008. Environ. Entomol. 38:425–432). The specimen being preyed upon by *A. ameiva* expressed great maxillae (ca. 1 cm), and while continually moving them, they eventually reached the tail and posterior legs of the lizard. The lizard continued biting the beetle between the head and the thorax and then turned it onto its back, pressing the articulation points of the open elytra and breaking them one at a time. Following this, the lizard continued to bite until the head was completely severed from the beetle's body. Grasping the beetle by its anterior legs, the lizard tore off its membranous wings and then discarded them, ingesting only the beetle's abdomen and the remaining thorax. Finally, the lizard swallowed the severed head posteriorly. The total time of the interaction was about five minutes.

The encounter of *Ameiva ameiva* and the cerambycid beetle presented here allows some considerations on the behavior of this lizard species. The ability to break the wings of the beetle one by one after turning it onto its back suggests that feeding behavior of this species shows cognitive deliberation abilities and perhaps this is one of the determinant conditions for the ubiquitous distribution of this lizard throughout several ecosystems of South America. The ability of *A. ameiva* to subjugate an aggressive, well-armored arthropod of such a large size suggests that the lizard probably is capable of preying upon several other great invertebrates, in addition to small vertebrates. Further, it is possible that the most frequent findings of small insects in the gut contents of this species (e.g., data presented by Colli [1991, *op. cit.*] and Vitt and Colli [1994, *op. cit.*]) might be the result of greater availability of smaller prey rather than indicating higher priority prey items in nature.

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***ASPIDOSCELIS COZUMELA* (Isla de Cozumel Whiptail). LIFE HISTORY.** The diploid parthenogenetic *Aspidoscelis cozumela* complex of whiptail lizards (sensu Reeder et al. 2002. Am. Mus. Novit. 3365:1–61) comprises either two species (*A. cozumela* and *A. rodecki*; Fritts 1969. Copeia 1969:519–535; Hernández-Gallegos et al. 1998. Biogeographica 74:117–124) or three species (*A.*

cozumela, A. maslini, and *A. rodecki*: Taylor and Cooley 1995a. Herpetologica 51:67–76; Taylor and Cooley 1995b. J. Herpetol. 29:583–592; Manríquez-Morán et al. 2000. J. Herpetol. 34:634–637; Taylor et al. 2005. J. Herpetol. 39:266–277; Liner 2007. Occas. Pap. Mus. Nat. Sci., Louisiana State Univ. 80:1–60; Elizalde-Rocha et al. 2008. Rev. Biol. Trop. [Int. J. Trop. Biol.] 56:1871–1881) depending on the taxonomic concept accepted. I agree with workers who regard *A. cozumela* as an endemic species to Isla de Cozumel, Quintana Roo (Taylor and Cooley 1995a, b, *op. cit.*; Manríquez-Morán et al. 2000, *op. cit.*; Taylor et al., *op. cit.*; Liner, *op. cit.*), the largest Mexican Atlantic island, situated in the Caribbean Sea ca. 25 km from Puerto Morelos of the Yucatán Peninsula. Manríquez-Morán et al (2000, *op. cit.*) hypothesized that *A. cozumela* was derived from an individual of *A. maslini* from the mainland possessing three centromeric fissions among its chromosomes, the latter species itself a hybrid derivative of *A. angusticeps* × A. *deppii* (Fritts, *op. cit.*; Moritz et al. 1992. Herpetologica 48:417–424; Hernández-Gallegos et al. 1998, *op. cit.*). Here, I provide data on reproduction (clutch range and $\bar{x}$ ± SE; SVL range and $\bar{x}$ ± SE; yolked follicle range and $\bar{x}$ ± SE; length and width of oviductal eggs range and $\bar{x}$ ± SE), sample composition (number of generations present), and life cycle (age at maturity and life span) for an insular species that utilizes human-modified (e.g., urban development) and hurricane-impacted (e.g., by Category 4 Wilma on 21 October 2005) coastal habitats elevated only a few meters above sea level. According to Konrad (1996. Caribbean Tropical Storms. RCM 1:98–130), the northeast tip of the Yucatán Peninsula near the island in question receives the greatest number of hurricane strikes in the region.

I examined 169 (86.2%) of the 196 specimens of *A. cozumela* listed by site from the University of Colorado Museum of Natural Histiory (UCM), including those transferred to the California Academy of Science (CAS), obtained in 1959 (N = 79) and 1961 (N = 117) by T. P. Maslin and associates (see McCoy and Maslin 1962. Copeia 1962:620–627) on Isla de Cozumel: 3 km N of San Miguel de Cozumel [26 June 1959 (UCM 12454, N = 1); 28 June 1959 (UCM 12455–12475, N = 21)]; 4 km N of San Miguel de Cozumel [29 June 1959 (UCM 12476–12500, N = 25); 5 km S of San Miguel de Cozumel [1 July 1961 (UCM 15415–15436, N = 22); 4 July 1961 (UCM 15437–15450, 15451–15460 (= CAS 94032–94041), 15461, N = 25); 9 km SE of San Miguel de Cozumel at a lagoon [30 June 1959 (UCM 12501–12532, N = 32); San Miguel de Cozumel [2 July 1961 (UCM 15400–15414, N = 15); 1–2 July 1961 (UCM 15462–15516, N = 55)]. I also examined specimens from the University of Kansas Natural History Museum (KU) collected in 1962 by W. E. Duellman and associates on Isla de Cozumel at 3.5 km N of San Miguel de Cozumel [8 August 1962 (KU 70762–70790, N = 29)]. I obtained size (as SVL to the nearest 1 mm) for all *A. cozumela* from KU, and all except 27 females of *A. cozumela* from UCM, transferred to museums other than the CAS, from the original UCM numbered sample. Females of this species from UCM were dissected to count and measure oviductal eggs and yolked ovarian follicles.

The 26–30 June 1959 UCM sample of *A. cozumela* included by sizes (as 5 mm SVL increments where applicable) these frequencies for 68 specimens: 30–34 (1, 1.5%); 50–54 (2, 2.9%); 55–59 (13, 19.1%); 60–64 (20, 29.4%); 65–69 (14, 20.6%); 70–74 (16, 23.5%); and 75–77 (2, 2.9%). Among these was 1 individual of 33 mm SVL hatched a few days before it was collected. With the possible exception of two individuals of 50–54 mm SVL, all other specimens in the sample were reproductively mature, some of the smallest of which possibly represented mature young-of-year (YOY) and the largest being in the second summer of life based on subsequent studies of *A. cozumela* by Oswaldo Hernández-Gallegos (pers. comm.). The 1–4 July 1961 UCM sample of *A. cozumela* included by sizes (as 5 mm SVL increments where applicable) these frequencies for 101 specimens: 30–34 (15, 14.9%); 35–39 (13, 12.9%); 40–44 (1, 1.0%); 55–59 (9, 8.9%); 60–64 (29, 28.7%); 65–69 (17, 16.8%); 70–74 (9, 8.9%); and 75–77 (8, 7.9%). This sample included a large number of YOY lizards (30–44 mm SVL, N = 29, 28.7%), apparently from asynchronous early clutches (see Manríquez-Morán et al. 2005. Herpetologica 61:435–439; fig. 1); all other individuals in the sample were reproductively mature, and possibly represented a minimum of two year classes. The 8 August 1962 KU sample of *A. cozumela* included by sizes (as 5 mm SVL increments where applicable) these frequencies for 29 specimens: 30–34 (2, 6.9%); 45–49 (1, 3.4%); 50–54 (2, 6.9%), 55–59 (2, 6.9%); 60–64 (11, 37.9%); 65–69 (7, 24.1%); 70–74 (2, 6.9%); and 75–77 (2, 6.9%). This sample included only three definite YOY lizards (30–49 mm, 10.3%); all other individuals in the sample were reproductively mature or nearly so. Based on the 1959 UCM sample, *A. cozumela* attains reproductive maturity at ca. 52 mm SVL. Each of the following statements for a SVL group includes the numbers of gravid females followed by clutch size based on the same or a smaller number of lizards with undamaged eggs. Among females 50–54 mm SVL, 2 (100 %) were gravid; clutch size was 1 in the undamaged lizard. Among 13 females 55–59 mm SVL, 2 (15.4%) were gravid; clutch size was 2 in the undamaged lizard. Among 20 females 60–64 mm SVL, 7 (35%) were gravid; clutch size was 1–2 ($\bar{x}$= 1.7 ± 0.17 SD, N = 7). Among 14 females 65–69 mm SVL, 6 (42.9%) were gravid; clutch size was 2 ($\bar{x}$= 2.0, N = 6). Among 16 females 70–74 mm SVL, 6 (37.5%) were gravid; clutch size was 1–2 ($\bar{x}$= 1.7 ± 0.21, N = 6). Among females 75–77 mm SVL, 2 (100%) were gravid; clutch size was 1–2 ($\bar{x}$= 1.5 ± 0.50, N = 2). Overall, 67 (98.5%) lizards examined in the 1959 sample were sexually mature; however, only 25 (37.3%) were gravid owing to apparent asynchrony in reproductive cycles among females (see Manríquez-Morán et al. 2005., *op. cit.*). Only 8 (11.9%) of these females contained oviductal eggs. Mean clutch size for all gravid 1959 females is 1.7 (1–2, N = 24); each individual with oviductal eggs had a clutch of 2. Based on the 1961 sample, *A. cozumela* attains reproductive maturity at ca. 55 mm SVL, 3 mm larger than reflected by the 1959 sample. That size at maturity is variable in this species is further evidenced by these data for smallest gravid females: 56 mm SVL in 1994–1995 (Manríquez-Morán et al. 2005, *op. cit.*) and 54–59 mm SVL in 1997–2002 (Hernández-Gallegos et al. (2003. Biogeographica 79:1–17). Pertaining to the 1961 UCM sample, among 9 females 55–59 mm SVL, 2 (22.2%) were gravid; clutch size was 2 ($\bar{x}$= 2.0, N = 2). Among 29 females 60–64 mm SVL, 7 (27.5%) were gravid; clutch size was 1–2 ($\bar{x}$= 1.6 ± 0.19, N = 7). Among 17 females 65–69 mm SVL, 8 (47.0%) were gravid; clutch size was 1–2 ($\bar{x}$= 1.6 ± 0.20, N = 8). Among 9 females 70–74 mm SVL, 1 (11.1%) was gravid; clutch size was 2. Among 8 females 75–76 mm SVL, 1 (12.5%) was gravid; clutch size was 3. Overall, 72 (71.3%) lizards in the 1961 sample were mature adults, 19 (18.8%) were gravid, and 3 (3.0%) contained oviductal eggs. Mean clutch size for all 1961 gravid females was 1.7 (1–3 ± 0.13, N = 19); individuals with oviductal eggs had clutches of 2.

In the pooled 1959 and 1961 UCM sample, females with data (N = 43) had clutches (sample size in each category in parens) of 1 (13), 2 (29), and 3 (1); mean clutch size and SVL for these females were 1.7 ± 0.08 (1–3) eggs and 65.4 ± 0.87 (52–77) mm, respectively. Among the 140 adult females ($\bar{x}$= 64.8 ± 0.51, 52–78

mm SVL) in the pooled sample of *A. cozumela* were 31 (22.3%) containing yolked ovarian follicle of 3–10 ($\bar{x}$= 6.1 ± 0.50) mm in diameter, 11 (7.9%) with oviductal eggs of 8–9.5 ($\bar{x}$= 8.4 ± 0.15) mm in width and 15–19 ($\bar{x}$= 16.0 ± 0.50) mm in length, and 97 (69.7%) that were not gravid. None of the variation in clutch size among 43 females could be explained by SVL (based on adjusted r^2 = 0.0365, P = 0.12).

Over 30 years after T. P. Maslin and associates obtained the large samples of *A. cozumela* in the vicinity of San Miguel de Cozumel (ca. 20.5117°N, 86.9462°W; datum: WGS84; elev. ca. 1 m) on the northwestern "corner"of Isla Cozumel in 1959 and 1961, Manríquez-Morán et al. (2005, *op. cit.*) reported on 70 specimens obtained in monthly sampling (November 1994–October 1995) ca. 25 km to the northeast on the eastern coast of the island (20.6000°N, 86.7333°W; datum: WGS84, elev. 2 m). Their data for 18 gravid females, clutch size based on oviductal eggs ($\bar{x}$= 1.8 ± 0.71, 1–4), SVL ($\bar{x}$= 64.5 ± 1.20) mm, and width ($\bar{x}$= 8.5 ± 0.68 mm) and length ($\bar{x}$= 15.3 ± 1.28 mm) of freshly laid eggs, for an east coast group of the species are similar to my findings for western groups. Moreover, the correlation reported by Manríquez-Morán et al. (2005, *op. cit.*) between clutch size and SVL in 18 *A. cozumela* (r^2 = 0.44, P = 0.0028) is contingent upon one female with 4 eggs, all other others having clutches of 1 (N = 5) or 2 (N = 12) eggs. Exclusive of the "outlier," among the remaining 17 specimens there is no correlation between clutch size and SVL (r^2 = 0.0869, P = 0.13), as was similarly reported for samples analyzed in this study. Combining data from both studies, only 2 (3.3%) females of 60 gravid *A. cozumela* had clutches greater than 2 eggs (i.e., 3 and 4).

Data presented by Manríquez-Morán et al. (2005, *op. cit.*; fig. 1) for *A. cozumela* revealed only immature lizards to be active in October–February; adult and immature lizards were present in March–September samples. Hernández-Gallegos et al. (2003, *op. cit.*) concluded that *A. cozumela* is an essentially annual species. Hatchlings produced over several weeks or months in one calendar year grow to adulthood at various time in the next year and most die in early fall. Hernández-Gallegos (2004. Ph.D. thesis, Universidad Nacional Autónoma de México) provided evidence of essentially annual life cycles for Yucatecan whiptail lizards based on survival rates for the parthenogenetic species *A. cozumela* (4.5%) and *A. maslini* (10.9%) and their gonochoristic ancestors *A. depii* (6.3%) and *A. angusticeps* (11.5%). Using these activity patterns, it is possible to infer the essentials of the life cycle of *A. cozumela* (i.e., account for the content of the 1961 UCM sample of *A. cozumela*). Individuals of 30–44 mm SVL were likely hatched within six weeks of the dates of collection 1–4 July; they would have remained active the rest of the year and into their first reproductive season beginning in March or April of the following year. SVL growth would continue as vitellogenesis began; by then most of these females in the 1961 UCM sample would have been 55–69 mm SVL. Based on this reasoning, most adult lizards in the 1961 sample of *A. cozumela* were hatched in the summer of 1960. However, it is reasonable to infer that a few lizards in the 68–77 mm SVL range were in their third summer of life (i.e., 2 calendar years of age); this would be consistent with the low survival rates reported *A. cozumela* and other Yucatecan species of *Aspidocelis* by Hernández-Gallegos (2004, *op. cit.*). In conclusion, *A. cozumela* is a small, rapidly maturing, and short-lived whiptail species. I concur that most individuals of *A. cozumela* die within a year of hatching as reported for the species by Hernández-Gallegos et al. (2003, *op. cit.*) and Manríquez-Morán et al. (2005, *op. cit*). Nevertheless, collecting success reflected by the museum holdings and published works recorded herein indicate that *A. cozumela*, characterized by small size, rapid maturation, and multiple clutches, continues to maintain high population densities in mostly coastal habitats on Isla de Cozumel (Manríquez-Morán et al. 2008. Revista Mexicana de Biodiversidad 79:421–426; fig. 1) allopatric to Yucatecan congeners (i.e., *A. angusticeps*, *A. deppii*, *A. maslini*, and *A. rodecki*).

I thank Shi-Kuei Wu (UCM), Robert C. Drewes (CAS), and William E. Duellman (KU) for the opportunity to examine specimens in their care. Oswaldo Hernández-Gallegos, (Universidad Autónoma del Estado de México) kindly provided theses and manuscripts pertaining to Yucatecan *Aspidoscelis* in advance of publication. This work is further evidence of the long-term impact of field studies conducted in the Yucatán region in the 1950s and 1960s by T. Paul Maslin (UCM. deceased), and his student, C. J. McCoy (later of the Carnegie Museum of Natural History, deceased). This note was greatly improved by the editorial expertise of Oswaldo Hernández-Gallegos and Associate Editor Marc P. Hayes and helpful suggestions of Harry L. Taylor (Regis University).

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***ASPIDOSCELIS INORNATA CIENEGAE* (Cuatro Cienegas Whiptail). PREDATION.** On 7 September 2010 at 1214 h we observed a juvenile male *Coluber* (=*Masticophis*) *taeniatus* (432 mm SVL), predating an individual *Aspidoscelis inornata cienegae* at the base of a mesquite tree (*Prosopis glandulosa*) in the eastern portion of the Cuatrocienegas Basin, state of Coahuila, Mexico, 1.2 km W of Rancho Pozas Azules (26.80957°N, 102.01943°W, [datum WGS84] 717 m. elev.). The *C. taeniatus* was collected and deposited in the Collection of Museo de Zoología Facultad de Ciencias, UNAM (MZFC 25287). This is the first report of a predator of this endemic *A. inornata* subspecies (Wright 1994. Southwest. Herpetol. Soc. Spec. Publ. 5:255–271; Wright and Lowe 1993. J. Arizona-Nevada Acad. Sci. 27:129–271).

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***ASPIDOSCELIS RODECKI* (Rodeck's Whiptail). LIFE HISTORY.** Diploid parthenogenetic *Aspidoscelis rodecki* was described as a subspecies of *A. cozumela* (=*Cnemidophorus cozumelus*) by McCoy and Maslin (1962. Copeia 1962:620–627) and either redefined or confirmed as a species by Fritts (1969. Copeia 1969:519–535), Taylor and Cooley (1995. Herpetologica 51:67–76), Hernández-Gallegos et al. (1998. Biogeographica 74:117–124), Taylor et al. (2005. J. Herpetol. 39:266–277), Liner (2007. Occ. Pap. Mus. Nat. Sci., Louisiana State Univ. 80:1–60), and Elizalde-Rocha et al. (2008. Rev. Biol. Trop. [Int. J. Trop. Biol.] 56:1871–1881). Currently, all-female groups of lizards allocated to *A. rodecki* (*sensu* Reeder et al. 2002. Am. Mus. Novit. 3365:1-61; Elizalde–Rocha et al., *op. cit.*) are present on the Yucatán Peninsula at coastal Puerto Juárez and Punta Sam and nearby Caribbean Isla Contoy and Isla Mujeres; all are parts of Quintana Roo, México. Fritts (*op.*

cit.) provided evidence that *A. rodecki* is a hybrid-derivative of the gonochoristic species *A. angusticeps* × *A. deppii*; parthenogenetic *A. maslini* and *A. cozumela* were derived from a separate hybridization and postformational event, respectively, between these species (Moritz et al. 1992. Herpetologica 48:417–424; Hernández-Gallegos et al. 2003a. J. Herpetol. 37:527–532). Here, I provide data on reproduction (clutch range and $\bar{x}$ ±SE; SVL range and $\bar{x}$ ±SE; yolked follicle range and $\bar{x}$ ±SE; length and width of oviductal eggs range and $\bar{x}$ ±SE), sample composition (number of generations present), and life cycle (age at maturity and life span) in a species that utilizes human-modified (e.g., urban development) and hurricane-impacted (e.g., Category 4 Wilma on 21 October 2005) coastal and island habitats elevated only a few meters above sea level. According to Konrad (1996. Caribbean Tropical Storms. RCM 1:98–130), the northeast tip of the Yucatán Peninsula near the islands in question receives the greatest number of hurricane strikes in the region.

I examined 70 (76.9%) of the 91 specimens listed of *A. rodecki* from the University of Colorado Museum of Natural History (UCM), including those transferred to the California Academy of Science (CAS), obtained in 1961 by T. P. Maslin and associates (see McCoy and Maslin, *op. cit.*) from Quintana Roo: Isla Contoy, 21.4955°N, 86.7986°W, datum: WGS84 [23 June 1961 (UCM 15304, N = 1)], Isla Mujeres, 21.2419°N, 86.7391°W [22 June 1961 (UCM 15305–15341, 15342 = CAS 94030, 15343–15349, 15351–15370, N = 65); and Puerto Juárez (mainland, 21.1838°N, 86.7413°W [27 June 1961 (UCM 15371–15372, 15373 = CAS 94031, 15374–15395, N = 25)]. I obtained size (as SVL to the nearest 1 mm) for all except 21 females of *A. rodecki* (transferred to collections other than CAS) in the original UCM numbered sample. Females were dissected to determine reproductive status, and identify the number and measure oviductal eggs and yolked ovarian follicles when present.

The 22–27 June 1961 UCM sample of *A. rodecki* included by sizes (as 5 mm SVL increments where applicable) these distributions for 70 specimens: 30–34 (23, 32.9%), 35–39 (4, 5.7%), 40–44 (1, 1.4%); 50–54 (1, 1.4%), 55–59 (9, 12.9%), 60–64 (24, 34.3%), 65–69 (6, 8.6%), 70–74 (1, 1.4%), 75 (1, 1.4%). That the small number of lizards in the 65–75 mm SVL range (8, 11.4%) is indicative of a short life cycle in *A. rodecki* (i.e., few lizards live long enough to attain these lengths) rather than sampling error is consistent with life history data reported for another Yucatecan parthenogenetic species. Hernández-Gallegos (2004. Ph. D. Thesis, Universidad Nacional Autónoma de México) reported an annual die-off rate of 95.5% for individuals of the closely related Isla de Cozumel endemic *A. cozumela* (maximum SVL 77 mm), which like *A. rodecki* is an early-maturing and short-lived species derived via *A. maslini* from a hybrid of *A. angusticeps* × *A. deppii* (Moritz et al., *op. cit.*; Manríquez-Morán et al. 2000. J. Herpetol. 34:634–637).

