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SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

www.ssarherps.org

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

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

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

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

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

Future Annual Meetings

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

ABOUT OUR COVER: *Telmatobufo venustus*

The Chile Mountains False Toad is covered extensively in this issue (see Fenolio et al., pp. 514–519) but the unique, threatened area in which this rare creature lives is worth discussion. Recognized as one of the world's biological hotspots, the Chilean Winter Rainfall-Valdivian Forests Region (CWRVFR) is practically an island, albeit mostly surrounded by landforms. Unstable during the Eocene, under the ocean in the Miocene, and finally, profoundly modified by tectonic action during the late Pliocene and Pleistocene, CWRVFR was then subjected to glacial scouring. Bounded by the Pacific Ocean, the Andes Mountains, and the Atacama Desert, the region is covered by ancient forests of *Nothofagus*, *Araucaria*, and *Laurelia* dating from the Tertiary. These came into contact with tropical floras owing to the drastic geological changes. The resulting modern vegetation, like the fauna, reflects a high degree of endemism (Formas 1979. La herpetofauna de los bosques temperados de Sudamerica, pp. 341–369 *In* W. E. Duellman, Jr. [ed.], The South American Herpetofauna: Its Origin, Evolution, and Dispersal. Monogr. 7, University of Kansas Museum of Natural History, Lawrence).

Indeed, of the more than 40 species of amphibians in the CWRVF, the majority are unique to that region. Endemics include such oddities as *Rhinoderma* (two species), *Insuetophrynus*, *Calyptocephalella* (each with a single species), *Eupsophus* (several species), and *Telmatobufo* (with four species including *T. venustus*, the subject of our cover). *Rhinoderma darwinii* and *R. rufum* are considered flagship species for the region; the former is vulnerable "VU" while the latter is critically endangered "CR" (IUCN) or possibly extinct.

Overgrazing, invasive species, sedimentation and silting, urbanization, and logging are all contributing factors to the degradation of this habitat. Recent problems include development of coastal areas to foster tourism and the construction of major hydroelectric dams. A newly proposed dam project threatens the most pristine sectors of Patagonia. Many persons and institutions in Chile are concerned and struggling to protect her unique wilderness heritage, but the global economy and the country's burgeoning population make for a formidable obstacle. There is reason for optimism, both because of world conservation interest and the spirit in Chile, which abides by a local proverb: "No one has done well who has not suffered disillusionment."

Danté Fenolio (below), **Andrés Charrier**, and **Pilar Calderón** collaborated to produce the cover image. The frog was photographed on a mossy boulder at the site where it was encountered. A gold/silver mesh reflector and natural sunlight were used for illumination. A Sony Alpha 100 with a 10–20mm lens on a tripod with a 2.5-second exposure at f./20 with an ISO speed of 200, rendered the "foggy" look of the passing stream water.

Fenolio is the resident Amphibian Conservation Scientist for the Atlanta Botanical Garden's amphibian conservation program. His work with the Garden focuses on the population ecology of the Georgia Blind Salamander, *Eurycea* (=*Haideotriton*) *wallacei*, and in establishing assurance colonies of Chile's most threatened amphibian species at the National Zoo of Chile in Santiago. The first stage of the project, a breeding facility and captive assurance colony of Darwin's Frogs, *Rhinoderma darwinii*, now exists at the zoo and is producing offspring. New amphibians to the project include the cover species, *Telmatobufo venustus*. An avid wildlife photographer for most of his life, Fenolio is wrapping up a book focusing on wildlife that is adapted to darkness. Andrés Charrier and Pilar Calderón have been involved in the fieldwork in Chile for the Darwin's Frog Conservation Initiative. Both have made significant contributions to the project. Andrés Charrier (Centro de Estudios Avanzados de Ecología y Biodiversidad, Universidad Católica de Chile) now works on amphibian projects across much of south Chile.

PHOTO BY WILLIAM W. LAMAR

SSAR BUSINESS

2011 Annual Meeting, Minneapolis, Minnesota

The 54th Annual Meeting of SSAR took place from 6–11 July 2011 at the Hilton Minneapolis Hotel, Minneapolis, Minnesota, USA. The Organizing Societies were Society for the Study of Amphibians and Reptiles (in conjunction with the International Society for the History and Bibliography of Herpetology), American Elasmobranch Society (celebrating its 27th annual meeting), American Society of Ichthyologists and Herpetologists (celebrating its 91st annual meeting) and The Herpetologists' League (celebrating its 69th annual meeting). The meeting was hosted by University of Minnesota and St. Olaf College. The hard-working local hosts, Ken Kozak (Chair), Pat Ceas, and John Moriarty were assisted by the staff of Kansas State University Division of Continuing Education and many student volunteers.

Just over 850 herpetologists and ichthyologists from at least 27 different countries attended the 2011 JMIH. Following recent trends, this number was lower than last year. Almost 500 papers and approximately 250 posters were presented. Four symposia were held, including one in honor of the 80th birthday of John Legler ("Biology of Turtles of the Upper Mississippi River Basin: A Symposium in Honor of the 80th Birthday of John M. Legler and his 50 Years of Fieldwork with Turtles in the USA, Mexico, Central America, and Australia"). SSAR sponsored the symposium "Assisted Reproductive Technologies and Genetic Resource Banking: Tools for Conserving Declining

Amphibians." This symposium was organized by Jennifer Germano and Andy Kouba, who wish to thank SSAR and all of the participants and attendees. The symposium featured 14 speakers (ranging from graduate students to senior researchers) and was followed by a productive Skype-facilitated discussion that included colleagues from the UK, Russia, and Australia who were unable to be in Minnesota (Fig. 1).

After a busy day of Board and Executive Committee meetings, the 2011 JMIH began officially with the Plenary Session on the morning of July 7th. Ken Kozak, Chair of the Local Host Committee, welcomed attendees to the meeting and thanked the many student and postdoctoral volunteers, the JMIH Meeting Committee, and K-State for their hard work. He reviewed many of the upcoming social events and reminded people of the JMIH logo competition (see below). Susan Wells (Director, Bell Museum of Natural History, University of Minnesota) then welcomed us to Minneapolis and affirmed the importance of studying the whole organism. President Joe Mendelson summarized some SSAR events to look out for over the next few days, particularly the Ernie Liner Mardi Gras Live Auction. ASIH representatives presented a number of awards (the Robert Gibbs Award to William F. Smith, the Fitch Award to Raymond Semlitsch, and the Johnson Award to Henry Mushinsky). Cathy Bevier announced the second winner of the Meritorious Teaching Award in Herpetology, Dr. Robert Powell (Avila University). With this award, Bob (long time SSAR member and former editor of *Catalogue of American Amphibians and Reptiles*) is recognized for his exceptional accomplishments and contributions to herpetological education, particularly at the undergraduate level. Priya Nanjappa presented two awards from PARC (Partners in Amphibian and Reptile Conservation): the Alison Haskell Award for Excellence in Herpetofaunal Conservation to Alvin Breisch, and the Visionary Leader Award to Whit Gibbons.

AES Plenary speaker Kenneth Goldman gave a presentation on "The History of Studying Endothermy in Fishes: How many Places can you Stick a Thermometer?" He reviewed the history of temperature measurements, spoke about the many important contributions of Frank Carey, and reviewed the development of our understanding of endothermy in fishes.

Aaron Bauer, HL Distinguished Herpetologist for 2011, then spoke on "Hands, Sands, and Southern Lands: Geckos in Time and Space" during which he recalled 29 years of "geckomania," including 70 trips to Africa, 40 trips to Australia and the Pacific, 20 trips to tropical Asia, and over 100 trips to Europe. During these many trips, there were no deaths or serious injuries, however, he contracted one tropical disease, was involved in the destruction of two cars, and had one specimen stolen by a meerkat. Aaron spoke of the long, independent evolutionary history of gekkotans and the many factors that make them unique, particularly toe adhesion. In closing, Aaron, in his position as Secretary General of the World Congress of Herpetology (WCH), issued an invitation to next year's 7th WCH in Vancouver.

James Hanken was the last Plenary speaker of the morning and gave the ASIH past-Presidential address on "Plotting the Future of Comparative Biology." He views this as being both a very exciting time to be a comparative biologist, with the discovery and description of many new species in an "age of taxonomy," as well as a tragic time, with the increasing loss of biodiversity and threats to museums and natural history collections, with recent budget cuts and job losses. Jim noted declining memberships in many taxonomically-based societies, including some herpetological societies (although commenting that this is not the case for SSAR). He voiced concern of a growing recognition by some that our fields are too highly fragmented and that we lack a united voice. He indicated that changes in the ways professional societies operate and view themselves are likely if they are to continue to remain viable and have any meaningful impact on our field (e.g., more strategic actions, an increasing focus on the "big picture," greater collaborations among the societies) and suggested that we must play a more active role in counteracting the views expressed in reports such as that of U.S. Senator Tom Coburn on NSF. Jim is currently serving as chair of an AIBS Ad Hoc Committee on Biodiversity-related Sciences. The charge to this committee is to gather information on the feasibility of a biodiversity-related science policy initiative and submit a report on their findings by the end of this year. Jim's take-home message was that taxon-based societies can, and should, play an essential role in planning the future of comparative biology, but that they also need to change the way they do business if their efforts are to be effective.

Thirteen images were submitted to the JMIH logo competition. Attendees cast their vote for their favorite logo throughout the meeting. Congratulations to the winner, Kevin Wang. The image he created is now being used on the JIMH website (http://www.dce.k-state.edu/conf/jointmeeting).

Social and Professional Events

Phil Bishop (University of Otago, New Zealand) kicked off SSAR's many contributions to the 2011 JMIH with his President's Travelogue on the evening of July 6th. Phil spoke on "An Austral Perspective: Herpetological Adventures South of the Equator." He documented his travels and research on amphibians in South Africa, New Zealand, Australia, and Fiji. Phil was recently appointed by the IUCN as Chief

PHOTO BY M. PREEST

Fig. 1.

PHOTO BY M. PREEST

Fig. 2.

Scientist for the Amphibian Survival Alliance (ASA) and he gave a paper a few days later on the activities of the ASA ("The Amphibian Survival Alliance Jumps into Action").

The now-annual SSAR/HL Student Reception was held late afternoon on July 7th. The room was packed with students and invited professional herpetologists. President Mendelson gave a warm welcome to our student members and encouraged them to enjoy finger food, drinks, and meeting senior herpetologists (Figs. 2, 3). The student reception was followed by the Joint Meeting Reception. A short bus ride delivered us to the Nicollet Island Pavillion in the middle of the Mississippi River (Fig. 4). A stroll around the southern end of the island followed dinner for some, while others were content to sit and catch up with friends and colleagues (Fig. 5). The group photo (by Matthew D. Potenski) was taken outside the Pavillion (http://www.dce.k-state.edu/conf/jointmeeting/images/jmih2011_group.jpg).

Dawn Wilson and Robert Espinoza organized a highly successful and well-attended lunch-time student workshop, "Law and Order in Herpetology: Permits and Regulations for Importation and Exportation" (held on July 8th). Seven panel members from the zoological, museum, conservation, non-profit, and academic communities talked about their experiences obtaining permits to work in countries other than the US, as well as permits to import live and preserved material (Fig. 6). Attendance by students was so high that we ran out of pizza (sorry—we promise more next time!). The panel members had lots of great advice and responded to many questions from the audience, e.g., how to handle importation of specimens not definitively identified.

This year's very special Live Auction, the "ASIH/HL/SSAR Ernie Liner Mardi Gras-Auction" was held on July 10th. Ernie, a long-time member of The Ohio Herpetological Society and SSAR, and a former member of the Board of Directors passed away in September of 2010. The auction consisted entirely of materials from Ernie's estate that were donated to the three societies. Brian Crother (then SSAR President) and a number of his students from Southeastern Louisiana University (Chris Murray, Justin Rheubert, Jenifer Lee, and Ryan Willis) worked hard over several days to pack the materials Ernie had donated to the societies. Breck Bartholomew arrived in Houma, Louisiana with a 26-foot U-Haul truck and Brian, Breck, Chris, and Justin spent 10–12 hours simply loading the truck. Breck transported the collection to Salt Lake City and it is being processed for sale through online auction. SSAR is very grateful to Breck, Brian, and Brian's students for their work on behalf of the societies.

Breck showed up in Minneapolis with less than 1% of Ernie's collection. The range and quantity of items was truly impressive—books, jewelry, door mats, stuffed, blow-up, and plastic animals, porcelain figurines, snake sticks, artwork, fridge magnets, caps, bottles of herpetologically named wine, mugs, glasses, t-shirts, ties, newspaper clippings, and even Ernie's honorary doctorate diploma, mortar board, and hood from the University of Colorado! Auctioneers Brad Moon, John Moriarty, Steve Mullin, and Aaron Bauer were ably assisted by Greg Watkins-Colwell and a small and busy army of students (Heather Heinz, Jolene Rearick, Alicia Kennedy, Brittany Barker, and Jenny Gubler). President Mendelson created a slide show of Ernie's life that ran throughout the evening. Bidding on many items was spirited and the auction ran close to midnight. It was an appropriate way to celebrate Ernie's life and contributions to herpetology and it will be difficult to top the 2011 Live Auction (Figs. 7–9).

Breck also displayed many items from Ernie's estate at the SSAR Publications booth (Fig. 10). For a small donation to either the Ernie A. Liner or the Roger Conant Endowments one could select from an array of objects. Not many people left Minneapolis without an Ernie Liner fridge magnet!

Mike Jorgensen and Vinny Farallo organized this year's Silent Auction. The silent auction changed location this year in an effort to increase visibility and could be found outside the Plenary Session entrance in the main break area. Donors this year included Kraig Adler, Ronn Altig, Breck Bartholomew, The Herpetologists' League, Allen Press, and University of California Press, and helped to bring in US $1763 for the SSAR Student Travel Fund (more than doubling amounts earned in previous years). Once again, the ten recipients of the US $400 SSAR Student Travel Award (Fig. 11) took turns to work the silent auction table for 2–3 hrs throughout the course of the meetings; all agreed that this "service" was a great way to meet new colleagues at the meeting.

The end-of-meeting Banquet was held on July 11th. Larry Allen again served as Master of Ceremonies. On behalf of the JMIH Societies, he thanked the local hosts and K-State for another enjoyable and successful meeting. Larry then introduced those at the head table (including President Mendelson, Treasurer Nicholson, and Secretary Preest) and asked past-presidents of the societies in attendance to stand (including four past-presidents of SSAR). ASIH election results were announced, certificates of appreciation were presented, and resolutions were read. Various awards from ASIH, AES, and HL were announced. Pat Gregory (University of British Columbia) issued an enthusiastic invitation to herpetologists *and* ichthyologists to attend the World Congress of Herpetology in Vancouver, 8–14 August 2012. Larry thanked those in the room for attending what could be the penultimate traditional banquet and promised a "highly modified version" of the end-of-meeting banquet at the 2013 JMIH (10–15 July) to be held in Albuquerque, New Mexico.

PHOTO BY M. PREEST

FIG. 3.

FIG. 1. Speakers in the SSAR-sponsored symposium. Back row (L to R): Lucia Arregui Almendral, Jonathan Aaltonen, Gina Della Togna, Tricia Rowlison, Michelle Wilkes Martin, Andy Kouba, Frank Molinia, Marlys Houck, Carrie Vance, John Clulow, Vance Trudeau. Front row (L to R): Wang Qijun, Natalie Calatayud, Aimee Silla, Jen Germano, Cecilia Langhorne. Not pictured: Chester Figel, Blair Hedges.

FIG. 2. Bob Aldridge (SSAR President-Elect) chatting to Tony Wilmes and Matt Rucker at the SSAR/HL Student Reception.

FIG. 3. Winners of door prizes at the SSAR/HL Student Reception. Steve Whitfield, Sue Kim, Daniel Paluh, and Maggie Hantak (L to R), with Dawn Wilson in the background.

Board, Long Range Planning, and Business Meeting Summaries

SSAR Board Meeting

Society President Joseph Mendelson called the Board Meeting to order at 0805 hrs on July 6th, 2011 in the Hilton Hotel, Minneapolis, Minnesota. In attendance were the following members of the Board of Directors, Editors, and Committee Chairs: Kraig Adler (Editor, *Contributions to Herpetology*; Chair, Long Range Planning Committee), Bob Aldridge (President-Elect), Breck Bartholomew (Publications Secretary), Aaron Bauer (Editor, *Facsimile Reprints in Herpetology*), Cathy Bevier (Chair, Herpetology Education Committee), Rafe Brown (Chair, Seibert Award Committee), David Cundall (Board Member, Reg. 2012), Raul Diaz (Webmaster), Kevin de Queiroz (Board Member, Reg. 2012), Tiffany Doan (Board Member, Reg. 2014), Richard Durtsche (Coordinator, Symposium Committee), Pat Gregory (Board Member, non-US 2012), Robert Hansen (Editor, *Herpetological Review*), Mike Jorgenson (Chair, Silent Auction Committee), Joseph Mendelson, III (President), John Moriarty (Editor, *Herpetological Circulars*), Erin Muths (co-Editor, *Journal of Herpetology*), Kirsten Nicholson (Treasurer), Ann Paterson (Board Member, Reg. 2012; Chair, Membership Committee), Gad Perry (co-Editor, *Journal of Herpetology*), Marion Preest (Secretary), Al Savitzky (SSAR Representative to AIBS and BioOne), Carol Spencer (Board Member, Reg. 2014), Greg Watkins-Colwell (Chair, Nominations Committee; Organizer, SSAR/HL Live Auction), and Dawn Wilson (Chair, Student Participation Committee). Additional society members present included Robin Andrews, Marina Gerson, and Henry Mushinsky. Introductions were made and minutes of the 2010 Board of Directors Meeting (Providence, Rhode Island) were approved.

Annual reports for 2010/2011 were submitted by all Officers, Editors, and Committee Chairs.

Officers' Reports.—President Joseph Mendelson reported that SSAR was involved as a Festival Partner with the USA Science & Engineering Festival in Washington D.C. in October, 2010. The first of the 2011 issues of *Journal of Herpetology* and *Herpetological Review* revealed changes in formats and increased use of color. Joe extended kudos to Editors Bob Hansen, Erin Muths, and Gad Perry. A Zoo Atlanta volunteer has begun the important and long-awaited task of completing and copyediting the indexing effort for *Herpetological Review*. This will allow *Herp. Review* to be searchable and posted in online databases. President Mendelson was involved in the work of the Long Range Planning Committee, the Membership Committee, and the JMIH Meeting Management and Planning Committee. He reported writing or signing a number of letters pertaining to SSAR business over the past year and made arrangements for Phil Bishop to be the 2011 SSAR President's Travelogue speaker. Joe was also involved in receiving the estate from Ernie Liner and organizing the three-society auction in Ernie's memory.

Past-President Crother reported appointing Kraig Adler as chair of the Long Range Planning Committee, Ann Paterson as chair of the Membership Committee, Raul Diaz as Webmaster, and Rafe Brown as chair of the Seibert Awards Committee. The EBSCO contract that was approved by the board at the 2010 meeting was completed and signed. Brian sent a letter of thanks to Thomas Beauvais for his generous donation to support increased use of color in our journals. He reported that, following discussion after the 2010 JMIH, the SSAR Board voted to approve changes to the Meeting Management Committee to make it a JMIH committee rather than an ASIH committee.

Treasurer Kirsten Nicholson reported that, overall, the finances of SSAR are quite sound and that 2010 was a good year for us. Expenses

PHOTO BY ROBERT HANSEN

FIG. 4. Sundown on the Mississippi River, looking into downtown Minneapolis, as seen from the Nicollet Island Pavillion, site of the Joint Meeting Picnic.

were less than expected and income higher than expected, resulting in a net profit of $52,433. In addition, the stock market has steadily increased and our portfolio has returned to its pre-crash levels (as of May 2011). In our first year of participating as partners in the JMIH finances, SSAR paid approximately $500 to ASIH for SSAR-specific costs. Kirsten indicates that, in terms of our journals, we generally perform at the very edge of our expenses. We will have to increase our income to accommodate changes to the journals. The approved 2010 budget was balanced and about half of our expenses were over-budget with half under or right on budget, although overall we came in under-budget. Breck Bartholomew took over membership management and the society should be extremely grateful, as the cost to us is vastly less than we had with Allen Press, Inc. Our income from memberships was greater than anticipated and the number of members has increased from last year for both individual and institutional subscriptions. The Publications Office went over-budget, but that is largely due to the expenses incurred handling the Ernie Liner collection. Due to the nature of this year's auction, no funds will be collected in support of student travel. The Society's investments increased slightly during 2010, in keeping with the trends in the global market. The total market value increased 15% from US $493,004 to an ending value of US $571,156, although the book value increased by only 2%. As of May 2011, we had returned to our pre-crash values of over US $600,000, but this last month has seen a dive below US $600,000. The general strategy Kirsten has been employing is a balance between growing our investments as best we can, given our total circumstances, yet allowing for increased spending as it pertains to our initiatives.

Secretary Marion Preest provided Officers, Editors, and Committee Chairs with minutes of the 2010 Board Meeting and summarized the 2010 Annual Meeting for publication in *Herp. Review*. She keeps track of changes in personnel and regularly updates SSAR letterhead, informs the Editors of *Journal of Herpetology* and *Herp. Review* of these changes, and provides various updates to Webmaster Raul Diaz. She routinely writes letters to student winners of awards (e.g., Kennedy, GIH, etc) and prepares announcements for publication in *Herp. Review*. Marion compiled the 2011 Annual Report and prepared agendas for the Board and Business Meetings for the 2011 JMIH. She again organized a reception for student members of SSAR and HL to be held at the JMIH. There was some discussion by the Board of non-students and individuals who are not members of either SSAR or HL registering for the reception. We are trying to balance a desire to make this an open and inclusive event with our ability to cover costs. Marion corresponded with the Board regarding various issues that needed a vote, e.g. renewal of the JMIH memorandum of understanding, approval of JMIH symposia, etc. She ensured that SSAR members who do not provide email addresses to the membership office received paper ballots for the 2010 election. Voting participation (both electronic and paper) was again very low, even though electronic voting this year did not require login or a password, and thus was very simple. A suggestion was made that we publish a notification of upcoming elections in *Herp. Review* and/or on the website. Those who wish to vote, but are not able to do so electronically, could contact the Secretary and request a paper ballot.

Publications Secretary Breck Bartholomew reported that total income from the Publications Office in 2010 was US $57,715.13. He is requesting a budget for 2011 that includes funds to process the Ernie Liner bequest, which will eventually be paid back from proceeds from the sales. Breck would like to remainder books that are no longer selling well enough to justify storage space. The Board suggested that, prior to remaindering the books, Breck make them available to members at deeply discounted prices (plus costs of postage) and that he send them to libraries at academic institutions for outreach purposes. Joe asked that Breck summarize the discussion of the Board and then provide the Board with an outline of how he wishes to proceed, e.g., sell, give away, remainder.

George Pisani (Trustee) reported that he again filed SSAR's annual corporate report with the Office of the Kansas Secretary of State.

Editor's Reports.—Andy Price, Editor of *Catalogue of American Amphibians and Reptiles*, reported that accounts 881–900 (2 gymnophiones, 3 salamanders, 3 frogs, 2 turtles, 7 lizards, 3 snakes) will be published sometime this year. Andy suggested that the Board needs to make a decision about the future of *CAAR* in light of his decision to resign as Editor and difficulty in recruiting editors and authors. He raised two possible options. The first is to cease publication of *CAAR*. The second is to go digital and publish an account on the website whenever one is ready. Andy indicated that he is willing to modify his decision to resign if the Board approves the second option.

Kraig Adler, Editor of *Contributions to Herpetology*, reported that "*Biology of the Reptilia*, Volume 22, *Comprehensive Literature of the Reptilia*, by Ernest A. Liner was published in March 2010 and "*Snakes of Honduras*" by James McCranie was published in March 2011. "*Herpetology of Armenia and Nagorno-Karabakh*" (by Marine Arakelyan, Felix Danielyan, Claudia Corti, Roberto Sindaco, and Alan Leviton), will be published in late 2011. "*Contributions to the History of Herpetology*," vol. 3 (by Kraig Adler, John S. Applegarth, and Ronald Altig), "*A Contribution to the Herpetology of Northern Pakistan*" (by Rafaqat Masroor), "*A Guide to the Snakes of the Philippines*" (by Rafe Brown, Alan Leviton, Maren Gaulke, and Arvin Diesmos), "*Field Guide to Amphibians and Reptiles of the West Indies*" (by S. Blair Hedges), and "*Lizards of Southern Africa*" (edited by William R. Branch and Aaron Bauer) are planned beyond 2011.

Editor Aaron Bauer (*Facsimile Reprints in Herpetology*) reported that no new titles were published in the past year and a single publication is planned for 2012 (Duméril and Bibron's "*Erpétologie Générale ou Histoire Naturelle Complète des Reptiles*" (1834–1854) [to be guest edited by Kraig Adler]). As the result of a generous donation, Aaron expects to be able to sell this *Facsimile* at < US $300. This is a very large, multi-volume *Facsimile* and the costs of shipping (especially overseas) and storage will be high. Various options to reduce weight, e.g., combining individual volumes, are being evaluated. A suggestion was made to especially encourage prepublication sales so as to reduce storage costs by not overproducing. Eventually an electronic version will be available, but currently demand is for a paper copy. The majority of projects planned beyond *Erpétologie Générale* are in various states of completion and are collected works *Facsimiles*.