Each of the following statements for a SVL group of *A. rodecki* includes the number of gravid females followed by clutch size based on the same or a smaller number of lizards with undamaged eggs. Based on the 1961 UCM sample, *A. rodecki* attains reproductive maturity at ca. 57 mm SVL. Among females 55–59 mm SVL, 7 (77.8%) were gravid; clutch size was 2 ($\bar{x}$ = 2.0, N = 5). Among females 60–64 mm SVL, 19 (79.2%) were gravid; clutch size was 1–3 ($\bar{x}$ = 1.9 ± 0.33 SD, N = 17). Among females 65–69 mm 5 (83.3%) were gravid; clutch size was 2–3 ($\bar{x}$ = 2.3 ± 0.50 SD, N = 4). The female of 71 mm SVL was gravid; clutch size was 3. The female of 75 mm SVL was gravid; clutch size was 5. Overall, 27 (38.6%) lizards in the sample are definitely young-of-year (YOY), 2 (2.9%) are either older YOY or second summer subadults, 41 (58.6%) are mature adults, 33 (47.1%) are gravid (5 damaged), and 8 (11.4%) contain oviductal eggs. Females with with either yolked ovarian follicles or oviductal eggs (N = 28) had clutches (sample size in each category in parens) of 1 (2), 2 (22), 3 (3), and 5 (1); mean clutch size and SVL for these females were 2.1 ± 0.13 (1–5) eggs and 62.6 ± 0.74 (57–75) mm, respectively. Asynchrony in reproductive cycles is indicated among the 41 adult females in the 1961 sample of *A. rodecki* ($\bar{x}$ = 62.3 ± 0.58, 55–75 mm SVL); 13 are not gravid, 20 (71.4%) of 28 undamaged individuals have yolked ovarian follicles of 3.5–10.0 ($\bar{x}$ = 6.6 ± 0.52) mm, and 8 (28.6%) have oviductal eggs of 7.5–8.0 ($\bar{x}$ = 7.8 ± 0.09) mm in diameter and 14.5–16.0 mm ($\bar{x}$ = 15.1 ± 0.14) mm in length. In the 1961 sample of *A. rodecki*, a correlation existed between clutch size and SVL (adjusted r^2 = 0.35, P = 0.0005). However, this correlation is contingent upon one extraordinary female (UCM 15333) of 75 mm SVL with 5 eggs (minimally in its second summer); removal of it from the model results in loss of the correlation between SVL and clutch size in the sample (adjusted r^2 = 0.03, P = 0.2006).

Using monthly samples of *A. cozumela* obtained from Isla de Cozumel in November 1994–October 1995, Manríquez-Morán et al. (2005. Herpetologica 61:435–439; Fig. 1) reported only immature individuals in October–February samples; immature and adult lizards were present in March–September samples. Hernández-Gallegos (2004, *op. cit.*) concluded that *A. cozumela* is an essentially annual species. Hatchlings produced over several weeks or months in one calendar year grow to adulthood at various times in the next year and most die by early fall. Hernández-Gallegos (2004, *op. cit.*) provided evidence of essentially annual life cycles based on survival rates for the Yucatecan parthenogenetic species *A. cozumela* (4.5%) and *A. maslini* (10.9%) and their gonochoristic ancestors *A. depii* (6.3%) and *A. angusticeps* (11.5%). Although his study of the life cycle of *A. rodecki* was terminated by urban development of lizard habitat, based on life cycle data for closely related Yucatecan species it is possible to approximate the number of generations represented in the 1961 UCM sample of *A. rodecki*. The 28 individuals of 30–44 mm SVL (40.0%) were likely hatched within six weeks of the dates of collection 22–27 June 1961; they would have remained active the remainder of that year and into their first reproductive season beginning in March or April of the following year. Growth in SVL would continue as vitellogenesis began; by then most of these females in the UCM sample would have been 52–65 mm SVL. Based on this reasoning, most adult lizards in the 1961 sample of *A. rodecki* were hatched in the summer of 1960. However, it is reasonable to infer that a few lizards in the 68–75 mm SVL range were in their third summer of life (i.e., 2 calendar years of age); this interpretation of data would be consistent with the low survival rates reported for other Yucatecan species of *Aspidocelis* by Hernández-Gallegos (2004, *op. cit.*). Based on the SVL range and numbers of specimens in the UCM samples from mainland Puerto Juárez and Isla Mujeres, *A. rodecki*, like *A. cozumela* (Hernández-Gallegos et al. 2003. Biogeographica 79:1–17), is a mostly annual whiptail lizard species that is capable of attaining high population densities in optimal habitats of limited availability (Elizalde-Rocha et al., *op. cit.*), sympatric with *A. angusticeps* at Puerto Juárez (Fritts, *op. cit.*), but on Isla Mujeres allopatric to all Yucatecan congeners (i.e., *A. angusticeps*, *A. deppii*, *A. maslini*, and *A. cozumela*). The size of a sample (N = 28) of live *A. rodecki* collected on Isla Contoy in 1995 and 1996 (see Hernández-Gallegos 2003a, *op. cit.*) indicates that the species is also well established on the small island of 317 ha, allopatric to congeners.

Nevertheless, I opine that collection of monthly samples of *A. rodecki* at mainland Puerto Juárez and on Isla Contoy and Isla Mujeres, which would only modestly extend our knowledge of reproduction in this species, would be questionable based on the precarious conservation status of this parthenogen owing to habitat destruction by activities of developers (see Elizalde-Rocha et al., *op. cit.*).

I thank Shi-Kuei Wu (UCM) and Robert C. Drewes (CAS) for the opportunity to examine specimens in their care. Oswaldo Hernández-Gallegos (Universidad Autónoma del Estado de México) kindly provided theses and manuscripts pertaining to *A. rodecki* in advance of publication. This study is further evidence of the long-term impact of field studies in the Yucatán region in the 1950s and 1960s by T. Paul Maslin (UCM, deceased), and his student, C. J. McCoy (later of the Carnegie Museum of Natural History, deceased). Oswaldo Hernández-Gallegos and Marc P. Hayes provided indispensable advice in the preparation of this report.

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***CHALCIDES SEPSOIDES* (Wedge-snouted Skink). ENDOPARASITES.** *Chalcides sepsoides* is widespread in the Middle East and is known from Tunisia, Libya, Egypt, Israel, Jordan, Saudi Arabia, Eritrea, and Yemen (Uetz and Hosek 2011. The Reptile Database http://www.reptile-database.org. Accessed 2 December 2011). To our knowledge there have been no helminths reported from *C. sepsoides*. The purpose of this note is to establish the initial helminth list for *C. sepsoides*.

The body cavity of one *C. sepsoides* collected 1 May 1958 at Elat, South District, Israel (29.5500°N, 34.9500°E; datum WGS84) and deposited in the Zoological Museum of Tel Aviv University (TAUM), Tel Aviv, Israel as TAUM 3064 was examined. One oval shaped whitish helminth ca. 2 mm in length was found. It was examined under a dissecting microscope, identified as an oligacanthorhynchid acanthocephalan cystacanth and deposited in the United States National Parasite Collection, Beltsville, Maryland as USNPC 105148.

Acanthocephalans require an arthropod intermediate host in which the cystacanth develops (Kennedy 2006. Ecology of the Acanthocephala. Cambridge University Press, Cambridge, UK. 249 pp.). Since no development beyond the cystacanth stage occurs in lizards, they likely serve as paratenic (transport) hosts. Development to the adult acanthocephalan occurs when a definitive host ingests the infected lizard. Cystacanths have been reported from a large number of lizard hosts (Bursey and Goldberg 2003. J. Parasitol. 89:573–576). *Chalcides sepsoides* represents a new host record for oligacanthorhynchid cystacanths.

We thank Shai Meiri (TAUM) for permission to examine *C. sepsoides*, Erez Maza (TAUM) for facilitating the loan and the National Collections of Natural History at Tel Aviv University for providing samples of *C. sepsoides* for this study.

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***CTENOSAURA BAKERI* (Utila Spiny-tailed Iguana). ENDOPARASITES.** *Ctenosaura bakeri* is known only from Utila Island, Honduras (de Queiroz 1987. Copeia 1987:892–902). To our knowledge, there are no reports of helminths from *C. bakeri*. The purpose of this note is to establish the initial helminth list for *C. bakeri*.

Nematodes were recovered from fecal matter and gut dissections from two recently diseased wild and one recently diseased captive *C. bakeri* from Utila Island, Honduras (16.1032°N, 86.8992°W, datum WGS84) during 2011 and fixed in 10% formalin for 24 h and preserved in 95% ethanol. Nematodes were cleared in glycerol, mounted on glass slides, examined under a compound microscope and identified as *Cyrtosomum scelopori*, *Oswaldofilaria brevicaudata,* and *Ozolaimus ctenosauri*. Voucher specimens were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, USA as: *Cyrtosomum scelopori* (USNPC 104929), *Oswaldofilaria brevicaudata* (USNPC 104930), *Ozolaimus ctenosauri* (USNPC104931).

Cyrtosomum scelopori is widespread in lizards from the Caribbean, southern United States, Mexico, and Panama and is known to occur in over 50 species (McAllister and Bursey 2007. Comp. Parasitol. 74:179–184). The method of transmission of *C. scelopori* from host to host is not known, however, mating has been suggested as an infection route; once infected, autoinfection maintains the infection (Anderson 2000. Nematode Parasites of Vertebrates. Their Development and Transmission. CABI Publishing, Oxon, UK. 650 pp.). *Oswaldofilaria brevicaudata* is known from lizards in Mexico, Central and South America; hosts are summarized in Bursey et al. (2007. Comp. Parasitol. 74:108–140). Infection by *Oswaldofilaria* species occurs by injection of microfilariae from an infected mosquito (Anderson 2000, *op. cit.*). *Ozolaimus ctenosauri* was described from *Cyclura acanthura* from Oaxaca and Puebla Mexico (Caballero 1938. An. Trop. Med. Parasitol. 32:225–229) and occurs mainly in iguanids from Mexico (Moravec 1996. J. Parasitol. 82:1011–1016). It was also reported from *Ctenosaura oedirhina* from Honduras (Goldberg et al. 2011. Herpetol. Rev. 42:600–601). *Ozolaimus ctenosauri* is an oxyurid nematode, which does not utilize an intermediate host (Anderson 2000, *op. cit.*). Infection likely occurs by *C. bakeri* ingesting eggs while it forages for food. *Ozolaimus ctenosauri, O. brevicaudata,* and *C. scelopori* represent new host records for *C. bakeri*. Honduras is a new locality record for *Cyrtosomum scelopori* and *Oswaldofilaria brevicaudata*.

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***CTENOSAURA PECTINATA* (Mexican Spiny-tailed Iguana). ALBINISM.** On 12 July 2011 a young albino *Ctenosaura pectinata* was collected in the vicinity of Ahualulco de Mercado, Jalisco, Mexico (20.70134°N, 103.97356°W, datum WGS 84; elev. 1320 m) by local residents. The specimen was photographed by MVB and then returned to the wild where it was initially captured. This specimen presented typical albino characters including general lack of pigmentation, as exhibited by pink irises, red pupils, and yellow coloration all over its body (including limbs and tail). The normal color pattern of this species is black or grey with yellow-

ish flanks in males and orange in females; the tail has alternating light and dark bands. Hatchlings are green in color and darken as they age (Garcia and Ceballos 1994. Guía de Campo de los Reptiles y Anfibios de la Costa de Jalisco, México. Fundación Ecológica Cuixmala, A. C. Instituto de Biología, UNAM, México D.F. 184 pp.). This is the first report of albinism in this endemic Mexican species. Photographs of the specimen were deposited in the University of Texas at Arlington (UTADC 6980-82).

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***GALLOTIA GALLOTI* (Canary Lizard). NECTARIVORY.** Hardly known a few decades ago, the phenomenon of lizards as pollinators and seed dispersers within insular systems has received increased attention in recent years, as demonstrated by the growing list of mutualistic interactions and studies on lizard ecology in oceanic islands (Hansen et al. 2007. Am. Nat. 169:534–542; Olesen and Valido 2003. Trends Ecol. Evol. 18:177–181).

Within the genus *Gallotia*, endemic to the Canary Islands (with seven described species), the omnivorous *G. galloti* is one of the best-studied members, reported as an important seed disperser (fleshy fruit represents >50% of its diet; Valido and Nogales 1994. Oikos 70:403–411), and which also consumes nectar from several plant species (Valido et al. 2002. Acta Oecol. 23:413–419; Valido et al. 2004. J. Biogeogr. 31:1945–1953). Herein, we add to this increasing list of *Gallotia*-plant interactions two new records of nectarivory and putative pollination by *G. galloti* on two Canarian endemics: *Canarina canariensis* (Campanulaceae) and the threatened *Lotus maculatus* (*Rhyncholotus* group; Fabaceae) on the island of Tenerife.

Between 8 and 31 March 2005, we recorded several visits of *G. galloti* (two juveniles and one adult male) to flowers of *C. canariensis* for nectar feeding in cleared sites in a laurel forest from northwestern Tenerife (Monte del Agua y Pasos, 630–760 m elev.). Most of the flowers visited by lizards were situated on the ground (on rocky substrate), facilitating access (Fig. 1). In only one case, a juvenile individual had to climb to reach a flower resting on a tree branch, at ca. 1 m above the ground. All the interactions seemed to be legitimate, as the lizards had to contact stigmas and secondarily presented pollen on the style by inserting their entire heads into *Canarina* flowers to get to the nectar.

Our observations of Gallotia-Lotus interactions were made on the north coast of Tenerife (El Sauzal, approx. 10 m elev.). We used binoculars and video camera to observe the behavior of the lizards on and around the plants in a small, relict natural patch during three flowering periods (2006, 2007, and 2009). Between 26 and 30 March 2006, we monitored five plants during 12.5 h observation, in which 13 juvenile lizard individuals were detected. They visited a total of 28 flowers, but some of them made illegitimate visits (N = 13, 46.4%), since they tore apart one of the corolla lobes or chewed the calyx at the margin of its lobes to reach the nectar without contacting sexual organs. It was not until the 2009 monitoring that we could confirm legitimate visits by *Gallotia* adults, both female (Fig. 2) and male, as well as foraging movements between plants up to 6 m apart. In addition, *Lotus* flowers were visited for nectar by ants (Formicidae), solitary bees (Halictidae), the endemic butterfly *Cyclyrius webbianus* (Lycaenidae), and by an individual of the allochthonous micromammal *Mus musculus* (Muridae), but only the latter contacted floral reproductive organs.

Both plant species are considered to be bird-pollinated based on their floral characteristics (Dupont et al. 2004. Funct. Ecol. 18:670–676; Olesen 1985. Bot. J. Linn. Soc. 91:395–414), but bird visits have only been confirmed under natural conditions for *C. canariensis* (Valido et al. 2004, *op. cit.*; Rodríguez-Rodríguez and Valido 2011. Amer. J. Bot. 98:1465–1474). Therefore, our data are a stimulus for future assessments of the actual role of lizards in the reproduction of these plants. In the case of *C. canariensis*, this presumptive mutualistic interaction with *G. galloti* is expected to be favored at forest gaps and edges of roads crossing laurel forests, as road edges are proposed as dispersal corridors for this reptile (Delgado et al. 2007. Biod. Conser. 16:2949–2963). Introduced rodents *M. musculus* and *Rattus rattus* (Muridae), as well as the endemic gastropod *Plutonia lamarckii* (Vitrinidae), have also been observed feeding on nectar, although only the latter two are known for their herbivory effects on *Canarina* reproduction pattern, since they mainly consume floral reproductive tissues (Rodríguez-Rodríguez and Valido 2011, *op. cit.*).

Our observations on the relationship between *L. maculatus* and *G. galloti* during three consecutive years suggest that

PHOTO BY JOSÉ J. HERNÁNDEZ

FIG. 1. *Gallotia galloti* (male) approaching a *Canarina canariensis* flower to feed on nectar.

PHOTO BY PEDRO FELIPE

FIG. 2. *Gallotia galloti* (female) visiting *Lotus maculatus* flowers. By introducing the snout to reach the nectar, the reptile presses the keel down and consequently pumps the pollen out.

the foraging behavior of this lizard is not a rare phenomenon. The high risk of extinction of this plant, catalogued as "critically endangered" (IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. www.iucnredlist.org), seems to be due to a combination of anthropogenic factors (e.g., introduced herbivores, intense collection, gardening, and habitat destruction), but some authors have also suspected that it could be a consequence of the extinction of past avian pollinators (Olesen 1985, *op. cit.*). According to this, bird visitation on L. berthelotii, another representative of the Canarian bird-flower element, has been recently recorded in non-native populations (Ollerton et al. 2009. Naturwissenschaften 96:221–232). But for *L. maculatus*, the only potential pollinator bird species that had been observed close to the plants of this natural patch was *Sylvia conspicillata* (Sylviidae), just once during ca. 30 h obervation (F. Siverio, pers. obs.). This low arrival rate of a potential pollinating bird seems to be due to the absence of a shrubby corridor, apparently eradicated by human activity, between this species' habitat and the isolated *Lotus* patch. If the *Gallotia-Lotus* interaction has occurred earlier or is a consequence of the restricted distribution of the plant is not possible to assess, but reality is that individuals of this sympatric lizard population are presently the most frequent flower visitors.

Some of the observations described here were made as part of the work for a documentary film series (Canarias, reductos de biodiversidad) on Canarian biodiversity conducted by Alas Cinematografía S.L. We thank Pedro Felipe and José J. Hernández for their valuable help in the field, as well as Jens M. Olesen and Benigno Padrón for reviewing an early draft of the manuscript.

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***LEIOCEPHALUS CARINATUS* (Northern Curly-tailed Lizard). DIET.** A recent review documented that insular species of lizards are more likely to incorporate plant material (e.g., flowers, nectar, pollen) into their diets than mainland species (Olesen and Valido 2003. Trends Ecol. Evol. 18:177–181). *Leiocephalus carinatus* is commonly found on islands across the Bahamas and has been described as a mostly terrestrial species with a relatively diverse diet (Schoener et al. 1982. Oecologia 53:160–169). Schoener et al. (1982, *op. cit.*) investigated prey specimens from *Leiocephalus* lizards in the Bahamas and found that plant matter comprised up to 47.4% of their diet. Flowers and buds were commonly included. Here we report two observations of *L. carinatus* feeding on the epiphytic orchid *Cattleyopsis lindenii*.

On the morning of 26 May 2011, we observed an individual *L. carinatus* (>70 mm SVL) on a small island in the vicinity of Snake Cay, Great Abaco Island, Bahamas, consuming the flower of the orchid *C. lindenii*. The lizard climbed up a relatively thin tree trunk (ca. 3 cm diameter) before orienting itself in a lateral position in order to reach for the flower petals on a nearby branch (perch height: 94 cm; perch diameter: 1 cm). From this position, the lizard consumed most of the flower; only the base of the stigma was left on the inflorescence. A second observation was recorded on the afternoon of 27 May 2011. On this occasion, the lizard (a male, 130 mm SVL) was observed slowly moving across the ground and appeared to exhibit a searching behavior, in which it frequently stopped, assumed an alert posture, and slowly moved its head in different directions. After performing one of these searches, the lizard quickly climbed up a tree trunk (ca. 5 cm diameter) to a height of 85 cm and tore one flower off the inflorescence of an orchid. After tearing off the flower, the lizard immediately returned to the ground, where it consumed the complete flower. While on the ground, the lizard repeatedly made exaggerated swallowing movements while engulfing the complete flower; this behavior lasted ca. 4 minutes. Although the lizards were not marked, the differences in SVL suggest that we observed two individuals.

On both of these occasions, the lizards climbed up perches in order to gain access to the flowers, and either consumed multiple petals or the complete flower. This suggests that the curly-tailed lizards were not eating the flowers as a byproduct of trying to catch an insect. Instead, *L. carinatus* might actively search for flowers as part of its diet. It has been suggested that lizards may act as pollinators for some species of plants (Olesen and Valido 2003, *op. cit.*), though in this case, by consuming the entire flower, *L. carinatus* may have an impact on the reproductive success of *C. lindenii*.

We thank M. Leal and D. Steinberg for encouraging us to report our observations and for reviewing the manuscript. We also thank the Bahamian Ministry of Agriculture and Bahamas Environment, Science, and Technology (BEST) Commission of the Ministry of the Environment for providing permits. These observations were made while participating on a Training Research Fellowship supported by National Science Foundation (DEB-0949357).

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***LIOLAEMUS cf. ELONGATUS*. TRAUMA SURVIVAL.** The ingestion of unnatural food items can provoke multiple complications in an animal, such as gastrointestinal blockages, perforations, suffocation, and poisoning, often leading to death, but little scientific information is published on this subject. Published accounts on reptiles typically include larger taxa such as turtles, crocodiles, or large-bodied lizards (e.g., Gillett and Jackson 2010. Biawak 4:99–102; Trembath and Freier 2005. Herpetofauna 35:48–49). Observations on this subject in smaller lizards are

FIG. 1. A) Lizard and chicken bone after extraction for size comparison (white arrow shows protrusion with scar mark; B) radiograph of the injured lizard, black line shows the major axis of the bone ingested.

poorly documented, and are particularly unknown for both the genus *Liolaemus* and southern South America.