Aaron reported that, in consultation with Greg Watkins-Colwell, he had made the decision to cancel a reprint of J. E. Gray's series of catalogues of the amphibians and reptiles in the collection of the British Museum. Aaron believes that the playing field for *Facsimiles* has changed fundamentally recently and that serious reconsideration of the *Facsimile Reprints in Herpetology* series is required. The historical role of the *Facsimiles* series was to serve the herpetological community by making available difficult-to-obtain older literature, chiefly works of real utility to some subset of our community. The exponential increase in the availability of literature however has effectively narrowed SSAR's niche in this field. Aaron has come to the conclusion that it is not cost effective to continue with the reprinting of most single-volume titles that are 1) available through literature portals, and 2) do not have illustrations or have only simple black and white illustrations that reproduce well in electronic copy and hard-copy printouts therefrom and thus, that only certain types of publications are likely to be viable projects for reprints. The upcoming

facsimile of Duméril and Bibron is a case in point. This work, in addition to being very widely used and needed by the community, has many color plates, is represented online by relatively poor scans, and is so large as a whole that it is rather awkward to work with in an online format. Likewise, Aaron believes that the collected works of single authors (e.g., Peters, Peracca, Smith, etc.) are also strong candidates for facsimiles. These include tens to hundreds of individual publications that would be difficult for readers to assemble, even if most are available in some electronic format. They also provide complete annotated bibliographies and can include cumulative indices that offer added value. A third type of product might be a facsimile of a foreign language work with a complete English translation (a competing publisher has, for example, recently published a facsimile and translation of Laurenti's [1768] Latin work). There was brief discussion of Aaron's report and the Board indicated its trust that Aaron would do what is best for the series.

John Moriarty (Editor, *Herpetological Circulars*) reported that HC-39 (*A Guide to Tissue Collection, Preservation, and Management for Reptiles and Amphibians*) is in preparation, with publication planned for late 2011. The Seventh Edition of the *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico* will be published as HC-40. The revision will be given away at the World Congress in Vancouver in 2012.

Joe Mitchell, Editor of *Herpetological Conservation*, reported that no inquiries for publication were received in 2010 and that no progress was made on the book covering herpetological conservation in agricultural landscapes.

According to Editor Robert Hansen, *Herpetological Review* continues to operate smoothly. Volume 41 consisted of 528 pages and Volume 42 is projected to run >600 pages. Personnel changes include Robert Reed (Associate Editor) stepping down and Jodi Rowley, Felix Cruz, Priya Nanjappa, and Wulf Schleip joining the staff as either Associate or Section Editors. Support from the Thomas Beauvais Fund permitted an increase in the selective use of color and the last half of 2010 brought a flurry of activity. Following board approval, many things were set in motion including recruiting new editorial personnel, hiring a professional design team (Eagle Mountain Publishing), developing new content sections, soliciting contributions, and evaluating design options. The first edition of the redesigned *Herp. Review*, featuring full color throughout, appeared in March 2011 and has been received favorably. Beginning in 2011 (vol. 42), Bob initiated a new section (Conservation) to better reflect the importance of conservation-related issues in herpetology. He also created a new section for the publication of captive-based observations (Herpetoculture Notes) and resurrected a long-dormant feature (Institutional Profiles) with the first contribution appearing in the June 2011 issue. Another section (National and Regional Organizations) will debut later in 2011.

Full-issue pdf files of *Herp. Review* are available to SSAR members on the ZenScientist website. To promote membership in SSAR, copies of the new *Herp. Review* were distributed *gratis* to attendees at the All Florida Herpetology Conference in April. Reciprocal advertising agreements have been reached with a number of other publications/organizations that will permit SSAR to advertise membership/subscription options. As mentioned in President Mendelson's report, a comprehensive index to back issues of *Herp. Review* is in the works.

Editors of *Journal of Herpetology*, Erin Muths and Gad Perry report that former Editor, Geoff Smith, continues to provide editorial assistance and that the current Associate Editor roster contains some new names. In order to save money and better fit the standard pdf page size for electronic reprints, the Journal switched format in 2011. This also allows it to be bundled with *Herp. Review* for mailing, providing further savings. Erin and Gad reported that overall submissions set a new record in 2010. Submissions so far for 2011 (115) are similar to the number submitted during the same period in 2010 (135) and much higher than during 2009 (61). Rejection rate has remained fairly stable over the past few years. The amount of time needed to reach an initial decision remains similar to that in the past few years. Duration to reach a final decision peaked for manuscripts accepted in 2009, but has been reduced in 2010 to the lowest level Allen Press reports for our journal. There is currently approximately a 9-month wait between acceptance of a paper and publication. Erin and Gad expect to be able to maintain these numbers, or improve on them, in 2011. The biggest challenge to doing so is obtaining timely reviews. Securing willing, capable, and available Associate Editors is becoming quite difficult as well. The USA remains the leading source of manuscripts. Brazil is consistently the second largest source of submissions. Argentina also tends to be high, as are Australia, China, and Mexico. The larger number of manuscripts from non-English speaking countries places an added burden on the editorial process. The Editors note that they need to find a Brazilian Associate Editor.

The Editors conducted a quality analysis this year using the ISI Impact Factor. Overall they feel that our position is strong and continues to improve, but they would like to see it advance even further.

Committee Chair Reports.—The Conservation Committee (Betsie Rothermel, Chair) took action on a number of significant items during the past year: a) they sent comments to the U.S. Fish and Wildlife Service (USFWS) regarding designation of critical habitat for the Mississippi Gopher Frog, specifically expressing concern that the proposed "buffer radius" was too small and that greater emphasis

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FIG. 5.

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FIG. 6.

should be placed on habitat quality and management issues within the areas considered for inclusion; b) in response to the USFWS issuing a Notice of Inquiry regarding a petition to list all live amphibians in trade as injurious unless free of *Batrachochytrium dendrobatidis* (*Bd*), they prepared and submitted an extensive report summarizing the current scientific knowledge of the biology of *Bd*, its impacts on amphibians in the U.S., and surveillance and control techniques. They expressed support for the concept of regulations to help control the spread of this pathogen, but argued that focusing solely on *Bd* was short-sighted and suggested that USFWS should also consider other emerging pathogens in the development of any regulations and control measures; c) they sent a joint letter to key House and Senate representatives asking them to preserve funding for the State Wildlife Grant (SWG) and North American Wetland Conservation Act programs.

Joe Beatty (Chair, Dean Metter Award Committee) received 27 proposals this year and two winners were chosen. They are: Brandon Fessler, an M.S. student in the Department of Biological Sciences at Central Washington University in Ellensburg, Washington, whose dissertation research deals with seasonal behavior, habitat use, and spatial ecology in *Dicamptodon tenebrosus*; and Jessica Wood, a Ph.D. student at the University of Missouri, Columbia, whose research will analyze call plasticity and mate recognition in *Hyla femoralis*.

Chair of the Grants-in Herpetology Committee, Josh Kapfer, received 49 proposals this past year. Most applications were in the "Laboratory Research" category. The winners each receive US $500 and they are:

Conservation - Anne G. Stengle, University of Massachusetts

Education - Michelle Lester, Yakima Area Arboretum

Field Research - Michael Habberfield, State University of New York, Buffalo

Laboratory Research - Beck A. Wehrle, California State University, Northridge

Travel - Denita M. Weeks, California State University, Northridge

International - Kerry L. Holcomb, Central Washington University

Josh reported that reviewer criteria were implemented this year to streamline the review process and reduce subjectivity in evaluations. Additionally, the deadline for proposal submission was moved to 15 December in the hopes of easing the burden on reviewers.

The organization of the SSAR-GIH announcement was re-worked after the 2011 grant submission deadline. This decision was based on questions received from potential grant applicants prior to the 2011 submission deadline. The new announcement is on the website.

The 19th annual Seibert Awards Competition (Pat Owen, Chair) was run at the 53rd Annual Meeting of SSAR in Providence, Rhode Island. There were 35 eligible presentations. The Seibert Award winners for 2010 were: **Systematics/Evolution**: *Cameron Siler* and Rafe Brown, University of Kansas, "Historical processes behind patterns of limb reduction and loss in an island radiation of fossorial lizards." **Ecology**: *Jennifer Stynoski*, Virginia Noble, Meredith Strider, University of Miami, Organization for Tropical Studies, University of Maryland, "To eat but not to be eaten: honest begging signals and visual detection of predators and mothers by tadpoles of the Strawberry Poison Frog (*Oophaga pumilio*)." **Physiology/Morphology**: *Denita M. Weeks* and Robert E. Espinoza, California State University, Northridge, "Geckos on ice: unexpected thermal tolerances and temperature-dependent performance of the world's southernmost gecko." **Conservation**: *Daniel Leavitt*, Texas A&M University, "*Sceloporus arenicolus*, an endemic lizard in an endangered ecosystem."

Honorable mentions were: **Systematics/Evolution**: *Philip L. Skipwith*, Aaron M. Bauer, and Todd R. Jackman, Villanova University, "Molecular phylogenetics of New Caledonian diplodactylid geckos." **Ecology**: *Oliver Hyman* and James P. Collins, Arizona State University, "Negative influence of phosphorus on prevalence of the frog killing pathogen, *Batrachochytrium dendrobatidis*." *James Paterson*, Brad Steinberg, and Jacqueline Litzgus, Laurentian University, Algonquin Park, "Comparisons of hatchling survivorship and spatial ecology between two sympatric turtle species."

All winners received a check for US $200 and a book from University of California Press compliments of Chuck Crumly.

Cathy Bevier (Chair, Herpetology Education Committee) indicated her decision to step down as chair of this Committee. The Herpetology Education Committee continues to update the committee website and to respond to various enquiries submitted to the Herp Hotline. Members have also been active in developing and encouraging educational activities in herpetology. The Committee received support in 2009 from SSAR, HL, and ASIH for a proposal for a Meritorious Teaching Award in Herpetology. Ten nominations were received and considered by a Committee consisting of professional and student members of the three participating societies. The winner for 2010 was Dr. Whit Gibbons.

Kennedy Award Chair, Lynnette Sievert, announced that the winning paper for 2010 is by Cameron Siler (co-authored with Arvin C. Diesmos and Rafe M. Brown), "New Loam-Swimming Skink, Genus *Brachymeles* (Reptilia: Squamata: Scincidae) from Luzon and Catanduanes Islands, Philippines." Journal of Herpetology 44:49–60. Cameron will receive a check for US $200 or $400 equivalent in SSAR publications.

The Long Range Planning Committee (*Chair*: Kraig Adler, *Members*: Breck Bartholomew, Rafe Brown, Indraneil Das, Tim Halliday,

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FIG. 7.

FIG. 5. Richard Wassersug and Marty Crump at Nicollet Island Pavillion.

FIG. 6. Panel members at the SSAR Student Workshop on permits and regulations (L to R): Linda Ford, Rafe Brown, Carol Spencer, Joe Mendelson, Robert Espinoza, Tiffany Doan, and Priya Nanjappa.

FIG. 7. Erin Muths, Meredith Mahoney, and Brad Moon enjoying themselves at the Ernie Liner Live Auction.

Robert Hansen, Kris Kaiser, Roy McDiarmid, Jim Murphy, Ann Paterson, Gad Perry, Marion Preest) was established in late 2010 by then-President Brian Crother. After familiarizing itself with the SSAR budget and several rounds of discussion, the committee submitted a series of recommendations to the Board in November regarding changes to *Herp. Review*. Since then, the committee has dealt with a number of issues including a proposal to increase membership dues and institutional subscriptions, a proposal from Allen Press to co-publish *Journal of Herpetology*, a proposal to assume management of *Contemporary Herpetology*, and a revision of the Society's website. In its deliberations, many members of the LRPC have pointed out that our website needs to be revised to make it more user-friendly (both for members and for SSAR officers and editors who need to revise or post information) and needs to be expanded to make it more beneficial for our membership. To date, the SSAR website has been staffed by loyal volunteers who have done a remarkable job, but our site no longer fully serves the many needs of our broad-based clientele. It was clear that only a few members of the LRPC had the necessary knowledge to contribute to this discussion, so a subcommittee was formed consisting of Bob Hansen, Breck Bartholomew, and Raul Diaz. Kraig asked them for a report by June 1st. This report was shared with the full LRPC and then discussed.

Kraig Adler ended his report with some personal comments regarding his view of the state of SSAR. His tone was optimistic and he particularly noted the recent increase in society membership, the receipt of the Special Libraries Association Award in 2009, the recent changes in *J. Herp.* and *Herp. Review*, and the important role of the Membership Committee. He also commented on the opportunities that will be presented to, and must be capitalized on by, SSAR at the WCH in 2012. Ann, Breck, and Kraig will work on producing a membership brochure to include with registration materials at the WCH. Joe will ask for assistance with this from the Media Department at Zoo Atlanta.

In his capacity as President, Joe Mendelson serves as SSAR representative on The Meeting Management and Planning Committee (MMPC). The Committee met in Minneapolis in March to develop a meeting schedule and review conference facilities. Future meetings are to be held as follows:

2012 — Vancouver (WCH)

2013 — Albuquerque

2014—TBA, possibly in the southeastern USA

Joe indicated that is it not entirely clear what role SSAR representatives will have in organizing the WCH, as the JMIH Planning Committee has no plans to meet before the 2012 meeting. Pat Gregory (Chair, WCH Vancouver Local Committee) indicated that abstracts will be submitted directly to WCH and the WCH Program Committee will put together the program. He is asking for symposia requests from SSAR, ASIH, and HL. Pat received some materials from Brian Crother two years ago describing SSAR's meeting requirements. He will send this to Joe for review. Pat promises "all the SSAR events without the work!" In terms of finances, each Society will cover the costs of society-specific events, e.g., room charges. The SSAR Board of Directors approved another three-year MOU that formalizes the JMIH in terms of cost- and profit-sharing.

Bob Cashner, chair of the JMIH Meeting Management and Planning Committee, reported that when the committee met in March there was discussion of a strategy of engaging hotel chains in multi-year contracts as a possible way to have less expensive accommodations. This has not been fruitful, however, the MMPC and K-State support efforts to find hotels that will reduce some of our meeting expenses.

Two symposia are already planned for 2012: "Biogeochemical Methods to Study Ectotherm Ecology and Physiology" (Chair: Sora Kim, sponsored by AES and ASIH); and "Technology and Innovation in Herpetology and Ichthyology Collections" (co-Chairs: Greg Watkins-Colwell and Mark Sabaj Perez), sponsored by SSAR, HL, and ASIH.

Bob Cashner also commented that committee members were aware of criticism of the JMIH and of suggestions that smaller meetings of a subset of the societies be considered. He remarked that we get the best offers from hotels when we fill our room blocks. A possible university venue was investigated for 2013, but without success. The MMPC has responded to concerns about costs by plans to cut the length of the meeting, replacing the banquet with an alternative activity, and selecting cities that allow for flights from a variety of starting locations.

Ann Paterson, Chair of the Membership Committee, assembled a committee of volunteers from a variety of backgrounds. During 2010–2011, the Membership Committee: 1) discussed and compiled a list of current membership benefits; 2) compiled a list of possible future benefits that could be offered; 3) prepared surveys of current SSAR members and of non-members to better understand the interests of these constituencies; 4) contacted varied organizations and outlets to attempt to survey a wide range of both members and non-members; 5) distributed a link to both surveys on the ZenScientist site; 6) compiled survey results to date as a basis for discussion; and 7) developed a proposal of ideas to pursue in 2011–2012.

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Fig. 8.

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Fig. 9.

The Nominations Committee (Greg Watkins-Colwell, Chair) compiled a list of nominees (see below) for the positions of President-Elect, Regular Board Member, Conservation Board Member and At-Large Board Member. Kirsten Nicholson and Marion Preest were willing to run again for the positions of Treasurer and Secretary respectively. *President-Elect*: Robert Aldridge, Frank Burbrink; *Treasurer*: Kirsten Nicholson; *Secretary*: Marion Preest; *Board Member* (*Regular*): Tiffany Doan, Lisa Hazard, Carol Spencer, Greg Watkins-Colwell; *Board Member* (*Conservation*): Jennifer Pramuk, Priya Nanjappa; *Board Member* (*At-Large*): Tony Gamble, Travis LaDuc.

Resolutions Chair, Robert Denton, presented resolutions at the SSAR Business Meeting in Providence in 2010. These have been published in *Herp. Review*.

Brian Crother, Chair of the Standard English and Scientific Names Committee, indicated that the 7th edition of the Standard English and Scientific Names List will be available online by the time of the 2011 JMIH. He thanks Raul Diaz (webmaster) and the members of the Committee. Each update of the online version will be given a different name, e.g., Version 6.0, 6.1, 6.2, etc. For the WCH in 2012, we will produce a hard copy to be distributed free to all of the meeting participants. The names list is sanctioned by SSAR, HL, ASIH, the Canadian Association of Herpetology, the Canadian Amphibian and Reptile Conservation Network, and Partners in Amphibian and Reptile Conservation (PARC).

Dawn Wilson reported that SSAR held a pizza lunch and workshop ("Grants: What is out there and how to write a successful grant proposal") at the 2010 JMIH. A panel of experts was assembled that included the following people: Robert Espinoza, Karen Warkentin, Al Savitzky, Rafael de Sá, Dawn Wilson, and Henry Mushinsky.

Mike Jorgensen and Vinny Farallo replaced Matt Venesky and Cari Hickerson as co-chairs of the Student Travel Awards Committee. In 2011, in an attempt to increase visibility, Silent Auction items were placed in the registration lobby at the JMIH. The winners of the Travel Awards were required to staff the display table throughout the meeting. US $733 was raised in 2010. An important goal this past year was to increase donations and diversify donors. To achieve this, Mike sent an email to approximately 20 distinguished herpetologists with a personal letter describing the Silent Auction and the Student Travel Awards and solicited herp-related donations. Mike and Vinny intend to solicit donations from herpetologists each year, but not to solicit a donation during consecutive years from the same individual(s). The Silent Auction and Travel Awards now have a Facebook page and applications for awards are being accepted from both graduate and undergraduate presenters.

The main addition to the SSAR website was the Standard English and Scientific Names page along with a SSAR Facebook group page. The new SSAR logo was posted, and updates to the homepage content were made. A subcommittee of the Long Range Planning Committee (Bob Hansen, Breck Bartholomew, Raul Diaz) has begun discussion of the design and functionality of the website, and a new website should be in the works this year.

Coordinator's Reports.—Election Officer, Dan Noble, reported that most ballots were submitted electronically and the following individuals were elected in 2010:

President-Elect – Robert Aldridge
Treasurer – Kirsten Nicholson
Secretary – Marion Preest
Board Members (*Regular*) – Tiffany Doan, Carol Spencer
Board Member (*Conservation*) – Jennifer Pramuk
Board Member (*At Large*) – Travis LaDuc

In 2010, the SSAR/HL Live Auction featured items from the Roger Conant collection. Auctioneers for 2010 were John Moriarty and Frank Burbrink. The Live Auction Committee (Greg Watkins-Colwell, Coordinator) discussed the involvement of HL in the running of the auction and ways to improve the collaboration. The live auction made US $4,107 which was split 50-50 with HL. Additionally, the Roger Conant portion of the auction was for SSAR only, and brought an additional US $1,706 for a total of US $3,759.50. The 2011 Live Auction will consist entirely of materials from Ernie Liner and proceeds will be split among SSAR, ASIH, and HL. The Board approved a request to donate a free membership to be given away at the auction.

Al Savitzky, SSAR representative to AIBS and BioOne, reported that AIBS continues to serve as an effective umbrella organization for societies concerned with organismal and environmental biology. AIBS is deeply involved in a strategic planning process to evaluate its own role in the biological community, its unique contributions as an umbrella organization, and the value of its various activities and services. In recent years, two of those services have emerged as especially important elements of the AIBS program: public policy and education. AIBS is facing many of the same challenges as its member organizations, including declining individual membership and rising costs of operations and meetings, and has taken a number of steps to reduce its costs.

BioOne is a nonprofit electronic publishing consortium that serves many society publishers of journals in organismal biology and

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FIG. 10.

FIG. 8. Heather Judd drumming up donations by selling beads at the Liner Auction.

FIG. 9. Kirsten Nicholson, Jenny Gubler, and friend at the sales desk during the Liner Auction.

FIG. 10. SSAR publication booth display of a (very) small selection of items from Ernie Liner for the live auction.

ecology, as well as a few other fields. Al attended the annual BioOne Publishers and Partners Meeting in 2011. This year marks the 10th anniversary of the launch of the first BioOne collection, and during this time, BioOne has returned US $13.5 million to its society publishers. Over the 10-year period, the cost of BioOne to libraries has increased only 9.2%, whereas the Consumer Price Index has increased 23.5%. Such cost containment is consistent with BioOne's role as a collaboration between scientific society publishers and academic libraries.

Al reported that those at the annual meeting heard from a number of speakers, including one who noted a trend among university presses nationwide to publish more works by their own campus authors rather than by off-campus authors, and another who likened the support of open access scientific journals to the support of lighthouses in 19th Century Great Britain, where dues were assessed to shipping companies based on the size of the ships. BioOne is considering a pilot experiment in which libraries are assessed an "open access sustainability surcharge" to support OA content. Finally, Al made his annual inquiry about the prognosis for continuing print publication of JMIH society journals. As expected, more journals are now pursuing online-only or online-primary options. It seems that online-only as the basic membership benefit, with optional print-on-demand, is likely to emerge as the most common model, probably within the next few years. With declining membership among many organismal societies (SSAR is a rare exception), the publication of archival quality print journals will encounter a negative economy of scale, rendering the publication of archival print journals unsustainable. Few societies are planning yet for that eventuality. Al drew the Board's attention to the potential royalties that could be made if *Herp. Review* was available through BioOne. Breck recalled that a number of years ago BioOne was approached about *Herp. Review*. However, they were not interested because they viewed this publication as a news journal. Al thought that it was worth going back to BioOne and asking them again.

This year, SSAR Symposium Coordinator, Richard Durtsche, received two proposals. The first proposal, "Rethinking Normal: Moving from Theory to Action in the Face of Invasive Species and Global Change," was submitted by Joseph Mendelson III as lead organizer, with James P. Collins, Michael E. Dorcas, Karen R. Lips, Priya Nanjappa as co-chairs. The goal of this symposium is to move the discussion of invasive species (both invasive herpetofauna and those species that affect native herpetofauna) beyond just reports of exotic species and the ecological changes they cause, and into the realm of "The New Normal." Participants will discuss how globalization and invasive species, including emerging infectious diseases, are affecting the concepts, principles, and ethics related to rapidly changing ecosystems. The second proposal, "Technology and Innovation in Herpetology and Ichthyology Collections" was submitted by Greg Watkins-Colwell and Mark Sabaj Perez. The organizers' goal is to provide a symposium that is dedicated to collections by providing a platform for introducing researchers to new issues relevant to collections and also providing an environment where recent collection-relevant findings may be shared. Both symposium proposals were sent out for external review (two reviewers each). The reviews and proposals were submitted to the SSAR Board for consideration of sponsorship.

New Business.—Several recommendations were received from the LRPC (Kraig Adler, Chair).

1) *A recommendation to increase membership dues and institutional subscriptions for 2012*: SSAR has not increased dues in several years. The proposed increases result in dues that are not out of line with those of our sister societies. Kraig remarked that we need to increase our revenue stream, not just reduce costs. Our profit margin is very small (or non-existent) for some categories of membership, e.g., student memberships are currently US $35/yr and the mailing costs *alone* for journals to international students annually are US $31.44! The LRPC thinks that increases are warranted in virtually all categories of memberships in order to cover the costs of changes in format in our signature journals, a professional redesign of our website, launching a highly-effective membership campaign, and many other enhanced member services (e.g., increases in the Student Travel Awards budget). In addition to recommending dues increases, the LRPC also recommended formation of a new category (Regular, > 70 yrs of age) at a rate lower than that of a Regular membership. The Board discussed the proposed dues increases and the possibility of some members and institutions dropping their memberships in the light of these increases. Although we have had some institutions drop subscriptions that provide paper copies of our journals in favor of cheaper electronic access, the difference in dues is made up for in royalties from BioOne. Joe Mendelson suggested that student and zoo memberships should be equal. Breck expressed concern that the "shock" of moving from a student membership to a regular membership may lead to some individuals not renewing their memberships. The Board realizes that offering an electronic-only option will happen in the near future. The net effect on our finances is difficult to predict (how will lower dues be balanced by reduced printing and mailing costs?). Some changes to the proposed dues scheme and the effect on the bottom line were discussed and the Board approved the following changes effective January 2012:

- Regular – increase from $70 to $95
- Regular, seniors over 70 (new category) - $50
- Family – increase from $85 to $105
- Sustaining – increase from $100 to $125

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Fig. 11.

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Fig. 12.

- Student – increase from $35 to $45
- Zoo – increase from $35 to $45
- *Herp. Review*-only – increase from $25 to $50
- Institutional, *Herp. Review*-only – increase from $50 to $75
- Institutional, *Herp. Review* and *J. Herp.* – increase from $140 to $195

2) *A recommendation to reject a proposal from Allen Press to co-publish Journal of Herpetology*: In February, President Mendelson referred to the Board a 37-page proposal from Allen Press (AP), which resulted from prior contacts by AP with the co-editors of *J. Herp.*, Gad Perry and Erin Muths. AP proposed assuming much greater responsibility for *J. Herp.* including storing the journals, billing for page charges, setting of market rates, etc. In effect, AP would become the publisher of *J. Herp.* and SSAR responsible only for its content. The LRPC had several rounds of comments and responses. Most members found the proposal unacceptable on several grounds, both philosophical as well as material. For example, some could not see SSAR giving up control of its own journal to this degree. Others were persuaded by SSAR's earlier experience with AP when they took over membership management services, which turned out to have numerous hidden charges and ultimately a cost that was unsustainable for the society. Some pointed out that, if AP collected all page charges, then the editors would not be able to waive these costs for students or authors in developing countries, as they do now, thus reducing the coverage and attractiveness of *J. Herp.* as an international journal. Ultimately, three questions were posed to the LRPC: 1) Accept proposal as is; 2) Send questions to AP to resolve issues; and 3) Decline AP's proposal. Nine votes were received to decline the proposal, two votes to send questions to AP, and there was one abstention. The LRPC recommends that the Board decline AP's proposal. However, from the committee's discussion there are certain specific elements of the proposal that, on further investigation, we may wish to adopt. For example, the ability for the editors to store large data appendices electronically at AP would save much space (and cost) in *J. Herp.* Thus, a specific proposal could be entertained for such a service on a simple fee basis.

Discussion by the Board focused on these additional services. Secretary Preest recalled that SSAR received a proposal from Steve Godley two years ago offering to make appendices to papers published in our journals available on the website. These appendices could include audio and video files, photographs, databases, etc. Raul Diaz indicated that this is something we can do ourselves and do not have to involve Allen Press. The Board voted to decline the proposal from Allen Press as written.

3) *A recommendation against SSAR adopting Contemporary Herpetology*: In February, immediate Past-President Crother asked the LRPC to consider the possibility of adopting the existing open-access herp journal, *Contemporary Herpetology* (CH). Because there is no print version, the relative costs are low and it has the advantage of being able to include color video clips. On consideration, however, the LRPC decided against recommending SSAR adoption. The reasons were varied, but include these: SSAR already sponsors seven different publication series; *CH* would be an additional drain on society resources and, especially, on the small cadre of capable editors needed to staff our many existing series; and the advantages of *CH* could be incorporated into existing SSAR serials (for example, if the society's web page is to be expanded, video clips supporting articles in *J. Herp.*, *Herp. Review*, and other SSAR publications could be posted there). The Board supported the recommendation of the LRPC. Because *CH* has several attractive features, like the ability to post video clips, they referred this matter to the LRPC's website subcommittee to see if there are features that could be adopted for the benefit of the herpetological community.

The Co-Editors of *Journal of Herpetology* brought six issues to the attention of the Board.

1) *Difficulties in obtaining qualified Associate Editors and reviewers*: Gad and Erin reported that this remains the biggest challenge to a more rapid manuscript handling process. Many leading journals provide AEs some sort of recognition for their services. The suggestion last year to provide AEs free membership was one attempt to address this problem, however this was rejected by the Board. Gad and Erin requested that the Board reconsider this matter. Joe suggested that the co-Editors expand their Editorial Board and use them to help review manuscripts. For example, when individuals agree to be added to the Editorial Board, they must also agree to review up to 15 manuscripts per year. There was some discussion of the use of "tokens" to reward prompt reviewers and of using graduate students to help with reviews. An op-ed piece from the President could be used to remind members of the importance of this service to the continued quality of our journals. An online check box could be provided for members to indicate that they are willing to serve as reviewers when they renew their membership. The Board rejected the proposal to provide Associate Editors with free memberships, but it was agreed that some sort of gesture might be appropriate. The co-Editors were asked to consider this matter further.

2) *Page charges*: The Editors submitted a proposal regarding page charges as requested by the Board in 2010. According to this policy the Editors would retain the ability to waive page charges in special circumstances. There was some concern expressed that making page charges mandatory might hold up publication, however the Editors did not view this as a problem. The Board requested that Gad and Erin consider policies being used by the Editors of *Copeia*

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FIG. 13.

FIG. 11. Winners of the Student Travel Awards (L to R): Jason Warner, Anthony Geneva, Rob Denton, Aimee Silla, Mike Jorgensen (Chair, Student Travel Award Committee), Daniel Paluh, Chris Howey, President Joe Mendelson, III, Travis Hagey, and Anne Stengle.

FIG. 12. Joe Mendelson, Kirsten Nicholson, and Kraig Adler—happy to be ending the Board Meeting with a balanced budget!

FIG. 13. Some of the winners and recipients of honorable mention in the 2011 Henri Seibert Award Competition along with the Chair of the Seibert Committee and President Mendelson (L to R): Rafe Brown (Chair), James Paterson, Steve Price, Joe Mendelson, Andrew Durso, Charles Linkem, and Yik-Hei Sung.

and *Herpetologica* and develop a coherent page charge policy that includes the use of color.

3) *Preparing for e-publishing*: Gad and Erin noted that journals are increasingly going wholly or optionally digital and that *J. Herp.* needs to be prepared for such a move. They acknowledged that the LRPC is considering this issue and support providing a digital-only subscription option.

4) *Second language abstracts*: International journals often offer the option of a second language abstract and Gad and Erin would like to do the same. Allen Press can handle a variety of languages, although Spanish and Portuguese are expected to predominate. Gad and Erin foresee the authors providing the abstract upon submission, and an independent reader confirming that the content indeed matches the English-language abstract upon acceptance. The Department of Classical & Modern Languages & Literatures at Texas Tech is offering to provide this service for $15/manuscript. The Board viewed this as an important and long overdue concept. There was discussion of the use of SSAR members to review abstracts. Robin Andrews suggested that authors provide JPEG (or other) files of abstracts in the case of languages Allen Press is unable to typeset. The Board voted to approve offering second language abstracts and the request for a budget to cover associated costs.

5) *Editorial office expenses*: In the past, institutions for which editors have worked have provided many services for free, e.g., phone service, mail service, occasional office services, and an editorial assistant. With budget cuts looming, Texas Tech University has indicated its desire to have SSAR assume those costs. The Board voted to assume these costs if/when necessary.

6) *Co-publishing*: Following inquiries about additional services that Allen Press provides to *Herpetologica* but not *J. Herp.*, Gad and Erin learned that The Herpetologists' League has a different kind of contract with AP than does SSAR. They therefore asked AP to provide SSAR with a similar offer. This offer was forwarded to the Board and Long Range Planning Committee (LRPC) for increased overview and in-depth assessment. Gad and Erin appreciate the job that the LRPC did in exploring the ramifications and agree with some of the concerns that have been identified. However, they asked the Board to overrule the recommendation of the LRPC. As noted above, the Board voted to adopt the recommendation of the LRPC and decline the proposal from Allen Press as written.

Henry Mushinsky presented a report from an *ad hoc* committee on increasing JMIH society interactions. Included in this report were suggestions to form a JMIH Conservation Committee, to have greater co-sponsorship of symposia that would be less taxonomically based and more problem-oriented or topically based, to develop a joint JMIH Society webpage, to enter into joint negotiations with publishers, and to form an umbrella society that would, for example, take control of membership tracking and treasurer duties. There was no discussion of this report, as it will be considered by the LRPC later this year, before coming to the Board.

Brian Crother developed a policy on complimentary life membership and receipt of *gratis* copies of SSAR publications. The Board approved the recommendation to provide an Honorary Life Membership to individuals who donate $\geq$ 10 times the current cost of a life membership. It also approved the recommendation that those listed on the SSAR letterhead (i.e., officers and editors) be provided with *gratis* copies of society publications. There was discussion of giving "gift certificates" valid towards purchase of SSAR publications to Associate Editors of our journals. This suggestion was tabled.

There was discussion of what to do with SSAR's share of the proceeds of the Ernie Liner Auction. An Ernie Liner Endowment will be set up to support up-and-coming herpetologists. Further discussion will occur once the endowment is in place.

Once again, the Board discussed a name for the new Student Poster Competition. Roger Conant's name was suggested. Kraig offered to consult Roger's will to determine if this is appropriate. Discussion followed the Board meeting and it was suggested we name the Grants in Herpetology program after Roger. The Board later voted unanimously to support this proposal and we are pleased to announce the Roger Conant Grants in Herpetology Program.

Copyright issues and electronic access to articles published in *Herp. Review* and *J. Herp.* were discussed. Free access to these articles affects royalties we receive from JSTOR and BioOne. SSAR needs to develop and enforce a policy regarding copyright issues. Breck, with assistance from Kirsten and Editors Hansen, Perry, and Muths will develop such a policy and the Secretary will distribute this to the Board for discussion and a vote. A copy of the policy will be displayed on the website and included in print journals once finalized.

The Herpetology Education Committee submitted two proposals for the Board to consider. The first was a proposal that, in all cases where appropriate (e.g., in Annual Meeting information), "students" or "graduate students" be substituted by "undergraduate and graduate students." The Board approved this proposal. The second was a proposal for a new program that will cover single-day meeting registration fees for a pre-baccalaureate student (plus accompanying person if appropriate). There was discussion of how such individuals would be identified and selected, e.g., selected by a random drawing of names. A suggestion was made that prospective students be identified by local herpetologists, and applicants submit essays to members of the HEC, who will then select a winner. The Board approved this proposal.

Ann Paterson summarized the many activities of the Membership Committee, focusing particularly on the results of an extensive survey they administered recently. The importance of the Society website to the activities of this committee was recognized, and Ann was added to the LRPC website subcommittee.

The Board voted to donate its share of the proceeds of the 2012 Live Auction to the WCH minus associated costs. SSAR would appreciate an acknowledgment from WCH of this donation.

An enquiry was received from Josh Kapfer regarding increasing the number of GIH Awards. Gad Perry suggested that awards could be split between US and non-US members of SSAR. The Board was in favor of increasing the number of awards, but upon review of the budget, decided that this was not the year to increase the GIH budget. They agreed to consider this request in the future.

A balanced budget for 2011 of US $394,800 was approved by the Board and the meeting was adjourned at 1525 hrs (Fig. 12).

LRPC Meeting

An open meeting of the Long Range Planning Committee (LRPC) occurred on July 9th. LRPC Chair, Kraig Adler, called the meeting to order. Approximately 30 members of SSAR were in attendance. Kraig distributed an agenda and introduced members of the LRPC and other officers present. Four topics were the focus of discussion: future meetings (specifically venues and programs), the SSAR website, electronic-only memberships, and SSAR as an international society. Kraig began with a brief history of the annual meetings of SSAR. Over the years, annual meetings have consisted of SSAR-only, SSAR + HL, SSAR + HL + ASIH, and SSAR as part of JMIH. Herpetologist-only meetings are smaller than those including ichthyologists and might permit meeting on a university campus (rather than at a hotel or large conference center), something that younger members of SSAR will not have experienced. A question was raised about why SSAR

stopped meeting on campuses; the response was that the change was made for convenience and because it was getting difficult to find individuals willing to put the effort into organizing meetings. Someone pointed out that universities don't "reward" or encourage the effort involved in hosting a university-based meeting. K-State's involvement means that meetings are less work for the local committee, but this also reduces valuable input from that committee. Breck Bartholomew voiced his opinion that, unless we can find committed local committees, we needed to stick with the JMIH arrangement. Dawn Wilson suggested that mistakes in planning are more likely with local committees "starting from scratch every year" rather than having continuity with K-State. Having a template that gets refined and passed on each year would help with this problem. Mo Donnelly pointed out that the JMIH had received an offer from the University of New Mexico for the 2013 meeting but, because of university regulations, this would need to be a dry meeting. Someone suggested that the costs of university-based meetings were likely to be substantially higher than we remember from past meetings, e.g., we would not receive complimentary rooms as we do with hotels (assuming we meet our room block). The meeting would not necessarily have to be held at a university, i.e., a smaller herps-only meeting could be held at a conference facility.

Discussion then turned to SSAR's web presence. A website subcommittee (Bob Hansen, Chair, Breck Bartholomew, Raul Diaz) was formed recently (Ann Paterson was added to this committee at the Board Meeting). Bob briefly reviewed the history of the Society's website and indicated that we are ready to start with a "clean slate." Raul Diaz projected websites of other organizations on a screen and showed us sites of increasing complexity. We want the site to inform members and the public about the Society and also about the field of herpetology. The new SSAR website needs to be able to accommodate membership functions (complementing the ZenScientist site), be a dynamic site that plays a large role in meeting the needs of our members, permit downloading of SSAR publications, provide links to other herp sites, etc. There were suggestions of President's blogs and posting of teaching modules. There was some discussion of member-only versus public access and of peer-reviewed Wiki forums within the website. These would only be available to SSAR members to write/edit, and work on the Wiki pages would not be anonymous.

The following suggestions were made: that we provide pictures of officers, editors, and committee chairs on the webpage, that we have a mentoring program available through the website, that we provide information about keeping captive animals, that we post herp-related advertisements (similar to those currently in *Herp. Review*) on the website, that we post downloadable photos, teaching modules, lectures, membership directory (with rules as to use and the ability to unsubscribe), access to articles, videos of President's Travelogues and Plenary Sessions, videos of field experiences, videos of presentations by Seibert Award winners, videos of Student Poster Award winners, etc.

Concern was expressed about the amount of work all of this would entail for our webmaster (currently Raul). If we adopted an open-source platform such as Drupal, it would be possible for others (officers, editors) to update relevant parts of the website. Having this succeed would require multiple volunteers being responsible and diligent.

There was brief discussion of electronic-only membership in SSAR. Kraig thinks we will have an electronic-only membership option available within a year. A poll was taken of those in the room under 40 yrs of age. Of the 15 individuals present, seven indicated they would select an electronic-only option, three would select print-only option and five indicated they would choose an electronic + print option. A suggestion was made that we ask the same question of the entire student membership

Finally, there was discussion of the role of SSAR as an international society. Despite the fact that most members and officers of SSAR are in North America and that most of the meetings are held in North America, SSAR very much considers itself an international society. Kraig asked whether there was interest in more international venues for meetings—there was! Kris Kaiser thought that holding meetings in regions other than North America sent a very important message to non-US members of SSAR, many of whom are financially unable to attend meetings in North America. There was talk of setting up an endowment for non-US student members of SSAR to attend meetings in North America. SSAR could think about broadcasting sessions at meetings on the website to non-US members and posting abstracts in languages other than English on the website. This would make them accessible to non-English speaking members as well as freeing up print space in *J. Herp.*

SSAR Business Meeting

Later that same day, the Annual SSAR Business Meeting was called to order by President Mendelson (1805 h on July 10th). Attendance was high—well over 100 members of SSAR were present. Joe commented on and held up for display, certificates of appreciation from SSAR to Bob Powell, Andy Price, and George Rabb. Robert Powell was Index Editor for *Catalogue of American Amphibians and Reptiles* (*CAAR*) from 1988–1991 and Editor-in-Chief from 1991–2004. Andrew H. Price has served as Section Editor for Sauria and Amphisbaenia for *CAAR* from 1987–present and as Editor-in-Chief from 2005–present. As Editors, Bob and Andy served *CAAR* from account no. 506 in 1991 through account no. 900 (appearing later this year). We greatly appreciate the dedication that Bob and Andy have shown to *CAAR* and SSAR. George B. Rabb, Director Emeritus of Brookfield Zoo, was presented with a life-time achievement award to recognize his career commitment to conservation of wildlife globally, with special reference to his leadership in implementing the IUCN Species Survival Commission, the Declining Amphibian Populations Taskforce, the Amphibian Ark, and most recently the Amphibian Survival Alliance. SSAR is proud to count George Rabb among our membership.

Officers, Editors, and Committee Chairs who were at the Business Meeting introduced themselves to the other attendees and gave brief summaries of their Annual Reports and relevant information from the Board Meeting. Bob Hansen requested that those interested in reviewing material for *Herp. Review* (students especially) contact him. Gad Perry echoed that sentiment and asked that, if you are contacted to review a manuscript and are unable to do so, you notify the editors of *J. Herp.* promptly. Winners of the 2011 Seibert Awards were announced (Fig. 13). The Society was asked to endorse a resolution from the Amphibian Survival Alliance to support amphibian conservation. The Board later voted electronically and unanimously supported this resolution. A proposal was received to unify the Conservation Committees of the four JMIH Societies (AES, ASIH, HL, SSAR). A committee representing all societies (5 members from SSAR, including one student) will be formed to investigate this proposal over the next year. The meeting was adjourned at 1935 h.

— Respectfully submitted by Marion Preest, SSAR Secretary

NEW BOOK FROM S.S.A.R.

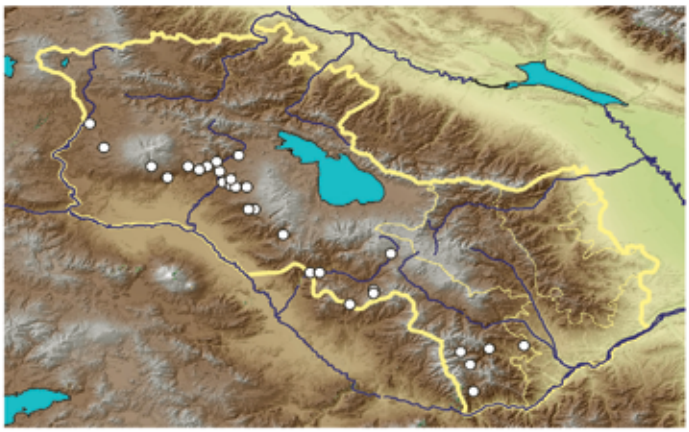
HERPETOFAUNA OF ARMENIA AND NAGORNO-KARABAKH

by Marine S. Arakelyan, Felix D. Danielyan, Claudia Corti, Roberto Sindaco, and Alan E. Leviton

Paleontological notes by David Vasilyan

THIS VOLUME COVERS THE HERPETOFAUNA OF ARMENIA and its neighboring republic of Nagorno-Karabakh, situated in the mountainous South Caucasus between the Black and Caspian seas, and surrounded by Georgia, Azerbaijan, Iran, and Turkey. The geographic position of these republics, the complicated regional geological structure, and zonation contribute to many types of ecosystems and biodiversity richness. Located at the crossroads between Asia and Europe, the Caucasus has been identified by the World Wildlife Fund for Nature as a "Global 200 Ecoregion" and by Conservation International as one of the world's 25 most biologically rich global "hotspots." The herpetofauna of Armenia and Nagorno-Karabakh includes 59 species, more than half of which are threatened, and of which 11 are endemic to the Armenian Plateau and Lesser Caucasus.

The book covers 17 families: 4 of amphibians, including both salamanders and frogs: Salamandridae (1 genus: 1 species), Pelobatidae (1:1), Bufonidae (1:1), Hylidae (1:2), Ranidae (2:2); 12 families of reptiles, including 3 families of turtles: Emydidae (1:1), Bataguridae (1:1), Testudinidae (1:1); 5 families of lizards: Gekkonidae (1:1), Agamidae (3:3), Anguidae (2:2), Lacertidae (5:17), Scincidae (3:4); and 4 families of snakes: Typhlopidae (1:1), Boidae (1:1), Colubridae (12:16), and Viperidae (3:4). Among the lizards, the lacertid genus *Darevskia* is of particular interest because it was among these lizards and in Armenia that Ilya Darevsky, to whose memory this volume is dedicated, first discovered parthenogenesis in reptiles.



There is an historical review of herpetological studies in the region (beginning with expeditions by czarist Russia in 1835) and an extensive key to species (with 72 interpretive photographs). **Each species account includes:** synonymy, type locality, taxonomic notes, distribution, habitat, size, karyotype, conservation status, and major references. There is an extensive bibliography and a comprehensive index. The color plates contain 151 photographs of animals and their habitats plus 60 colored maps with individual localities plotted.

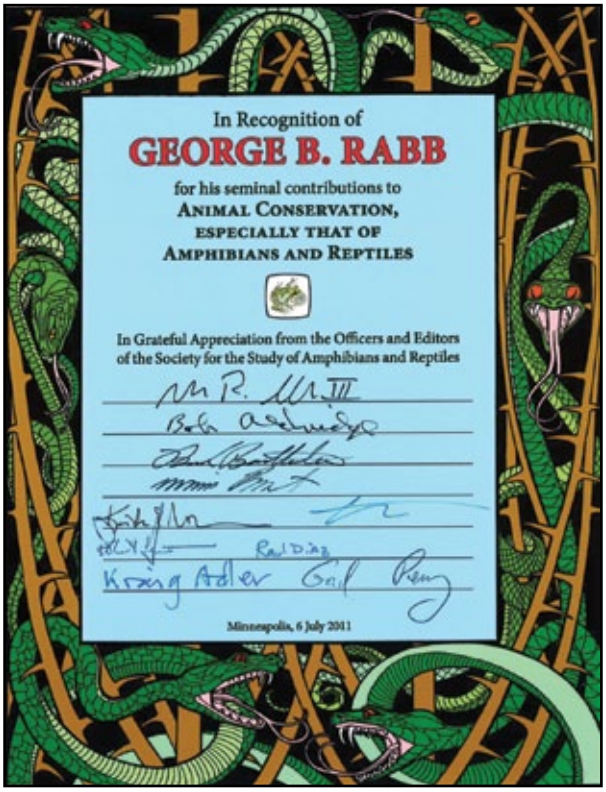
The team of authors consists of two Armenians (Marine Arakelyan and Felix Danielyan) and two Italians (Claudia Corti and Roberto Sindaco) who have conducted all of the field investigations, much of it spanning nearly two decades, and an American (Alan Leviton) who specializes on Asian herpetology.

Specifications: *186 pages, 7 × 10 inches, 60 color maps, 72 figures, 4 tables, 151 color photographs, clothbound. ISBN 978–0–916984–84–7.* ***To be issued December 2011.***

PRICES: **SSAR members US$35 before April 2012; Institutions, non-members US$40.** ***SHIPPING:*** **USA address, add US$5; non-USA, at cost.**

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

Lifetime Achievement Award for George Rabb



At the 2011 SSAR Board Meeting, George B. Rabb, Director Emeritus of Brookfield Zoo, was presented with a lifetime achievement award to recognize his career commitment to conservation of wildlife globally, with special reference to his leadership in implementing the IUCN Species Survival Commission, the Declining Amphibian Populations Taskforce, the Amphibian Ark, and most recently The Amphibian Survival Alliance. SSAR is proud to count George Rabb among our membership.

Seibert Award Winners for 2011 Announced

The 20th annual Seibert Awards were presented at the 54th Annual Meeting of the SSAR in Minneapolis, Minnesota, 6–11 July 2011. These awards are named in honor of Henri C. Seibert, an early and tireless supporter of SSAR (having served as an officer for over 20 years). In recognition of outstanding student presentations at the annual meeting, a single award was given in each of the following categories: Evolution/Systematics (9 presentations), Ecology (12 presentations), Physiology/Morphology (6 presentations) and Conservation (8 presentations). All awardees will receive a check for US $200 and a book from Chuck Crumly at University of California Press.

The Winners –Systematics/Evolution: **Daniel Scantlebury** (University of Rochester), "Patterns of Adaptive Radiation in West Indian Dwarf Geckos (Sphaerodactylidae: *Sphaerodactylus*)." Ecology: **James Paterson**, Brad Steinberg, and Jacqueline Litzgus (Laurentian University), "Generally Specialized or Especially General? Habitat Selection by Snapping Turtles (*Chelydra serpentina*)." Conservation: **Jeanine Refsnider** and Fredric Janzen (Iowa State University), "Nest-site Choice in Response to Climate Change and Effects on Offspring Performance in a Turtle with Temperature-dependent Sex Determination." Physiology/Morphology: **Angela Rivera** (Clemson University), "Evolution of Flapping in Turtles: A Comparative Examination of Forelimb Kinematics and Muscle Function across Three Lineages (Trionychidae, Carettochelyidae, Cheloniidae)."

The judges were Cathy Bevier (Colby College), Rafe Brown (University of Kansas), Tiffany Doane (Central Connecticut State University), Nirvana Filoramo (Wesleyan University), Mac Given (Neumann College), Noah Gordon (University of Evansville), Eric Juterbock (The Ohio State University), and Patrick Owen (University of Cincinnati).

SSAR Student Poster Awards, 2011

Because of the continuing success of the SSAR Seibert Award competition for best student presentation at the annual meeting, SSAR decided to expand its annual award offerings to recognize student poster entries as well. President Mendelson suggested the creation of the SSAR Student Poster Award to the Board of Directors during the 2010 meeting and it met with unanimous support from the Board. 2011 was the inaugural year for the award with 20 entries in three categories. This year's judges were Tiffany Doan (chair, Central Connecticut State University), Marina Gerson (California State University, Stanislaus), Carol Spencer (University of California, Berkeley), Greg Watkins-Colwell (Yale Peabody Museum), Matthew Gifford (University of Arkansas at Little Rock), Dana Drake (University of Missouri), and John Roe (University of North Carolina).

The Winners.—Evolution, Genetics, & Systematics: **Anthony Geneva** (University of Rochester), "A Multi-locus Molecular Phylogeny of Distichoid Anoles." Ecology, Natural History, Distribution, & Behavior: **Beth Pettitt** (University of Minnesota), "Oviposition and Tadpole-rearing Site Selection of a Phytotelm-breeding Frog, *Anomaloglossus beebei*." Physiology & Morphology: **Mingna Zhuang** (University of California, Berkeley), "Comparative Gliding Performance of *Anolis carolinensis* and *Anolis sagrei*."

NEWSNOTES

Jones-Lovich Grant in Southwestern Herpetology

Thanks to the generosity of Larry Jones and Rob Lovich, 100% of the proceeds from the sale of their book, *Lizards of the American Southwest* (2009, Rio Nuevo Press), goes to support herpetological graduate field research in the American Southwest, including the southwestern United States and northwestern Mexico. An award (US $1000) will be presented to one winner. This research can focus on any aspect of amphibian or reptile biology, including behavior, conservation, ecology, physiology, or morphology and systematics. See The Herpetologists' League web site for application form, complete rules and details, along with the cover page at: http://www.herpetologistsleague.org/dox/joneslovichgrant.pdf. Entries must be received by 5:00 pm Pacific Time on 9 January 2012.