On 8 February 2011, an adult male *Liolaemus cf. elongatus* (70.8 mm SVL) was collected on a rocky cliff on the north shore of Laguna del Maule, 1 km S Road 115, Talca Province, Maule Region (VII Administrative Region), Chile (36.016694°S, 70.562083°W, datum:WGS84; elev. 2210 m). This area is frequently used for such outdoor recreation activities as hiking, climbing and camping. When the lizard was inspected in the lab for conservation purposes, one of us (CHFP) noticed a deformation in the trunk with a bulge on the right side and a wound between the lateral scales in the left side of the chest. Palpation of the abdomen revealed a solid mass in the stomach region (Fig. 1A). After radiographic examination, a large object was observed (Fig. 1B) and a subsequent dissection revealed a triangular 29 mm long and 8.19 mm wide chicken bone inside the stomach, with its pointed tip (5.82 mm) protruding through the stomach wall. The pointed tip was in contact with the skin and probably generated the scar that was visible externally. The stomach was full with digested insects and perforation was completely cicatrized with connective tissue around the bone. This lizard did not appear to experience any obvious restrictions in prey capture, digestion, or mobility, as it was chased between rocks for around 10 m prior to capture. No sign of malnourishment was observed at the time of collection. Voucher specimen (LJAMM-CNP 14065) is deposited in the herpetological collection Luciano Javier Avila Mariana Morando (LJAMM-CNP) of the Centro Nacional Patagónico (CENPAT-CONICET), Puerto Madryn, Argentina.

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***MESASPIS GADOVII* (Gadow's Alligator Lizard). ENDOPARASITES.** *Mesaspis gadovii* is known from parts of Guerrero and Oaxaca, Mexico (Flores Villela and Gerez 1994. Biodiversidad y Conservacíon en México; Vertebrados, Vegetacíon y Uso del Suelo. UNAM, D.F., México. 439 pp.). To our knowledge there are no helminths reported from *M. gadovii*. The purpose of this note is to establish the initial helminth list for *M. gadovii*.

Four *M. gadovii* (mean SVL = 78.0 mm ± 6.3 SD, range = 70–85 mm) collected 1971, 1973, 1977 from Guerrero, Mexico and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA were examined for helminths. The digestive tract was removed through a mid-ventral incision, and the esophagus, stomach and small and large intestines were examined for helminths under a dissecting microscope. Two species of nematodes were found which were cleared in glycerol, cover-slipped on a microscope slide, and studied under a compound microscope. Seventeen individuals of *Oswaldocruzia nicaraguensis* were found in the small and large intestines of LACM 109287, 127412 and 127413. Prevalence (number infected lizards/number lizards examined x 100) = 75%; mean intensity (mean number helminths per infected lizard ± 1 SD) = 5.7 ± 6.4 SD; range : 1–13. One nematode, *Physaloptera retusa* prevalence = 25%) was found in the stomach of LACM 127412. No helminths were found in LACM 75503. Helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as: *O. nicaraguensis* (USNPC 105146) and *P. retusa* (USNPC 105147).

Oswaldocruzia nicaraguensis was originally described from *Ameiva festiva* from Nicaragua by Bursey et al. (2006. J. Parasitol. 92:350–352) and was also reported in *Anolis capito* (as *Norops capito*) from Nicaragua (Bursey et al. 2007. J. Parasitol. 93:129–131). Other hosts include *Anolis biporcatus, A. limifrons* (Costa Rica, Panama), *A. capito, A. lionotus* (Panama) (Bursey et al. 2012. Comp. Parasitol. [in press], and *Sphenomorphus cherrieri* (Costa Rica) (Goldberg and Bursey 2007. Herpetol. Rev. 38:83–84). *Physaloptera retusa* is widely distributed in a few New World amphibians and many lizards; hosts are listed in Bursey et al. (2012, *op. cit.*). *Mesaspis gadovii* represents a new host record for *O. nicaraguensis* and *P. retusa*. Mexico is a new locality record for *O. nicaraguensis*.

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***PHELSUMA MADAGASCARIENSIS GRANDIS* (Madagascar Giant Day Gecko). CANNIBALISM.** Cannibalism in most species of reptiles appears to take place opportunistically as a normal predatory behavior and can be considered as the major mortality sources for certain juvenile lizard species (Siqueira and Rocha 2008. S. Am. J. Herpetol. 3:82–87; Stone and Snell 2002. Herpetol. Rev. 33:53). While passing through Betsiaka on 24 January 2010 at 0940 h in the District of Ambilobe, northern Madagascar (13.160°S, 49.240°E), we observed an adult male *Phelsuma madagascariensis grandis* eating a juvenile conspecific on a fence post. The juvenile day gecko was swallowed from its head to mid body upon our first observation and was completely ingested within 20 min. *Phelsuma m. grandis* is one the largest species in the genus, with a total length of up to 280 mm. Males are larger than females and are extremely aggressive (Glaw and Vences 2007. A Field Guide to the Amphibians and Reptiles of Madagascar. 3rd ed. Cologne, Vences and Glaw, Verlag. 496 pp). In captivity, this species feeds on fruits, a wide variety of invertebrates and vertebrates, and parent individuals may eat their young or harass them, leading to poor development or death (LaFerriere 2007. http://www.genevievesgeckos.com/site/care_sheet_Phelsuma.html. Accessed 25 October 2011). The cannibalistic observation reported here corroborates the statement by Siqueira and Rocha (2008, *op. cit.*) that most cannibalism in lizards appears to take place by males. This observation is also noteworthy because it is the first record of cannibalism in *P. m. grandis* outside of captive breeding, and provides supplementary information on feeding behavior of Malagasy lizards.

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***PHRYNOSOMA BRACONNIERI* (Short-tailed Horned Lizard). PREDATION.** The Loggerhead Shrike (*Lanius ludovicianus*) is a passerine bird that is known to feed on a wide variety of prey, including grasshoppers, small mammals, reptiles and other birds.


PHOTO BY SANDRA FABIOLA ARIAS-BALDERAS

FIG. 1. *Phrynosoma braconnieri* impaled on a leaf-spine of *Agave salmiana*.

One of the feeding strategies includes impaling a prey item onto a thorn, twig or barbed wire. This behavior allows the shrike to secure its prey while it tears pieces of flesh and also allows for food storage (Craig 1978. The Auk. 95:221–234). There are accounts of various lizard species being predated upon and impaled by this bird, including *Aspidoscelis sexlineatus* (Tyler 1991. Proc. Oklahoma Acad. Sci. 71:17–20), *Scincella lateralis, Eumeces inexpectatus,* and *Anolis carolinensis* (Yosef and Grubb 1993. The Condor. 95:127–131). Predation on *Phrynosoma* by this shrike has been reported for *P. platyrhinos* (Pianka and Parker 1975. Copeia. 1975:141–162), *P. mcallii* (Young et al. 2004. Science 304[5667]:65), *P. modestum* (Reid and Fulbright 1981. Southwest. Nat. 26:204–205), and *P. cornutum* (Lemos-Espinal et al. 1998. Herpetol. Rev. 29:168). Little is known about the natural predators of southern Mexican *Phrynosoma* species. To our knowledge, no predators or predation events have been reported for *P. braconnieri*.

On 27 June 2010, at San Nicolas Tepoxtitlán, Puebla, México (18.386389°N, 97.686111°W, datum WGS84; elev. 1915 m), an adult *Phrynosoma braconnieri* was found dead and impaled on the tip of a leaf-spine on an agave (*Agave salimiana*) (Fig. 1). The lizard was pierced by the agave's spine at the neck, and the spine exited the victim's head via the right eye. *Lanius ludovicianus* is common at the site of observation and we believe this observation to be the result of predation on the horned lizard by this bird species. Color slides were deposited (MFESI-REPT 862–865) at Colección de Anfibios y Reptiles, Museo de Zoología, FES-Iztacala, Universidad Nacional Autónoma de México. This is the first record of *P. braconnieri* being impaled as a prey item by a shrike and the first account of predation on this horned lizard.

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***PHRYNOSOMA MODESTUM* (Round-tailed Horned Lizard) × *P. SOLARE* (Regal Horned Lizard). PUTATIVE HYBRID**. The phylogenetic relationship of horned lizards, genus *Phyrnosoma*, has been difficult for taxonomists to resolve because there is incongruence between morphological and genetic characters (Hodges and Zamudio 2004. Mol. Phylog. Evol. 31:961–971; Leaché and McGuire 2006. Mol. Phylog. Evol. 39:628–644). However, at the species level, all are morphologically distinct (Sherbrooke 2003. Introduction to Horned Lizards of North America. University of California Press, Berkeley. 178 pp.). Phenotypic characters used to differentiate species include morphology, metrics, scalation (especially of the cranial horns and lateral fringe scales), color (recognizing that some species are highly polymorphic), and pattern. Taxonomists currently agree there is but a single genus of horned lizards, and species may occur sympatrically, but documentation of individuals exhibiting intermediate characters (i.e., hybrids) is rare. The exception is that of *P. mcallii* x *P. goodei* and *P. platyrhinos*, with morphological and genetic hybrids being described in their contact zone of southwestern Arizona and southeastern California (Pianka and Hodges 1998. Reptiles 6:48–63; Mulcahy et al. 2006. Mol. Ecol. 15:1807–1826; W. Flaxington 2007, see http://calphotos.berkeley.edu, ID number 0000 0000 0507 1961). These known or putative hybrids have intermediate phenotypic characters. In this note, we describe a putative hybrid between *P. modestum* and *P. solare* at a contact zone in southeastern Arizona.

On 17 March 2011, we were engaged in a long-term monitoring project of a lizard assemblage near Safford, Graham Co., Arizona, USA, when an unusual-looking horned lizard was observed (Fig. 1) on Forest Road 57 near the junction with Marijilda Creek (32.706735°N, 109.775670°W; WGS84; 1227 m elev.). Four *Phrynosoma* species have been documented from the vicinity: *P. modestum*, *P. solare*, *P. cornutum*, and *P. hernandesi* (Jones 2009. Sonoran Herpetol. 22:94–98), but only *P. modestum* and *P. solare* are common. At first glance, the lizard reported here appeared

FIG. 1. Putative *Phrynosoma modestum* x *P. solare* hybrid from Graham County, Arizona.

FIG. 2. Close up of the head and cranial horns.

to be *P. modestum*, but upon closer inspection we noticed it had a single row of lateral fringe scales. The cranial horn morphology was unlike any of the sympatric species (Fig. 2). The adult animal (ca. 70 mm SVL) was photographed and released on site. Although it would have been beneficial to collect the specimen for morphometric and genetic analysis, it was more important from our standpoint to leave the animal on site because a hybrid could contribute to the changing composition of the lizard community over time.

By comparing the photographs of the specimen with photographs and specimens of the other sympatric horned lizards, as well as published literature (Sherbrooke 2003, *op. cit.*; accounts in Jones and Lovich [eds.] 2009. Lizards of the American Southwest. Rio Nuevo Publ., Tucson, Arizona. 567 pp.), we believe the animal to be a hybrid between *P. modestum* and *P. solare*. The specimen had characters of one species or the other, both species, or intermediate characters. We also sent the photographs to a horned lizard expert, Wade Sherbrooke, to review; he suggested the same putative identification. The most diagnostic characters for comparison are probably the lateral scales and cranial horns. There is one lateral row of fringe scales in *P. solare*, *P. hernandesi*, and the putative hybrid, but none in *P. modestum*; *P. cornutum* has two rows. Both *P. modestum* and *P. solare* have four occipital horns, but the shape and size differs greatly. *Phrynosoma modestum* has relatively short, evenly sized, widely spaced occipital horns that do not touch at the base. The temporal horns are of moderate length. *Phrynosoma solare* has long, wide occipital horns that form a semicircle with the long temporal horns, all of which touch at the base. Also, in *P. modestum*, the rear of the head forms a relatively straight line between the posterior temporal horns, while in *P. solare* the rear of the head forms more of a semicircle. The cranial horns of *P. cornutum* and *P. hernandesi* are quite different; the former has three cranial horns (two long lateral horns and one very small central horn) while the latter has a notch in the back of the head with minute horns. In the specimen reported here, the horns were different than any of the four species in the area, but there were four occipital horns, as in the two common species. The occipital horns were fused into two pairs; the pairs were not touching at the base, nor were they touching the bases of the temporal horns. The occipital horns were intermediate in length between *P. solare* and *P. modestum*, and the temporal horns were shorter than *P. solare*. The snout–vent length was about as large as *P. modestum* attains (Hodges 2009. *In* Jones and Lovich 2009, *op. cit.*), which is the smallest of the local species. The tail in cross section appeared intermediate between *P. solare* (wide and relatively flat) and *P. modestum* (narrow and cylindrical), although this character was not quantified. The base of the tail was not broad, as in *P. modestum*; rather, it was similar to the other sympatric horned lizards. Qualitatively, the enlarged, keeled scales (spines) of the dorsum were most similar to *P. modestum* or intermediate between *P. modestum* and *P. solare*.

The general color pattern was not typical of any species in the study area, but was similar to both *P. solare* and *P. modestum*. Although there are specific differences, both species have a lighter central dorsal color with a darker dorsolateral color. Both of these species are weakly patterned, while *P. cornutum* is invariably strongly patterned, and *P. hernandesi* is highly variable. There were two other color patterns worth mentioning. In our specimen, there was a dark marking on the mid-dorsal area on the top of the head bordered by a lighter area. This same pattern has been seen in juvenile *P. solare* in the study area and elsewhere. It is also apparent in *P. cornutum* of all age classes. This feature is lacking in the *P. modestum* we have seen. Also, there were stripes radiating ventrally from the eye. This is fairly diagnostic in *P. cornutum*, but we have seen similar markings in some *P. modestum* and *P. solare*.

If our specimen were simply an anomalous *P. solare* with fused occipital horns, the bases of the pairs would be expected to touch each other, as well as the temporal horns. Also, it would be expected that the temporal horns would be long in our specimen, but this is not the case. This specimen also lacked the light mid-dorsal stripe, which is fairly diagnostic in *P. solare*. The specimen was not as spiny dorsally as typical *P. solare* and the tail was not as broad.

The study area was selected as a long-term monitoring site for lizards because it has among the highest diversity of lizards in the USA and it is situated at an ecotone in a convergence zone of physiographic provinces, so would be expected to show changes in the lizard assemblage concomitant with a changing environment (Jones 2009, *op. cit.*). This accounts for the presence of four sympatric species of *Phrynosoma* found in such a small area. The local distributions of the four species are imperfectly understood, but the two common species are microsympatric where their ranges overlap. *Phrynosoma solare* is primarily a Sonoran Desert species, while *P. modestum* is primarily a Chihuahuan Desert species. These two deserts meet in the San Simon Valley in the vicinity of our study area (Brown and Lowe 1980. Biotic Communities of the Southwest. USDA Forest Service Gen. Tech. Rep. RM-78 [map]). The study area has about equal numbers of Sonoran and Chihuahuan desert species (Jones 2009, *op. cit.*). Thus, a primary objective in our study is to track changes in the assemblage of horned lizards and other species in this contact zone, in an area commonly referred to as the Cochise Filter-Barrier (Morafka 1977. A Biogeographical Analysis of the Chihuahuan Desert Through its Herpetofauna. Dr. W. Junk, The Hague. 321 pp.). Individuals of the *Sceloporus magister* complex in the area are phenotypically similar to, or intermediate between, the Sonoran Desert ('*magister*') and Chihuahuan Desert ('*bimaculosus*') forms (Phelan and Brattstrom 1955. Herpetologica 11:1–14; pers. obs.). At least two parthenogenetic whiptails of hybrid origin also occur in the study area (Jones 2009, *op. cit.*), *Aspidoscelis uniparens* and *A. flagellum* (= *A. sonorae* complex). Because the changes in lizard assemblage we are tracking include species composition (e.g., Sonoran vs. Chihuahuan desert) and hybridization, the documentation of hybridization events and potential hybrid vigor is a significant component of the study.

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***PHRYNOSOMA TAURUS* (Bull Horned Lizard). PREY.** *Phrynosoma taurus* is a Mexican endemic lizard that occurs from southern Morelos eastward to eastern Puebla and southward to northwestern Oaxaca (Reeve 1952. Univ. Kansas Sci. Bull. 34:817–960). It feeds on a variety of arthropods such as ants (Formicidae), beetles (Curculionidae, Meloidae, Scarabeidae, and Tenebrionidae), termites (Termitidae), crickets (Acrididae and Gryllacrididae), flies (Calliphoridae) and butterfly larvae (Lepidoptera) (Canseco-Márquez and Gutiérrez-Mayen. 2010. Anfibios y Reptiles del Valle de Tehuacan-Cuicatlan. CONABIO. 137 pp.; Lemos-Espinal et al. 2004. Herpetol. Rev. 35:131–134). Up to 56% (by volume) of the diet of this species consists of ants (Pianka and Parker 1975. Copeia 1975:141–162). To our knowledge, there is no record of

vertebrate prey in the diet of this or any other *Phrynosoma* species in the wild. However, there is a report of cannibalism in *P. solare* held in captivity (Comstock A.B. 1939. Handbook of Nature Study. Cornell Univ. Press. 887 pp.), and saurophagy by *P. hernandesi* and *P. cornutum* seems to be well known among herpetoculturists, but not recorded in scientific literature (Lemos-Espinal J. A., unpubl. data).

On 12 August 1999, an adult female *Phrynosoma taurus* was collected (LEUBIPRO [Laboratorio de Ecología UBIPRO, Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México] 3023; SVL 57.16 mm, TL 65.27 mm) in the Valley of Zapotitlán Salinas, Puebla (18.305694°N, 97.482056°W; WGS 84; 2100 m elev.) under the shade of an agave. As part of a dietary analysis in the reptile assemblage in this valley, we conducted a stomach content analysis of this specimen, which revealed a partially digested (without head and tail) juvenile *Sceloporus gadoviae* (neck–vent length 13.36 mm, femur length 4.79 mm, leg total length 15.68 mm). Other items found were ants (Formicidae: Ponerinae).

To our knowledge this represents the first record of a vertebrate in the diet of any *Phrynosoma* species in the wild.

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***SCELOPORUS OCCIDENTALIS* (Western Fence Lizard). NECROPHILIA.** Observations of necrophilia, the act of copulation or attempted copulation with a dead conspecific or heterospecific, are limited to few reports in the Lacertilia. To our knowledge, this behavior has been reported in four lizard species, including the Giant Ameiva, *Ameiva ameiva* (Costa et al. 2010. Herpetol. Notes 3:79–83; Vitt 2003. *In* Pianka and Vitt [eds.], Lizards: Windows to the Evolution of Diversity, p. 103. Univ. of California Press, Berkeley), Long-nosed Leopard Lizard, *Gambelia wislizenii* (Fallahpour 2005. Herpetol. Rev. 36:177–178), Lesser Earless Lizard, *Holbrookia maculata* (Brinker and Bucklin 2006. Herpetol. Rev. 37:466), and the Sleepy Lizard, *Tiliqua rugosa* (How and Bull 1998. Herpetol. Rev. 29:240; Sharrad et al. 1995. W. Austr. Nat. 20:33–35). Here we report on an observation of necrophilia in a fifth lizard species, the Western Fence Lizard, *Sceloporus occidentalis*.

FIG. 1. Male *Sceloporus occidentalis* initially attempting to mate with female corpse in typical copulatory position (A); male beginning to carry female corpse down cement wall (B); male then resuming a bite-hold on female corpse in nuchal region (C) and then assuming copulatory position once again (D).

On 11 April 2011, one of us (RE) found an adult female *Sceloporus occidentalis* that had apparently drowned in an outdoor Rubbermaid® tub (approximately 57 cm x 15 cm), filled to the brim with rain water in Butte Creek Canyon, Butte Co., California, USA (39.735847°N, 121.682378°W, datum: WGS 84; elev. 164 m). The dead lizard was removed from the water in the tub and placed on the outer rim in the open sun. At ca. 1730 h that afternoon, it came to the attention of RE that the dead lizard was no longer present where it had earlier been placed. Upon closer inspection, the corpse was being carried off by an adult male conspecific. As the behavior continued, it was photographed (Fig. 1). The male had a bite-hold on the female in the nuchal region, a behavior employed during copulation in many iguanian lizards (Noble and Bradley 1933. Ann. New York Acad. Sci. 35:25–100). It was attempting to carry the corpse along the top of a cement wall after orientating its body in a copulatory position. The male then attempted to carry the corpse down the vertical surface of the wall, but could not bear the weight, and dropped the corpse. It then proceeded to climb down to where the female corpse had landed on the ground. There, the male resumed biting the female corpse in the nuchal region and attempting to position himself for copulation. Noticeable everted hemipenes were not detected. At ca. 1742 h the male was frightened off by the activity of photographing the sequence of events. RE then placed the female back on the outer rim of the tub. The next morning (12 April), the female corpse was found back down on the ground where it had been dropped by the male the previous afternoon.

Some reported observations of necrophilia have been hypothesized to relate to pair-bonding in the monogamous *T. rugosa* (How and Bull 1998, *op. cit.*) or elicited by perceived copulation receptivity correlating to female nuptial coloration in *H. maculata* (Brinker and Bucklin 2006, *op. cit.*). However, *S. occidentalis* is a polygynous species (Massot et al. 2003. Behav. Ecol. 14:650–655) without known long-term pair-bonding behaviors and females of this species do not express brightly colored nuptial coloration. The behavior reported here is presumed to have been a direct result of hormonally mediated overstimulation, leading to the male's misconception of a receptive (but lifeless) female during breeding season as was concluded for similar behavior in *A. ameiva* (Vitt 2003, *op. cit.*). To our knowledge, this is the first report of necrophilia for this species.