New Smithsonian Graduate and Professional Course—Species Monitoring and Conservation: Amphibians

The Smithsonian-Mason Global Conservation Studies Program will offer "Species Monitoring and Conservation: Amphibians" at the Smithsonian Conservation Biology Institute, Front Royal, Virginia, USA from 26 March to 6 April 2012. Visit http://conservationtraining.si.edu or contact SCBItraining@si.edu for more information about this course and additional upcoming courses of potential interests to herpetologists.

MEETINGS

Exploring the Secret Lives of the World's Most Studied Snake Group: A Second *Biology of the Rattlesnakes Symposium*

As the lightning of a monsoonal thunderstorm lit up the night sky, the second *Biology of the Rattlesnakes Symposium* got underway on the evening of 23 July 2011, at the Tucson, Arizona, Marriot University Park hotel. Hotel employees marveled at the throng of rattlesnake devotees, some 240 strong (Fig. 1), that began the registration process in a room filled with vendors displaying ophidiophilic T-shirts, hats, books, artwork, snake hooks, and radiotelemetry equipment—not to mention the numerous live rattlesnakes on exhibit.

PHOTO BY BILL LOVE

FIG. 1. Participants at the Second Biology of the Rattlesnakes Symposium, July 2011, Tucson, Arizona.

The formal symposia commenced the next morning with a stellar keynote address by Harry Greene of Cornell University, New York: "*Fifty years after Klauber: What's it Like to be a Rattlesnake?*" Harry set a much-appreciated tone with his appeal to portray rattlesnakes in the best possible light (deemphasizing their danger) while articulating their capacity to "think" and solve survival-related problems. Upwards of 65 oral and 14 poster presentations then followed over the three-day period, which included one all-day session at the beautiful facilities of the Arizona-Sonoran Desert Museum. The majority of papers focused on field ecology research, though studies of behavior, morphology, physiology, systematics, venom, toxicology, and snakebite were also represented. Two photographers, Manny Rubio and Bill Love, showcased their beautiful images of snakes and snake lovers.

The formal meetings concluded with a banquet featuring Jonathan Campbell of the University of Texas at Arlington, who described his fascinating career work on rattlesnakes and other venomous snakes in Mexico and Mesoamerica. The banquet also included a lively auction to benefit a graduate student research fund. Many participants attended the barbecue the next day at the Chiricahua Desert Museum in Rodeo, New Mexico, with proceeds also benefiting the graduate student research fund.

This taxon-specific meeting continued the tradition of prior symposia devoted to venomous snakes. According to the 80 respondents of an online survey, fewer than half (only 35%) attended the first *Biology of the Rattlesnakes Symposium* at Loma Linda University, California, in 2005. Only a smattering (up to 8%) previously attended the *Biology of the Pitvipers Symposium* (1989), the *Biology of the Vipers Symposia* (2000, 2007, 2010), or the *Eastern Massasauga Symposia* (1992, 1998, 2005). Clearly, many of the participants at the Tucson meeting represented "new blood," enthralled by the latest research findings on the world's most studied group of snakes (Beaman and Hayes 2008). University faculty, staff, and students comprised the majority of participants, but those of other diverse professions attended as well, including government, zoo, museum, and healthcare employees. Although many individuals enjoyed herping in the nearby area, particularly during the night hours, socializing with other herpetologists rated as one of the favorite aspects of the symposium.

The popularity of this symposium assured a future encore. According to the survey, participants favored the idea of meeting every three years, preferably in the southwestern U.S. during the late summer. However, Mexico was deemed feasible by many as a future meeting locale, with Central America and South America less desirable.

Overall, the participants gave the meetings high praise. The organizers, Bob and Sheri Ashley of Ecouniverse and the Chiricahua Desert Museum, Rodeo, New Mexico, assisted by Lori King Painter, also of New Mexico, did an outstanding job. Generous donations kept the cost of the symposium appreciably affordable to many. The primary sponsors included BTG (marketer of CroFab antivenom for humans), Red Rock Biologics (marketer of rattlesnake vaccines for dogs and horses), Rare Disease Therapeutics (distributor of Bioclon antivenoms for snakes and invertebrates), the Arizona-Sonora Desert Museum, and the Chiricahua Desert Museum.

A refereed volume similar to *The Biology of Rattlesnakes* (following the 2005 meeting) and those generated by prior symposia (*Biology of the Pitvipers, Biology of the Vipers*) will be published in due course.

Reference

Beaman, K. R., and W. K. Hayes. 2008. Rattlesnakes: Research trends and annotated checklist. *In* W. K. Hayes, K. R. Beaman, M. D. Cardwell, and S. P. Bush (eds.), The Biology of Rattlesnakes, pp. 5–16. Loma Linda University Press, Loma Linda, California.

—Contributed by **WILLIAM K. HAYES**, Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, California 92350 USA; e-mail: whayes@llu.edu.

Meetings Calendar

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

12–13 January 2012—California-Nevada Amphibian Population Task Force Meeting, Placerville, California, USA. Information: bradford.david@epa.gov

14 January 2012—California Reptile and Amphibian Conservation and Management Forum, Placerville, California, USA. Information: Brian Todd (btodd@ucdavis.edu).

16–19 February 2012—"Connecting Efforts and Identifying Gaps in Southeastern Amphibian and Reptile Conservation." Southeastern Partners in Amphibian and Reptile Conservation (SE PARC) Annual Meeting, Fall Creek Falls State Park, Tennessee, USA. Information: SEPARC@SEPARC.org.

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

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

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

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

CURRENT RESEARCH

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

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

Anolis Lizards Demonstrate Problem Solving

Cognitive ecology is the study of how functional explanations of behavior, such as those provided by behavioral ecology, can be integrated with an understanding of the underlying neural and physiological mechanisms. An important component of cognitive ecology is the study of behavioral flexibility. According to theoretical predictions, species that need to exploit a variety of resource types or habitats, or have a complex social structure are likely to show elevated levels of behavioral flexibility. As a consequence, study of behavioral flexibility has concentrated on birds and mammals, as they are traditionally thought to have these characteristics. In contrast, these attributes are not normally associated with ectothermic vertebrates, and as a consequence, they have been neglected in studies of behavioral flexibility. In order to begin to redress this imbalance, the authors of this paper have examined behavioral flexibility in the arboreal lizard *Anolis evermanii* from Puerto Rico. A range of tasks were designed to test cognitive abilities. First, lizards were presented with an opaque grey platform with two wells. Habituation to this experimental setup was conducted over three steps. First, a reward (freshly killed *Hermetia illucens* larvae) was placed in one of the wells, then a small, blue-colored disc was placed next to the well, and finally, this disc was used to half cover the well. For the first part of the experiment, this disc was fitted tightly over one well containing a reward. Of the six lizards (three males and three females) used, four successfully removed the disc to access the reward using one of two strategies, either biting the edge of the disc or using their snout as a lever to dislodge it. These four lizards were used in two subsequent experiments in which the second well was covered with a 'distracter' (either a yellow disc or a disc colored with blue and yellow concentric circles). Overwhelmingly, using both distracters, each of the four lizards was able to successfully choose the target without mistake. Finally, trials were conducted to test reversal learning by placing the reward under the blue and yellow disc. Two of the four lizards were able to demonstrate reversal learning, while the other two stopped responding due to lack of reinforcement. The ability of these lizards to solve a novel motor task using multiple strategies, associative and reversal learning, demonstrates sophisticated cognitive abilities, including behavioral flexibility. The authors highlight that as a group, *Anolis* lizards are known to exploit a range of different ecological conditions and exhibit complex behavior, attributes normally associated with behavioral flexibility. The authors do point out that this group's ability to display behavioral flexibility may have facilitated its ecological diversification. These findings do suggest that the cognitive abilities of ectothermic tetrapods are more developed than previously thought.

Leal, M., and B. J. Powell. 2011. Behavioural flexibility and problem-solving in a tropical lizard. Biology Letters (*in press*). doi: 10.1098/rsbl.2011.0480.

Correspondence to: **Manuel Leal**, Department of Biology, Duke University, Durham, North Carolina 27708, USA; e-mail: mleal@duke.edu.

Impact of Small-scale Fisheries on Marine Turtles

The impact of industrial fisheries on non-target, 'bycatch' species has been well documented, and has been implicated as a key factor driving population extirpation in marine turtles. Recently, awareness has been growing that similar impacts could result from interactions with small-scale fisheries. Small-scale fisheries (SSF) are defined by smaller vessels with minimal levels of mechanization compared to industrial fisheries. Although bycatch by SSF may be less than industrial fisheries at the individual level, fleets may be extremely large, especially in developing countries. In this study, the authors examined the impact of SSF on marine turtles in Peru. Onboard and shore-based observers assessed bycatch levels of four different fisheries (bottom set nets, driftnets, and two longline fisheries) from three SSF ports in Peru from 2000 to 2007. In total, 264 fishing trips were observed, with 807 turtles captured, approximately 92% of which were released alive. Loggerhead Turtles made up 51.2% of this bycatch, Green Turtles 41.4%, Olive Ridley Turtles 3.2%, Leatherback Turtles 2.1%, and unidentified species 2.1%. From this survey effort, it was estimated that approximately 5900 sea turtles are captured annually from these three SSF ports alone. The authors estimate that there are greater than 100 SSF ports in Peru representing more than 950 vessels and 37,000 fishers and as a result, the impact of SSF on sea turtles in the region may be severe. The authors also discuss the use of marine turtles as important food sources for coastal communities, and how these issues should be considered when recommending management and conservation strategies.

Alfaro-Shigueto, J., J. C. Mangel, F. Bernedo, P. H. Dutton, J. A. Seminoff, and B. J. Godley. 2011. Small-scale fisheries of Peru: a major sink for marine turtles in the Pacific. Journal of Applied Ecology (*in press*). doi: 10.1111/j.1365-2664.2011.02040.x.

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Seasnakes Shelter in Disused Seabird Burrows

Ecosystem engineers alter the physical environment to increase their own fitness, but in the process can benefit other species, by providing new habitats, increasing productivity of an area or enhancing the functioning of the local ecosystem. Burrowing species are one such example of ecosystem engineers providing habitat for sympatric species, however some burrowing species behaviorally exclude other sympatric species from using these burrows. In this study, the authors have examined the use of burrows created by the Wedge-tailed Shearwater (*Puffinus pacificus*), on New Caledonia in the Pacific Ocean. Two species of laticaudine seasnakes are abundant on New Caledonia: the primarily terrestrial Yellow-banded Sea Krait (*Laticauda saintgironsi*) and the more aquatic Blue-banded Sea Krait (*Laticauda laticaudata*). For this study, the authors used video cameras to inspect 102 burrows. It was found that *L. laticaudata* are restricted to burrows that are closer than 4 m to water's edge, while *L. saintgironsi* tended to utilize burrows further inland. Seasnakes and shearwaters were never observed in the same burrow, suggesting shearwaters actively defend these burrows. To examine burrow defense behavior more closely, model snakes were inserted into burrows, and the frequency of attack by adult shearwaters was recorded. In total, 165 model snakes were introduced into 55 burrows (three models per burrow: blue & black- and yellow & black-banded, to mimic *L. saintgironsi* and *L. laticaudata* respectively, and one all-black control model), eliciting 41 responses from resident shearwaters. In 34 cases, the model was attacked, on six occasions the resident bird stood or sat on the model and in one case the adult shearwater fled the nest. These experiments revealed that the likelihood that a bird would attack a model snake was unrelated to its color. The authors outlined the advantages of sheltering in burrows for seasnakes, including protection from predators, thermal benefits, and increased access to fresh water. This study provides an example of an ecosystem engineer acting both as a facilitator and a competitor of a sympatric species.

Lane, A. M., and R. Shine. 2011. When seasnake meets seabird: ecosystem engineering, facilitation and competition. Austral Ecology 36:544–549.

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Effective Population Size Correlated with Breeding Pond Size in an Endangered Salamander

One of the fundamental goals of conservation biology is the maintenance of genetic diversity and population viability. Effective population size (N_e), essentially the number of individuals that will contribute genes equally to the following generation, is an important factor in maintaining genetic diversity, preventing inbreeding depression, and predicting the likelihood of population persistence. In this study the authors examined the correlation between breeding pond characteristics and effective population size in the endangered California Tiger Salamander, *Ambystoma californiense*. Microsatellite markers were used to assess effective population size as well as heterozygosity and allelic diversity. The area of each pond was calculated and each was classified as being either a hydrologically modified perennial pond or a naturally occurring vernal pond. Although no correlation was found between pond area and either heterozygosity or allelic diversity, there was a strong positive relationship between N_e and pond area, particularly for vernal ponds. The authors propose that this may be due to large vernal ponds drying out relatively slower than smaller ponds, and therefore suffering lower mortality. The relationship between N_e and pond size was logarithmic, which, according to the authors, suggests that there is an upper limit to N_e in large ponds. Despite the low effective population sizes in smaller ponds, there was no observable reduction in allelic diversity or heterozygosity, suggesting that these ponds are not experiencing the usual fitness costs associated with small populations such as bottlenecks and inbreeding depression. The authors suggest that understanding the relationships between N_e and habitat characteristics would be very important for wildlife managers designing comprehensive conservation plans.

Wang, I. J., J. R. Johnson, B. B. Johnson, and H. B. Shaffer. 2011. Effective population size is strongly correlated with breeding pond size in the endangered California tiger salamander, *Ambystoma californiense*. Conservation Genetics 12:911–920.

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Relationships Between Body Size and Habitat in Turtles and Tortoises

Chelonians, the turtles and tortoises, display remarkable size variation, spanning almost four orders of magnitude. At one end of the scale are tiny terrestrial species like *Homopus signatus*, the 80 g Speckled Padloper Tortoise, and at the other, the gigantic marine turtles such as the 500 kg Leatherback (*Dermochelys coriacea*). Despite the remarkable size variation observed, understanding of the evolutionary basis for this variation remains poor. In this study, the authors tested the hypothesis of a correlation between habitat (freshwater, terrestrial, oceanic, and insular) and body size by evaluating the fit of different models of turtle body size evolution to a time-calibrated phylogeny including about 70% of extant chelonians and replete with estimated ancestral habitat states. The results of these analyses provided strong support for different optimal sizes in chelonians that occupy different habitats. In the best performing model, optimal body size for marine chelonians and those from oceanic islands was large (island optimum = 82.6 cm, marine optimum = 132.6 cm) relative to optimal size in freshwater and mainland species (freshwater optimum = 33.7 cm, mainland optimum = 24.18 cm). Traditionally, large optimal body size in oceanic island tortoises was thought to reflect a preadaptation for increased dispersal ability, necessary for initial colonization. The authors suggest that the retention of large body size for chelonians on oceanic islands reflects the low predation and unpredictable climatic conditions, such as drought or low resource availability, characteristic of islands. In addition, long distance travel between feeding sites may still be important for island turtles. The authors suggest that the relatively large body size of marine turtles might

also reflect an adaptation to long distance travel, as well as to cold conditions encountered during these journeys. The greater variety of potential niches in terrestrial and freshwater environments may ensure that the relationship between body size and habitat is more complex for chelonians in these habitats.

Jaffe, A. L., G. J. Slater, and M. E. Alfaro. 2011. The evolution of island gigantism and body size variation in tortoises and turtles. Biology Letters 7:558–561.

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MicroRNA Analysis Used to Investigate Origin of Turtles

Despite a number of previous studies, the phylogenetic position of the turtles remains contentious. Some morphological analyses place turtles outside Diapsida, the clade that includes crocodiles, lizards, tuatara, and birds. Other morphological studies have placed turtles within Diapsida, close to the Lepidosauria (tuatara and lizards). Finally, although the majority of molecular studies do place turtles within Diapsida, they instead ally them most closely with Archosauria (crocodilians and birds). The authors highlight that the conflicting phylogenetic relationships inferred from these different analyses are just three different rooting hypotheses for a single, unrooted four-taxon tree (birds and crocodiles are always sister, which leaves three branches upon which the root can be placed). In this study, the authors examined a heretofore unevaluated molecular character type: microRNA (miRNA) genes. miRNAs are short (~22 base pair) RNA molecules that help determine the fate of messenger RNA molecules, and as new miRNAs are added to metazoan genomes infrequently over time and are rarely lost, they represent useful tools for shedding light on phylogenetic relationships. RNA was extracted from single individuals representing turtles (*Chysemys picta*), lizards (*Anolis carolinensis*), and crocodilians (*Alligator mississippiensis*). These were then compared to a number of previously published sequences, including mammals (platypus, opossum, and human), birds (Zebra Finch and chicken), and a frog. Maximum parsimony analysis was performed and Bremer support used to assess the support of each node. Results of this analysis unambiguously support a turtle and lizard clade, with these two groups sharing four unique miRNA gene families that are not observed in any other organism's genome. Further, no miRNAs are found in all diaspsids but not turtles, nor in turtles and archosaurs but not diapsids. The authors posit that these findings suggest that a number of morphological convergences and reversals have occurred within the reptile tree, and propose that the lepidosaur/turtle crown clade be called "Ankylopoda," meaning "fused foot."

Lyson, T. R., E. A. Sperling, A. M. Heimberg, J. A. Gauthier, B. L. King, and K. J. Peterson. 2011. MicroRNAs support a turtle + lizard clade. Biology Letters (*in press*). doi: 10.1098/rsbl.2011.0477.

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Simultaneous Polyandry Provides Genetic Benefits to Offspring of African Tree Frog

Polyandry, multiple female matings within a single reproductive cycle, is widespread across a range of taxa. It may be driven by males forcing copulation. However, in some cases females gain direct material benefits, such as parental care or nutrient donations, or genetic benefits that indirectly increase female fitness. Hypotheses of the genetic benefits of polyandry fall into three main categories. First, females that mate with multiple males reduce their chance of mating with an inferior quality male. Second, females may increase their chances of mating with a genetically compatible male. Third, polyandrous females have more genetically diverse offspring, which may benefit females because genetically dissimilar offspring compete less for resources, or because genetic diversity increases the likelihood that some will be able to respond to novel selective conditions. In some species, the females engage in simultaneous polyandry, where one female mates with multiple males at the same time. For instance, up to 90% of female Gray Foam Nest Treefrogs (*Chiromantis xerampelina*; a southeast African species) mate with up to ten males simultaneously. Although this represents an extreme example of polyandry, the hypothesis that females are gaining genetic benefits from this reproductive strategy has not previously been evaluated. In this study, the authors compared the fitness of offspring produced by polyandrous and monandrous matings. Body size did not differ between females involved in monandrous and polyandrous matings and offspring of these two matings did not differ in age or size at metamorphosis. However, offspring from polyandrous matings had higher mean survival and a reduced variation in offspring survival. The authors suggest that these results implicate genetic factors as a possible mechanism favoring polyandrous matings. However, a series of breeding experiments controlling for maternal quality and possible paternal material effects needs to be carried out to definitively determine whether paternal sire effects, genetic compatibility, or offspring genetic diversity underlies the advantage of this reproductive mode.

Byrne, P. G., and M. J. Whiting. 2011. Effects of simultaneous polyandry on offspring fitness in an African tree frog. Behavioral Ecology 22:385–391.

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Age Does Not Diminish Regenerative Capabilities in Newts

The regenerative capacity of newts is remarkable, encompassing both tissues and organs, as well as external limbs, tails, and eyes. This ability is particularly interesting for medical regeneration research, and as a consequence, newts have been studied in this context for over 200 years. Despite the long history of research, one persisting question remains: to what degree does age or repeated injury deplete a newt's ability to regenerate tissue? Previous studies have suggested that repeated

amputations still lead to regeneration, but occasionally with mistakes, such as missing bone structure. However, these studies may have lacked adequate controls. Further complicating these studies, newts generally do not thrive in captivity, and it is difficult to determine the age of wild caught individuals. In order to investigate the regenerative capacity of newts over time and repeated injury, the authors conducted a long term study in a captive population of Japanese Newts, *Cynops pyrrhogaster*. Newts were collected in 1994, and over the subsequent 16 years, eye lenses were removed from the same animals 18 times. Understanding regeneration of this specific tissue is of heightened interest, as lens loss is very rare in nature and therefore should not be under natural selection (lens regeneration in newts has also fascinated biologists for over a century). The 17th and 18th regenerated lenses were virtually identical structurally to the lenses removed from 14-year old adult newts with unaltered lenses. Further, quantitative PCR showed that gene expression patterns were very similar to those of the control group. These findings, which suggest that amphibian regeneration does not diminish with age or repeated injury, are contrary to traditional thought and are of great importance to medical regeneration research.

Eguchi, G., Y. Eguchi, K. Nakamura, M. C. Yadav, J. L. Millián, and P. A. Tsonis. 2011. Regenerative capacity in newts is not altered by repeated regeneration and ageing. Nature Communications 2:384.

Correspondence to: **Goro Eguchi**, National Institute for Basic Biology, National Institutes of Natural Sciences, Nishigonaka 38, Myodaiji, Okazaki, Aichi 444-8585, Japan; e-mail: shokei@shokei-gakuen.ac.jp.

Some Opossums have Rapidly Evolved a Resistance to Viper Venom

"Evolutionary arms races" are situations in which two species (frequently predator and prey) have undergone marked evolution in the effort to keep up with each other. Despite being accepted as a common evolutionary scenario, no evolutionary arms race between a predator and a venomous prey species has been demonstrated with molecular data. The authors of this paper used molecular data to test the hypothesis that one New World opossum lineage within the family Didelphidae has evolved a resistance to the venom of one of their preferred prey items, pit vipers (Crotalinae). Previous work had established that one venom toxin, C-type Lectin-like Protein (CLP), targets platelets, the structures in charge of forming blood clots. Specifically, CLP attacks a membrane protein called the von Willebrand Factor (vWF). The authors accumulated DNA sequence data representing a stretch of the vWF known from previous studies to be particularly affected by CPL for a series of didelphid opossums (including both venom resistant and non-resistant species) and other mammals. They then employed rigorous, likelihood-based methods to evaluate two models of evolution: one dividing nucleotide site substitutions into two categories for all taxa (no selection and purifying selection; H_0) and one allowing for a third category (positive selection) for venom-resistant opossums (H_A). The authors also used a Bayesian method to identify nucleotide sites along the sequence that are under particularly strong positive selection in the viper-eating opossum lineage. These analyses revealed that the vWF protein of venom-resistant opossums has experienced an elevated rate of evolutionary change relative to other mammals. The likelihood test found the alternative model was a significantly better fit than the null model, and 10% of the nucleotide sites were found to be under strong positive selection in the ophiophagous opossums. One interesting discovery was that the enigmatic South American Water Opossum (*Chironectes minimus*), which is thought to specialize on fish and crustaceans and is the sister taxon to the established viper-eating opossums clade, was found to have the molecular signal of venom resistance. Whether this species exhibits a derived diet and evolved from a viper-eating ancestor or if it is a secret ophiophage remains to be determined. Finally, the authors point out that in theory, arms races where the prey is dangerous to the predator should result in the most rapid rate of character evolution, and therefore the assumption that snake venom evolved primarily for prey apprehension should be re-examined.

Jansa, S. A., and R. S. Voss 2011. Adaptive evolution of the venom-targeted vWF protein in opossums that eat pitvipers. PLoS ONE 6:e20997.

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Daphnia magna as a Possible Control for Amphibian Chytrid Fungus

The chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*), is a nearly global concern with its negative impacts on amphibians well documented. Despite the extent of this crisis, the authors of this review paper (Woodhams et al. 2011) suggest that rescuing amphibian diversity in the face of *Bd* is an achievable aim. The authors examined different disease mitigation strategies, discussed the precedent for each strategy, and assessed their long-term potential. The authors suggest that sustainable conservation is dependent on long-term population persistence and co-evolution with the potentially lethal pathogens. As such, strategies should not rely exclusively on pathogen elimination or captive breeding, but also focus on reducing pathogenicity and host susceptibility in already infected populations. The authors propose population level treatments based on three steps: first, identify mechanisms that allow disease suppression in the population; second, the parameterization and testing of models of disease/host dynamics; and third, the trialing of adaptive management in field populations.

In line with the first of the three steps suggested by Woodhams et al. (2011), a recent study (Buck et al. 2011) has explored the use of biological controls, which could potentially aid in disease mitigation. The authors show in this paper that the zooplankton *Daphnia magna* consumes the infective stage of *Bd*, aquatic zoospores, 3–5 µm in diameter. According to previous studies, *Bd* infection leads to host mortality when a threshold density of sporangia is reached. By consuming infective *Bd* zoospores, *D. magna* may limit the numbers to below the mortality threshold. The authors suggest that increasing zooplankton densities where they are deficient could help at-risk anuran populations persist despite the presence of *Bd*.

Woodhams, D. C., J. Bosch, C. J. Briggs, S. Cashins, L. R. Davis, A. Lauer, E. Muths, R. Puschendorf, B. R. Schmidt, B. Sheafor, and J. Voyles. 2011. Mitigating amphibian disease: strategies to maintain wild populations and control chytridiomycosis. Frontiers in Zoology 8:8.

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Buck, J. C., L. Truong, and A. R. Blaustein. 2011. Predation by zooplankton on *Batrachochytrium dendrobatidis*: biological control of the deadly amphibian chytrid fungus? Biodiversity Conservation (*in press*) doi: 10.1007/s10531-011-0147-4.