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***SCELOPORUS POINSETTII* (Crevice Spiny Lizard). REPRODUCTION.** *Sceloporus poinsettii* ranges from southwestern New Mexico and central Texas, south to Zacatecas, Mexico, from 300–2560 m; it is live-bearing (Stebbins 2003. A Field Guide to Western Reptiles and Amphibians, Houghton Mifflin Co., Boston, Massachusetts. 533 pp.). Minimum litter sizes in the literature for *S. poinsettii* are variable, including 4 (Webb 2009. *In* Jones and Lovich [eds.], Lizards of the American Southwest: A Photographic Field Guide, pp. 246–249. Rio Nuevo Publ., Tucson), 6 (Ballinger 1973. Ecology 54:269–283), 7 (Stebbins 2003, *op. cit.*).

The purpose of this note is to report a new minimum litter size for *S. poinsettii*. Two females from Durango, Mexico, deposited in the herpetology collection (LACM) of the Natural History Museum of Los Angeles County, Los Angeles, California, USA, were examined: LACM 50871, SVL = 86 mm, collected August 1968 (23.7000°N, 105.7000°W, datum: WGS 84); LACM 97372, SVL = 102 mm, collected August 1967 (26.2333°N, 105.1500°W, datum: WGS 84). Each contained two enlarging pre-ovulatory follicles, 7 mm in diameter. Two is a new minimum litter size for *S. poinsettii*.

I thank Christine Thacker (LACM) for permission to examine *S. poinsettii*.

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***UTA STANSBURIANA* (Common Side-Blotched Lizard). MORTALITY.** On 18 October 2011 on Fort Bliss Army base at McGregor base camp (McGregor Range, New Mexico; 32.081505°N, 106.162715°W), I observed a hatchling *Uta stansburiana* (approximate SVL 30 mm) trapped in the web of a Black Widow Spider (*Latrodectus* sp.). The web was located inside an aluminum storage building with enough space between its rolling bay doors and frame that small wildlife species (lizards, snakes, rodents, invertebrates) could enter and exit freely. The web was occupied by a spider when this discovery was made (Fig. 1) and approximately six other Black Widows were present on different webs in the same building. The web was strong enough to trap the lizard by the tail, thus tethering it so that it could only run in circles to attempt escape, clearing the blown sand in a circular pattern where it had run (Fig. 1). This lizard was captured and released outside before a photograph was taken. Near the hatchling, at ground level, there was also a dead adult conspecific (approximate SVL 70 mm) trapped in the same web (Fig. 1). While there was one necrotic spot on the adult lizard's head suggesting a bite from the spider, there was no sign of it being consumed. It is believed that the spider may have bitten the larger lizard to subdue it (which may have killed it) as the lizard struggled to free itself from the web. As no evidence of the spider feeding on the dead individual was observed and the hatchling was left unharmed with the spider actively on its web, it is believed the two lizards became trapped in the web, which was near an opening to the outside, and were not recognized by the spider as prey under these circumstances. However, that the web of the Black Widow Spider is capable of capturing this lizard species could indicate that this and similarly-sized species could be potential food items for this arachnid. At the very least, the web of this species appears to pose a mortality risk for all age classes of this reptile.

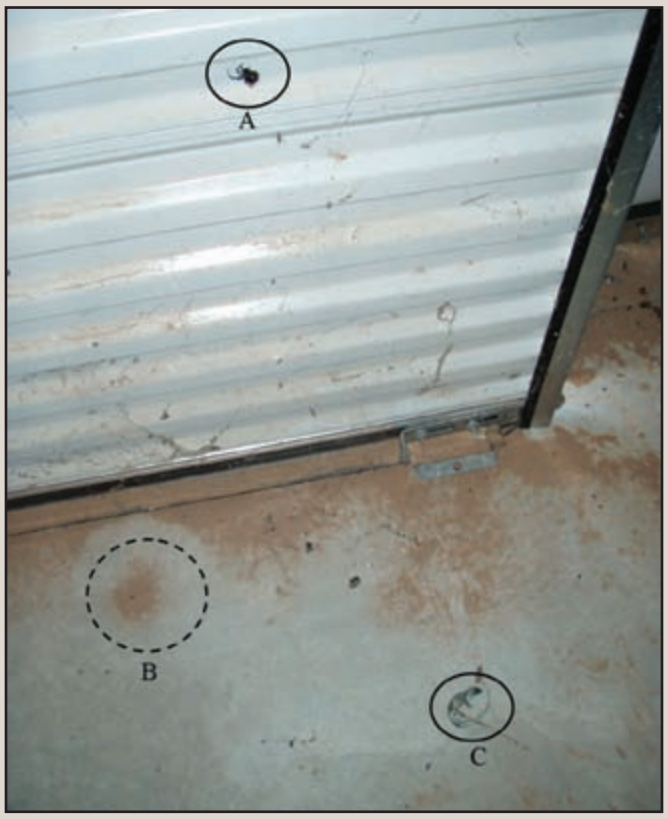

FIG. 1. Arrangement of (A) *Latrodectus* sp. on its web with (B) the path of the smaller *Uta stansburiana* being tethered and running in circles, and (C) the dead adult *U. stansburiana*.

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***VARANUS PANOPTES* (Yellow-spotted Monitor). DIET AND PREY CAPTURE.** The Yellow-spotted Monitor is a large, generalist carnivore inhabiting riparian areas and floodplains in northern Australia (Cogger 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney. 808 pp.). This monitor consumes a wide variety of prey, including lizards (Blamires 2004. Copeia 2004:370–377; Shine 1986. Herpetologica 42:346–360). Recent research demonstrated dramatic declines in counts of *V. panoptes* with the arrival of invasive Cane Toads (*Bufo marinus*). Between 77 and 90% of two populations died due to lethal toxic ingestion of toads in the Northern Territory (Doody et al. 2009. Anim. Conserv. 12:46–53). During this same period, counts of the Gilbert's Dragon (*Amphibolorus gilberti*) increased dramatically (Doody et al. 2009, *op. cit.*). The Gilbert's Dragon is a small to medium-sized, carnivorous agamid that also occupies riparian habitats in northern Australia (Cogger 2000, *op. cit.*). Although the counts of *V. panoptes* and *A. gilberti* appeared to be linked, the latter was not reported in the diet of the former, and it was unclear whether the latter increased in numbers, or responded behaviorally (i.e., did the declines in *V. panoptes* lead to a mesopredator release, whereby *A. gilberti* populations boomed, or was the apparent increase in *A. gilberti* due to a shift in conspicuousness via reduced predation risk [Doody et al. 2009, *op. cit.*]?). It was also unknown if *V. panoptes* readily consumes *A. gilberti*. Here we provide four observations of *V. panoptes* preying upon *A. gilberti*. We discuss the implications of our observations for the diet of *V. panoptes*, predation risk for *A. gilberti*, and the indirect effects of invasive Cane Toads on *A. gilberti*.

At approximately 1230 h on 6 May 2009 we chanced upon a sub-adult *V. panoptes* (~90 cm in total length) foraging in the semi-shaded riparian area at Branco's Hole, a billabong along the Chamberlain River in El Questro Wilderness Park, Western Australia (15.979167°S, 127.911111°E). The immediate riparian area is sandy, with an overstory of freshwater mangroves (*Barringtonia racemosa*), paperbarks (*Melaleuca* spp.), and Pandanus (*Pandanus aquaticus*). As we surrounded the monitor for a closer look it ran between two of us (SD and DR) and under a freshwater mangrove tree, during which time it inadvertently flushed an *A. gilberti*. The dragon immediately ran rapidly in a perpendicular direction to the approaching monitor, towards patchy vegetation and logs. The monitor immediately gave chase

and captured the dragon (both on the full run) approximately 8 m from the area where the dragon was flushed. The monitor captured and held the dragon at mid-body, shook it vigorously 3–4 times before manipulating it and swallowing it head-first. The entire process took about two minutes.

A second observation took place by RL in January 2007. A sub-adult *V. panoptes* (~ 60 cm in total length) was observed thrashing about in dense grass at the base of a tree at Mornington Wildlife Sanctuary, Western Australia (17.5°S, 126.1°E). Upon closer inspection, the *V. panoptes* had captured a sub-adult *A. gilberti* (~25 cm total length). Once disturbed, the dragon, held by its shoulder and forelimb, was immediately dropped by the monitor. The *V. panoptes* then fled to nearby cover, while the *A. gilberti*, although clearly stunned, appeared fine and slowly disappeared into the dense grass.

In January 2008, RL observed an adult *V. panoptes* (~1 m in total length) in active pursuit of an *A. gilberti* at Marion Downs Wildlife Sanctuary, Western Australia (17.5°S, 126.1°E). The dragon was initially observed basking on the seat of a quad bike, and as it leapt off the bike onto the ground it was instantly pursued by the *V. panoptes*. The chase was rapid and both traveled about 40 m, by which time they disappeared together underneath a shipping container. Although the outcome is unknown, the close proximity of the monitor to the dragon at that stage suggested that the monitor successfully preyed upon the dragon.

In February 2008, a fourth observation was made by RL. A large, adult *V. panoptes* (~1.3 m in total length) successfully captured and consumed an *A. gilberti* at Mornington Wildlife Sanctuary, Western Australia (17.5°S, 126.1°E). The *V. panoptes* sprinted from underneath a building and grabbed a large (~35 cm total length) adult male *A. gilberti* by the head. Without too much struggle, and with a couple of large jerks and gulps, the dragon was consumed within ~20 seconds of capture. The *V. panoptes* then began foraging among the grass.

A dietary study using museum specimens did not yield *A. gilberti* in the diet of *V. panoptes*, although one specimen was found in the stomach of one *V. gouldii*, a closely related species (Shine 1986, *op. cit.*). However, in an internet article, an anonymous writer discussed how he "previously had a lot of quite tame Ta-ta Lizards (Gilbert's Dragons) hanging around my camp," in Arnhem Land, Northern Territory (http://cubits.org/crocodiles/articles/view/1059, accessed 20 October 2011). Upon the arrival of a 1.5 m *V. panoptes*, the writer added "The monitor ate some and scared the rest off." Based on that statement and our observations, *A. gilberti* may be a common food item for *V. panoptes*. This result supports the link between declines in *V. panoptes* and concurrent increases in *A. gilberti* associated with the arrival of Cane Toads in the Northern Territory (Doody et al. 2009, *op. cit.*). It also supports the possibility that the increases in *A. gilberti* were numerical responses to declines in *V. panoptes*. However, we cannot rule out the possibility that increases in *A. gilberti* counts reflected behavioral responses. Remarkably, *V. panoptes* is able to pursue and capture *A. gilberti* in full flight, making the former a major predator threat to the latter. Thompson and Thompson (2001. J. Royal Soc. W. Australia 84:153–158) observed *A. gilberti* to move rapidly to thick vegetation in response to approaching *V. mertensi* and *V. mitchelli*. The elimination or severe reduction of a key predator may decrease predation risk (or perceived predation risk), resulting in *A. gilberti* using more open areas and making it more conspicuous in population counts.

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SQUAMATA — SNAKES

***BOTHROPOIDES NEUWIEDI* (Neuwied's Lancehead). ENDOPARASITES.** *Bothropoides neuwiedi* is a terrestrial snake that occurs in temperate, tropical, and semitropical forests and restingas in Atlantic Rainforest biome of Brazil (Xavier 2004. *In* Campbell and Lamar [eds.], The Venomous Reptiles of the Western Hemisphere, vol. I, pp. 410–422. Cornell Univ. Press, Ithaca, New York). There are no previous reports of helminths parasitizing *B. neuwiedi*.

We examined a single female *B. neuwiedi* (CRLZ 00137; SVL = 61.3 cm) from the Coleção de Répteis do Laboratório de Zoologia (CRLZ) do Centro Univesitário de Lavras – UNILAVRAS of Reserva Biológica Unilavras – Boqueirão, municipality of Ingaí, state of Minas Gerais, Brazil (21.346389°S, 44.99083°W, datum: WGS84; 1250 m elev.). The snake was collected in 2009 and was identified according to Campbell and Lamar (2004. The Venomous Reptiles of the Western Hemisphere, v. I. Cornell Univ. Press, Ithaca. 475 pp.). The stomach and intestine were removed and examined for helminths using a stereomicroscope. Nematodes were cleared in Amann's lactophenol (1:1:2:1 phenol: lactic acid: glycerine: water) and were identified according to Vicente and Santos (1974. Atas Soc. Biol. 17:69–71). Nineteen individuals of one species of Nematoda, *Physaloptera liophis* (Spirurida, Physalopteroidea), were collected from the stomach and small intestine. Nematodes were deposited in the Helminthological Collection of Oswaldo Cruz Institute (CHIOC), Rio de Janeiro (CHIOC number 35801). *Physaloptera liophis* was first described from the stomach of *Liophis miliaris* from Brazil (Vicente and Santos, *op. cit.*) but has not been reported in other host species (Pinto et al. 2010. Neotrop. Helminthol. 4:137–147). Thus, our observation represents a new host record of *P. liophis* and the first helminth species reported in *B. neuwiedi*.

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***BOTHROPOIDES ERYTHROMELAS* (Jararaca). DEFENSIVE BEHAVIOR: DEATH-FEIGNING.** Death-feigning (thanatosis) is a state of immobility in response to external stimuli and is a defense mechanism against predators shared by various animals, including snakes (Vogel and Han-Yuen 2010. Russ. J. Herpetol. 17:15–21). *Bothropoides erythromelas* is a poorly-studied species found in northeastern Brazil, especially in semi-arid

northeastern region (Vanzolini et al. 1980. Répteis da Caatinga. Acad. Brazil. Ciências, Rio de Janeiro. 161 pp.). Here, we report two observations of thanatosis in *B. erythromelas*.

Two *B. erythromelas* were captured by hand at 1600 h on 12 March 2008 (male; SVL = 48 cm; 68 g) and at 1400 h on 3 April 2011 (male; SVL = 51 cm; 72 g) in Fazenda Saco, Sertão do Pajeú, municipality of Serra Talhada, Pernambuco, Brazil (7.929049°S, 38.295342°W, datum: WGS84). Each time the snakes were handled, they readily exhibited death feigning behavior with the mouth slightly open and the ventral part of the body facing upward; the behaviors lasted about 6 and 15 min, respectively. Playing dead is a behavior rarely seen in natural situations, but handling may induce this behavior in several species of snakes (Vogel and Han-Yuen, *op. cit.*). Photographs of the events were deposited in herpetological collection into the Universidade Federal Rural de Pernambuco, Unidade Acadêmica de Serra Talhada, Pernambuco, Brazil.

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***BOTHROPS JARARACUSSU* (Jararacussu). DIET.** *Bothrops jararacussu* is a large venomous snake (to 2 m total length) that is known to feed on mammals, birds, amphibians, and insects (Freitas 2003. Serpentes Brasileiras. Universidade Feira de Santana, Bahia, Brazil. 160 pp.). On 21 September 2009 an adult female *B. jarracussu* (SVL = 1039 mm; tail length 165 mm) was given to the Museu de Biologia Prof. Mello Leitão (MBML) after being killed by a rural worker on the trail between Banestes Association and Pousada Paradiso, Santa Teresa, Espirito Santo, Brazil (19.928068°S, 40.590666°W, datum: WGS84). Upon dissection, we discovered a female *Metachirus nudicaudatus* (Brown Four-eyed Opossum), with four young, in the snake's stomach (Fig. 1). The prey item had been swallowed headfirst and the lack of digestion indicated that it had been consumed recently.

Metachirus nudicaudatus is a strictly terrestrial didelphid (Grand 1983. Austral. J. Zool. 31:299–312) and a habitat and dietary generalist. The fact that the marsupial was carrying young may have made her more vulnerable to predation by the *B. jararacussu*. Both specimens were deposited in the MBML museum collection: MBML 2774 (*B. jararacussu*) and MBML 3491 (*M. nudicaudatus*).

PHOTO BY F. A. LANSCHI

FIG. 1. *Metachirus nudicaudatus* (Brown Four-eyed Opossum), with four young, that was consumed by a *Bothrops jararacussu* in Brazil.

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***CROTALUS ATROX* (Western Diamond-backed Rattlesnake), *CROTALUS RUBER* (Red Diamond Rattlesnake). LOSS OF RATTLE AND STYLE/MATRIX.** Loss of rattle segments commonly occurs in all species of rattlesnakes as a result of rattle position (age), injury, attempted predation, and other factors (Klauber 1972. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind, Univ. California Press, Berkeley, 1533 pp.; reviewed by Rowe et al. 2002. *In* G. W. Schuett et al. [eds.], Biology of the Pitvipers, pp. 385–404. Eagle Mountain Publishing, Eagle Mountain, Utah). However, in several species (e.g., *C. catalinensis, C. ruber lorenzoensis, C. willardi, S. miliarius*), complete or nearly

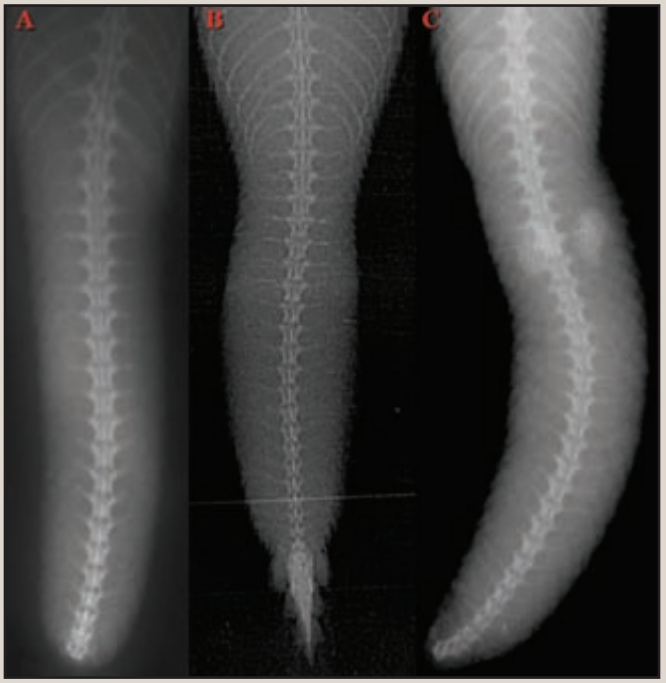

FIG. 1. Radiograph images of rattle-less *Crotalus atrox* and *C. ruber*. (A) Adult female *C. atrox* with rattles and style/matrix absent. (B) Adult female *C. helleri* with intact rattles and style-matrix for comparison. (C) Adult male *C. ruber* with rattles and style/matrix absent.

FIG. 2. Adult male *Crotalus ruber* (Fig. 1C) photographed in situ.

complete rattle loss is a stable feature in populations and appears to be heritable. In these cases, the gripping claws of the rattle segments are sufficiently smooth to permit slippage; hence, accumulation of segments to form a rattle string does not occur (Rowe et al., *op. cit.*). This condition is termed "rattle-less" (Klauber, *op. cit.*; Rowe et al., *op. cit.*; Setser et al. 2011. J. Herpetol. 45:333–335). Here, we report the loss of both rattle segments and the style/matrix in adults of *C. atrox* and *C. ruber*.

On 17 September 1999, at 2110 h, an adult female *C. atrox* (SVL = 740 mm; tail length = 50 mm; 333 g) was collected on Sun Valley Parkway, 15.2 km W of the McMicken Dam Spillway, 39 km W of Central Phoenix, Maricopa Co., Arizona, USA (33.6573°N, 112.6335°W, datum: Conus 27; elev. 418 m). It was noted that the snake lacked rattle segments and she was retained. Upon closer inspection it was determined that the basal segment of the rattle was also absent; hence, most likely, the style/matrix was damaged or absent (Zimmerman and Pope 1948. Fieldiana Zool. 32:355–413; Klauber, *op. cit.*; Meik and Pires-daSilva 2009. BMC Evol. Biol. 9:35). Scars to the tail were not detected nor loss of scales. Accordingly, it was concluded that there was no evidence of recent injury. Nonetheless, injury as a neonate or juvenile was a possibility. Subsequently, the tail region was subject to radiography, and it was confirmed that the style/matrix was absent (Fig. 1A). Thus, although the cause of this condition could be either congenital or the result of injury (e.g., predation attempt), we favor the former. Despite the loss of rattles, the snake exhibited classical defensive behaviors including coiling and tail vibration (Klauber, *op. cit.*).

On 10 April 2011, at 1538 h, an adult male C. ruber (SVL = 895 mm; tail length = 75 mm; 479 g) was collected in the Jamul Ecological Reserve, in San Diego County, California, USA, near the intersection of SR-94 and Otay Lakes Road (32.66610°N, 116.84090°W, datum: Conus 27; elev. 242 m). The snake was lacking a rattle, including the basal segment (Fig. 2), and no scars or scale losses on the tail were observed. Subsequently, the tail region was radio-graphed, and it was confirmed that the rattle style/matrix was absent (also exhibited classical defensive behavior including coiling, tail vibration, and hissing (Klauber, *op. cit.*).