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Environmental DNA Used to Detect Presence of Stream Amphibians

Methods for detecting the presence of aquatic organisms by assaying water samples for their DNA (environmental, or "eDNA" methods) have become useful tools for wildlife managers, such as in monitoring the spread of invasive species. Most applications of these methods have been in large bodies of standing or slowly moving water. The authors of this paper employed these methods to determine their effectiveness in detecting a pair of high-gradient, low-order stream amphibians: Idaho Giant Salamanders (Dicamptodontidae: *Dicamptodon aterrimus*) and Rocky Mountain Tailed Frogs (Ascaphidae: *Ascaphus montanus*). Water samples were taken in the spring and fall from streams known to be inhabited by these species. These streams were also evaluated for these species' larval densities. This water was passed through a filter, which was then subjected to several well-established molecular genetic methods for extracting and amplifying DNA. The authors were successful in detecting both species in the streams despite variability of success among the methods. Fall samples had a higher frequency of detection than spring samples, which the authors attribute to the reduced metabolic activity exhibited by these species early in the year. Indeed, detection was largely influenced by species and season, with no apparent correlation with density. The authors emphasize the utility of these methods in lotic systems and the promise they hold for assessing the presence of rare or otherwise hard to detect aquatic vertebrates.

Goldberg, C. S., D. S. Pilliod, R. S. Arkle, and L. P. Waits 2011. Molecular detection of vertebrates in stream water: a demonstration using Rocky Mountain tailed frogs and Idaho giant salamanders. PLoS ONE 6:e22746.

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Female Lacertid Lizards Can Use Scent to Determine Male Body Size

Although female mate choice is common in vertebrates, conclusive evidence demonstrating female choice in lizards is rare, especially in territorial species. Territoriality complicates female choice because females have access to relatively few males (depending on the relative sizes of male and female home ranges) or incur significant fitness costs sampling males far from home. Despite this, recent studies have shown that females of some territorial lizard species in the family Lacertidae can use scent marks to assess subtle aspects of male fitness, such as body condition, social dominance and parasite load. Additionally, males of the lacertid *Podarcis hispanica*, have been shown to use scent to assess important traits, such as body size, of rival males. However, the importance of similar scent marks in female mate choice in this species is unknown. In this study, the authors have examined whether female *P. hispanica* can use scent marks to determine male traits and if they can, how they use this information. Female lizards caught in Valencia, Spain, were simultaneously exposed to three choice areas marked with either the scent of a small male, the scent of a large male or a control (no scent). Results indicated that females preferentially associated with scent marked choice areas, but did not distinguish between large and small males. Interestingly, when exposed to simulated dusk conditions, females preferentially sheltered in refuges scented marked by small males. The authors suggest that these results are evidence that females of this species, like males, can determine body size from scent markings. The observation that females preferentially associate with males in simulated dusk may be a strategy to avoid the costs of harassment or forced copula by large males.

Carazo, P., E. Font, and E. Desfilis. 2011. The role of scent marks in female choice of territories and refuges in a lizard (*Podarcis hispanica*). Journal of Comparative Psychology 125:362–365.

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OBITUARIES

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Daryl R. Karns
July 23, 1949—June 7, 2011

Daryl Ralph Karns died unexpectedly at age 61 on June 7, 2011, near his home in Madison, Indiana. He left a legacy of global scientific research in the field of amphibians and reptiles, and a teaching career that spanned 27 years at Hanover College in Hanover, Indiana. Karns was born the son of Ralph R. and Lillian M. Heinze Karns on July 23, 1949. He is survived by his wife, Dr. Pamela A. Middleton, his brother, Rodney Karns, his sister, Jarmila Fuller, and their families. He grew up in Homewood, Illinois, on the far southeast side of Chicago and attended the Homewood-Flossmoor Community High School.

PHOTO BY SANDRA GUTHRIE

FIG. 1. Professor Daryl R. Karns, 23 July 1949 – 7 June 2011. This photograph was taken in March of 2011 adjacent to the trail head of the nature trail system now named *The Daryl R. Karns Natural History Trails* on the campus of Hanover College, Hanover, Indiana.

While a student at Homewood-Flossmoor High School, Daryl considered a career in theater and participated in the debate team. He loved to recall that at more than one debate competition he found himself paired up with John Belushi, from New Trier Township High School. However Daryl's career path was strongly influenced by other experiences. Foremost were several school field trips to the Field Museum of Natural History in Chicago where Daryl became a young expert on dinosaurs and other vertebrates. These were capped off with a personal "field trip" arranged by a close friend of his mother's to the home of Karl P. Schmidt, Chief Curator of Zoology at the Field Museum, who was also a resident of Homewood, Illinois. Thirty years later, sitting in what had been Schmidt's office at Field Museum, Daryl would recall the details of the artifacts in K. P. Schmidt's home "museum" and how it stimulated his interest in natural history.

For his undergraduate work Karns attended the University of Wisconsin-Madison from which he received his bachelor's degree in zoology in 1972. He went on to the University of Kansas where he served as a curatorial assistant in the paleontology collection at the Dyche Museum of Natural History, and earned a master's degree in systematics and ecology in 1974. While at the University of Kansas, he planned and designed a series of field identification guides to the vertebrates of Kansas utilizing an illustrated flow chart (Karns et al. 1974).

Next Karns joined the U.S. Peace Corps which led to his assignment in Senegal, West Africa, as a research scientist in the Smithsonian Institution-Peace Corps Environmental Program (SI-PCEP) from 1974 to 1976. SI-PCEP was an international initiative to develop biodiversity and conservation biology projects. While serving in Senegal, Karns collaborated with Mamadou Cissé of the Département de Zoologie des Vertébrés terrestres at the Institut Fondamental d'Afrique Noire (IFAN) and the University of Dakar. They conducted surveys and later published papers on the systematics and ecology of Senegalese lizards (Cissé and Karns 1977, 1978; Karns and Cissé 1975). Two of the three Cissé and Karns papers were published in French in the *Bulletin de l'Institut Fondamental d'Afrique Noire*.

Following his work in Senegal, Karns initiated his Ph.D. work at the University of Minnesota (Minneapolis). There he worked as a curatorial assistant and research assistant at the James Ford Bell Museum of Natural History, while conducting his doctoral research in the Department of Ecology and Behavioral Biology at the University under the direction of Professor Philip Regal. His research, which involved extensive field work in the peat bogs of northern Minnesota, focused on the effects of acidic bog habitats on amphibian reproduction (Karns 1984). Whenever Daryl talked about the temperature extremes and insect concentrations that he encountered during his year-round visits to the bogs, it gradually became clear that he really loved the challenges that came with working in difficult habitats.

Karns received his Ph.D. in 1984, and later published much of his thesis research in the *Journal of Herpetology* (Karns 1992a), and in a chapter on amphibians and reptiles in *The Patterned Peatlands of Minnesota* (Karns 1992b). In 1986, he published an 88-page guide to field study techniques entitled *Field Herpetology: Methods for the Study of Amphibians and Reptiles in Minnesota,* based on his field work experience in Minnesota and his studies at the University of Kansas (Karns 1986a). It was funded by the Minnesota Department of Natural Resources (MDNR) and the James Ford Bell Museum of Natural History. Karns geared the guide to amateur naturalists, citizen-scientists, agency personnel, and teachers in Minnesota. However the techniques are applicable beyond the Great Lakes region and include extensive coverage of drift fence and funnel trapping, breeding call surveys, and museum specimen preparation. This guide is still useful for undergraduate and graduate field biology courses. It is available as a pdf on the MDNR website. (http://files.dnr.state.mn.us/eco/nongame/projects/consgrant_reports/1986/1986_karns.pdf).

Karns joined Hanover College as an assistant professor in 1984. He was promoted to associate professor in 1990, and to

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full professor in 1997. He was also appointed Interim Director of the Rivers Institute at Hanover College for 2004–2005, and subsequently to the position of Director of Science Programs at the Rivers Institute.

While he was at Hanover, Karns met fellow college professor Pamela A. Middleton, whom he married in 1996. Pam received her M.D. that same year, having returned to medical school several years before. While Pam was participating in a medical program in Kenya as part of her training, Daryl returned to Africa to join her for travel, and it was there that he proposed.

From the time he arrived at Hanover Daryl was an enthusiastic and vibrant teacher who brought his passion for research into the courses he taught: introductory biology, biodiversity, herpetology, tropical biology, ecology, evolution, conservation biology and comparative anatomy of vertebrates. He also directed numerous student independent study projects, and his enthusiasm for working with students was characterized by energy, sensitivity, and genuine concern for their welfare and career paths.

Among Daryl's first field projects at Hanover College in 1985 and 1986, was an ecological study of the herpetofauna of the Jefferson Proving Ground (JPG), Clifty Falls State Park and natural areas on the Hanover campus, all located in Jefferson County (Karns 1986b, 1994). The JPG is a former weapons testing facility (closed in 1995) that is now partly within the 20,200 hectare Big Oaks National Wildlife Refuge. He was a key researcher at Big Oaks National Wildlife Refuge where he was a member of the Big Oaks Conservation Society and founder of the Heritage Conservancy, a trust to protect area lands. On the Saturday before his death Daryl had been out at Big Oaks, serving as an instructor at one of their public events and working with students on independent projects. Joe Robb, refuge manager at Big Oaks, had worked closely with Karns since 1998, and recalled that "Daryl had a level of curiosity and enthusiasm that was infectious."

In May 2007, Karns instituted the first BioBlitz at Hanover, a 24-hour intense species inventory of the campus. Daryl was a BioBlitz enthusiast and was one of the major organizers of BioBlitzes held by the Indiana Academy of Science. He, his students, and Indiana herpetological colleagues could always be counted on to participate. Karns also served as adviser to the campus Nature/Outdoors Club and directed numerous other off-campus environmental projects statewide.

The Indiana Department of Natural Resources established committees to review annually the conservation status of nongame animals. Karns joined the Nongame Amphibian and Reptile Technical Advisory Committee in 1985, and was chair from 1991 to 1999. Early meetings were held in the living room of Dr. Sherman Minton Jr., Indiana's premier herpetologist. Several hours of discussing Indiana herpetological matters were followed by lunch with persimmon pie for dessert, prepared by Madge Minton. In 1996, as chair of the Indiana Academy of Science Organizing Committee, Karns, and his wife Dr. Middleton, were instrumental in planning and conducting a celebration of the life and career of Dr. Minton on the occasion of the publication of the second edition of his book, *Amphibians and Reptiles of Indiana* (Minton 2001).

For the past 21 years, Daryl Karns was a primary investigator in field research at the Field Museum of Natural History that was so much a part of his early life. This began in the summer of 1989, when Daryl first met Harold K. Voris, Curator of Amphibians and Reptiles, at the American Society of Ichthyologists and Herpetologists meetings in San Francisco and they discovered their common connections with both Hanover College and the Field Museum. At that time Robert F. Inger and Voris were conducting a number of systematic herpetological surveys in Southeast Asia. They had initiated surveys in 1986 at Danum Valley in the Malaysian state of Sabah on the island of Borneo, and Harold's invitation to Daryl to join him for the work in Borneo proved too much for Daryl to resist. Harold vividly recalls Daryl's great excitement—especially since his primary research interest was in evolutionary ecology—on taking his first trip to Borneo where Alfred Russel Wallace had made evolutionary history through his collections and reports on the vast tropical diversity of Southeast Asia.

Daryl's formal affiliation with the Field Museum began in 1990 as a Research Associate. It was the beginning of an extremely productive period in his life in which he worked with Harold Voris, researching amphibians and reptiles of Southeast Asia, especially the aquatic snakes. But Daryl's affiliation with the Field Museum was more than a formality—he became a valued and welcomed member of the Field Museum community. He conducted tours for Field Museum, participated in Members' Nights, attended seminars, brought Hanover students to work there during the summers, and in general he became a Field Museum "regular" whose company and keen mind were enjoyed by all. At one point Daryl reflected on this experience, saying, "I was raised in the south suburbs of Chicago and visited the Field Museum many times as a child. Today, it is still a thrill for me every time I walk into the central hall of the Field Museum, one of the great museums of the world, and disappear behind those mysterious doors labeled 'Research Staff Only.' My Research Associate position over the last 14 years has allowed me to do things and go places that belong in the domain of National Geographic specials."

By 1992, Daryl began to work with Harold on the aquatic snakes of Southeast Asia with an emphasis on homalopsid snakes (Karns and Voris 1996). They began with field studies on *Enhydris plumbea* in an abandoned rice paddy in Sabah, Borneo. This wetland habitat was located with the help of Rob Stuebing, a faculty member of the University of Malaysia, Sabah campus.

PHOTO BY VICKY MERETSKY

FIG. 2. Professor Karns (on left) with his BioBlitz team in June 2009 at the Loblolly Marsh Wetland Preserve in Jay County, Indiana. The Hanover College student holding the snapping turtle is Andrew S. Hoffman.

PHOTO BY ALAN RESETAR

FIG. 3. Daryl Karns (on right) with John C. Murphy in Voris' research lab in the Division of Amphibians and Reptiles at the Field Museum of Natural History, March 2004.

Daryl and Harold benefited greatly from the generous logistical support and hospitality of Rob and his family, as well as that of the staff and administration at the Sabah State Museum. In fact, it was in Rob's lab that Daryl was bitten on the thumb by a large female *E. plumbea* while applying a PIT tag. After calmly removing the snake from his thumb he continued to work while remarking on how it stung. Later at a local coffee shop Daryl held his thumb in an iced coffee, hoping that it would reduce the swelling but it just drew stares. *Enhydris plumbea* is mildly venomous and much later the photograph of the bite on Daryl's thumb made it into print (Norris and Minton 2001) with an unintentional twist that became the basis for later joking—in the figure caption the snake identification was scrambled and *Enhydris plumbea* became *"Enhydrina plumbea"—Enhydrina* being a genus of extremely deadly true sea snake! After that Voris liked to introduce Karns to fellow herpetologists as the guy who suffered an *Enhydrina* bite and lived to tell about it!

Under the sponsorship of the Prince of Songkhla University in Hat Yai (Thailand) and Dr. Vachira Lheknim, a four-year project on the ecology of *Enhydris enhydris* on the edge of Lake Songkhla was initiated in 1995 by Karns and Voris. During this project Jack and Raynoo Cox generously provided hospitality in Bangkok that included many wonderful Thai meals at their home and in the numerous great local restaurants. This project was the first in which John Murphy (also a Research Associate at Field Museum), Harold, and Daryl worked together in the field and from this point on they worked as a research team. Daryl's enthusiasm in the field was very contagious. He was always interested in following the trail for another kilometer or looking over the next hill despite temperature extremes or rain. Typically, while exploring Angkor Wat in Cambodia one steamy sunny day, Daryl decided that he should not pass up climbing to the top of a Khmer pyramid despite the fact that the temperature was well above 40°C!

During Daryl's 2001–2002 sabbatical, the team focused on the ecology of mangrove-dwelling snakes at two locations on the island nation of Singapore. This work was sponsored and generously hosted by the faculty and students of the National University of Singapore (NUS) and the Raffles Museum of Zoology. It was here, with the industrious efforts of Siva (N. Sivasothi) at NUS that the "Snake Hunters" group was formed. This was a volunteer group of about 30 students and local naturalists who worked with the Field Museum team to conduct nightly snake surveys in local mangrove swamps. Bruce Jayne (University of Cincinnati and Field Museum Research Associate) also joined this effort, conducting feeding studies on two species of crab-eating homalopsids. Daryl's focus was on radio-telemetry of both the Bockadam Snake (*Cerberus rynchops*) and the Crab-eating Snake (*Fordonia leucobalia*). In this work he excelled. His trademarks—keen interest, patience, and careful data management—allowed him to succeed in tracking snakes in mangrove swamps, certainly among the most challenging habitats to work in on our planet (Karns et al. 2002).

Daryl's final field work in Southeast Asia began in 2004 with a focus on several species of snakes in Indochina, the center of distribution of the family Homalopsidae. This research was sponsored by Chulalongkorn University in Bangkok and the faculty and students of the Thai Turtle Lab led by Dr. Kumthorn Thirakhupt as well as Tanya Chanard and many others at the National Science Museum of Thailand. Our aim was to learn as much as possible about the natural history, ecology, distribution, dispersal abilities, and population relationships of the species in Thailand's wetlands. This field work extended through 2007 and left us with an inventory of results on three fascinating species: *Enhydris enhydris*, *E. plumbea*, and *E. subtaeniata*.

Karns' work on homalopsid snakes also became a vehicle for involving a number of Hanover College students in research at the Field Museum, in Singapore and Thailand, as well as at Hanover, yielding a long list of "homalopsid alumni"—biology majors who worked on homalopsid snake research at some point during their years at Hanover, usually as part of their respective independent studies. Financial support for these projects came from the Hanover College Richter Fund, the Rivers Institute Grant Committee, the Field Museum, the MacArthur Foundation, and the National Geographic Society. Students Jeff Goodwin, Ashley O'Bannon, Luke Starnes, Emma Thompson, Tom Goodwin, Emily Abernathy, Stacey Sellins, Jerry Suddeth, Bobak Kechavarsi, and Megan Rinehart co-authored published papers that resulted from their work. The majority of these students have continued their education in professional and graduate schools and pursued careers in science. Several decided to change career plans and go into research because of their Field Museum experience.

A prolific writer and presenter, Karns published nearly 40 peer-reviewed journal articles and technical reports. He authored or was involved in 18 popular articles, reviews, and videos, contributed 31 conference papers, and gave 43 seminars and public presentations. In addition, he secured a number of grants, awards, and fellowships for the College. As in the field work, during the data analysis and writing phase of our collaborations, Daryl's enthusiasm for discovery coupled with his careful analyses and love for scientific writing made working with him a joy. His skills as a proofreader extraordinaire and honest critic made him indispensable to our program. Tragically, Daryl's untimely death occurred before he could learn that a homalopsid snake species new to science was being described in his honor by John Murphy (Murphy 2011). Naming this new species after Daryl was a highly deserved tribute to his many contributions to our knowledge of homalopsid snakes, and he would have considered it one of his highest honors.

Karns will be remembered at Hanover for being an outstanding teacher, dedicated faculty member and colleague, and for his wide-ranging contributions to the Rivers Institute. To recognize the many significant contributions he made to his field, Karns received the first annual Hanover College Faculty Award for Excellence in Scholarly and Creative Activity at this year's Honors

Convocation, held April 7, 2011. The College has now renamed this award "The Daryl R. Karns Award for Faculty Scholarship and Creative Activity" in recognition of his many contributions and his exceptional academic standards, and as a memorial to its first recipient. In an additional tribute, at the memorial service held for Daryl on the campus of Hanover College, June 12, 2011, the President of the College officially named the nature trail system at the College, *The Daryl R. Karns Natural History Trails*.

Daryl had many wonderful characteristics that stood out in all the arenas of his life: he was a hard worker, very reliable, always respectful of others, and had great personal and intellectual integrity. His positive outlook, enthusiasm, and great sense of humor made us all want to have his companionship throughout our lives. He will be greatly missed by his many students, colleagues and friends at Hanover College, at Field Museum and in the field of herpetology at large.

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ZOO VIEW

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A Brief History of Crocodilian Science

The recent history and development of crocodilian science, and the people who made advances through pioneering studies on crocodilians spans more than 300 years. However, crocodilians were well known to ancient people thousands of years ago. Crocodilians were considered gods for their seemingly mystical powers, procreative ability, and longevity. Ptolemy X and Alexander I dedicated a temple to the crocodile god *Sebek* or *Souchos* about 95 BC. Crocodiles were accepted as the national emblem of Egypt and the Ptolemys, and appeared on imperial Roman coins. Lest we consider ourselves innovative in our care of zoo crocodilian collections, we should remember that the early Romans brought men from distant regions that were reported to have special skills to care for captive crocodiles (Grant 1992).

Although crocodilians and their ancestors have been around for about 200 million years, crocodilian science is relatively new. In this paper we attempt to put into perspective the history of crocodilian science and the people who were, and are today, part of this ongoing story. It is a starting point to be continued. The inclusion or omission of anyone in this paper should not be construed to discredit or endorse anyone or their work. It is not possible to include each and every scientist who worked in some aspect of crocodilian sciences. The majority may have conducted crocodilian research for specific projects and then moved on to other interests. Others have made crocodilian science their life's work. Some folks were lucky enough to be in the right place at the right time, with the right interests. Some still are making crocodilian history.

Periods in crocodilian science.—The history of crocodilian science falls into periods of special interest, each with its own focus and direction (Table 1). Scientific knowledge of crocodilians found its infancy during the golden period of global exploration and colonization. It was a time when the great nations of the world were establishing colonies, business interests, missions, and government offices in far-away regions where the fauna and flora were often new to science and a topic of curiosity. Government offices were often staffed by people with considerable education and wide interests. Many of today's great museum collections reflect the hunting activities and hobbies of district officers, government hunters, and "amateur" naturalists of the time, who collected and catalogued the rocks, insects, animals, and plants as a digression from the hardships and boredom of performing their official duties far from home.

Western science only became aware of the presence of a Chinese Alligator (*Alligator sinensis*) when it was reported by a Shanghai Customs Officer, A. A. Fauvel, in 1879 (Fauvel 1879), although it was known to Chinese scholars for 3,000 years.

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It is also during this period that many of the world's greatest museums were built. They became homes to the new breed of naturalist-scientists, and where heretofore unknown and unnamed specimens, including crocodilians, often found their way. They now make up the voucher collections that form the

Table 1. Historic events in crocodilian science.

Year	Event
1758	A system of classification described (Linnaeus 1758)
1768	Class Reptilia (Laurenti 1768)
1933	Mixed species of crocodilians exhibited, Bronx Zoo, NY (DeSola 1933; Ditmars 1913)
1935	First observations of wild American Alligators (McIlhenny 1935)
1963	Sexing technique developed for all crocodilian species (Brazaitis 1968)
1964	First museum quality record keeping system for zoos (Dowling and Gilboa 1968)
1966	Endangered Species Act, amended 1969, 1981, 1988
1970	Nesting ecology of alligators — field study (Joanen 1970)
1970	First crocodilian genetics study (Cohen and Gans 1970)
1971	IUCN Crocodile Specialist Group founded
1971	Species identification of crocodilian hides and products (King and Brazaitis 1971)
1973	Comprehensive identification account of living crocodilians (Brazaitis 1973a)
1973	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
1977	First crocodilian behavior studies (Garrick and Lang 1977)
1980	First SSP/studbook initiated to coordinate breeding efforts for Chinese Alligator (Behler)
1980	Maternal behavior and vocalization, young and mother (Watanabe 1980)
1982	Temperature dependent sex determined (Ferguson and Joanen 1982)
1983	Biochemical and immunological systematics of Crocodylia (Densmore 1983)
1986	AZA Crocodilian Advisory Group founded
1986	St Augustine Alligator Farm joins AZA
1989	Social displays of American Alligators (Vliet 1989)
1994	Genetic fingerprint profiles described (Aggarwal et al. 1994)
2003	Phylogenetic approaches toward crocodilian history (Brochu 2003)
2006	*Mecistops* resurrected (McAliley et al. 2006)
2007	*Tomistoma* into Family Gavialidae (Willis et al. 2007)
2008	Molecular support for intergeneric crocodylian relationships (Gatesy and Amato 2008)
2009	Barcoding of crocodilian meat for species identification (Eaton et al. 2009)

Table 2. Natural history museums holding significant crocodilian collections.

Museum	Established
The Muséum national d'Histoire naturelle, Paris, France	1793
The National Museum of Brazil, Rio de Janeiro, Brazil	1818
Louis Agassiz Museum of Comparative Zoology, Harvard University, Cambridge, MA, USA	1859
The American Museum of Natural History, NY, USA	1869
Natural History Museum (British Museum), London, UK	1880
Florida Museum of Natural History of the University of Florida, Gainesville, FL , USA	1891
Field Museum of Natural History, Chicago, Ill, USA	1893
National Museum of Natural History, Smithsonian Institution, Wash. D.C., USA	1910
Senckenberg Natural History Museum, Frankfurt, Germany	1914
Yale Peabody Museum of Natural History, New Haven, CT, USA	1866

basis for the comparative studies that are so important to our understanding of animal relationships. Large crocodiles were often killed because of the danger they posed to people. Thus, the largest crocodile skulls found in collections today are usually animals killed out of necessity or sport, often dating back to the mid-to-late 1800s and early 1900s.

Although regional museums may have extensive collections of native species, or specialize in certain taxa, those museums that enjoyed national prestige or university support amassed collections representing species from around the world. Museums also made expeditions to remote or little known regions to fill their collections. For example, the expeditions of the Chicago Field Museum of Natural History to the Philippines in the 1930s produced extensive collections that included crocodilians, and yielded the first description of *Crocodylus mindorensis*, the Philippine Crocodile (Schmidt 1935). With the advent of molecular studies of crocodilians (Aggarwal et al.1993; Amato 1991, 1994; Amato et al. 1998; Cohen and Clark 1967; Cohen and Gans 1970; Densmore 1983; Densmore and Owen 1989; and many others), it became necessary for museum collections to change their specimen preparation methods and increase their storage. Tissue collections often grew out of research by individual scientists and the most extensive tissue collections are maintained in university museum collections or other research facilities. Several museums house collections of crocodilian specimens that are significant either in terms of specimen count, taxonomic importance, or historical value (Table 2).

Taxonomy.—Endemic people certainly were aware of the ferocious beasts that lived in nearby rivers and swamps, possibly accounting for a sudden disappearance of friends or family last seen bathing in the river. But crocodilians as a living group attracted scholarly interest after the Swedish botanist, zoologist, and physician Carolus Linnaeus published *Systema Naturae* in 1758 and 1766 (*Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. Translated: "System of nature through the three kingdoms of nature, according to classes, orders, genera and species, with characters, differences, synonyms, places").

Linnaeus provided an organized system of classification that still stands, based on a division of Kingdoms: *Regnum Animale*, *Regnum Vegetabile* and *Regnum Lapideum*—animals, plants, and minerals. The tenth edition of this book, published in 1775, is considered the starting point of modern zoological nomenclature. The works of Laurenti (1768) and Linnaeus (1758, 1766) heralded a truly scientific period of interest in classifying all living creatures, including crocodilians.

Fig. 1. Gerard Krefft (1830–1881) (http://wikipedia.org/wiki/File:Krefft_Gerard_1830-1881.png).

Nearly all of the crocodilian species we know today (Table 3) were originally described between 1758 and 1828 (Table 4), with the exception of two species: the New Guinea Crocodile (*Crocodylus novaeguineae*) in 1928, and the Philippine Crocodile (*C. mindorensis*) in 1935 (Table 1). An overview of the original descriptions of reptiles is given by Uetz (2010).

The International Commission on Zoological Nomenclature was founded in 1895 and publishes the *International Code of Zoological Nomenclature* (ICZN) (1961). Probably one of the most interesting application of ICZN rules occurred in the naming of the Australian Johnston's Crocodile.

Johann L. G. Krefft, Director of the Australian Museum (Fig. 1), had sent a plaster cast (Fig. 2) of a crocodile discovered by a Mr. Johnston of Cardwell, Rockingham Bay, Queensland, Australia, to Dr. John Edward Gray (Fig. 3), Keeper of Zoology at the British

TABLE 3. Crocodilian species and their global distribution, derived from Brazaitis (1973), King and Burke (1989), Sill (1968), Thorbjarnarson (1992, 1996).

Species	Common name	Modern distribution
Family: Alligatoridae		
Genus: *Alligator*		
A. mississippiensis	American Alligator	North America: SE USA
A. sinensis	Chinese Alligator	Asia: middle Yangtse River - Wuhu, Anhui Province
Genus: *Caiman*		
C. crocodilus	Caiman	Central and South America
C. c. crocodilus	Common Caiman	S. America: Amazon River drainage basin
*C. c. apaporiensis**	Rio Apaporis Caiman	S. America: east of the Andes; middle Rio Apaporis
C. c. fuscus	Rio Magdalena Caiman	S. America: northern Andes: Rio Magdalena, Atlantic drainage; northwestern Venezuela
C. c. chiapasius	Central American Caiman	Mexico, C. America and S. America: west of the Andes
C. latirostris	Broad-snouted Caiman	South America
C. l. latirostris	Broad-snouted Caiman	S. America: W and S Atlantic drainages of Brazil, Paraguay, Uruguay, northern Argentina
*C. l. chacoensis**	Argentine Broad-snouted Caiman	South America: northern Argentina; Paraguay, Parana river drainages
C. yacare	Yacare Caiman	South-central S. America: Paraguay, Parana, Guapore river drainages, not Amazon
Genus: *Melanosuchus*		
M. niger	Black Caiman	S. America: Amazon River basin and drainages
Genus: *Paleosuchus*		
P. palpebrosus	Dwarf Caiman	S. America: tropical S. America
P. trigonatus	Smooth-fronted Caiman	S. America: Amazon (forest) basin
Family: Crocodylidae		
Genus: *Crocodylus*		
C. acutus	American Crocodile	N. and S. America: S. US; neotropical: Mexico, Central America; west coast S. America, Peru to Venezuela; Caribbean Islands
C. intermedius	Orinoco Crocodile	South America: Orinoco River and drainages
C. johnsoni	Johnston's Crocodile	Australia: northern territories
C. mindorensis	Philippine Crocodile	Western Pacific: Philippine Islands
C. moreletii	Morelet's Crocodile	Central America: Atlantic drainages; Mexico, Belize, Guatemala
C. niloticus	Nile Crocodile	Africa: Sub-Sahara, historically to Israel and Jordan; Madagascar
C. novaeguineae	New Guinea Crocodile	Western Pacific: Indonesia and Papua New Guinea
C. palustris	Mugger or Marsh Crocodile	South Asia, Indian sub-continent
C. p. palustris	Indian Marsh Crocodile	South Asia, Indian sub-continent: lowland India, Pakistan
*C. p. kimbula**	Ceylon Marsh Crocodile	South Asia: Sri Lanka
C. porosus	Saltwater Crocodile	N. Australia, SE Asia, India, Western Pacific, Palau, Solomon Islands, Vanuatu
C. rhombifer	Cuban Crocodile	Caribbean: Zapata Swamp, Isle of Pines
C. siamensis	Siamese Crocodile	SE Asia and Malaysia (historical); recent Laos, Cambodia
Genus: *Mecistops*		
M. cataphractus	African Slender-snouted Crocodile	Central West Africa: mostly tropical forest
Genus: *Osteolaemus*		
O. tetraspis	Dwarf Crocodile	Central West Africa
O. t. tetraspis	West African Dwarf Crocodile	Central West Africa: mostly tropical forest
O. t. osborni	Congo Dwarf Crocodile	Central West Africa: Congo Basin
Family: Gavialidae		
Genus: *Gavialis*		
G. gangeticus	Indian Gharial	India, Indian sub-continent: rivers of northern India and eastern Pakistan
Genus: *Tomistoma*		
T. schlegelii	Malayan False-gharial	SE Asia: lowlands of Thailand, Malaysia, Indonesia

*Subspecies not recognized by all authorities.

Museum, London. Krefft had earlier sent Gray a photograph in 1871, and had described the crocodile in a subsequent publication (Krefft 1873), where he called the taxon *Crocodylus johnsoni*, misspelling the name of the discoverer. Gray (1874) called attention to the error—but too late. The error stands to this day, in accordance with the rules of the International Commission on Zoological Nomenclature: once misspelled always misspelled with few exceptions. Taxonomists have revisited crocodilian systematics many times over the years (Boulenger 1889; Brazaitis 1971, 1973a, 1973b; King and Burke 1989; Mertens 1943; Mook 1921; Wermuth and Mertens 1977; Werner 1933). Determining the relationships among species draws more heavily on molecular data than physical appearance in modern studies. However, given the rich fossil diversity of the group, studies involving both molecular data and paleontology were inevitable (Brochu 2001a, 2001b, 2003; Brochu and Densmore 2001). Conservation genetics laboratories, such as those at the American Museum of Natural History's Center for Conservation Genetics (New York), Texas Tech University's Department of Biological Sciences (Lubbock, Texas), and the Yale Institute of Biological Sciences, Molecular Systematics and Conservation Genetics Laboratory (New Haven, Connecticut), have emerged as important centers for crocodilian genetics research.

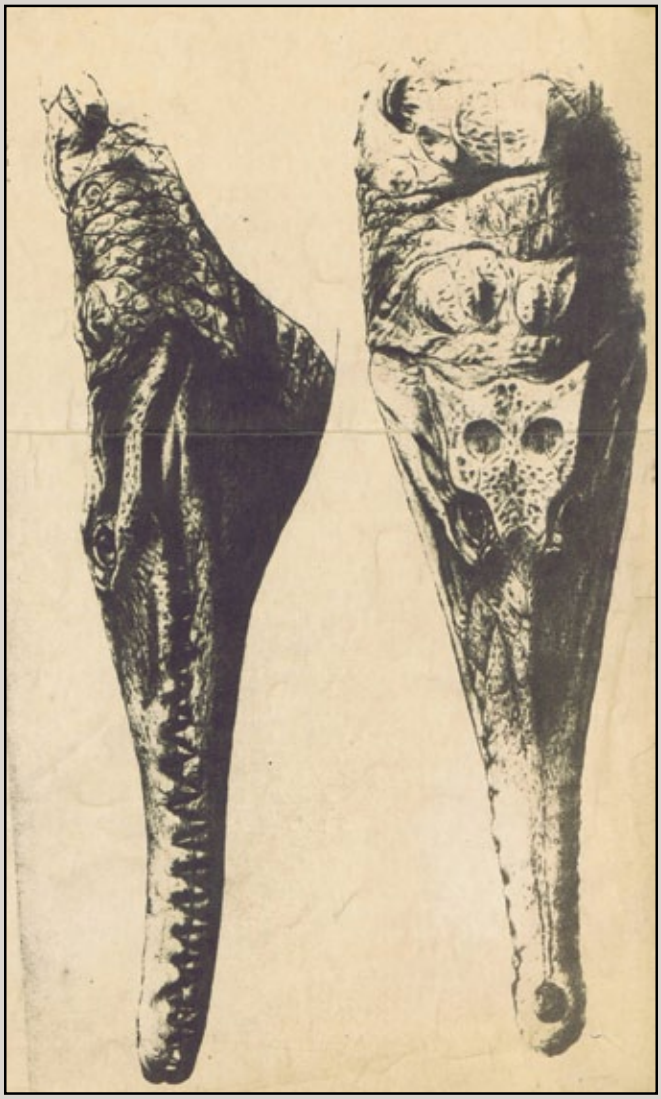

FIG. 2. Plaster cast of head of originally described as Johnston's Crocodile, *Crocodylus johnsoni*. (Adapted from Krefft 1873).

Disparities in morphology-based phylogenies and those based on molecular studies, as well as the impact of technical advances in phylogenetic analysis soon became apparent (Brochu 1997, 2001b; Gatesy and Amato 2008; Poe 1996; Willis 2009). Crocodilian phylogeny continues to be rearranged (Gatesy and Amato 2008), most recently with the transfer of *Tomistoma* from the Crocodylidae to Gavialidae (Willis et al. 2007), and the reassignment of *Crocodylus cataphractus* to the genus *Mecistops* (McAlily et al. 2006).

Crocodilian morphology and physiology.—The structure and morphology of crocodilians continues to interest and astound scientists and lead to discoveries as technologies improve. Few modern crocodilian morphologists can rival the early anatomical works of Albert M. Reese. Between 1901 and 1948, Reese published more than 30 papers ranging from bibliographies of crocodilian literature to all aspects of crocodilian anatomy and biology (Reese 1915). Angus d'Albini Bellairs, an evolutionary biologist, published extensively on crocodilian structure and evolution (Bellairs 1960).

Roland A. Coulson, Louisiana State University, published more than 50 papers on alligator metabolism between 1950 and 1983, pioneering much of what we know of how crocodilians function and use energy (Coulson and Hernandez 1964). His colleague, Thomas Hernandez, published at least 30 papers in a similar period (Hernandez and Coulson 1952). The Louisiana State University, Baton Rouge, continues to be a major resource for crocodilian management, nutrition, and veterinary science.

Perhaps some of the most important contributions to our knowledge of crocodilian eggs and embryonic development came from Mark W.J. Ferguson, a young oral surgeon at Queen's University in Belfast, Northern Ireland, with an interest in human cranial-facial reconstruction. The palatal development of

FIG. 3. John Edward Gray (1800–1875) (http://en.wikipedia.org/wiki/John Edward Gray).

alligators during developmental stages had direct application to his human work, and provided crocodilian science with an understanding of the stages of incubating alligator eggs and embryonic development (Ferguson 1981). Ferguson and Ted Joanen at Rockefeller Wildlife Refuge, in Louisiana, were the first to describe incubation temperature dependent sex determination in a crocodilian (Ferguson and Joanen 1982).

Saving crocodilians: a new era for crocodilian science.—The late nineteenth through the twentieth century were not kind to crocodilians. By 1971, burgeoning human populations encroaching on crocodilian habitat and abusive hunting for the exotic leather and pet trade threatened all of the commercially valuable species with extinction. Hunting meat for human consumption was a serious threat to crocodilians and continues today (Eaton et al. 2009). Demand from the exotic leather industry in particular had almost destroyed the very resource upon which the industry depended. Something had to be done.

In March 1971, the first meeting of crocodilian specialists was held at the Bronx Zoo Reptile House in New York. It was a precursor to the present IUCN Crocodile Specialist Group (CSG) and included zoologists, recognized crocodilian experts, conservation interests, and representatives of the crocodilian leather industry from around the world (Fig. 4).

Under the leadership of Harry Messel, Professor of Physics and Head of the School of Physics at the University of Sydney, and F. Wayne King (then Curator of Reptiles, Bronx Zoo), University of Florida, the CSG was the first and perhaps most successful of the Specialist Groups. It adopted a strategy for the conservation of crocodilians that was based on the sustainable utilization of a valuable wild resource. Crocodilians as a whole did not enjoy a favorable public image and were generally considered dangerous. However, their skins were well known to be of significant commercial value.

The CSG actively partnered with the commercial crocodilian skin industry to provide assistance in surveying and documenting the extent and health of wild crocodilian populations, developing a tailored strategy for utilization, and encouraged national regulation that might be favorable to both commercial trade and crocodilian conservation. Crocodilian conservation was inextricably tied to the market value of skins. Generally speaking, commercially valuable crocodilian species have particularly benefited from the collaborative strategy. Captive propagation has improved the numbers of animals of endangered species held in captivity many fold and made many thousands of skins available for commercial trade that might otherwise have come from wild populations.

However, wild populations of a number of species continue to decline for lack of conservation funding, continued loss or the degradation of critical habitat, and abusive hunting for bush meat and holistic medicines. These include critically endangered species such as the Chinese Alligator (*Alligator sinensis*), Philippine Crocodile (*Crocodylus mindorensis*), Orinoco Crocodile (*C. intermedius*), Indian Gharial (*Gavialis gangeticus*) and Malayan False Gharial (*Tomistoma schlegelii*), and perhaps the Cuban Crocodile (*C. rhombifer*), African Slender-snouted Crocodile (*Mecistops cataphractus*), and Mugger or Marsh Crocodile (*C. palustris*) (Table 3). Large-scale captive management of closely related species for enhancing skin production has also led to the purposeful hybridization of large numbers of otherwise rare species, such as Cuban Crocodiles and American Crocodiles *(Crocodylus acutus*); Siamese Crocodiles (*C. siamensis*) and Saltwater Crocodiles (*C. porosus*); and multiple species of caiman (*Caiman crocodilus*), possibly threatening the genetic integrity of some already endangered species (Brazaitis and Abene 2008).

Fig. 4. Top row from left to right: Tony Pooley, Nile Crocodiles, Natal Parks Board, South Africa; Max Downs, New Guinea Crocodiles, Papua New Guinea; Peter Brazaitis, Reptile Keeper, Bronx Zoo, NY, USA; Prof. Angus A. d'A. Bellairs, evolutionary biologist and anatomist, UK; Dr. Robert Bustard, Indian and Australia crocodilians; Dr. Hugh Cott, African ecology of the Nile crocodile, UK; Dr. F. Wayne King, conservationist, Curator of Reptiles, Bronx Zoo, NY; Prof. Federico Medem, South American crocodilian biologist, Instituto Roberto Franco, Colombia. Front Row: Moira A. G. Warland, IUCN; Mrs. Clare Hagan, CEO, Hagan and Co., New York; Utai Yangprapakorn, Samut Prakarn Crocodile Farm and Zoo, Thailand; Dr. Robert (Bob) Chabreck, Louisiana Department of Fur, Fish and Game, Louisiana, USA; Charoon Yangprapakorn, Thailand; James H. Powell, journalist, Mexican crocodiles; Fred Hauptfuhrer, World Wildlife Fund.

Fig. 5. Adult female Orinoco Crocodile, *Crocodylus intermedius*, captured for transit to Hato Masaguaral in 1984. The crocodile shown had come close to capturing Dr. Myrna Watanabe on a visit the previous year. From left to right: three ranch-hands, Tomás Blohm, Peter Brazaitis and capture chicken, ranch-hand (rear), John Thorbjarnarson (second row, originally hired by Tomás to study Orinoco Crocodiles), ranch manager, Mark Ludlow (field researcher), ranch-hand.

Two years after the CSG was formed, a plenipotentiary meeting was held in Washington, D.C. from 12 February to 2 March 1973 just prior to the Convention on the International Trade in Endangered Species of Fauna and Flora (CITES). CITES was ratified by the United States on January 14, 1974, as did five other

countries the same year, and went into effect in the United States on 1 July 1975. The "Washington Convention" (CITES), under the United Nations Environmental Program, would provide for the regulation of commercially traded species, including virtually all crocodilians.

A framework for controlling the international trade in wildlife had been created. Enforcement in the USA would fall to the US Fish and Wildlife Service under the provisions of the US Endangered Species Act (ESA) and a host of other new and broadened national and state wildlife legislation. Although mainstream biologists might be well known for their scientific writings and research, a host of state, national, and international law enforcement officers deserve no less recognition for their role in saving crocodilians from extinction, by their efforts to halt the contraband trade in crocodilians.

The structure for enforcing and prosecuting wildlife violations called for the application of wildlife sciences to the judiciary process in a new discipline: forensic wildlife sciences (Brazaitis 1986; 1987). As the majority of crocodilian species were now protected and violations were subject to civil or criminal prosecution, crocodilians and their derivatives became the immediate focus of enforcement. The Clark R. Bavin National Fish and Wildlife Forensic Laboratory was founded in 1988 in Ashland, Oregon by the US Fish and Wildlife Service. Under the directorship of Ken Goddard, the laboratory is a state-of-the-art forensic analysis facility and the only forensic laboratory in the world dedicated entirely to solving wildlife crime.

National and international attention was focused on endangered and threatened species including crocodilians. The International Union for Conservation of Nature (IUCN), founded in 1948, published the IUCN Red Data Book to identify threatened species (Groombridge and Wright 1982). In October 1991, in Gland, Switzerland, the World Conservation Union, the United Nations Environment Programme (UNEP), and what was then called World Wildlife Fund, the World Wide Fund for Nature (WWF) joined to adopt a universal strategy of *Caring for the Earth, A Strategy for Sustainable Living*. It was a perfect fit for improving the crocodilian image, conservation, and by default—for trade as well. It was a jump-start for crocodilian sciences. The IUCN Crocodile Specialist Group would become the advisory council of world specialists to CITES and countries around the world on matters of crocodilian management and conservation.

Outstanding crocodilian conservationists.—Many people and agencies, both governmental and private, played an important role in furthering crocodilian conservation. Tomás Blohm of Caracas, Venezuela, was the recipient of the Order of the Golden Ark, created by Prince Bernhard of the Netherlands for leadership in conservation in 1971. Blohm had traditionally maintained one of his cattle ranches, *Hato Masaguaral*, in a natural state and had for many years welcomed researchers from around the world to study the endemic wildlife. Blohm and his wife Cecilia M. de Blohm set the course for the conservation movement in Venezuela.

The Orinoco Crocodile is native to the Orinoco River and its tributaries in Venezuela. The species had become all but extinct in Venezuela as a result of exploitation for the skin trade. A few adult individuals had been sequestered on the ranches of a few landowners, to protect the remaining animals. In 1984 an adult pair of Orinoco Crocodiles was transported from a hidden lagoon on property owned by Blohm adjacent to Camatagua Reservoir near Caracas, to his ranch *Hato Masaguaral* (Fig. 5), to form the nucleus of a captive group of breeding crocodiles that would eventually produce offspring to reintroduce the species in Venezuela. To date, the Venezuela program has released over 6,335 animals of which 2,475 animals were produced from the *Hato Masaguaral* program.

PHOTO BY PETER BRAZAITIS

FIG. 6. A Cuban Crocodile, *Crocodylus rhombifer,* hatches from an egg at the Bronx Zoo, New York in 1983.

John Thorbjarnarson, University of Florida and the Wildlife Conservation Society, New York, was undoubtedly the best known field biologist in crocodilian field conservation in recent times. He began his career with studies of the Orinoco Crocodile in Venezuela. As a member of the IUCN Crocodile Specialist Group and the AZA Crocodilian Advisory Group, his crocodilian interests touched on virtually every species, in captive propagation and wild populations. His field studies of crocodilian populations and natural history have produced numerous scientific and popular papers (Thorbjarnarson 1991, 1992, 1996). Perhaps one of the most valuable to international crocodilian conservation was his comprehensive paper published by IUCN in 1992. Tragically, he died on 14 February 2010, in India, at the age of 53 from acute malaria.

New directions.—If crocodilians were to be saved from extinction, crocodilian sciences had to move in new directions: behavioral, population biology, ecology, captive management and husbandry.

Probably the single most important discovery to make selective crocodilian breeding and management possible was the simplest: a method for determining the sex of crocodilians. The story is amusing. Robert Chabreck (1963) reported a manual probing method for sexing alligators that had been employed in Louisiana, in the *Proceedings of the 27th Annual Conference, Southeastern Association of Game and Fish Commission.* Separately and without knowledge of Chabreck's presentation, one of this paper's coauthors, Peter Brazaitis, had applied a similar manual probing technique that successfully determined sex in a wide range of crocodilian species at the New York Zoological Society's Bronx Zoo. However, the technique was considered too risqué for the zoo's scientific journal *Zoologica* and it was not until a number of years after the initial study was completed that

TABLE 4. Chronology of original crocodilian classification.

Year	Author	Taxon
1758	Linnaeus, Carolus (Carl von Linné)	Species: *Lacerta crocodilus* (= *Caiman crocodilus**)
1768	ibid.	Class: Reptilia
1768	ibid.	Genus: *Crocodylus*
1768	ibid.	Species: *Crocodylus niloticus*
1789	Gmelin, Johann	Order: Crocodylia
1789	ibid.	Species: *Gavialis gangeticus*
1801	Daudin, François Marie	Species: *Alligator mississippiensis*
1801	ibid.	Species: *Caiman latirostris*
1801	ibid.	Species: *Caiman yacare*
1801	Schneider, J. G.	Species: *Paleoschus trigonatus*
1801	ibid.	Species: *Crocodylus porosus*
1801	ibid.	Species: *Crocodylus siamensis*
1807	Cuvier, Georges Léopold Chrétien Frédéric Dagobert	Family: Alligatoridae
1807	ibid.	Genus: *Alligator*
1807	ibid.	Family: Crocodylidae
1807	ibid.	Subfamily: Crocodylinae
1807	ibid.	Species: *Paleosuchus palpebrosus*
1807	ibid.	Species: *Crocodylus acutus*
1807	ibid.	Species: *Crocodylus cataphractus* (= *Mecistops cataphractus**)
1807	ibid.	Species: *Crocodylus rhombifer*
1811	Oppel, M.	Genus: *Gavialis*
1819	Graves,M. L.	Species: *Crocodylus intermedius*
1825	von Spix, Johann Baptist Ritter	Genus: *Caiman*
1825	ibid.	Species: *Melanosuchus niger*
1831	Lesson, R. P.	Species: *Crocodylus palustris*
1838	Müller, S.	Genus: *Tomistoma*
1838	ibid.	Species: *Tomistoma schlegelii*
1851	Duméril, A. M. C. and Bibron, G.	Species: *Crocodylus moreletii*
1854	Adams, A.	Family: Gavialidae
1861	Cope, Edward D.	Genus: *Osteolaemus*
1861	ibid.	Species: *Osteolaemus tetraspis*
1862	Gray, J. E.	Genus: *Melanosuchus*
1862	ibid.	Genus: *Paleosuchus*
1868	Cope, Edward D.	Species: *Caiman crocodilus fuscus*
1873	Krefft, G.	Species: *Crocodylus johnsoni*
1876	Bocourt, F.	Species: *Caiman crocodilus chiapasius*
1879	Fauvel, A. A.	Species: *Alligator sinensis*
1928	Schmidt, K. P.	Species: *Crocodylus novaeguineae*
1935	ibid.	Species: *Crocodylus mindorensis*

*Name in current use.

the data were published, without zoo permission, in the *British Journal of Herpetology* (Brazaitis 1968).

Population biology.—Paramount in this new era of crocodilian conservation was determining the status of wild crocodilian populations throughout the world to investigate possible harvest quotas and to encourage investments in crocodilian conservation initiatives. It was also important to determine population characteristics and distribution limits for species. Universities, international conservation organizations, and governments rushed to comply with CITES requirements for scientific data on population levels and sustainability in order to set harvest quotas. Some pioneers were already deeply involved in crocodilian field research.

Ornithologist John James Audubon (1785–1851) and botanist/naturalist William Bartram (1739–1823) made some of the earliest observations of American Alligator natural history during their wanderings through the southern United States (Audubon 1827; Bartram 1773–1774). However, E. A McIlhenny was probably one of the first to comprehensively document the life history of a crocodilian, the American Alligator in Louisiana (McIlhenny 1935). A comprehensive bibliography of the American Alligator was published by the US Department of Energy's Savannah River Ecology Laboratory (Brisbin et al. 1986).

Robert Chabreck and Ted Joanen continued field research on alligators in the coastal marshes of Louisiana. Joanen, who directed the management of the Rockefeller Wildlife Refuge of the Louisiana Department of Wildlife and Fisheries at Grand Chenier, and the Louisiana alligator program, took the lead to ensure the survival of alligator populations in Louisiana. This work began even before national and international interest focused on endangered crocodilians and the results were used to create conservation programs. They developed strategies for the captive

Table 5. Noteworthy biologists who pioneered crocodilian population science.