Although the rattle-less condition occurs in certain insular populations of *C. ruber* from the Sea of Cortez (e.g., *C. r. lorenzoensis*), to our knowledge, loss of the style/matrix has not been described. Moreover, the rattle-less individuals have not been documented in mainland populations. There are, however, recent reports of rattle loss in *C. atrox* (Painter et al. 1999. Herpetol. Rev. 30:44; Holycross 2000. Herpetol. Rev. 31:177–178). Painter et al. (*op. cit.*) also provided radiographic evidence that clearly showed the absence of the style/matrix, which led the authors to conclude that the condition was likely congenital. Although the cause(s) for the absence of the style/matrix (e.g., congenital vs. injury) in our two cases are indeterminable, a congenital (heritable) hypothesis poses a set of testable research questions that warrant evaluation. If the condition is heritable, for example, examination of Hox gene expression domains along the primary axis would lend potential insights to the development of the style/matrix (e.g., Cohn and Tickle 1999. Nature 399:474–479; DiPoi et al. 2010. Nature 464:99–103; Woltering et al. 2009. Dev. Biol. 332:82–89), and hence the rattle itself.

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***DENDROPHIDION PAUCICARINATUM* (White-lipped Forest Racer). ELEVATION.** Ranging throughout premontane and lower montane regions of Costa Rica and western Panama, *Dendrophidion paucicarinatum* is one of four species within the genus represented in Costa Rica. Its elevational limit is poorly defined. Savage (2002. The Amphibians and Reptiles of Costa: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.) notes its range as 1040–1500 m. Solorzano (2004. Snakes of Costa Rica. Editorial INBio, Santo Domingo, Costa Rica. 791 pp.) extends the limit slightly, with a range of 1000–1800 m.

On 25 February 2011, at 1430 h, we found a *D. paucicarinatum* (adult male; SVL = 72.5 cm; total length = 110 cm; 100 g) about 1 km up the Sendero Catarata trail in San Gerardo de Dota, Puntarenas Province, Costa Rica in the Chacon Private Reserve (9.54611°N, 83.80516°W, datum: WGS84; elev. 2260 m). The snake was discovered stretched out in the leaf litter at the base of a palm tree near a small stream. Another *D. paucicarinatum* (adult male; SVL = 86 cm; total length = 124 cm; 100 g) was encountered on 3 March 2011, at 1255 h. It was found on the Sendero Cascada trail, which is located in the same general region as the previous snake, though at a higher elevation (9.54575°N, 83.80216°W, datum: WGS84; elev. 2350 m). These discoveries extend the elevational range for this species by 460 and 550 m, respectively. Interestingly, *D. paucicarinatum* had never been recorded in extensive surveys conducted at the study site since 2006, suggesting that our observations may represent a recent elevational range expansion, possibly due to climate change or other factors.

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***DIPSAS GAIGEAE* (Gaige's Thirst Snake). REPRODUCTION.** *Dipsas gaigeae* is a relatively small gastropod-eating snake that is endemic to the Pacific versant of Mexico. The species occurs at moderate to low elevations between the states of Jalisco and Guerrero. The reproductive characteristics of this secretive species are poorly known. Based on preserved specimens from Colima and Jalisco, Kofron (1982. J. Herpetol. 16:270–286) reported finding a female with two eggs in September and a second female with five eggs on an unspecified date. Hale (1977. J. Herpetol. 11:374–377) reported the only known oviposition data for *D. gaigeae*. The snake was captured on 7 August 1972 and subsequently laid four eggs on 16 September 1972, which presumably hatched in December when the neonates were first noticed. Here we report on an additional instance of oviposition in *D. gaigeae*.

On 7 July 2009, at 0001 h, we captured a gravid female *Dipsas gaigeae* (UTA R-59482; Field ID, JAC 30673; SVL = 453 mm, total length = 569 mm) on a road near Ixtlahuacan, Colima, Mexico (19.05038°N, 103.78700°W, datum: WGS84 datum; elev. 326 m). The snake was brought back to the laboratory at the University of Texas at Arlington and maintained in captivity until she laid three eggs (32.07 x 12.14, 33.94 x 11.79 and 32.31 x 11.65 mm) on 14 August 2009. However, a fourth egg was retained ca. 1.0 cm from the entrance of the cloaca. After two days, in order to avoid

potential complications for the mother, some fluid was drained from the egg using a syringe. Shortly following this procedure the egg was passed, which was rubbery and slightly shriveled. The three potentially viable eggs were placed on wet vermiculite (1:1 weight ratio of water to vermiculite) in an incubator at 24°C. Unfortunately, none of the eggs hatched (UTA R-59481 for all four eggs).

The female was collected in July at the beginning of the rainy season, which is consistent with the previous reports of gravid females being found in Colima and Jalisco during the rainy season between July and October (Hale, *op. cit.*; Kofron, *op. cit.*). The number of eggs produced is also consistent with previous observations, further suggesting this species has a clutch size ranging from 2–5 eggs.

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***DRYMARCHON COUPERI* (Eastern Indigo Snake). JUVENILE OBSERVATIONS.** *Drymarchon couperi* is one of the largest North American serpents (to 2.63 m total length; Conant and Collins 1991. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. 3rd ed. Houghton Mifflin, Boston, Massachusetts. 616 pp.). In the northern part of their range (i.e., northern Florida and Georgia), adult *D. couperi* have an intimate association with *Gopherus polyphemus* (Gopher Tortoise) burrows, which they use as overwintering sites (Hyslop et al. 2009. Copeia 2009:458–464). As a result, cool-season (November 1–March 31) visual encounter surveys (VES) of *G. polyphemus* burrows in xeric sandhills are an effective way to survey for *D. couperi*. Stevenson et al. (2009. Herpetol. Cons. Biol. 4:30–42) conducted a mark-recapture study of *D. couperi* on the Fort Stewart Military Reservation, Georgia, USA (31.88°N, 81.57°W, datum: WGS84). During multiple cool-season surveys conducted between 1998 and 2007, they captured and marked 93 *D. couperi*. However, only two (2%) individuals were young-of-the-year (i.e., juveniles, 35–90 cm SVL) and 19 (20%) were subadults (90.1–120 cm SVL). This apparent inability to detect juvenile and subadult *D. couperi* has resulted in a large deficiency in our understanding of the ecology of these age classes. Here we report additional observations of juvenile *D. couperi* in southern Georgia gleaned from on-going surveys at Fort Stewart (J. Macey, unpubl. data), the literature, the Georgia Department of Natural Resources' Natural Heritage Program database, major museum collections in Georgia and Florida, and interviews with local herpetologists.

Between 2007 and 2011, four additional juvenile *D. couperi* were captured on Fort Stewart during cool-season VES. All four of these observations were of snakes on the surface near or on the apron of active/inactive (N = 3) or abandoned (N = 1) *G. polyphemus* burrows. In contrast, 54 adults and 11 subadults were captured during those same surveys. We identified 13 additional observations of juvenile *D. couperi* in Georgia between 1975 and 2008. These observations included three juveniles found on the surface during the cool season near *G. polyphemus* burrows (N = 1), *Dasypus novemcinctus* (Nine-banded Armadillo) burrows (N = 1; Williamson and Moulis. 1994. Savannah Sci. Mus. Spec. Publ. No. 2., 418 pp.), and stump hole refugia (N = 1). Two observations were individuals alive or dead on roads during the fall (September 10 and October 2), another was in a trap at a drift fence array (October 21; Hyslop et al. 2009. Florida Sci. 72:93–100), and a third was under anthropogenic debris (April). Six observations were of individuals active on the surface but not associated with any cover, including four recent hatchlings found on the same day at the margin of a cypress pond (30 August; Williamson and Moulis, *op. cit.*). At least six of our 13 additional observations (46%) were made in xeric sandhill habitat and three (23%) were in the cool-season.

We are unsure of the reasons behind the extreme disparity between juvenile and adult *D. couperi* observations during cool-season surveys on xeric sandhills or the general paucity of juvenile *D. couperi* records. The success of cool-season VES on xeric sandhills in southern Georgia for finding adults suggests that juvenile detection rates are extremely low, juveniles rarely use *G. polyphemus* burrows as cool-season shelter, and/or juveniles use different habitats than adults. Lower detection rates could be a result of smaller size, more cryptic behavior, or fewer numbers of individuals. We feel this last possibility is unlikely since our Fort Stewart study site contains a robust, reproducing population (Stevenson et al. 2009, *op. cit.*). The small size of juvenile *D. couperi* may allow them to use smaller shelters as overwintering sites, although thermal data indicate that *G. polyphemus* burrows provide the warmest microclimates during the cool season (J. Bauder, unpubl. data). Juveniles may also rarely bask outside of or move among burrows, a behavior that adults readily exhibit (Stevenson et al. 2003. Southeast. Nat. 2:393–408). Juveniles may also avoid *G. polyphemus* burrows used by adults because of the threat of cannibalism, as adult *D. couperi* are strongly ophiophagus (Stevenson et al. 2010. Southeast. Nat. 9:1–18). However, on Fort Stewart we have observed juveniles using burrows < 100 m of burrows used by adults in the same season. Although juvenile *D. couperi* do use xeric sandhills during the cool-season, it is possible that juveniles also overwinter in habitats other than xeric sandhills.

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***EPICRATES CENCHRIA* (Rainbow Boa). DIET AND FORAGING BEHAVIOR.** Predation on bats by snakes has been reported infrequently. Esbérard and Vrcibradic (2007. Rev. Brasil. Zool. 24:949–953) reviewed this phenomenon in the Neotropics and

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FIG. 1. *Epicrates cenchria* preying on *Lonchorhina aurita* in Pedra Branca Cave, Sergipe, Brazil.

reported 40 records involving 20 snake species, with half of the events involving boids, particularly species of the genus *Epicrates*. *Epicrates cenchria* is a semi-arboreal species with a diet that includes birds, reptiles (lizards), amphibians, and mammals (Bernarde and Abe 2010. Biota Neotrop. 10:167–173; Henderson 1993. Herpetol. Nat. Hist. 1:91–96). This species may hunt actively inside caves, or lie in wait at the entrance to capture bats in flight (Esbérard and Vrcibradic, *op. cit.*). Similar behavior has been observed in *Epicrates* in Cuba (Hardy 1957. Copeia 1957:151–152), but there are few records of this phenomenon in Brazil, and none in cave environments. Here we report predation of a bat (*Lonchorhina aurita*) by an *E. cenchria* in a cave in the Brazilian state of Sergipe.

On the morning of 30 October 2010, we observed an *E. cenchria* preying on a bat, *L. aurita* (Fig. 1), in Pedra Branca Cave, municipality of Maruim, Sergipe, Brazil (10.776°S, 37.145°W, datum WGS84). Pedra Branca is registered as cave number SE-06 by the Brazilian Speleological Society. It is a 100 m-long limestone cave, with an entrance 1.10 m wide and 0.63 m high. The cave is located within an area of permanent protection in a fragment of secondary Atlantic Forest and mangrove vegetation, 20 m from the Sergipe River. Four bat species are found in this cave: *Carollia perspicillata, Desmodus rotundus, Phyllostomus hastatus*, and *L. aurita*. The event was first observed in the constriction phase, which lasted at least four minutes. During other visits to the cave, an *E. cenchria* was observed near the entrance, although it is not known if it was the same individual.

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***EPICTIA MUNOAI* (Uruguayan Blindsnake). AGGREGATION.** In July 2004 we discovered an unusually large aggregation of *Epictia munoai* during an ecological study along the road RS 615 in the region from Bagé to Candiota, Brazil (30.5°–31°S, 54°–54.5°W; elev. 200–220 m). The region consists of a grassy plain with many termite nests. Using a lever to open a large number of nests, we dug out galleries in which we found hundreds of specimens of *E. munoai*. All of the nests examined contained snakes, both adults and young. We collected a sample of 30 specimens for the herpetological collection of the Museu de Ciências e Tecnologia, in Porto Alegre, RS Brazil (MCTP). Several specimens had termite nymphs in their mouths. We examined the digestive tracts of about 20 specimens and all were found to have eaten nymphs. Additional surveys in the Bagé-Jaguarão to Candiota region consistently yielded many *E. munoai*, but few were found in surveys at lower elevations (Cazuza Ferreira, Encruzilhada do Sul, Porto Alegre, Santa Maria, Uruguaiana, all in RS). The total sample (about 100 specimens) is housed in the collection of Museu de Ciências Naturais of the Fundação Zoobotânica, Porto Alegre (MCNRS).

McCoy (1960. Copeia 1960:368) described a large aggregation of *Leptotyphlops dulcis dissectus* in Oklahoma, USA, which he suggested might be related to reproduction. Rafael Lucchesi Ballestrin (pers. comm.) and Arlete Ballestrin Outeiral (2006. Doctoral dissertation, Pontifícia Universidade Católica do Rio Grande do Sul) both studied the snakes of the Serra do Sudeste (RS) and commented on the rarity of *E. munoai* in hot seasons, when they are most frequently found under rocks. Our observations, however, agree with Hibbard (1964. Copeia 1964:222), who noticed a breeding colony of the species, concluding that it is gregarious.

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***ERYTHROLAMPRUS MIMUS* (Stripe-bellied False Coralsnake). DIET.** *Erythrolamprus mimus* is a relatively uncommon terrestrial and diurnal or crepuscular snake that ranges from Honduras to Peru and Ecuador. The diet is known to include small to medium-sized snakes and lizards (Savage 2002. The Amphibians and Reptiles of Costa Rica. Univ. Chicago Press, Chicago, Illinois. 934 pp.; Solórzano 2004. Snakes of Costa Rica: Distribution, Taxonomy, and Natural History. Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica. 791 pp.) but also includes small frogs.

On 1 May 2011, at 1130 h, an adult *E. mimus* (SVL ca. 53 cm; US National Museum Field Series[USNM] 254191) was collected dead on the road on the entrance road to El Copé, Coclé Province, Republic of Panama (08.62343°N, 080.57100°W, datum WGS84), between the communities of Las Tablas and Las Tibias. The snake was split open and protruding from the body wall was a caecilian, presumably *Caecilia volcani* (USNM 254194). The anterior 21.6 cm of the caecilian was undigested. Anterior to the caecilian was a *Liotyphlops albirostris* (USNM 254195), also protruding from the body wall of the snake. The posterior 14.3 cm of the snake remained undigested. Both prey items were consumed tail-first, as suggested for ophidian prey consumed by *E. mimus* by Solórzano (*op. cit.*). This is the first record of *E. mimus* or other members of the genus feeding on a caecilian or non-colubrid snake.

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***LEPTODEIRA BAKERI* (Aruban Cat-eyed Snake). PREDATION.** Although predator-prey interactions typically involve vertebrate predators and invertebrate prey, there are several instances of invertebrates preying upon vertebrates (McCormick and Polis 1982. Biol. Rev. 57:29–58). However, many of these events are cases of specific ontogenetic vulnerability of the vertebrate prey, such as the case of aquatic insects preying upon larval amphibians (e.g., Formanowicz 1986. Herpetologica. 42:367–373). Herein, we report a large species of predatory invertebrate preying upon an adult snake.

On 1 July 2010, we observed a large *Scolopendra gigantea* (Amazonian Giant Centipede) consuming an adult *Leptodeira bakeri* within Arikok National Park, Aruba (Fig. 1). When encountered, the centipede had already consumed the flesh surrounding the head and approximately 5 cm of the flesh on the neck of the snake. The centipede was positioned on the trunk of an *Acacia tortuosa* (Twisted Acacia) approximately 0.5 m from the ground. Because of the location and positioning of both the snake and centipede, we interpret the event as a case of predation and not scavenging. Although centipedes are known to prey upon vertebrates (McCormick and Polis, *op. cit.*), and specifically snakes (Easterla 1975. Southwest. Nat. 20:411), many invertebrate-vertebrate encounters have involved nearly equally sized predators and prey. The observation by Easterla (1975, *op. cit.*) refers to a *Scolopendra heros* (Giant Desert Centipede) killing and consuming a juvenile *Rhinocheilus lecontei* (Long-nosed Snake) that was approximately twice its length. Although we did not measure the centipede or the snake, the snake appeared to be approximately three times longer than the centipede. Because both of these species are common on Aruba, this predation event may demonstrate a regular and significant ecological relationship that has been previously overlooked.

FIG. 1. *Leptodeira bakeri* being consumed by *Scolopendra gigantea* in Arikok National Park, Aruba.

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***LIOPHOLIDOPHIS SEXLINEATUS*. DIET.** *Liopholidophis sexlineatus* is frequently found in mountainous areas on the eastern coast of Madagascar (Cadle 1996. Bull. Mus. Comp. Zool. 154:369–464; Glaw and Vences 2007. A Field Guide to the Amphibians and Reptiles of Madagascar, 3rd ed. Vences, Cologne, Germany. 496 pp.; Vences et al. 2002. Ital. J. Zool. 69:263–284). It is a diurnal species with semiaquatic habits, and is thought to feed primarily on frogs (Vences et al., *op. cit.*), including *Ptychadena* spp., *Heterixalus* spp., and *Boophis microtympanum* (Glaw et al. 2007. Zool. Scripta 36:291–300). However, little is known regarding its diet and foraging behavior. Here we document an attempt of predation by a *L. sexlineatus* upon a *Trachylepis madagascariensis*, a common diurnal lizard that inhabits deforested habitats in mountain areas of central Madagascar.

At 1400 h on 5 February 2011, while walking in an area locally known as Andranolava, Andringitra Massif, southeastern Madagascar, (22.152500°S, 46.899222°E, datum: WGS84; elev. about 1970 m), we observed an adult male *L. sexlineatus* in the act of preying upon a *T. madagascariensis* on the ground near the trail (Fig. 1). The snake was wrapped tightly around the skink which had already lost the majority of its tail. The lizard attempted to escape by dislodging the snake using its limbs but ceased struggling after few seconds. The snake adjusted its prey in order to start swallowing. The skink was still alive with its broken tail facing the mouth of the snake. The snake tried to bite the broken tail

PHOTO BY G. M. ROSA

FIG. 1. Predation attempt by a *Liopholidophis sexlineatus* on a *Trachylepis madagascariensis*, in Andringitra National Park, Madagascar.

from various angles, but the position and direction of the hind limbs prevented the snake from swallowing the skink. After several failed attempts that lasted for slightly more than 3 min, the *L. sexlineatus* finally loosened its grip, allowing the skink to escape. This observation suggests that *L. sexlineatus* preys, at least occasionally, on *Trachylepis* skinks.

This study was carried out in collaboration with the Madagascar National Parks. We thank the Malagasy authorities, in particular the Ministère de l'Environnement et des Eaux et Forêts, for research permits. Fieldwork was partially funded by Gondwana Conservation and Research.

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***LYCODON AUCILUS* (Common Wolf Snake). PREDATION.** *Lycodon aucilus* is a nocturnal snake found throughout South Asia. It is common within the range and is frequently found near human habitations (Whitaker and Captain 2004. The Snakes of India. Draco Books, India. 481 pp.). *Hoplobatrachus tigerinus* (Indian Bullfrog) is the largest frog in South and Southeast Asia and is common in the region. It is nocturnal and preys on insects, crabs, small rodents and birds, skinks and snakes (Daniel 2002. The Book of Indian Reptiles and Amphibians. Oxford Univ. Press. UK. 238 pp.). On 14 July 2011, at 0200 h, we observed an adult *H. tigerinus* (SVL ca. 130 mm) preying upon a *L. aucilus* (total length ca. 770 mm) on an unpaved road located just outside of Lawachara National Park, Bangladesh (25.8907694°N, 88.8502083°E, datum: WGS 84). The *L. aucilus* was still alive even after we pulled it out of the frog's mouth.

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***MANOLEPIS PUTNAMI* (Thinscaled Snake). DIET.** *Manolepis putnami* is a small colubrid endemic to Mexico whose geographic distribution extends from the states of Nayarit to Chiapas, along the Pacific coast (Johnson 1978. Southwest. Nat. 23:538; Smith and Taylor 1945. Bull. U.S. Nat. Mus. 187, iv + 239 pp.). Little is known about the ecology of *M. putnami,* but it has been reported to feed on lizards, including *Sceloporus melanorhinus, S. uniformis,* and racerunners in the genus *Aspidoscelis* (Ramírez-Bautista 1994. Manual de Claves Ilustradas de los Anfibios y Reptiles de la Región de Chamela, Jalisco, México. UNAM, México. 127 pp.). However, the latter have been identified only to generic level. Herein, we report an observation of predation on *Aspidoscelis guttata* (Mexican Racerunner) by *M. putnami* in tropical deciduous forest of coastal Oaxaca.

On 10 June 2008, at 1300 h, an adult *M. putnami* was found constricting a juvenile *A. guttata* (Fig. 1) in deciduous tropical forest in the Jardin Botánico de la Universidad del Mar (15.916663°N, 97.076748°W; datum: WGS 84; elev. 91 m), located ca. 6 km N of Puerto Escondido, San Pedro Mixtepec, Oaxaca, Mexico. When the snake was found, it was constricting the lizard's body while biting the basal section of the tail. The snake continued constricting the lizard for ca. 15 minutes and then elongated its body, swallowed the prey, and retreated into the vegetation.

FIG. 1. An adult *Manolepis putnami* ingesting a freshly killed *Aspidoscelis guttata* in tropical deciduous forest of southern coastal Oaxaca, Mexico.