Name	Region of Study
Alvarez del Toro, Miguel	Mexico
Achaval, Federico	Uruguay
Blomberg, Goran	Botswana
Brazaitis, Peter	Brazil, Palau
Brisbin, I. Lehr	USA
Britton, Adam	Australia
Bustard, Robert	India
Campbell, George	USA
Campos, Zilca	Brazil
Chabreck, Robert	USA
Choudhury, B. C.	India
Cox, Jack	Borneo
Daniel, J. C.	India
David, Dennis	USA
Elsey, Ruth	USA
Godshalk, Robert	USA, Venezuela
Gorzula, Stefan	Venezuela
Graham, Allister	Uganda
Grigg, Gordon	Australia
Hall, Phillip	USA, Papua New Guinea, S. America
Herrera, Carlos G.	Colombia
Hines, Tommy	USA
Hollands, Martin	Papua New Guinea
Huang, Chu-chien	China
Hutton, Johnathan	Zimbabwe
Joanen, Ted	USA
Kar, Sudhakar	India
Kushlan, James A.	USA
Lamar, William	USA, Colombia
Lazcano-Barrero, Marcos	Mexico
Magnusson, William	Brazil
Manolis, Charlie	Australia
Maskey, Tirtha	Nepal
Mazotti, Frank	USA
McIlhenny, E. A.	USA
McNease, Larry	USA
Medem, Féderico	South America, Colombia
Moler, Paul	USA
Onions, J. T. Victor	Australia
Ottenwalde, Jose Alberto	Dominican Republic
Ouboter, Paul E.	Surinam
Plotkin, Mark	USA
Pooley, Tony	Natal, South Africa
Powell, James H.	USA, Mexico
Rao, Abdul Latif	Pakistan
Rao, R. J.	India
Rebello, George	Brazil
Rivero-Blanco, Carlos	Venezuela
Ross, Andy	USA, Philippines
Scott, Norman	Paraguay
Seijas, Andres Eloy	Venezuela
Singh, Lala A. K.	India
Stockwell, Jane Harvey	Australia
Subba, M. V.	India
Thorbjarnarson, John	USA, global
Trelancia, Ana Maria	Peru, Brazil
Varona, Louis	Cuba
Waitkuwait, Wolf-Ekkehard	W. Africa
Watanabe, Myrna E.	USA, China
Werner, Yehudah L.	Israel
Whitaker, Romulus	India
Woodward, Allen	USA
Yahoda, John C.	Ecuador
Yamashita, Carlos	Brazil

propagation, wild population management, and sustainable use of alligators that remain models for crocodilian management. Joanen and his colleague at Rockefeller, Larry McNease, published more than 40 papers on the natural history and management of alligators, beginning in 1970 (Joanen 1970) to 1982 (Brisbin et al. 1986). To many, they are the fathers of crocodilian conservation, population management, and captive husbandry technology.

As in Louisiana, the Savannah River Ecology Laboratory, Aiken, South Carolina, largely supported by the United States Department of Energy, under the leadership I. Lehr Brisbin, contributed immensely to our understanding of American Alligator ecology.

The Saltwater Crocodile populations of Australia enjoyed a similar benefactor. Harry Messel, University of Sydney, Australia, and his research team surveyed all of the river systems in northern and western Australia and developed field survey techniques that became the standard for crocodilian population studies. His series of monographs (Messel et al. 1981) on the status and ecology of *C. porosus* in Australia are monumental. This legacy of crocodilian research continues today at Australian universities.

Hugh B. Cott (1961), a zoologist, wildlife photographer, and military camouflage expert, was one of the first to extensively describe the natural history and nesting ecology of Nile Crocodile (*C. niloticus*) populations in Uganda and Northern Rhodesia.

The most prolific and adventurous South American crocodilian field biologist, and incidentally, a member of the royal family of Latvia, was Féderico Medem, Instituto Roberto Franco, Colombia. His field studies and extensive publications on South American crocodilians span decades (Medem 1952, 1955, 1958a, 1958b, 1960, 1962, 1963, 1967, 1968, 1969; Medem and Marx 1955). He was the first to conduct an exhaustive field survey of the distribution of South American crocodilians under the auspices of the New York Zoological Society. However, his work was not published until years later (Medem 1981, 1983).

Probably one of the most comprehensive field surveys of crocodilians ever undertaken was initiated as a result of CITES and the need to understand the identity, distribution, and taxonomy of South American caiman. Field investigations throughout central South America were conducted by three field teams: Bolivia—led by F. Wayne King, University of Florida (King and Roca 1989); Brazil—led by Peter Brazaitis (Brazaitis et al. 1997a, 1997b, 1998); Paraguay—led by Norman Scott (Scott et al. 1988).

In China, Huang Chu-chien (Zhujian) and colleague Zheng Zuoxin, Institute of Zoology, Chinese Academy of Sciences, Beijing, studied the distribution and natural history of the Chinese Alligator in south central China in Anhui, Zhejiang, and Jiangsu provinces. They observed life habits and described its extensive cave-building behavior. Aware that the species was critically endangered in the wild, Huang was instrumental in having the Forestry Bureau in Anhui Province set up the Xuancheng Alligator Breeding Farm in southern Anhui in 1980. He was assisted by Myrna Watanabe in 1981, the first westerner to have several months' access to the region since the Communist takeover of China in 1948. Watanabe reported the population to be critically near extinction and restricted to living on tree farms and in rice paddies (Watanabe 1982). John Thorbjarnarson confirmed the Chinese Alligator's approaching extinction in 2002 (Thorbjarnarson et al. 2002; Thorbjarnarson and Wang 2010). Although thousands of Chinese Alligators currently exist on alligator farms in China, the extinction of the wild population could be imminent. The first captive reproduction of Chinese Alligators in the

United States occurred in 1977 at the Rockefeller Wildlife Refuge, Grand Chenier, Louisiana. This successful program, developed by the late John Behler at the Wildlife Conservation Society, New York, contributed to the reintroduction of US captive-bred Chinese Alligators back into the wild in 2007.

It would not be possible to provide a complete list of field biologists and students who conducted surveys of crocodilians throughout the world. Table 5 is a partial list of field biologists known for their work in crocodilian conservation, particularly those who conducted initial surveys in the 1970s and 1980s, when the population status of most species was unknown, and crocodilian behavioral science was a new concept. The University of Florida and the Florida Field Museum of Natural History, Gainesville, Florida stand out as a seat of crocodilian population ecology and biology.

Field biologists are, by definition, some of the most dedicated of scientists, often giving up a life of comfort and family relationships and living in danger. They expose themselves to tropical diseases and death to unravel the secrets of living animals in their natural worlds. They deserve great credit.

Social behavior of crocodilians.—Crocodilian behavioral studies were pioneered by a handful of scientists in the late 1970s and 1980s. Kent Vliet extensively documented the social behavior of American Alligators and other crocodilians (Vliet 1989). He is particularly noted for documenting behaviors while in the water at eye-level with alligators.

Leslie Garrick, while an intern at the Bronx Zoo, New York, documented social signals of American Crocodiles in the Dominican Republic and crocodilians at the zoo (Garrick and Lang 1977). Garrick, together with Jeffrey Lang and Harry Herzog worked on many projects (e.g., Garrick et al. 1978). Lang continued his work in India on Mugger Crocodiles and the Indian Gharial.

R. Howard Hunt, Curator of Reptiles, Zoo Atlanta, was one of the first to successfully breed crocodilians in a zoological setting and reported maternal care behavior in Morelet's Crocodiles (Hunt 1975). Hunt and Myrna Watanabe studied American Alligator behavior (Hunt and Watanabe 1982), in wild populations in Okefenokee Swamp, Georgia, and Hunt later studied crocodile behavior in Belize.

Myrna E. Watanabe, New York University, recorded and documented American and Chinese Alligator vocalizations, and was the first to observe and report nest opening and communication between mother and young, and the maternal behavior of American Alligators (*A. mississippiensis*) in Okefenokee Swamp, Georgia (Watanabe 1980). She later continued her work in China, the first in recent times, collaborating with Chinese scientists on studies involving the Chinese Alligator (*A. sinensis*).

Crocodilian husbandry science.—Three primary strategies were employed for crocodilian conservation: ranching where the wild population remained a source for eggs and young; farming where breeding animals produced offspring that could be harvested when they achieved commercial size; direct harvesting of the wild populations, or in some cases a combination of more than one (Luxmoore et al. 1985). Eventually, farming and ranching initiatives would be present in most of the nations of the world where crocodilians were endemic.

Perhaps the oldest and best known continually operated crocodile farm is the Samut Prakan Crocodile Farm, Thailand, built in 1950. In the 1970s and 1980s, Ted Joanen pioneered modern farming and ranching techniques in Louisiana that are the current basis for commercial crocodile rearing as well as for the captive propagation of endangered and threatened species in zoos. In Africa, Tony Pooley (Natal Parks Board, St Lucia, South Africa) was developing farming strategies for the Nile Crocodile (*C. niloticus*). In South Africa and Zimbabwe, crocodile farms for skins and tourism were well established, and staffers were developing nutrition and immobilization techniques for transporting large crocodiles. In Papua New Guinea, Martin Hollands was developing a model ranching program for locals.

Today, more than 80 caiman farms in Colombia annually produce more than a million crocodilian skins that find their way into the commercial exotic leather trade, mostly comprised of caiman species that may be indiscriminately hybridized. Initiatives to translocate American Alligators, Nile Crocodiles, Saltwater Crocodiles, and other species to countries outside of their natural ranges for farming have been met with disapproval by the international conservation community. Hybridization of crocodilian species to enhance leather and meat production has already threatened the genetic integrity of endangered species, such as the Siamese Crocodile (*C. siamensis*), Morelet's Crocodile (*C. moreletii*), and Cuban Crocodile (*C. rhombifer*).

The crocodilian leather industry's place in the history of crocodilian science.—In 1973, the advent of CITES created an explosion in crocodilian interest and scientific research. To understand the industry implications for crocodilian science, it is important to understand the scope of the industry (MacGregor 2002). The first level of the industry is composed of the people who harvest and produce crocodilian skins. Producers include those who hunt the wild population, and crocodile farmers and ranchers. Suppliers, buyers, and skin graders are the next level in the industry, which move skins from producers to processors. The third level is tanneries, both in and outside producing countries. Another industry supplies chemicals and machinery. A fourth level includes the people who design fashions and the manufacturers who fabricate products made from tanned skins. Last are the buyers and retailers who market products. Until CITES came into force in 1975, the industry identified crocodilian species based on skin quality, skin characteristics, and the degree of processing difficulty (Fuchs 1974a, 1974b). The industry would have to learn a new scientific-based language, crocodilian taxonomy and classification (King and Brazaitis 1971). Compliance with CITES also meant that the industry would be deprived of access to CITES-listed crocodilian species, the crocodilians that had been the mainstay of the industry, whose populations the industry depleted. It was important for the industry to support crocodilian conservation, which, in turn, supported the industry.

Industry scientists reclassified and introduced new species of crocodilians to the scientific literature, although these classifications were largely based on skins of undocumented origins, (Fuchs 1971, 1974a, 1974b; Fuchs et al. 1990; Wermuth 1986; Wermuth and Fuchs 1978; Wermuth and Mertens 1977). This caused some concern about their taxonomic validity among crocodilian scientists (Frair and Behler 1983), but the names were, nonetheless, inadvertently incorporated into CITES identification manuals (CITES, 1981, 1983) for the purposes of international law enforcement.

Some members of the crocodilian industry were instrumental in altering the course of crocodilian science. They recognized that there had to be mutual cooperation to integrate the desire of scientists to halt the abusive use of crocodilians along with the reluctance of industry to conform to new regulation. They saw a need for a new way of dealing with the reality of the diminishing resource.

PHOTO COURTESY WILDLIFE CONSERVATION SOCIETY

FIG. 7. Male Cuban Crocodile, *Fidel*, original founder of a Cuban crocodile captive breeding dynasty, terrorizes the keeper staff during capture at the Bronx Zoo, Reptile House, New York, about 1969.

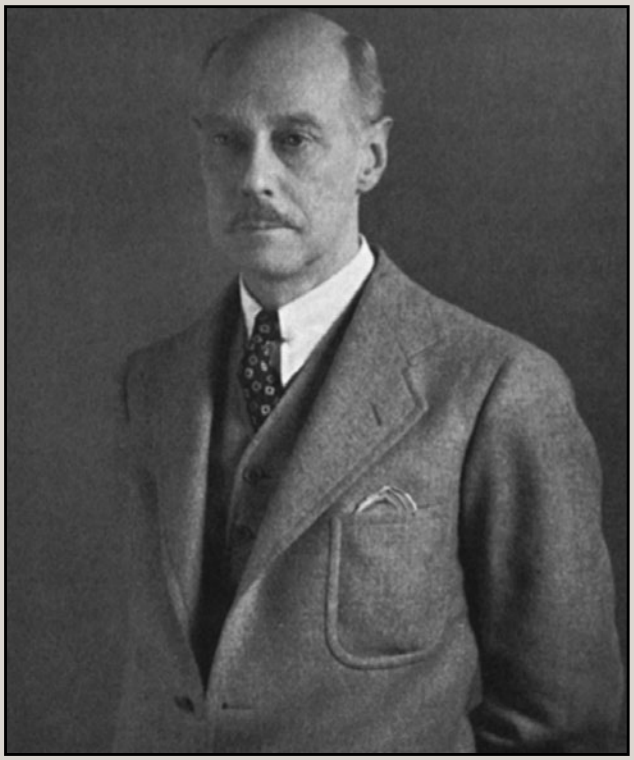

FIG. 8. Raymond L. Ditmars, first Curator of Reptiles at the Bronx Zoo, Wildlife Conservation Society, New York.

Don Ashley, a private alligator marketing consultant, recognized the economic needs of alligator farmers in Louisiana and Florida, yet urged close controls on crocodilian use in a market cleansed of illegal trade (Ashley 1979). Clare Hagan, Hagan and Co., New York, was a highly respected reptile leather product designer who immediately understood the need for change and set out to use her influence in the industry to support crocodilian and sea turtle conservation. Single-handedly, she put a stop to the use of sea turtle leathers in the fashion industry in the United States. Jay Wilson, a skin trader, assisted the IUCN CSG in making industry contacts at all levels of the trade, and helped sponsor South American students from leather-producing countries to go to US universities for education and training. Important leather tanners in the US, France, Japan, and Singapore funded population survey initiatives that would further crocodilian science, along with their own interests in procuring skins.

The AZA Crocodilian Advisory Group and international collaboration.—While international attention was focused on the development of political and national strategies for saving crocodilians and maintaining wild populations on a sustainable basis for commercial utilization, the zoological community recognized that for some species there were too few animals and sometimes no wild habitat left for sustainable populations. A small group of zoologists from some of the leading US zoological institutions met and were determined to take a hand in saving the critically endangered crocodilian species through captive breeding, starting with crocodilian collections already housed in US zoos. A Crocodilian Advisory Group (CAG) was formed and the initiative was sanctioned by the American Zoo and Aquarium Association in 1986. The CAG seeks to provide counsel on all aspects of zoo-based crocodilian conservation, and coordinates the use of available space and developing initiatives in North American zoos. The ongoing success of the AZA CAG would not be possible without the interest and commitment of David Drysdale, owner of the St. Augustine Alligator Farm, St. Augustine, Florida, and its staff.

John Behler, the late curator of reptiles at the Wildlife Conservation Society, New York, led the initiative and developed the first Species Survival Plan (Behler 1982) for a crocodilian, for the endangered Chinese Alligator. Following several unsuccessful attempts at the Bronx Zoo, Behler, Brazaitis, and Joanen, with founder stock from the Bronx Zoo and the Smithsonian National Zoological Park, Washington D.C., established the first collaborative breeding program for a crocodilian species. It stands as a model for AZA captive breeding programs for endangered species.

Colette Adams, Gladys Porter Zoo, Brownsville, Texas, led the initiative to restore Philippine Crocodiles to the wild as a result of a successful captive rearing program at the zoo. While the conservation of the Philippine Crocodile has suffered for lack of funding in the Philippines, Adams and Kent Vliet, CAG chair, are developing funding initiatives for continued captive propagation and future possible reintroduction programs.

The Bronx Zoo, New York, led the early effort to develop captive breeding technology beginning in the mid-1970s. Nine species of crocodilians, including critically endangered Cuban Crocodiles (Fig. 6), Siamese Crocodiles in 1983, and the first captive breeding of the endangered Malayan False Gharial (*Tomistoma schlegelii*) in 1985 in a North American Zoo (Brazaitis and Abene 2008). However, typically, "first breedings" are only a precursor to future successes as technology and husbandry improve and are tailored to the needs of individual animals and species. A pugnacious nature made Cuban Crocodiles particularly

difficult to manage (Fig. 7); juvenile Philippine Crocodiles were found to be totally intolerant, even to each other (Colette Adams, pers. comm.). Breeding of the Malayan False Gharial has now been successful in the private collection of AZA member Bruce Schwedick, and additional captive breeding facilities have been developed at the Virginia Aquarium, Virginia Beach, Virginia.

A global crocodilian community.—Crocodilians were already a subject of interest 100 yrs BC (Grant 1992). Private and zoological collections of crocodilians have existed in many parts of the world (Flower 1937; Honegger and Zeigler 1991; Trutnau and Sommerlad 2006).

The Atagawa Tropical & Alligator Garden in Japan, opened free to the public in 1958, conducted crocodilian breeding research and provided breeding stocks of crocodilians to zoos throughout the world.

The Samut Prakan Province crocodile farm in Thailand opened in 1950 and now houses over 60,000 crocodiles. The farm is a favorite tourist attraction, has published articles on crocodile biology and husbandry, and produces thousands of skins for the exotic leather trade.

The Madras Crocodile Bank Trust, in the state of Tamil Nadu, India, was established in 1976 as the idea of Romulus and Zai Whitaker. The mission of the Trust is to save India's three crocodile species, the Mugger Crocodile, Saltwater Crocodile, and the nearly extinct Indian Gharial.

Crocodile farms exist today throughout the world, in all of the warmer and temperate regions. Commercial husbandry practices were being developed in Australia, South Africa and Zimbabwe prior to the 1971 meeting of the crocodile specialists in New York.

The European zoological community has a long and venerable history involving crocodilian science. The European crocodilian community is part of the EAZA (European Association of Zoos and Aquaria) developing crocodilian captive breeding initiatives similar to those of the AZA CAG. As of 2008, 52 institutions, holding 147 animals, took part in a coordinated Dwarf Crocodile (*Osteolaemus tetraspis*) captive breeding effort that includes the latest in genetic modeling. A second program for the Malayan False Gavial is in development. Ongoing successful programs also include *Crocodylus johnsoni* at Frankfurt Zoo, with 100 offspring produced; a *C. mindorensis* program in development at the Chester, UK zoo; and *Mecistops cataphractus* at the Emmen Zoo, Holland, with more than 100 offspring produced (R. Sommerlad, pers. comm.).

Crocodiles not bad—crocodiles good!—The history of crocodilian science would be incomplete without calling attention to the importance of public awareness of crocodilians. While scientists studied the skulls and skins of crocodilians from the remote regions of the world in the obscure collections of museums and universities, the general public wanted to see and hear about these sometimes immense and terrifying creatures that obviously were related to mythical dragons and dinosaurs, and ate people if they could. This public interest came to the rescue of crocodilians worldwide when crocodilians needed attention most—at the brink of extinction.

Historically, nearly every zoo exhibited at least one crocodile or alligator, the bigger the better. Raymond L. Ditmars (Fig. 8) was curator of reptiles at the New York Zoological Park, New York, from 1899 until his death in 1942. He recognized the scientific value and visitor interest held by crocodilians (DeSola 1933; Ditmars 1913) and made the zoo's crocodilian collection (Fig. 9) one of the most important and well known at the time (Brazaitis and Abene

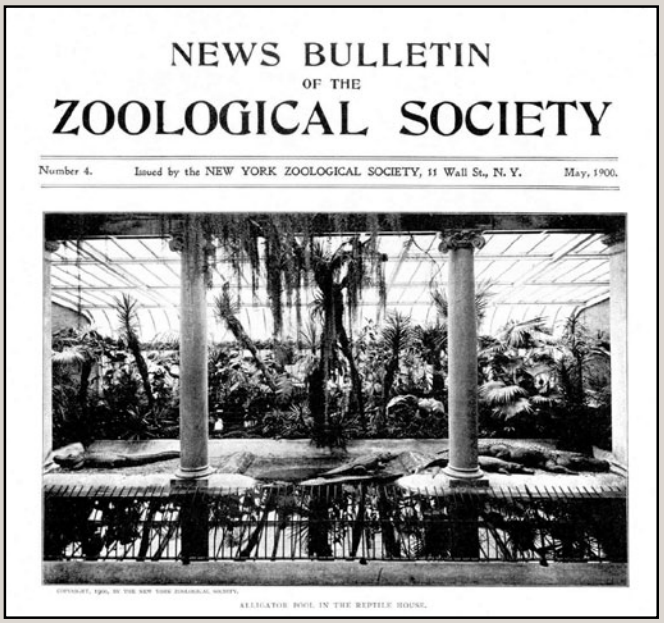
NEWS BULLETIN
OF THE
ZOOLOGICAL SOCIETY
Number 4. Issued by the NEW YORK ZOOLOGICAL SOCIETY, 11 Wall St., N. Y. May, 1900.

FIG. 9. Original 1900 crocodilian exhibit at the Bronx Zoo, Reptile House, designed by Raymond L. Ditmars.

The South Beach Alligator Farm and Burning Spring Museum in the 1890's.

FIG. 10. The St. Augustine Alligator Farm, St. Augustine, Florida, as it appeared in 1890.

FIG. 11. The St. Augustine Alligator Farm, St. Augustine, Florida, as it appears in 2011.

2008) through his popular and scientific publications. The legacy of Ditmars continues today through the work of the AZA CAG.

More than one private entrepreneur has made a living separating the curious from their money by offering a peek at "the biggest alligator in the world" for a small fee. The St Augustine Alligator Farm was never a farm for alligators but began as a tourist attraction that exhibited great numbers of American Alligators (Adams and Shiver 1993). Established in 1893, it continues to thrill and educate thousands of visitors from around the world. The "Alligator Farm" as it is locally called, became an accredited member of AZA in 1989 and under the ownership of David Drysdale, has become a pre-eminent center for crocodilian research and the captive breeding of endangered crocodilian species. It is the only institution in the United States to be dedicated entirely to crocodilian sciences and to exhibit all 23 recognized species of crocodilians.

E. Ross Allen was another early entrepreneur. He founded Ross Allen's Reptile Institute in Silver Springs, Florida, in 1929. The Institute exhibited a variety of crocodilians and other reptiles, and featured the role of the American Alligator in the life and culture of Native Americans. Allen died on May 17, 1981 at the age of 73, before realizing his dream of establishing "Alligator Town," dedicated to the preservation of the American Alligator.

Bruce Schwedick, a member of the AZA Crocodilian Advisory Group and a wildlife educator, pioneered mobile educational programs (Reptile Discovery Programs, Plant City, Florida) that take endangered species of reptiles, including crocodilians, to schools and audiences throughout the United States. As the U.S. representative to the international *Tomistoma* Task Force, he invests considerable time and personal funds to the conservation of endangered crocodilians.

In recent times, perhaps no other person has brought crocodilians to the attention of the public through the medium of worldwide television than Steve Irwin, best known as "The Crocodile Hunter." His television series reached millions of viewers around the world on nearly a daily basis. He and his wife Terri coowned and operated the Australia Zoo in Beerwah, Queensland, featuring Australian crocodilians and conservation. Irwin died on 4 September 2006 after being fatally stung by a stingray. Adam Britton, an Australian scientist, continues the effort to bring crocodilian science and education to the public forefront. There are many other private individuals who, in their own way, contribute immensely to the development of crocodilian sciences.

Many popular writers have contributed to crocodilian literature and science. Among the best known are Raymond L. Ditmars and Ralf De Sola of the then-New York Zoological Society (Ditmars 1913; DeSola, 1933), Wilfred T. Neill (Neill 1971), and C. A. W. Guggisberg (Guggisberg 1972).

It is fitting that this preliminary history of crocodilian science should end with illustrations of the precursor of the St. Augustine Alligator Farm as it appeared in 1890 (Fig. 10) and 120 years later (Fig. 11), spanning the period when crocodilian science has made some of its greatest advances.