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***NATRIX MAURA* (Viperine Snake). DIET: SCAVENGING.** *Natrix maura* is a medium-sized snake (558–910 mm total length) that inhabits aquatic habitats in the north coast of Africa and southern Europe (Maso and Pijoan 2011. Anfibios y Reptiles de la Peninsula Iberica, Baleares y Canarias. Ed. Omega, Barcelona, Spain. 848 pp.). On 26 April 2011, during a monitoring visit to a small reservoir close to Pontevedra, Spain (42.29°N, 8.36°W, datum: ED50) we found a small juvenile *N. maura* attempting to swallow a dead *Lissotriton boscai* (Bosca's Newt; Fig. 1). Previous studies have suggested that the diet of *N. maura* consists primarily of amphibians and fishes, but it can also capture reptiles and small mammals. Younger individuals also prey on invertebrates such as earthworms, snails, leeches, and insects (Santos et al. 2000. Ecography 23:185–192). Consumption of carrion has not been reported in previous studies, although Hailey and Davies (1986. Herpetol. J. 1:53–61) mentioned that *N. maura* can locate dead prey using exploratory cruising foraging behavior. Scavenging has been reported in a congener, *N. natrix* (Luiselli et al. 2005. Herpetol. J. 15:221–230; Poschadel and Kirschey 2002. Zeitschrift fuer Feldherpetologie 9:223–226). Thus, it is possible that this

FIG. 1. Juvenile *Natrix maura* swallowing a dead *Lissotriton boscai* (Bosca's Newt).

behavior has passed unnoticed in *N. maura*, but the species is able to use carrion as a food resource when it is available.

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***NERODIA ERYTHROGASTER ERYTHROGASTER* (Red-bellied Watersnake). NECROPHAGY BY DUNG BEETLES (SCARABAEINAE).** On 7 August 2011, we discovered a partially decomposed carcass of a yearling (ca. 36 cm total length) *Nerodia erythrogaster erythrogaster* on an unimproved sand road through sandy, pine-oak hammock habitat close to a large alluvial swamp associated with the Altamaha River (20.1 km S Ludowici, Long Co., Georgia, USA [31.540929°N, 81.660126°W, datum: NAD 83]). Adults of two species of dung beetles (two female *Phanaeus igneus* and 6–8 *Canthon* sp.) and a number of calliphorid flies were on or very near the carcass (Fig. 1). We watched as beetles appeared to tear tissue from the snake carcass and push it about; additionally, the *Canthon* beetles had excavated fresh burrows into the sand near the carcass.

Although most species of Scarabaeinae are coprophagous or necrophagous (Woodruff 1967. Ph.D. dissertation, Univ. Florida), there are few published records of *Phanaeus* spp. or *Canthon* spp. utilizing reptile/snake remains. Young (1981. Coleopt. Bull. 35:345–348) noted that on Barro Colorado Island, Panama, the tropical *C. moniliatus* occurred on reptile carrion and was attracted to reptile feces. Most *Phanaeus* species exploit moist excrement of large herbivores, with the food preferences of *P. vindex* including omnivore, especially swine, feces (Price and May 2009. Acta Zool. Mex. 25:211–238).

To our knowledge, this observation represents the first record of North American dung beetles using snake remains. Because a fairly large population of feral pigs (*Sus scrofa*) occurs at the site, it is possible that the watersnake was ingested by a pig and passed through only partially digested. If this occurred, it is possible that the beetles we observed were in fact attracted by the odor of swine feces rather than the carrion. In either case, though, the dung beetles were performing an ecosystem service by advancing decomposition of a squamate.

We thank Mark Deyrup and Skip Choate for help identifying the beetles.

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FIG. 1. Dung beetles (*Phanaeus igneus* and *Canthon* sp.) utilizing the carcass of a *Nerodia e. erythrogaster*, Long Co., Georgia, USA.

***NERODIA FASCIATA* (Southern Watersnake). ECTOPARASITES.** *Nerodia fasciata* is a common semi-aquatic species native to much of the southeastern United States (Conant and Collins 1998. A Field Guide to the Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin Co., Boston, Massachusetts. 640 pp.). Little is known about the ectoparasites of *N. fasciata*. Herein, we document the first account of a leech parasitizing a *N. fasciata*.

On 20 April 2011, at 2100 h, an adult *N. fasciata* (SVL ca. 76 cm) was observed in an ephemeral pond 0.18 km north of NW 82nd Boulevard and NW 51st Drive, Gainesville, Alachua Co., Florida, USA (29.73159°N, 82.39659°W, datum WGS84; elev. 58 m). The snake was in shallow water (< 15 cm deep) along the shoreline and allowed KLK to photograph it at a very close distance (approximately 7.5 cm). Upon examination of the photographs, we discovered nine leeches (Annelida: Clitellata: Hirudinida: Glossiphoniidae: *Placobdella papillifera*) on the head of the snake (Fig. 1). While typically encountered as free-living, this leech has also been collected as an ectoparasite from turtles (Klemm 1995. Identification Guide to the Freshwater Leeches [Annelida: Hirudinea] of Florida and other Southern States. Bureau of Surface Water Management, Florida Dept. Environmental Protection, Tallahassee. v + 82 pp; Readel et al. 2008. Copeia 2008:227–233).

Placobdella papillifera, one of 18 species in the genus (Klemm et al. 2011. Classification and Checklist of the Leeches [Phylum Annelida: Class Clitellata: Subclass Hirudinida] Occurring in North America North of Mexico. http://www.inhs.uiuc.edu/~mjwetzel/FWLeechesNA.html; accessed 20 July 2011), is widely distributed throughout the midwestern and eastern United States (Klemm, *op. cit.*), and has been reported to be widely distributed but low in abundance in Canada (Davies and Wilkialis 1982. Am. Midl. Nat. 107:316–324). Representative photographs of the snake and leeches were deposited in the Florida Museum of Natural History, University of Florida (UF 165479). Although leeches have been documented parasitizing *Regina septemvittata* (Queen Snake; Branson and Baker 1974. Tulane Stud. Zool. Bot. 18:153–171), this is the first known case of a leech parasitizing *N. fasciata*, or perhaps using the snake's smooth skin as an easy attachment site and/or mode of free transportation.

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FIG. 1. *Nerodia fasciata* with leeches (*Placobdella papillifera*) on its head.

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***NERODIA FASCIATA* (Southern Watersnake). FORAGING BEHAVIOR.** *Nerodia fasciata* is a common semi-aquatic species native to much of the southeastern United States (Conant and Collins 1998. A Field Guide to the Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin Co., Boston, Massachusetts. 640 pp.). Although recent observations have added considerable insight into diet partitioning and feeding strategies (Balent and Andreadis 1998. J. Herpetol. 32:575–579 ; Mushinsky and Hebrard 1977. Herpetologica 33:162–166; Mushinsky et al. 1982. Zoology 63:1624–1629), relatively little information is known about prey acquisition and capture (Gillingham and Rush 1974. J. Herpetol. 8:381–384). In this report, we document a noteworthy feeding behavior used by *N. fasciata* to effectively capture amphibian prey.

On 20 April 2011, at 2100 h, we attempted to photograph breeding frogs calling from the shoreline of an ephemeral pond 0.18 km N of NW 82nd Boulevard and NW 51st Drive, Gainesville, Alachua Co., Florida, USA (29.73159°N, 82.39659°W, datum WGS84; elev. 58 m). We observed two (apparently fat with recently ingested prey items) adult *N. fasciata* (SVLs ca. 60 and 76 cm) in shallow water (<15 cm deep) and aligned perpendicular to and within 7.6 cm of the shoreline. The larger snake swam along the shoreline and repositioned itself until it detected calling frogs, possibly by feeling vibrations (Friedel et al. 2008. Physical Rev. Lett. 100:048701). We observed this snake lunge forward and consume a *Hyla gratiosa* (Barking Treefrog) and *Lithobates sphenocephalus* (Southern Leopard Frog), yet still repostitioned itself along the shoreline once again (Fig. 1). About 9 m down the shoreline, the smaller snake was observed exhibiting the same behavior; one of the hundreds of nearby *H. gratiosa* tadpoles swam and touched the snake's body, upon which the snake quickly turned and unsuccessfully struck at the tadpole. At this same pond on 18 May 2011, at 2200 h, we observed six adult *N. fasciata*. Each snake was found exhibiting the same foraging strategy, with five of them were concentrated together within 3 m along the shoreline. We observed each of these snakes consume at least one frog, including *H. gratiosa, L. sphenocephalus, Acris gryllus* (Southern Cricket Frog), and *Anaxyrus terrestris* (Southern Toad). These observations augment the known complex feeding behavior exhibited by natricine snakes (Gillingham and Rush, *op. cit.*).

FIG. 1. Southern Watersnake (*Nerodia fasciata*) positioning itself perpendicular to the shoreline while foraging for amphibians.

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***NERODIA SIPEDON* (Northern Watersnake). DIET.** Watersnakes of the genus *Nerodia* are widely distributed in eastern North America but historically have not occurred west of the Colorado River. At least two species of *Nerodia* are now firmly established outside of their native range after being introduced to at least three localities in California. *Nerodia fasciata* is known from Los Angeles Co. (Balfour and Stitt 2002. Herpetol. Rev. 33:150) and Sacramento Co. (Balfour et al. 2007. Herpetol. Rev. 38:489), and *N. sipedon* is known from Placer Co. (Balfour et al. 2007. Herpetol. Rev. 38:489). Although all three populations occur in highly modified suburban or urban habitats, there is growing concern that wider establishment of these introduced species may have deleterious consequences for native wildlife. Concerns include possible competition with native snakes or impacts on native fish and amphibians.

On 5 July 2011, a female *N. sipedon* (SVL = 273 mm; 16.11 g) was captured by hand in Roseville City, Placer Co., California, USA. The snake was palpated to cause it to regurgitate its gut contents, which included another species introduced to California (a small, metamorphic *Lithobates catesbeianus* [American Bullfrog]), and a native amphibian, (an adult *Pseudacris regilla* [Pacific Chorus Frog]). To our knowledge, this represents the first confirmed report of a non-native watersnake feeding on a western species and partly validates concerns over impacts to native species.

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***PANTHEROPHIS SPILOIDES* (Gray Ratsnake). DIET.** On 12 June 2011, at 1409 h, I observed a mixed flock of birds mobbing a *Pantherophis spiloides* (ca. 1.2 m total length) in Macon Co., Alabama, USA (32.514536°N, 85.612337°W, datum WGS84/NAD83). The flock consisted of a male and female Summer Tanager (*Piranga rubra*), a Ruby-throated Hummingbird (*Archilochus colubris*), a Blue-gray Gnatcatcher (*Polioptila caerulea*), a Tufted Titmouse (*Baeolophus bicolor*), and a Northern Mockingbird (*Mimus polyglottos*). Initially, only the posterior portion of the snake was visible, while the anterior end was actively probing and moving within a Summer Tanager nest located 8.3 m high in a tangle of Muscadine (*Vitis rotundifolia*) vines suspended between several Loblolly Pines (*Pinus taeda*). After ca. 8–10 min, the snake exited the nest. There was a visible lump in the snake's belly, but it could not be determined if it had eaten eggs or hatchlings nor the number consumed. The snake crawled along the tangle of Muscadine vines into the adjacent trees and disappeared into a squirrel nest. There is an extensive list of birds and their young known to be eaten by *P. spiloides* (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 668 pp.). This observation is the first record of *P. rubra* eggs or young being consumed by *P. spiloides*.

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***PHILODRYAS OLFERSII* (Lichtenstein's Green Racer). DIET.** *Philodryas olfersii* is a non-venomous diurnal species that is distributed across several municipalities of Minas Gerais State, Brazil, in the transition areas between the Cerrado and the Atlantic Forest biomes (Bertoluci et al. 2009. Biot. Neotrop. 1:147–155; São-Pedro and Pires 2009. Ceres 2:166–171). It is considered terrestrial or semiarboreal and is known to feed on a variety of vertebrates, including rodents, anurans, birds, lizards, and snakes (Hartmann and Marques 2005. Amphibia-Reptilia 26:25–31; Sawaya et al. 2008. Biot. Neotrop. 8:127–149). In this study we report a *P. olfersii* preying upon a novel prey species in an urban environment.

On 12 January 2011, around 1550 h, we observed an adult female *P. olfersii* (SVL = 85.53 cm; total length = 117.26 cm; 310 g) in an urban household in the municipality of Lavras, Minas Gerais State, Brazil (21.9998°S, 44.2457°W; datum WGS84). The snake was discovered preying on a bird of the species *Melopsittacus undulatus*, popularly known as the Budgerigar (periquito australiano), which is widely commercialized in Brazil. The bird was being kept in a cage in the backyard of a house surrounded by walls approximately 3 m high. At the rear area of the home there was a small patch of remaining Cerrado vegetation. The snake (CRLZ 00270) was collected and deposited at the Coleção de Répteis do Laboratório de Zoologia, Centro Universitário de Lavras - UNILAVRAS, municipality of Lavras, Minas Gerais, Brazil.

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***PHILODRYAS PATAGONIENSIS* (Patagonian Green Racer). DIET.** *Philodryas patagoniensis* is a terrestrial species found in Argentina, Bolivia, Brazil, Chile, Paraguay, and Uruguay (Peters and Orejas-Miranda 1970. Catalogue of Neotropical Squamata Part I. Snakes. U.S. Nat. Mus. Bull. 347 pp.). It is considered to be a dietary generalist, feeding on amphibians, lizards, snakes, birds, mammals, fish, and amphisbaenians (Carvalho-e-Silva and Barros-Filho 1999. Herpetol. Rev. 30:170; Costa et al. 2010. Biot. Neotrop. 10:353–377). Here we report a new food item in the diet of *P. patagoniensis* in Brazil.

On 22 October 2009, an adult female *P. patagoniensis* (CRLZ 000157; total length = 92.1 cm; tail length 11.5 cm; 390 g) was found dead in an area of cerrado habitat in the Reserva Biológica Unilavras – Boqueirão (RBUB), Ingaí, Minas Gerais, Brazil (21.34638°S, 44.9908°W, datum: WGS84; elev. 1250 m). During necropsy we found an adult coleopteran in the snake's stomach and coleopteran elytra within the anterior portion of the small intestine. We also examined the gut contents of another female *P. patagoniensis* (CRLZ 000216; total length = 47.2 cm; tail length 8.2 cm; 40 g) of unknown provenance. In this specimen, the following food items were identified within the anterior portion of the small intestine: wings of Coleoptera, wings of Hemiptera, larvae of Coleoptera, and other insect body parts. These records represent the first instances of invertebrates in the diet of *P. patagoniensis*. Although it is possible that the invertebrate remains we observed were secondarily ingested (i.e., they were initially consumed by an anuran, lizard, or other animal that was subsequently eaten by the snake), we believe that this is unlikely because we found no other prey items in the stomachs, because the insects had relatively large dimensions, and because the elytra observed were already within the small intestine of the snake.

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***PITUOPHIS MELANOLEUCUS MELANOLEUCUS* (Northern Pinesnake). MALE-MALE COMBAT.** Combat behavior between male *Pituophis m. melanoleucus* in captivity was described by Shaw (1951. Herpetologica 7:149–168), but apparently few if any observations of this behavior in the wild have been published. R. T. Zappalorti (pers. comm.) reported never having observed male combat despite decades of fieldwork with *P. m. melanoleucus* in the New Jersey Pine Barrens.

On 30 May 2011, at 0950 h, while radiotracking a telemetered adult male *P. m. melanoleucus* (ca. 18.4 km WNW Wagram, Scotland Co., North Carolina, USA; 34.9938°N, 79.5381°W, datum: WGS84), I observed combat between two male *P. m. melanoleucus*. I had located the telemetered male underground in what appeared to be a Hispid Cotton Rat (*Sigmodon hispidus*) burrow complex in moderately dense ground cover at the edge of a large disturbed area. Air temperature was 30°C, and soil temperature 24°C. As I attempted to pinpoint the telemetered male's precise location, two untelemetered adult *P. m. melanoleucus* emerged from the burrow complex, the larger snake pursuing the smaller one. Both snakes were hissing loudly and thrashing about with their bodies intertwined, rubbing and shoving against one another (Fig. 1). At one point, the larger male was wrapped tightly around the smaller one, as if attempting constriction. The larger

FIG. 1. Combat between two male *Pituophis m. melanoleucus*, Scotland Co., North Carolina, USA.

male directed several short feint-strikes toward the smaller male's head and anterior body, and may have bitten him at least once. These behaviors are consistent with those described for captive *P. m. melanoleucus* by Shaw (*op. cit.*) and for various other Pituophis, both wild and captive (Bogert and Roth 1966. Am. Mus. Nov. 2245:1–27; Reichling 1988. Herpetol. Rev. 19:77–78).

After approximately 2 min, the snakes moved into thick vegetation and the smaller one attempted to retreat down a burrow. I captured both snakes at that point and they exhibited no further interest in each other after being handled. No attempt was made to measure lengths, but the larger male weighed 1442 g and the smaller one 823 g. I detected no female, but one could have been concealed nearby, likely underground. The telemetered male (intermediate in size between the two combatants) was underground nearby for the duration. Both male *P. m. melanoleucus* were implanted with transmitters and released at the capture site on 8 June 2011. No further interactions with conspecifics have since been observed in either snake. The infrequency with which combat behavior has been reported among members of the genus *Pituophis* under natural conditions suggests that such behavior may be relatively uncommon in snakes of this group.

The North Carolina Herpetological Society, Three Lakes Nature Center (Thomas J. Thorp), and Wake Audubon supported fieldwork leading to this observation. Jamie M. Smith assisted in extracting still images from my video footage. The North Carolina Wildlife Resources Commission provided endangered species permits.

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***RHABDOPHIS SUBMINIATUS* (Red-necked Keelback). DIET.** *Rhabdophis subminiatus* is a rear fanged, venomous snake that inhabits wet forests, tea plantations, grasslands, and paddy fields across Southeast Asia. It is diurnal, grows up to 1300 mm, and is known to prey on frogs, toads, lizards and small mammals (Whitaker and Captain. 2004. The Snakes of India. Draco Books, India. 481 pp.). On 22 July 2011, at ca. 1300 h, we captured an adult, *R. subminiatus* (total length = 530 mm) in a tea estate located just outside the Lawachara National Park, Bangladesh (24. 330963°N, 091.801120°E, datum: WGS 84; elev. 51 m). The specimen was euthanized and preserved in alcohol as a voucher. Upon dissection of the specimen, we discovered a *Fejervarya* sp. (Cricket Frog; SVL ca. 50 mm) in its stomach. The frog was not in sufficient condition to identify to species level.

We thank The Orianne Society and Center for Advanced Research and Natural Management, for funding and logistical support. The field work was conducted under the forest department permit given to S.M.A. Rashid (permit: 2M-47/11)

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***RHABDOPHIS TIGRINUS* (Tiger Keelback), *ELAPHE QUADRIVIRGATA* (Japanese Striped Snake). PREDATOR-PREY INTERACTION.** *Elaphe quadrivirgata* is known to prey on other snakes, and there are at least five records of it feeding on *R. tigrinus* (Tanaka and Mori 2001. Current Herpetol. 19:97–111). On 14 August 2011, at 1217 h, on an unnamed road between the defunct Oka bus stop and Otsuba bus stop in Innai-machi, Usa-shi, Oita Prefecture, Japan (33.3708°N, 131.2993°E, datum WGS84; elev. 275 m), we observed a ca. 80 cm long melanistic *E. quadrivirgata* on the roadside along a narrow water-filled drainage ditch. About 20 sec later, a *R. tigrinus* of similar size began moving towards the ditch from the opposite side of the ditch. The *E. quadrivirgata* rapidly approached the *R. tigrinus* and made a strike from across the ditch. The *R. tigrinus* countered with a right lateral strike delivering a bite to the anterior body of the *E. quadrivirgata*. The snakes locked up over the ditch and disengaged very quickly. For approximately 15 sec the snakes faced each from opposite sides of the ditch. A bleeding puncture wound was observed on the *E. quadrivirgata* but no wounds were apparent on the *R. tigrinus*. Subsequently, the *E. quadrivirgata* slowly crossed the ditch and moved out of sight under the vegetation.

Rhabdophis tigrinus is reported to display a suite of defensive behaviors that vary according to temperature, but it is seldom reported to strike (Mori and Burghardt 2001. Ethology 107:795–811). In this case, the *R. tigrinus* responded with a strike immediately and, apparently, effectively. To our knowledge, this is the first documented incident of *R. tigrinus* directly rebuffing a predation attempt by *E. quadrivirgata*. Fourteen photographs of the event were deposited in the University of Texas at Arlington Amphibian and Reptile Diversity Research Center's digital slide library (UTADC 6943–6956).

We thank Andrew Brinker and Akira Mori for assistance.

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***SALVADORA HEXALEPIS DESERTICOLA* (Big Bend Patch-nosed Snake). DIET.** *Salvadora hexalepis deserticola* is a poorly studied Chihuahuan Desert species that is reported to feed primarily on lizards (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington DC. 668 pp.; Lemos-Espinal and Smith 2007. Anfibios y Reptiles del Estado de Chihuahua, México. UNAM. CONABIO, México, DF. 613 pp.). On 22 August 2006, at ca 1900 h, we found a dead *S. h. deserticola* on the ground at La Escondida ranch, Nuevo Casas Grandes, Chihuahua, México (30.521258°N, 107.764980°W, datum WGS84; elev. 1611 m). The snake (female; SVL = 450 mm;

FIG. 1. *Salvadora hexalepis deserticola* found dead with an *Aspidoscelis exsanguis* protruding from its body in Nuevo Casas Grandes, Chihuahua, México.

total length = 600 mm; 41.77 g) had an *Aspidoscelis exsanguis* (Chihuahuan Spotted Whiptail) protruding from its body at 190 mm post-snout (Fig. 1). The lizard (SVL = 95 mm; 14.14 g) had been ingested headfirst and represented 33.85% of the snake's body mass. There was also a smaller (1.59 g) *A. exsanguis* in the snake's stomach. The specimens are preserved in the herpetological section of the scientific collection of vertebrates of the Universidad Autónoma de Ciudad Juárez (CCV 661). On 15 September 2006 we observed another *S. h. deserticola* (30.508225°N, 107.774205°W, datum WGS84; elev. 1637 m) attempting to eat an *A. exsanguis*, but when disturbed, the snake regurgitated. To our knowledge, these are the first records of *A. exanguis* in the diet of *S. hexalepis*.

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***THAMNOPHIS BUTLERI* (Butler's Gartersnake). MORPHOLOGY.** Apical pits are single or paired translucent epidermal depressions located on the posterior end (the apex) of the dorsal scales of some snake species. The function of apical pits remains ambiguous. Ball (1996. Reptile and Amphibian Magazine. July/August 1996:112–116) provided a brief summary of proposed functions for apical pits which included aiding in ecdysis, serving as a site for the release of sex-specific hormones, and serving as detectors of thermal variations. H. M. Smith (pers. comm. 2005) has suggested that they may be associated with sensory nerve endings and serve a tactile function. In snakes that possess them, apical pits may be observed on the animal itself or on their shed stratum corneum. *Thamnophis butleri* has been reported to lack apical pits (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, DC. 668 pp.; Marx and Rabb 1972. Fieldiana Zool. 63:92–99). Herein, I report the observation of apical pits on the shed skin of a *T. butleri*.

Thamnophis butleri shed skins (N = 8) were acquired from specimens at two sites located in southern Ontario, Canada: five from Bright's Grove, near Sarnia, and three from Luther Marsh in Dufferin and Wellington counties. Shed skins were cut, moistened with 70% isopropyl alcohol, spread on perforated plastic sheets, blotted dry, then pressed in a plant press for ca. 24 h (Gray 2005. The Serpent's Cast: A Guide to the Identification of Shed Skins from Snakes of the Northeast and Mid-Atlantic States. Center N. Am. Herpetol. Monogr. No. 1, ii + 90 pp.). After being pressed, sections of shed skins were examined for apical pits with a dissecting microscope at 10x and 30x magnification.

Of the eight shed skins examined, one from Bright's Grove contained scales with apical pits (Fig. 1). The scales were located laterally, on both sides above the anal plate region. There is considerable intraspecific and interspecific variation in the occurrence of apical pits in the genus *Thamnophis* (Conant 1961. Am. Mus. Novit. [2060]:1–20; Gray 2006. Bull. Chicago Herpetol. Soc. 41:85–88). For example, the closely related *T. brachystoma* appears to lack them (Gray 2006, *op. cit.*), whereas in *T. radix*, apical pits are visible in the shed skins of some specimens but not others (Gray, unpubl. data). Apical pits may have been overlooked in *T. butleri* due to their very limited distribution on the body or because apical pits are difficult to observe in long-preserved specimens (Conant, *op. cit.*).

Thanks to Jonathan Choquette for providing the shed skins used in this study. My gratitude is also extended to Douglas Rossman and Walter Meshaka, Jr. for reviewing the manuscript.

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***THAMNOPHIS EQUES MEGALOPS* (Northern Mexican Gartersnake). REPRODUCTION: LITTER SIZE.** As a result of extensive declines, *Thamnophis eques megalops* is a candidate for listing under the Endangered Species Act in the United States (U.S. Fish and Wildlife Service 2008. Fed. Reg. 73[228]:71778–71826). However, natural and life history of the species remains poorly known. As part of an Arizona Game and Fish Department monitoring and telemetry program on the species at Bubbling Ponds Hatchery (Yavapai Co., Arizona, USA), we captured an adult female *T. e. megalops* (SVL = 870 mm; 408 g) on 19 June 2009 (34.7649°N, 111.4940°W; datum NAD83). The female gave birth to 38 live young (no undeveloped ova) in the early morning of 20 June 2009 (Fig. 1). After parturition, the female's body mass was 229.5 g; neonates and placentas weighed 144.6 g. The 38 neonates had a mean SVL of 186.9 mm (range = 172–195 mm); mean total length of 243.4 mm (range = 225–258 mm); and a mean body mass of 3.71 g (range = 2.9–4.0 g). The female and 29 neonates were released near the point of the female's capture later that day; nine neonates were held in captivity and released in the same location on 18 September 2009. To our knowledge,

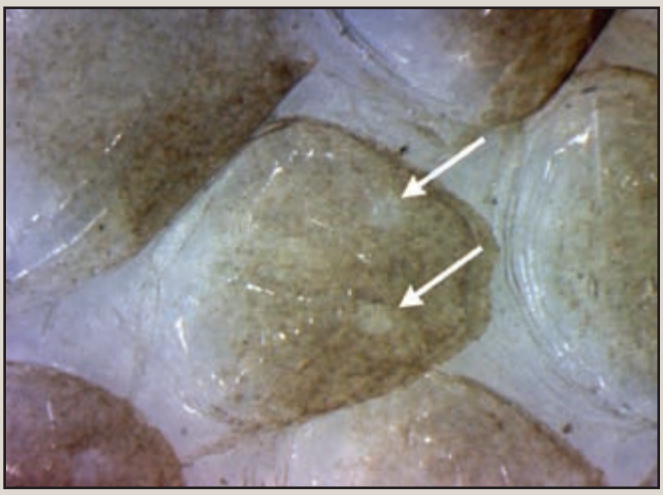

FIG. 1. Dorsal scales with apical pits on the shed skin of a *Thamnophis butleri* from Bright's Grove, Ontario, Canada.

FIG. 1. Adult female *Thamnophis eques megalops* and 38 newborn offspring, Yavapai Co., Arizona, USA.

this litter size is larger than previously reported (range = 4–26, mean = 14; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 668 pp.). Litter sizes are possibly larger at this human-modified fish hatchery site compared to more natural sites, due to artificially dense prey base (native and nonnative fishes, native *Anaxyrus woodhousii*, and nonnative *Lithobates catesbeianus* and *Ambystoma mavortium nebulosum*).

This research was conducted under protocol #09-004 from the Northern Arizona University Institutional Animal Care and Use Committee. We thank Harry Sweet and David Boyarski for assistance with measuring the neonates.

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***THAMNOPHIS RADIX* (Plains Gartersnake). DEFENSIVE BEHAVIOR: TONIC IMMOBILITY.** Tonic immobility is an antipredator behavior that works under the assumption that a predator will treat an immobile prey item differently than one that is actively trying to escape. Differential treatment can occur because the prey item has become more cryptic, or because immobility reflects death, decreasing the predator's attack response. Tonic immobility is often equated to thanatosis, or death feigning, but death feigning employs more dramatic and elaborate displays (e.g., mouth gaping, supination; Gregory and Gregory 2006. J. Comp. Psychol. 120:262–268). Death feigning and tonic immobility have been well described in *Heterodon* (e.g., Burghardt and Greene 1988. Anim. Behav. 36:1842–1844) and *Natrix* (e.g., Gregory et al. 2007. J. Comp. Psych. 121:123–129), but these behaviors appear to be more widespread than previously thought. Here, we report the first account of tonic immobility in *Thamnophis radix*.

At 1700 h on 16 June 2011, we encountered an adult female *T. radix* in a grassy field 15 km W of Morris, Minnesota, USA (45.62637°N, 96.05555°W; datum: WGS 84). The snake was moving when first sighted, and was pursued for several minutes before capture. While attempting to capture the snake we repeatedly blocked its escape with a net. It was at this point that the snake stopped, writhed in place for several seconds, and then became completely still. It remained motionless and regurgitated an earthworm as we handled it to determine sex and reproductive state. Unlike the limpness observed in some species that feign death, this snake was tense and retained its muscle tone both during and after handling. We placed the snake in the grass next to the regurgitated worm. The head of the snake was slightly bent and barely tucked under the body, while the tail was coiled, exposing the underside (Fig. 1). It held this position even when gently nudged and remained immobile for at least several minutes, as long as we could see it as we were walking away. Our observation suggests that *T. radix* are capable of tonic immobility, as has been reported in *T. elegans* and *T. sirtalis* (Gregory and Gregory 2006, *op. cit.*). Tonic immobility and other death feigning behaviors may be more common in colubrid snakes than previously suspected.

FIG. 1. Immobile *Thamnophis radix* showing position of head and tail, next to regurgitated earthworm.

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***XENOCHROPHIS PISCATOR* (Checkered Keelback). DIET AND FORAGING BEHAVIOR.** *Xenochrophis piscator* inhabits wetlands and paddy fields across South and Southeast Asia and is known to prey on frogs, fish, tadpoles, and occasionally rodents and birds (Whitaker and Captain. 2004. The Snakes of India. Draco Books, India. 481 pp.) A study conducted at a large lake in Cambodia found that fish comprised 77% of the diet of *X. piscator* (Brooks et. al. 2009. Copeia 2009:7–20). Here, we report observations of *X. piscator* feeding three anuran species, *Fejervarya* sp., *Duttaphrynus melanostictus*, and *Hoplobatrachus tigerinus* from a village located just outside of Lawachara National Park, Bangladesh (24.330963°N, 91.801120°E; datum WGS84).

At 1200 h on 28 August 2011, we observed a *X. piscator* (male; SVL = 435 mm, tail length = 199 mm) in a paddy field on the side of a road. After capturing the snake, it regurgitated a live adult *Fejervarya* sp. (SVL = 40 mm) that had been swallowed leg first. At 1330 h on 8 September 2011, a loud calling sound attracted our attention to shrub on the side of a paddy field. Upon closer examination, we observed a *X. piscator* (male; SVL = 560 mm; tail length = 232 mm) preying upon an adult *H. tigerinus* (SVL = 73 mm). The snake was swallowing the frog leg first but released the prey when disturbed by our presence. At 2100 h on 15 September 2011, we captured an *X. piscator* (female; SVL = 910 mm; tail length = 335 mm) on the side of a pond. We examined the snake's stomach contents by forced regurgitation and found two adult *D. melanostictus* (SVL = 64 mm and 70 mm). Both of the toads were swallowed leg first.

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BOOK REVIEWS

Herpetological Review, 2012, 43(2), 353–354.

Invasive Pythons in the United States – Ecology of an Introduced Predator

by Michael E. Dorcas and John D. Willson. 2011. University of Georgia Press, Athens, Georgia (www.ugapress.org). Softcover. xii + 156 pp. US $24.95. ISBN 978-0-8203-3835-4.

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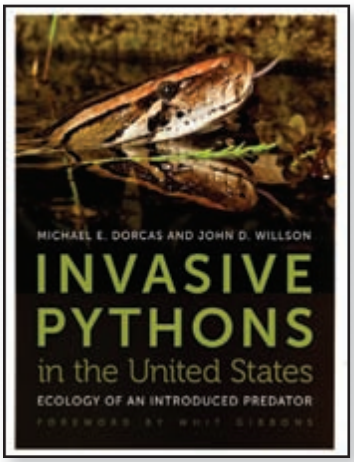

I was first confronted with the issue of invasive pythons in the southeastern United States, when Skip Snow (Wildlife Biologist in the Everglades) approached me in the late 1990s to ask about the construction and mechanism of python traps that I had built to capture wild Reticulated Pythons in western Borneo in 1996 (Auliya 2002). Clearly, this trap model did not get rid of the problem, and news of conflicts between the invasive Burmese Python and the native wildlife of Florida regularly makes the rounds in the international herpetological community.

The first time that I flicked through the pages of this book, I was impressed by the wealth of excellent photographs; the book includes approximately 180 color photos as well as color maps and graphs. I next realized that I was being introduced to numerous people dealing with this man-made problem, the majority of whom (even the authors!) were new to me, as my area of expertise is conservation herpetology in Southeast Asia. Thus I come to this book with a knowledge of the animals of concern in their native range, but totally impartial and objective with respect to this coverage of their role as invasives in America.

After identifying the pet trade as the reason behind the occurrence of Burmese Pythons in Florida the authors elaborate some disturbing facts: 1) maximum current numbers are estimated at hundreds of thousands (a more precise figure would have been desirable here); 2) the spread of these "invasives" into temperature regions is postulated; 3) potential threats to the native wildlife caused by these predators is indicated, however not yet clearly understood; and 4) these constrictors at a certain length pose a risk to humans. Interestingly, this first page also informs the reader that over the last 10 years alone 1600 specimens have been captured. If the maximum densities estimated are considered the scale of the threat can really be appreciated. Elsewhere in the introduction the authors emphasize the collection of accurate data on the Burmese Python in order to meaningfully evaluate its potential impact. The book is therefore intended to clear up any sensationalized information that has been previously published and to inform scientists and the general public about the reality of invasive pythons. Readers learn about the detrimental impacts that other invasive species (including plants) have on native environments in the southeastern United States before a final subsection "Why invasive pythons are important" outlines why these snakes are a threat.

The first chapter following the Introduction, "About Pythons," describes specific morphological and biological traits as well as behavioral ecology in just over 14 pages. As this book is also meant for the general public, some basic data on snakes in general and their similarities to lizards are also included. In this context five color photographs illustrate different snake and lizard species. A photograph illustrating the recurved teeth of pythons (p. 12) might have better been replaced by a photo showing the skull of a python to highlight its morphological distinctiveness. On page 13 the authors state, "some scientists believe that boas and pythons are closely related enough to be in the same family." Both groups were long been included in the Boidae (with some rare exceptions, see Hubrecht 1879), however, the definitive separation of Old World pythons from the Boidae into the Pythonidae follows Vidal and Hedges (2002), whose genetic research strongly supported the monophyly of pythons. Earlier approaches based on external morphological and osteological features distinguishing boas from pythons were initiated by Underwood (1976) and followed by Underwood and Stimson (1990) and Kluge (1991).

Additional information on python biology, also introducing other species (with excellent photographs) is provided, as is a short section on "Pythons as Pets." Here the authors briefly outline the python species most commonly kept as pets in the context of the owner's responsibilities and the problems that might arise should they escape. In a section entitled "Pythons as potentially invasive species," readers learn about specific natural history traits, e.g., reproduction and opportunistic feeding behavior, to understand why Burmese Pythons were able to become established and increase its population in southern Florida.

Part of the problem, as indicated by the authors, is the high density of reptile traders in this region. The question remains as to whether there is a regular intentional release of Burmese Pythons into southern Florida. I can very well imagine that some herpetoculturists do not see the invasiveness of Burmese Pythons as a true problem and have, at least in the past, restocked this introduced population (see pp. 66, 116). Man-made canals in South Florida have helped to support the dispersal and spread of these constrictors, even if they are not typically aquatic in the strict sense. Adults of some python species (e.g., *bivittatus, sebae,*

reticulatus) either move along water courses or wait to ambush prey that are attracted to water.

"Natural history of Indian and Burmese Pythons" gives information on taxonomy and native distribution, and explains how to distinguish between the two species. On p. 23, the authors state that Burmese Pythons occur on Borneo (which is incorrect), however the map on p. 25 and a statement on p. 27 correct this error. Distributional data on both species basically follows information provided by Reed and Rodda (2009), which, as the authors acknowledge, is an excellent and comprehensive source. A concise section on "Size" provides insights into the very large species and some size records, while the section "Habitats" is critical in order to understand and compare native habitats to those they are invading in South Florida. Other topics include: "Behavior and Physiology," "Food and Feeding," "Reproduction," "Predators and Parasites," and "Risk To Humans," all of which are very well illustrated.

"Scientific Research on Pythons" is one of the most important chapters. The authors correctly stress that without sound science it is not possible to make any concrete decisions about risk assessment and management strategies. This chapter introduces python researchers in the United States and the methodologies that they have applied. I was very impressed with this chapter, as it provides information otherwise not made transparent in any form of printed media, especially this comprehensively. Readers learn about how and why specific techniques are applied and gain an appreciation for the huge team of people including technicians and volunteers involved in the numerous aspects of python research.

The fourth chapter, "Burmese Pythons in the United States," may be the most important to readers in the US. Here the authors provide information about climate regimes and ecosystems used by Burmese Pythons in South Florida. An accompanying map illustrates the currently known distribution and spread of pythons in this region over the last 15 years. "How did pythons become established in Florida" includes a discussion of the hypothesis that Hurricane Andrew was one of the crucial reasons for the unintentional release of pythons, due to a destruction of reptile holding/breeding facilities in the vicinity. The authors detail and illustrate various model scenarios to explain and understand the potential range extensions of Burmese pythons, and rightly conclude that the "true potential for the spread of Burmese Pythons is likely to remain uncertain for many years." The book goes on to provide details on the morphometrics and biological and ecological traits of pythons established in South Florida "Impacts on native wildlife" is particularly depressing as it indicates that threatened native (e.g., the Florida Panther) may potentially be affected by pythons.

Chapter Five "Control measures for Burmese Pythons" provides information on capture techniques (traps, dogs), and elaborates on "Biological Controls" and "Regulations and Enforcement." I was shocked to read that even in 2010, most U.S. states "still had no laws preventing the release of exotic animals into natural environments," and that even though the state of Florida had adopted legislation in June 2010 to prohibit the possession of large constrictors, the capacity and financial resources to enforce this law were still lacking. Here the authors explain the conflicts of interest between the government and various stakeholders, demonstrating the complexity of this issue. On a related note I cannot help but note that in the period 2009–2010, the United States imported > 4200 live Burmese Pythons, with the majority originating from Vietnam, mainly sourced from "captive-bred" individuals (CITES Trade database – www.cites.org).

An important tool for readers is the short section "What if you see a python?" shedding light upon where and which authorities are in charge, if a python (as opposed to other snakes) has been encountered.

"Pythons in the Pet and Skin Trades" constitutes another essential component of this book, elaborating on the uses to which pythons have been put chiefly in the wealthier societies (i.e., the United States, Germany, Japan, among others). Readers are here made aware of the extent of the international commercial trade in reptiles (and of pythons in particular) and just how lucrative this is. The impact that the skin trade has on the Reticulated Python (in particular) is outlined (see also Auliya 2006). Besides legal imports of Burmese Pythons, the authors also mention the illegal trade from fraudulent labelling on behalf of exporting countries, as well as business relationships among American pet dealers (also see Smith 2011). Consequently, Dorcas and Willson have added the section "Responsible Pet Ownership" advising interested parties on how to correctly care for a python in captivity. The book closes with the rather pessimistic chapter "Other Species at Risk of Becoming Established in the United States," introducing African rock pythons, anacondas, boa constrictors, reticulated pythons and ball pythons. The final literature section provides a good selection of around 45 sources for additional reading on the topic and a six-page index makes the book even user-friendlier.

Michael E. Dorcas and John D. Willson superbly meet their objectives, maintaining objectivity throughout their presentation of this highly political topic. The book is not only highly informative but rather embarrassingly teaches us about where human behavior can lead. Indeed the book was necessitated by the largely uncontrolled and unregulated trade and keeping of exotic pets. On-going research will soon be able to tell how detrimental these "invasives" will be to native and threatened wildlife. All in all, this is a book that I highly recommend to all naturalists, especially those with a interest in herpetology and conservation.

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The Herpetofauna of Panay Island, Philippines—An Illustrated Field Guide

by Maren Gaulke. 2011. Edition Chimaira (www.chimaira.de). Hardcover. 390 pp. US $99.50. ISBN 978-3-89973-481-2.

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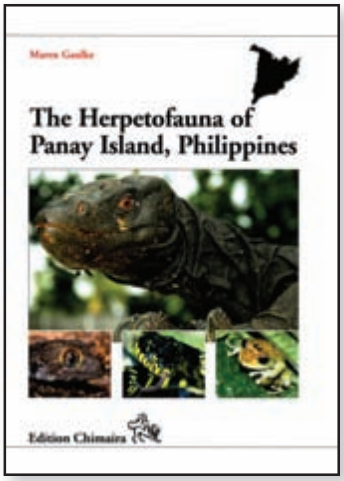

The Philippines, a country of incredible biodiversity and high levels of vertebrate endemism, spans the area between the Sundaland-Eurasian and Philippine Sea plates (Brown and Diesmos 2009). Beginning in the Mesozoic, various geological processes shaped the distribution of land, including the collision of sea plates, strike-slip fault formation, and volcanic activity (Dimalanta and Yumul 2004; Rangin 1990; Yumul et al. 2003, 2009). In addition to the geological processes that created the island arc system, Pleistocene sea level fluctuations have caused repeated and dramatic changes in the size and connectivity of islands (Hall 1996, 1998; Heaney 1986; Karns et al. 2000; Rohling et al. 1998; Siddal et al. 2003), creating an excellent model for a wide variety of systematic and evolutionary studies. Although processes of diversification in the archipelago are quite dynamic, biodiversity in general is partitioned across several major faunal regions corresponding to historically connected island platforms recognized as Pleistocene Aggregate Island Complexes (PAICs: Brown and Diesmos 2002, 2009). Within the Visayan, or central Philippine, PAIC lies the island of Panay.

As many of the seminal works describing Philippine amphibians and reptiles now are decades old (e.g., Brown and Alcala 1978, 1980; Inger 1954), new field guides integrating what we now know of the Philippine herpetofauna have the potential to become immediate reference tools. Maren Gaulke is among the most active researchers focused on understanding the diversity of amphibians and reptiles in the Philippines. With a long-term research program based on the northwest peninsula of Panay, Gaulke is ideally suited for such a review of the island's herpetofauna. An elegant preface by Wolfgang Böhme sets the stage for what will surely serve as a broadly used reference for students and researchers alike interested in Philippine biodiversity, particularly amphibians and reptiles. The book has numerous strengths, from descriptive accounts, an identification key, and an incredible number of photographs, to its physically manageable size as a working reference tool that can easily be carried into the field. Although the book falls short of being comprehensive in several respects, it still represents an excellent contribution to our understanding of the amphibians and reptiles of the western Visayas.

Throughout nine introductory chapters, Gaulke provides brief, but suitable, summaries of Philippine geography, climate, geology, zoogeography and biodiversity, flora, fauna, conservation, and legislation as it pertains to the country's biodiversity. As the focus of this work specifically deals with the herpetofauna of Panay Island in the central Philippines, the brevity of these first few chapters on these subjects will provide many readers with an appropriate first introduction to the material. Those looking for a definitive, thorough reference on any one of these topics will likely discover they must supplement the summary information with external sources. Two examples of this pertain to summaries of Philippine geology and zoogeography and biodiversity. First, a number of recent studies on the geologic history of the Philippines unfortunately are missing from the book. Discussion of two studies in particular that summarize the geologic origins of Panay Island, as well as the unique origins of the northwest peninsula of Panay, or the Buruanga Peninsula, would have increased greatly the breadth of the chapter on Philippine geology (Zamoros and Matsuoka 2004; Zamoros et al. 2008). Additionally, the summary of Philippine zoogeography and biodiversity may be viewed as an overly simplified introduction to the unique and dynamic patterns of faunal partitioning across the archipelago. Gaulke does summarize how faunal demarcations in the Philippines have traditionally been explained by the geography of Pleistocene aggregate island complexes (PAICs: Brown and Diesmos 2002, 2009; Heaney 1985; Heaney et al. 1998, 2005), and highlights how recent studies have indicated diversification in the Philippines likely is more complicated. However, over the last decade alone, the results of a large number of studies on diversification patterns in the Philippines have created fertile ground for a thorough review on this topic. Unfortunately, much of this literature is absent from the book. Regardless of these few shortcomings, the first nine summary chapters provide a sound introduction to major topics concerning the study and conservation of Philippine biodiversity.

The book represents a substantial source of literature references with 192 citations, compared with the 104 references cited in the previously published herpetofaunal study of Panay Island (Ferner et al. 2000). Although a more comprehensive approach to incorporating relevant literature may have been taken, with the inclusion of more in-depth comparisons to what is known of the amphibian and reptile diversity in other regions of the Philippines, the book provides an excellent, focused account of Panay's herpetofauna. Furthermore, with 258 figures, Gaulke provides an incredible photographic account of the diversity of Panay's amphibians and reptiles. A methodology chapter details the methods followed to develop taxonomic accounts and various sections of the book. Species accounts are arranged by Linnaean rank and alphabetical order within families. Throughout the last sections of the book, Gaulke summarizes doubtful Panay records and useful information concerning snakebites and the few venomous species known from the island. Additionally, two tables provide a simplified summary of species habitat preferences and faunal comparisons to other sub-provinces.

In general, the accounts provide an excellent overview of each representative species. Each account references the authoritative publication for the focal species, and provides information on etymology, description, habitat, biology, and distribution. Additional taxonomic notes and specific literature references are provided for select accounts. Although minor errors in format, spelling, and grammar exist, Gaulke has done an excellent job of keeping these few in number. Missing in species accounts are diagnosis sections, references to vouchered, museum specimens, and IUCN criteria-based conservation

assessments. Although Gaulke provides a general description of each referenced species, a brief paragraph providing a diagnostic account would have greatly strengthened the practical applications of this book as a complete field guide and reference source. Additionally, Gaulke provides no reference to Panay Island collections housed in many large, reputable museums around the world. Significant collections from Panay Island exist at the University of Kansas Natural History Museum (KU), the Texas Natural History Collections (TNHC), California Academy of Sciences (CAS), Field Museum of Natural History (FMNH), National Museum of the Philippines (PNM), and the Cincinnati Museum of Natural History (CMNH). Finally, the impact of this work on conservation efforts in the Philippines would have been greatly improved if the author evaluated each species against the International Union for Conservation of Nature (IUCN) criteria for classification.

A resurgence of research focused on the herpetofauna of the Philippines has taken place during the last decade, and the incorporation of genetic data into studies of biodiversity has resulted in continual changes to accepted taxonomy within the region. Although many of these changes create greater taxonomic stability, it makes it difficult for any large-scale endeavor, such as this book, to present updated, recognized taxonomic nomenclature at the time of publication. Gaulke explains this issue in the book's methodology. Several key taxonomic changes have taken place since the publication of the book. A portion of the genus *Sphenomorphus* has been systematically revised as a result of a recent phylogenetic study (Linkem et al. 2011) resulting in the following taxonomic changes to several Philippine species: 1) *Sphenomorphus abdictus*, *S. llanosi*, *S. coxi*, and *S. jagori* are now recognized to be members of a newly described genus *Pinoyscincus*; 2) *S. arborens* is now recognized to be a member of the resurrected genus *Insulasaurus* Taylor, 1922; and 3) *S. steerei* is now recognized to be a member of the genus *Parvoscincus* Brown and Greer, 1997. As a result of other recent studies, species of the genus *Zaocys* are now recognized as members of the genus *Ptyas* (David and Das 2004), and species of the genus *Parias* are once again recognized as members of the genus *Trimeresurus* (David et al. 2011). Finally, a large-scale revision of Philippine Slender Skinks (genus *Brachymeles*) resulted in the elevation of *Brachymeles boulengeri taylori* to full species status (*B. taylori* Brown, 1956; Siler and Brown 2010).

With the availability of high resolution, topographic maps of the Philippines, it is disappointing that more detailed sampling and species distribution information is not available throughout the book. Although it is clear that Gaulke has been involved in biodiversity surveys across much of Panay Island and its surrounding islets, the description of survey sites remains vague, and no specific reference is made to exact localities throughout the island. Unfortunately, this makes it difficult to: 1) draw comparisons between species accounts presented in this book and previous faunal inventories that documented species' distributions across georeferenced sites (Ferner et al. 2000); and 2) evaluate survey efforts across this geographically complex island, leaving the research community in the dark as to where regional gaps remain in our understanding of the Panay herpetofauna. Additionally, with such a rich history of biodiversity research on Panay Island, it is surprising that the author chose not to provide distribution maps for each species. These visual details would have been useful to local government units, students, and researchers.

Gaulke provides several nice line drawings to assist readers in understanding key morphological characters discussed in the book. These include figures showing labeled head scales, body scales, and scale counts for snakes (figs. 15, 16), figures showing an unlabeled dorsal view of the head of a skink and illustrations of morphologically distinct gekkonid digits, respectively (figs. 17, 18), and a figure showing an unlabeled, lateral view of the head of *Parvoscincus sisoni* (fig. 137). However, the book does not provide any additional diagnostic figures that would assist readers in understanding the many different morphological features used to diagnose species. This is surprising considering the number of illustrations that are present in the scientific literature for species of amphibians and reptiles in the Philippines. Basic diagnostic illustrations defining key characters for frogs, lizards and snakes would have added greatly to the educational value of the book; however, without these visual references, readers still will be forced to refer to external literature when needing to explore key diagnostic features of Panay's amphibians and reptiles.

The book contains many wonderful photographs of vertebrate species from Panay Island, from beautiful, full-page photographs of the frugivorous monitor lizard *Varanus mabitang*, to close-up views of the Rufous-headed Hornbill *Aceros waldeni* and the Philippine sailfin lizard *Hydrosaurus pustulatus*. Additionally, Gaulke provides a nice series of developmental photographs, including pictures of foam nests of the arboreal frog *Polypedates leucomystax*, tadpoles of two genera, *Kaloula* and *Rhacophorus*, hatchling and juvenile lizards of 16 genera, and lizard eggs of species of *Gonocephalus*, *Gekko*, and *Eutropis*. Although a number of pictures provide a summary of the general habitat types found on the island, more detailed photographs of the many microhabitats preferred by focal species are missing from the book.

In summary, the book provides a sound, thorough reference tool to tourists, wildlife units of the government, students, and researchers. Unfortunately, in several respects, the work falls short of being truly comprehensive; however, this will not keep readers at all levels of interest from finding valuable data, photographs, and background information on the unique herpetofauna of Panay Island. I have no doubt that this book will immediately become a widely used field guide, reference tool, and cited work.

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Saving Sea Turtles: Extraordinary Stories from the Battle Against Extinction

by James R. Spotila. 2011. The John Hopkins University Press (www.press.jhu.edu). Hardcover. xi + 216 pp., 8 pp. pls. US $24.95. ISBN 978-0-8018-9907-2.

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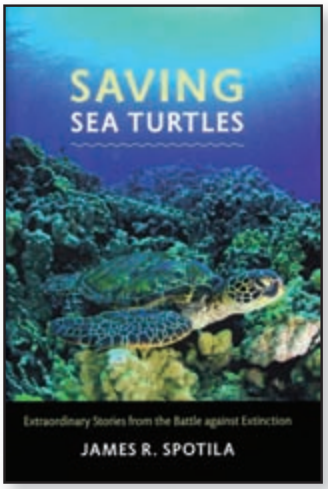

Many books have been written on marine turtle biology, but this book is an exceptional one with its catchy and narrative style. Interesting stories make this book fun to read, even for those whose primary interests are not chelonian. Further, the accessible language makes the book suitable both for non-specialists and for those for whom English is a second language. The book comprises 15 sections which are accompanied by 12 color photos grouped near the middle of the volume.

The book starts with some general information about marine turtle biology. In most of the remainder of the book, noted sea turtle specialist Jim Spotila tells stories about his past experiences with marine turtles, especially leatherbacks. In doing so he also weaves in information about the pioneer researchers of marine turtle studies throughout the world. This information is especially useful for the younger generation of marine turtle biologists. The book summarizes global problems that threaten sea turtle survival and highlights some conservation actions that help to preserve their future generations.

Spotila's stories include some based on work carried out with his former students and he even recounts some stories about non-marine turtles. A particularly engaging story describes the rescue of a European family during field work and another interesting anecdote concerned meeting the sailor who was famously photographed for Life Magazine when he kissed a nurse in Times Square in August 1945. In addition to these there are also success stories of long-term conservation actions such as the implementation of TEDs (Turtle Excluder Devices) in the USA, which took almost 30 years, and the ongoing struggles with the Costa Rican government over the management of a national park. The most intriguing part of the book is the innovative approach of the leatherback team to raise money for the turtle conservation; they used the satellite tagged turtles for a sponsored turtle race—excellent idea!

Although the book is thoroughly enjoyable, there are some minor issues I would like to mention. The author states that Archelon is responsible for the conservation of marine turtles in the Mediterranean. However, this entity is responsible for the conservation and monitoring of marine turtles only in Greece.

In the Mediterranean, each country has its own monitoring and conservation programs and the responsibility for marine turtle conservation belongs to either universities or the ministry of environment of the relevant country. One omission of relevance concerns the time between hatching and emergence of hatchlings (4–7 days; Godfrey and Mrosovsky 1997). I also feel that the sections on genetics should have included more information, particularly because recent innovations in molecular techniques have contributed greatly to our understanding of marine turtle biology and ecology. These insights include trans-Atlantic and trans-Pacific developmental migrations (Bolten et al. 1998; Bowen et al. 1995;), multiple paternity (Harry and Briscoe 1988; Kichler et al. 1999; Zbinden et al. 2007), and the use of DNA fingerprinting for genetic tagging (http://www.seaturtle.org/tagging/genetic.shtml), to name a few. Finally, the author summarizes global warming and its negative effects on marine turtles and suggests some potential mitigation measures. One of his main recommendations is to engage with China and India, countries that are producing more CO_2 than the USA according to him. However, Dr. Spotila seems to forget that the USA is the only country that has signed but not ratified the Kyoto protocol, and yet has one of the highest rates of greenhouse emissions. Perhaps a better recommendation would be to focus on reducing greenhouse gas emissions from the US. These issues aside, the book contains lots of interesting information and I strongly recommend it to everyone interested in marine turtle biology, regardless of their knowledge base or experience.

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A Field Guide to the Reptiles of South-East Asia: Myanmar, Thailand, Laos, Cambodia, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Borneo, Java, Bali

by Indraneil Das. 2010. New Holland Publishers Ltd. (www.newhollandpublishers.com). Hardcover. 376 pages. £35.00 (approx. US $57.00). ISBN: 978-1-84773-347-4.

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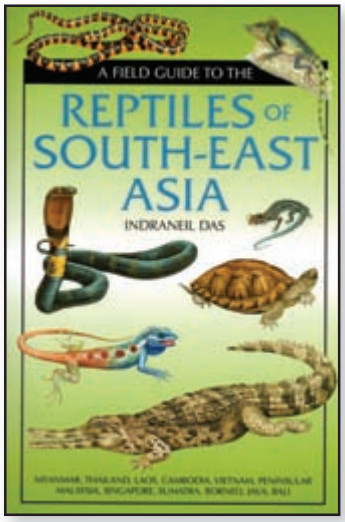


South-East Asia is a biodiversity hotspot for reptiles and now Indraneil Das, one of the best known herpetologists of this region, has contributed an important work to our knowledge of reptiles in this geographic area (including Myanmar, Thailand, Laos, Cambodia, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Borneo, Java, Bali; excluding the Lesser Sunda Islands, Timor, Philippines, and New Guinea). The book is the first comprehensive field guide in English covering species described up to 2008. For nearly every recognized species in the area (see comments below), a detailed account with characteristics, habitat, behavior, distribution, and conservation status is provided.

Beside some smaller chapters, the book is separated in two main parts: the species plates and their legends (pp. 18–165, 74 plates showing 489 taxa) and the species chapters (pp. 166–353). Instead of photographs the book uses well produced paintings by wildlife artists. As somebody who studied feathered reptiles before working with "true" reptiles, I am very satisfied with this kind of presentation. In bird field guides color paintings are the norm as they have the advantage that it is easy to compare different species on one plate. Moreover, all typical characters of a species can be shown in one specimen. Therefore, lay readers can easily use this book to identify reptiles they have seen on their holidays or it could be useful for e.g., customs officers as a guide to recognize CITES species. Even though the plates show nearly 500 taxa, only half of the 963 referenced species are imaged. A negative point is that there the plates precede the species chapters. The book would be more useful if at least families were described and imaged together. There are also some typographical errors, e.g., on the color plate showing pythons the names are mixed up. The same applies to the genus *Leiolepis* (plate 28). Here, the imaged *L. reevesii* is in fact *L. rubritaeniata*, whereas the imaged *L. rubritaeniata* is a true *L. reevesii* (easy to distinguish by the number of black lateral stripes).

It is mentioned in the introduction that all species described by the end of 2008 were included, but some taxa are lacking, e.g., *Bungarus niger* Wall, 1908 is not mentioned but occurs in the region. There are also few distributional errors. *Asthenodipsas vertebralis* is not endemic to the Malay Peninsula and *Boiga gokool* does not occur within the geographic region of the book. However, these are only minor mistakes for a few taxa in the context of the many species of reptiles in South-East Asia.

More important are taxonomic actions made by the author without any comments, e.g., *Ovophis convictus* and *Leiolepis ocellata* were both elevated to full species rank, whereas the synonymization of *Pareas macularius* was not accepted.

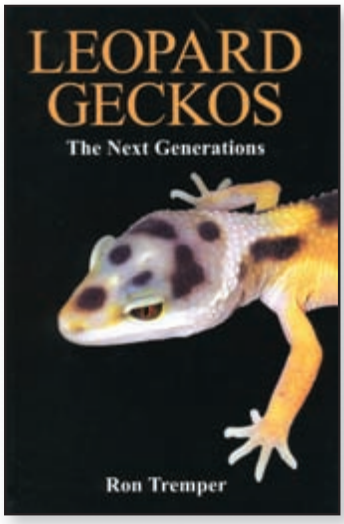
Unfortunately, there are several more critical remarks that must be made. Even in a field guide I would expect that the full scientific species names are provided, including genus and species name, author(s) and the year of the description. Also in a field guide I would prefer a systematic arrangement of the large evolutionary units rather than an alphabetical. It is curious to recognize the "Leiolepidae" (I prefer the usage of the correct name "Leiolepididae," but I think a family status for this group is overestimated) between Lanthanotidae and Scincidae, which does not reflect the relationships of these groups. More critically, unlike the field guides to feathered reptiles, no distribution maps are included; even simple shaded distribution maps would greatly increase the usage of the book. Finally, to make the book useful for professional herpetologists and other serious users, a species key should be added to the second edition, because many species are not imaged and the high number of described species precludes the enlargement of the species chapters to include more detailed descriptions.

Nevertheless, this book is an excellent summary of the reptiles from this area, and given the ever-increasing descriptions of new species from South-East Asia a second edition should follow. For now, the book is useful for professional herpetologists as it summarizes the reptile species of this biodiverse region in a single volume and includes a convenient 11-page (~400 references) bibliography. The book is an ideal guide for tourists, customs officers, and others who need an easy to use guide that covers the whole of this immense area of tropical Asia.

PUBLICATIONS RECEIVED

Leopard Geckos: The Next Generations

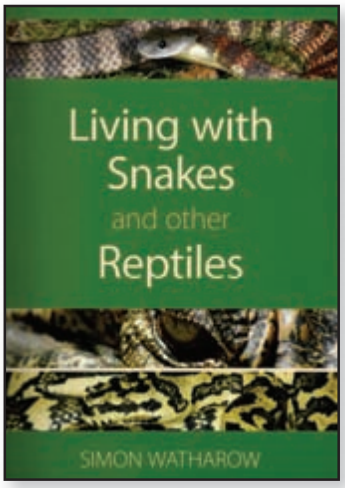
by Ron Tremper. 2012. Published by author (http://www.leopardgecko.com/book), Boerne, Texas. viii + 199 pp. Softcover. US $29.95. ISBN 978-0-615-610-535.



The Leopard Gecko (*Eublepharis macularius*) has become the most commonly kept pet lizard in the world. Although it is quite attractive in its native form, breeders have identified numerous genetic markers and have developed an extraordinary array of "designer morph" geckos whose ranks seem to expand every year as new traits make their debut. These novelties range from albinos to brilliantly orange or purple-and-gold geckos, and even a giant morph that is 50% larger than the standard Leopard Gecko. All of this is nicely summarized by Ron Tremper, the leading commercial breeder and innovator of Leopard Gecko morphs, and is a follow-up to an earlier volume (2005) coauthored with Philippe de Vosjoli and Roger Klingenberg that focused mainly on captive husbandry. In this latest work, Tremper presents a detailed visual catalogue (130 color images) of Leopard Gecko variation, and also offers a how-to-do-it-yourself manual in obtaining breeding stock, developing a breeding plan, and creating new variants.

Living with Snakes and Other Reptiles

by Simon Watharow. 2011. CSIRO Publishing (www.publish.csiro.au; available in the U.S. from Stylus Publishing: www.styluspub.com). Softcover. vi + 149 pp. US $29.95. ISBN 9780643097216.



Australia is home to a staggering number of reptiles, including a diversity of snakes that are potentially dangerous to humans. Encounters between humans and snakes can end badly, with envenomation occurring, or more commonly, the snake being killed. This book provides information on how to avoid such encounters. The book briefly covers snakes in history and why humans fear snakes before providing and overview of snake diversity, biology, and natural history in Australia. A 40 page chapter covers common representatives of both harmless and dangerous snakes likely to be encountered in different regions across Australia, with short species accounts and inset boxes listing commonly confused species. Like the rest of the book, this chapter is illustrated by color photos. A key chapter outlines way to make homes and properties less snake-friendly so as to avoid interactions. Suggestions focus on tidying landscapes to provide fewer retreats and reducing the prey base, particularly rodents, near the home. Shorter chapters cover "Living with Lizards" (with an emphasis on larger and more frequently encountered species), "Living with Crocodiles," and "Living with

Cane Toads." The last of these includes sections on euthanasia and disposal. Final chapters cover how to deal with snakes encountered in the home, the workplace, or outdoors and how to treat snakebite in humans and pets. An appendix lists common 'nuisance' snakes by Australian state and a glossary, list of contacts (government departments, snake catchers, etc.), two page bibliography, and index round out the book, which is also available electronically. This book is intended for people, especially those trying to avoid reptile encounters, living or paying extended visits to Australia, but it doubles as a portable guide to snakes, particularly those likely to be seen in and around the state capitols and other populated places.

Anfíbios Fazenda Rio Claro, Lençóis Paulista, SP Brasil

by Fábio Maffei, Flávio Kulaif Ubaid and Jorge Jim. 2011. Canal 6 Editora, Bauru-SP, Brazil (Contact the senior author: Maffei.fabio@gmail.com). Hardcover. 128 pp. Distributed to relevant schools and other institutions. ISBN 978-85-7917-163-5.

This Portuguese language guide covers the 40 species of anurans in seven families that may be found on the Fazenda (coffee plantation) Rio Claro, in the county of Lençóis Paulista in the Brazilian state of São Paulo. The area can be characterized chiefly as Mata Atlantica (Atlantic Rainforest), but with some influence from Cerrado. The book is illustrated in color throughout, with photos (many full page) showing pairs in amplexus, calling males, eggs, and tadpoles, as well as portraits of each species. One of the most striking images is of a spider eating a *Physalaemus marmoratus*. Each species account includes the Latin name and author, Portuguese name, and a brief text on biology, including vocalization. A standard graphic representation for each taxon combines information on the months of activity, a point locality map, an indication of whether the frog is a Mata Atlantica or Cerrado species, an indication of body size, and habitat (including types of water bodies used). The book closes with a short bibliography of 18 references. The volume provides residents and visitors with a detailed but accessible look at the composition of a southern Brazilian frog community. The fine photos and standardized graphics make it possible to use the book even if you don't read Portuguese.

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