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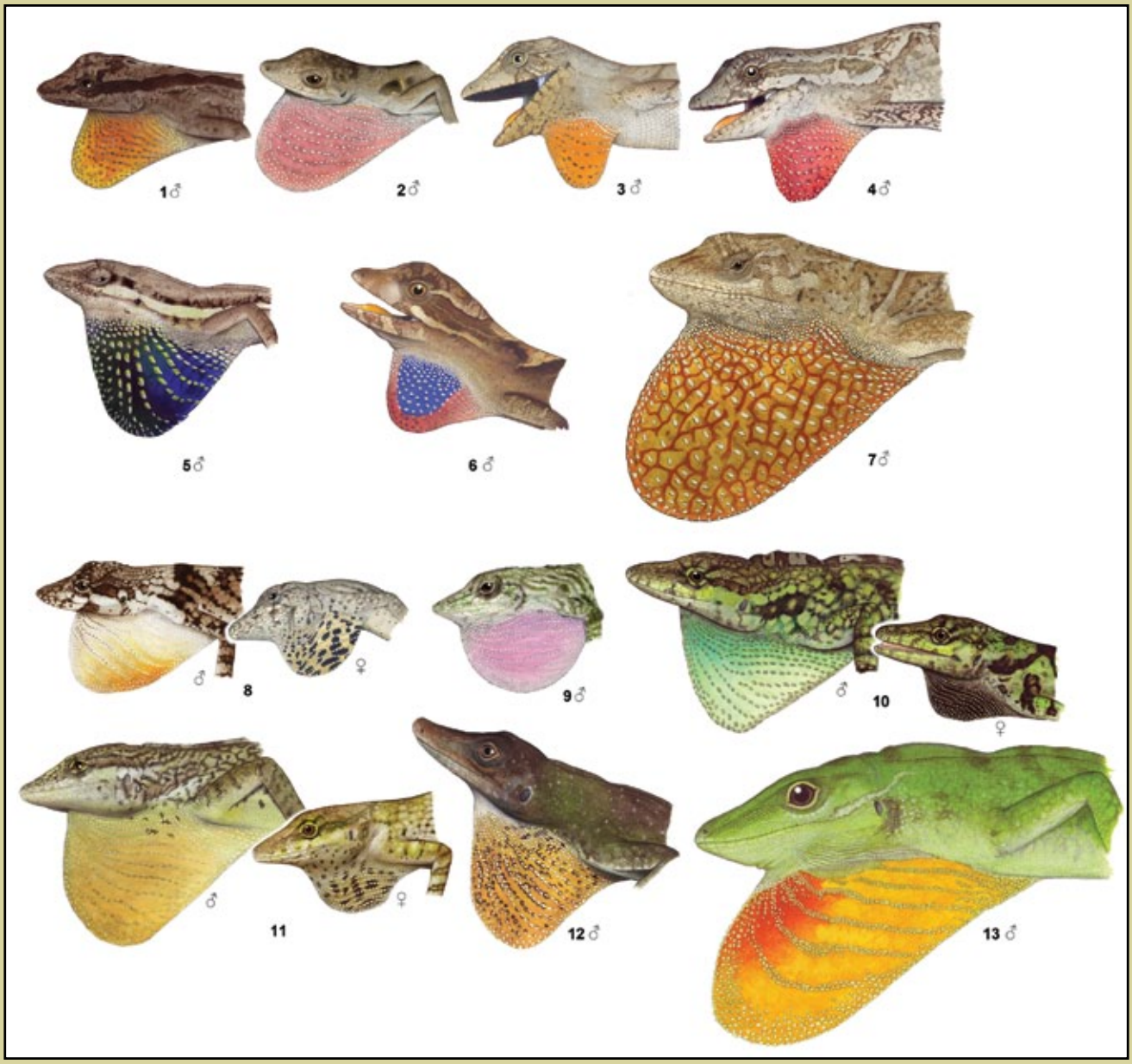

Dewlap Coloration of Some Species of Anoles from Venezuela

One of the most conspicuous characteristics of anoles (genus *Anolis*) is the presence of an extensible and often colorful dewlap or throat fan, which these lizards extend during territorial or sexual displays. The dewlap is always conspicuous in males (reduced in only a couple of species), and is slightly smaller to rudimentary in females. Coloration, size, and squamation of the dewlap are often species-specific and of high diagnostic value. Illustrated here are the dewlaps of eleven of the 24 currently known species of Venezuelan anoles: 1) *Anolis tropidogaster* male, 2) *Anolis fuscoauratus* male, 3) *Anolis chrysolepis planiceps* male, from localities on northcentral and northwestern Venezuela, 4) *Anolis chrysolepis planiceps* male, from localities on southern Venezuela, 5) *Anolis auratus* male, 6) *Anolis chrysolepis scypheus* male, 7) *Anolis onca* male, 8) *Anolis tigrinus* male (left) and female (right), 9) *Anolis euskalerriari* male, 10) *Anolis anatoloros* male (left) and female (right), 11) *Anolis jacare* male (left) and female (right), 12) *Anolis punctatus* male, 13) *Anolis squamulatus* male.

Gabriel N. Ugueto is a graphic designer, illustrator, and herpetologist born in Venezuela, but he has resided in Miami, Florida, since 1999. He has worked for the past eight years on the systematics and taxonomy of the South American herpetofauna. Currently, Gabriel's main interests are the systematics of Teiidae, *Anolis, Polychrus, Phyllodactylus,* and the herpetofauna of the Venezuelan islands in the southern Caribbean. His recent publications have appeared in *Caribbean Journal of Science, Zootaxa, Herpetological Review,* and *Herpetological Monographs* and include descriptions of several new species and taxonomic revisions. Additionally, he is the senior author of *Amphibians and Reptiles of Margarita, Coche and Cubagua*, Edition Chimaira, 2010. His illustrations appear in his own publications and those of several colleagues. Recently, his illustrations of lizards were published in *Libro Rojo de La Fauna Venezolana.*

Gabriel prepared this panel of Venezuelan anoles using a mixed technique that includes crayons, watercolor, and gouache. Each illustration was based on color photographs or direct observation of live specimens. The illustrations were then scanned and final touches were added digitally. Some of his scientific illustrations can be viewed at http://kana-hebi.deviantart.com

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Professional and Amateur Herpetology in Germany and German-speaking Countries

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The DGHT, German Society for Herpetology and Herpetoculture ("Deutsche Gesellschaft für Herpetologie und Terrarienkunde e.V.," www.salamandra-journal.com, www.dght.de), was founded in 1964 as a successor of the German herp group "Salamander" going back to the year 1918. One of the founders of DGHT was the famous German herpetologist Robert Mertens. As implied by its name, DGHT philosophy is to bring together professional scientists and amateurs, thus promoting their dialog at an international scale. This gives the society a unique strength currently uniting more than 7,000 members including several, in herpetology, internationally well acknowledged honorary members.

The society's mission is to contribute to both research on amphibians and reptiles and captive keeping and breeding. DGHT is strongly engaged in herpetological conservation and is accredited by the German Federal Nature Conservation Act. The society runs three funds: the Wilhelm Peters Fund dedicated to herpetological research, the Hans Schiemenz Fund attributed to assessing and protecting natural populations of amphibians and reptiles, and, in collaboration with the Zoological Society for the Conservation of Species and Populations (www.zgap.de), a fund supporting conservation activities to protect threatened amphibian and reptile species.

FIG. 1. *Mertensiella* focuses on special topics such as varanid lizard research (Advances in Monitor Research I and II, published in 1991 and 1999, respectively).

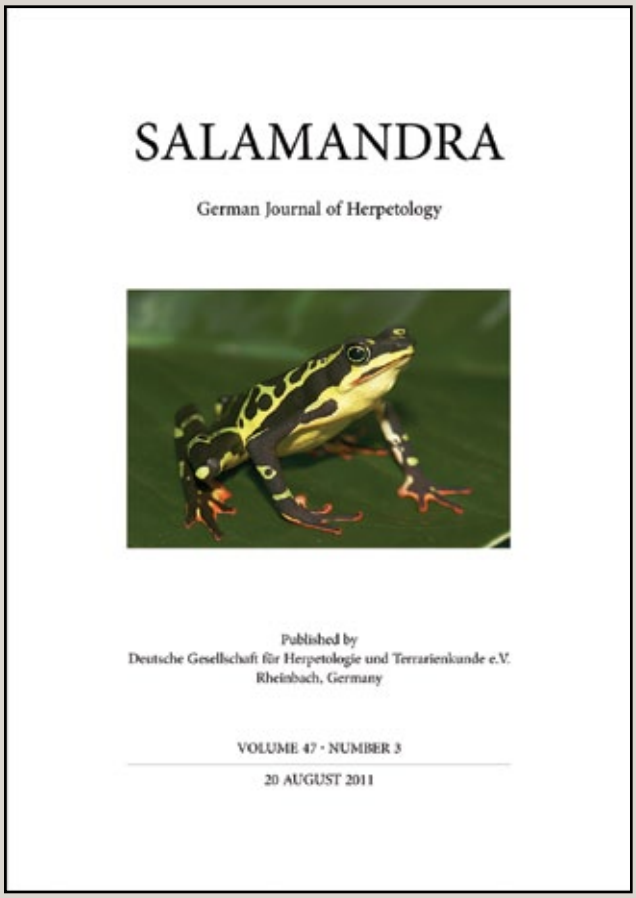

FIG. 2. *Salamandra* is the society's flagship scientific journal, published exclusively in English, covering broad range of topics, including systematics, ethology, ecology, and conservation biology.

Since the "Year of the Frog 2008," DGHT, in cooperation with the Association of German Zoo Directors (www.zoodirektoren.de), is involved in amphibian ex situ conservation efforts. Our activities especially unit conservation breeding projects run in Austria, Germany, and Switzerland and aims at a joint venture of zoos and private keepers. One of the target species is the critically endangered CITES Appendix 1 newt, *Neurergus kaiseri* (Luristan Newt), with currently more than 3,000 individuals, 85% of which are captive-bred.

DGHT is divided into more than 50 subgroups; besides local and regional branches in Germany, Austria, and Switzerland, there are working groups which put particular focus on different herps (e.g., anurans or chelonians), special topics (e.g., history of herpetology, veterinary science), or even more specialized on particular taxa (e.g., chameleons). Subgroups have their own meetings independent from the annual international meetings of the society combining herpetological science ("Deutscher Herpetologentag") and herpetoculturism, including herp travel reports, conservation, captive breeding, etc. ("DGHT-Nachzuchttagung"). Note that in September 2011, DGHT for the first time held a joint scientific meeting with Societas Europaea Herpetologica, SEH (www.seh-herpetology.org), the European herpetological society, at Luxembourg.

Among the print media of DGHT are *Salamandra—German Journal of Herpetology*, a quarterly journal publishing scientific contributions in English in all fields of herpetology, listed under Current Contents and soon under the Science Citation Index (available online), *Mertensiella*, a sporadically published supplement with special issues on particular topics (e.g., symposium volumes), *elaphe*, a colored quarterly German magazine reporting on different aspects of herpetology and herpetoculture, as well as internal political issues of DGHT. Furthermore, most of the working groups publish additional separate journals, e.g., *Radiata* (with English and German editions) (Figs. 1–4).

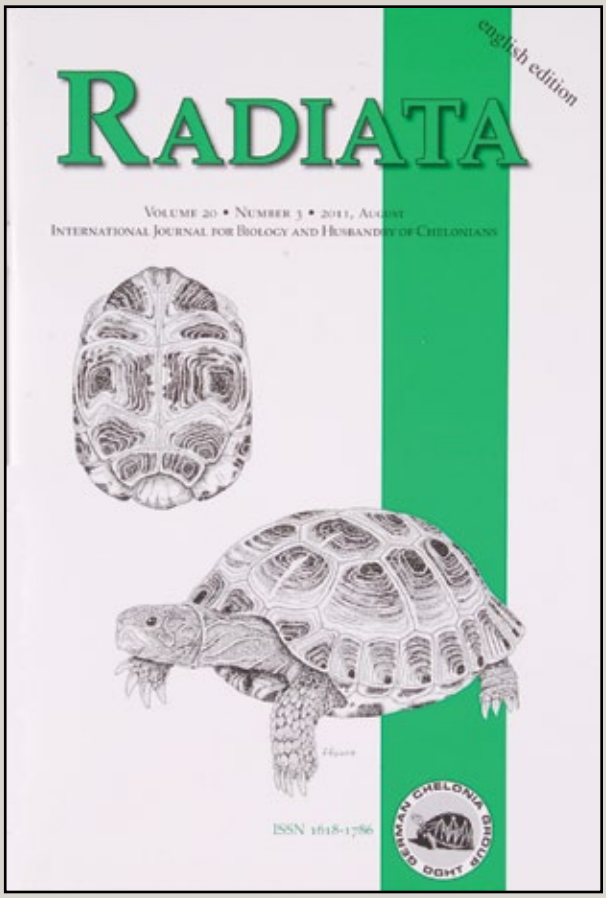

FIG. 3. *Radiata* focuses on the natural history, herpetoculture, and conservation of turtles and tortoises, and is published in German and English.

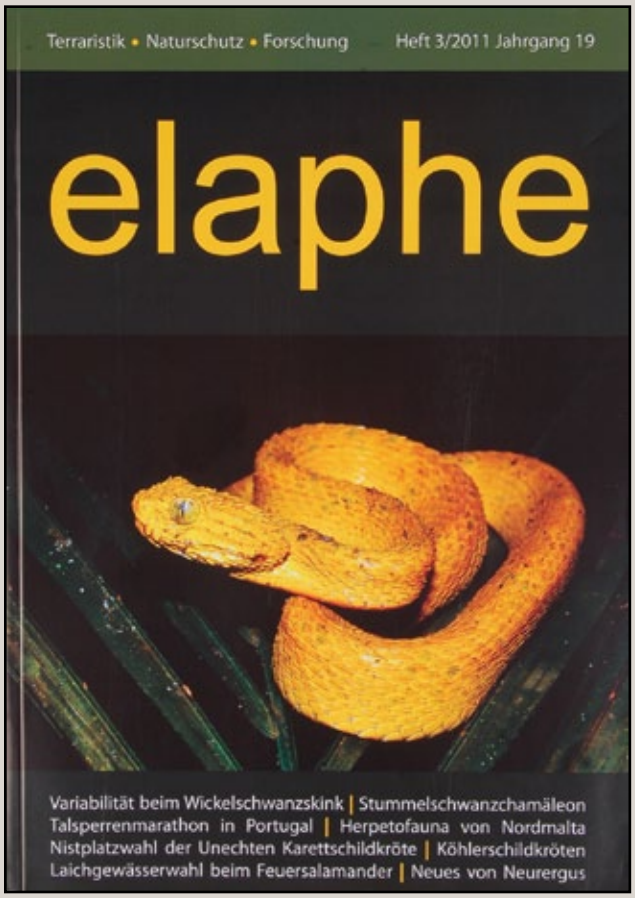

FIG. 4. The German language quarterly *elaphe* covers herpetology and herpetoculture, as well as news and information about the DGHT.

Herpetological Review, 2011, 42(4), 500–501.

Comment on the Conservation Status of the Desert Tortoise(s)

PHOTO BY JASON FOLT

FIG. 1. Adult *Gopherus morafkai* at burrow entrance, Maricopa County, Arizona, October 2010.

PHOTO BY TODD PIERSON

FIG. 2. *Gopherus morafkai*, Pima County, Arizona, August 2011.

Murphy et al. (2011) proposed that the Desert Tortoise (*Gopherus agassizii*) be split into two separate species. As suggested by their title, the authors made a significant effort to disentangle a dizzying array of confusion surrounding the taxonomy of the species. They elevated populations south and east of the Colorado River in Arizona and Mexico to species level and named them *Gopherus morafkai*, with tortoises north and west of the Colorado River retaining the name *Gopherus agassizii* (Figs. 1–4). Currently, *G. agassizii* (*sensu stricto*) is listed as Threatened under the U.S. Endangered Species Act (ESA), with the listed entity defined as a distinct population segment (Mojave population) of the larger species (*sensu lato*; USFWS 1990, 2010a). The Sonoran population segment (*G. morafkai*) was determined to be warranted for listing under the ESA, but precluded by higher priorities (USFWS 2010b). The boundaries and genetic basis for the species delineation proposed by Murphy et al. (2011) and the population designations recognized under the ESA are completely analogous, both divided precisely along the Colorado River.

After describing their taxonomic investigation, Murphy et al. (2011) comment on implications for conservation as a result of the proposed new species recognition, which would reduce the geographic range of *G. agassizii* to about 30% of its previously recognized range. These comments include several statements that are misleading or factually incorrect, which I wish to clarify here. Specifically, the paper's authors claim that "[t]he most important implication of describing *G. morafkai* is that Arizona and Mexico can no longer be considered to harbor a genetic reservoir for the Mojavian population of the desert tortoise" (and *vice versa*) and that the reduced range of *G. agassizii* indicates that the species may more appropriately be classified as Endangered, rather than Threatened.

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The first claim, that each species can no longer be considered a genetic reservoir for the other, is based on a premise with no historical basis, that tortoises on either side of the Colorado River were ever considered genetic reservoirs for one another. Recognition of genetic differences between the two populations/species of Desert Tortoises predates the listing of the Mojave population in 1990 (Jennings 1985; Lamb et al. 1989). Nothing in the listing rule, original recovery plan, or revised recovery plan suggest reliance upon the opposite population as a genetic reservoir. The final listing rule for the Mojave population recognized that the Colorado River "has been an effective geographic barrier, separating the Mojave and the Sonoran populations for millions of years" (USFWS 1990). The original recovery plan specifically recognized the importance of genetic differentiation in its recommendation that genetically homogeneous populations should be the sole basis for any research into translocations of Desert Tortoises (USFWS 1994). The revised recovery plan places greater emphasis on the use of experimental population augmentation as a recovery strategy, but it also specifically mentions the need to consider genetics in such a program (USFWS 2011). In summary, neither population/species has been considered a genetic reservoir for the other in Desert Tortoise management history.

The second claim, that the reduction in range of *G. agassizii* (*sensu stricto*) warrants species classification as Endangered, also ignores regulatory history. As noted above, the Fish and Wildlife Service recognized the distinction between the Mojave and Sonoran populations at the time the Mojave population was listed as Threatened. The status determination for the Mojave population of the Desert Tortoise was based on a threats analysis specific to that population (USFWS 1990; see also USFWS 2010a). Consideration of—or even the existence of—tortoises on the opposite side of the Colorado River played no part in determining that the Mojave population should be classified as Threatened, rather than Endangered. Likewise, the status determination for the Sonoran population was independent of the status, abundance, or existence of the Mojave population (USFWS 2010b). Taxonomic elevation of the Sonoran population to a full species has no effect on the Federal regulatory status of either species.

PHOTO BY KEVIN DURSO

FIG. 3. Adult *Gopherus agassizii*, Clark County, Nevada, May 2009.

PHOTO BY JACK GOLDFARB (WWW.JACKGOLDFARBPHOTOGRAPHY.COM)

FIG. 4. Adult *Gopherus agassizii*, Desert Tortoise Natural Area, Kern County, California, May 2009.

While Murphy et al. (2011) may have clarified long-standing confusion surrounding the taxonomy of the Desert Tortoise, clarifying the confusion their paper created about the conservation of the species is more than just an esoteric exercise. Press releases associated with the release of this paper generated a significant amount of media attention and public exposure about the new species and their supposed status (e.g., Center for Biological Diversity 2011; Danelski 2011). Incorrect public perception about how the proposed taxonomic change affects the species' status can only undermine the effectiveness of the ESA. Overstating a species' degree of endangerment, or otherwise misrepresenting important considerations relative to the species' status, opens the door to accusations by critics of the ESA of the distortion of science to serve ulterior, advocacy-based motives. On the other hand, setting unwarranted public expectations that new listing designations or regulatory changes should be forthcoming is destined to cause disillusionment among ESA proponents about the Act's effectiveness. Neither scenario serves the conservation purposes of the ESA.

Whether or not one agrees with the current official status designations of *G. agasszii* or *G. morafkai* under the ESA, tortoises on both sides of the Colorado River are recognized to be suffering from population declines. Conservation efforts are appropriately focused on factors contributing to these declines and on factors inhibiting the species' ability to maintain self-sustaining populations. Exaggerated claims of species imperilment distract from this focus.

Acknowledgments.—I thank L. Allison, C. Darst, K. Field, and C. Mullen for providing helpful comments to improve readability of the manuscript. The findings and conclusions in this article are those of the author and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

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ARTICLES

Herpetological Review, 2011, 42(4), 502–504.

Natural History Notes on the Ecology and Conservation Status of the Honduran Endemic Frog *Isthmohyla insolita* (Anura: Hylidae)

The Honduran endemic frog *Isthmohyla insolita* (McCranie, Wilson, and Williams; Fig. 1) was previously known to occur only at its type locality (McCranie and Wilson 2002), a small stream in primary forest at 1550 m elevation in the Cerro Texíguat Wildlife Refuge in the Cordillera Nombre de Dios of north-central Honduras. Egg masses of this species have been found on vegetation overhanging the stream and males were reported to attend single egg masses at night (Wilson et al. 1994; Fig. 2). During 2–6 September 2003, we visited the type locality of *I. insolita* to determine its population status. Herein we report *I. insolita* from a second nearby stream and include information on spatial distribution of its nests, behavior of a male guarding an egg mass, and an apparent population decline of the species at the type locality.

The second *Isthmohyla insolita* locality (15.4305°N, 87.3089°W) is a small stream at 1690 m elevation that is covered by secondary growth vegetation, consisting mainly of bushes 1–3 m in height and some scattered trees attaining heights of about 5 m. Apparently a landslide destroyed the original forest because for about 10–20 m on either side of the stream there is little soil and leaf litter and the ground is littered with rocks, logs, large fallen trees, and other debris apparently carried down by the landslide. The stream was about 50 cm wide and about 30 cm deep at its deepest point in the area we worked. The immediate area above the landslide supports moderately disturbed broadleaf cloud forest (Lower Montane Wet Forest formation, Holdridge 1967). The vegetation structure at the second locality differs significantly from the complex forest structure and high plant diversity at the type locality stream. In addition, the second stream is considerably smaller than the type locality stream, where an average width of about 3 m and a depth of about 1 m occurred in many places during September 2003. This new locality is about 0.5 km N of the species' type locality.

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On 4 September 2003, we heard several male *Isthmohyla insolita* calling near this new locality stream. Males began calling at 1845 h (about 15 min before dark) from vegetation overhanging the stream. One egg mass and one male were located and two other males were calling along the same section of the stream. These males were still calling when we left the site at about 1950 h.

During the day of 5 September 2003, we searched for egg masses in about a 150 m transect along the new locality stream. We found five *Isthmohyla insolita* egg masses (not collected). The five egg masses contained 47–76 (mean = 62.0 ± 11.7) eggs and were 1.5–3.4 m (mean = 2.6 ± 0.96) above the water. Wilson et al. (1994) reported that six *I. insolita* nests contained 23–44 (mean = 33.8 ± 8.5) eggs at the type locality stream in primary forest. The number of eggs per nest was significantly greater in the disturbed habitat than in primary forest ($t = 4.61$, $p = 0.001$, $df = 9$). The significance of the higher egg numbers in the nests found in the disturbed habitat at the new locality is unknown, but we stress that our results are restrained by the lack of multiple site analyses. All egg clutches were placed on the upper surface of leaves directly over the water. Four of the five nests found in 2003 were exposed to direct sun light, at least during some hours of the day. *Isthmohyla insolita* probably breeds throughout the rainy season as we found egg masses in the process of hatching, as well as recently laid egg masses.

Also during the day of 5 September, we located an adult male *Isthmohyla insolita* near one of the egg masses mentioned above. The frog was apparently sleeping 1.2 m above the water, with the egg mass suspended 2.0 m above the male's daytime retreat and on a different plant. The frog was perched in a head up position on the vertical stem of a small plant. On the afternoon of 6 September, the frog was in the same place and position as the previous day. We waited nearby for dark and recorded its behavior from 1735 to 1914 h. The frog began slow movements towards the egg mass at 1740 h until it reached a point about 2 cm from the eggs at 1833 h. After its first initial movement of about 1 cm, the frog began an alternating series of face rubbing (with alternating movements of its hands) and push-ups that lasted about 6 min. These actions were followed by a series of yawns that lasted about 3 min. The frog then varied its movements between remaining motionless, short jumps, and short walking movements until it reached its perch site near the eggs.

At 1835 h, the frog hit the leaf five times (about one hit per second) with its left hand. Each hit was strong enough to agitate the eggs in the mass. The frog remained motionless in that position until the end of the observation period at 1914 h (neither the frog nor the eggs were collected due to concerns about the species' population status).

There is a considerable diversity of parental care known in anurans, but attendance of arboreal eggs placed above streams is rare in the Neotropics. The best-known example of this type of behavior is that of the centrolenid genus *Hyalinobatrachium* and in some species of that genus this behavior is related to hydric brooding and guarding the eggs from predators (Duellman and Trueb 1986; Savage 2002). The attendance of terrestrial nests by salamanders is related to mechanical agitation of the eggs and is thought to serve the purpose of aeration and prevention of adhesions (Duellman and Trueb 1986; Bruce 1998). The behavior observed in *Isthmohyla insolita* does not appear to be related to hydric brooding, but at least one of the observed frog's actions could be described as mechanical agitation of the eggs. Longer periods of observation are needed to decipher the purpose and benefits of this complex behavior.

During the period of 2–6 September 2003, we walked three nights for about 3 h each (from about 1800 to 2100 h) along the stream at the type locality of *Isthmohyla insolita*. We did not find nests or adults of *I. insolita* along this stream, and heard only two males calling the first two nights. Thus, the abundance of *I. insolita* at that time appeared to be lower at its type locality than that observed during the previous visits to the stream in 1991, 1993, and 1995. The reason for this apparent decline might be related to the availability of nesting sites. During October 1998, Hurricane Mitch caused severe flooding in this region of Honduras. Rivers draining the southern flanks of the mountains in which the *I. insolita* localities lie, now flow in central channels among wide boulder fields devoid of vegetation. Such damage was also evident along the *I. insolita* type locality stream during 2003. On the second author's previous visits to the locality, there was abundant leafy vegetation and moss covered tree branches overhanging the stream that were being used as nesting sites by *I. insolita* (see Wilson et al. 1994; McCranie and Wilson 2002). However, during September 2003, there was very little vegetation overhanging the stream and moss covered branches above the stream were absent. Thus, nesting sites were either unavailable or limited in scope at that time and might have been the reason for the few frogs along this stream at that time. However, complicating this scenario is that between 1993 and 1995 declines in other streamside frogs apparently occurred along this stream (McCranie and Wilson 2002). During August 1991 and July–August 1993, the hylid frogs *Plectrohyla guatemalensis* and *Ptychohyla spinipollex* and the craugastorid frogs *Craugastor aurilegulus* and *C. stadelmani* were frequently seen along this stream. However, during July 1995, *Ptychohyla spinipollex* was present in reduced numbers, but the other three frog species could not be found despite a concerted effort to do so. *Isthmohyla insolita* remained common at the site during July 1995, so the factors causing the decline of the other species did not appear to be affecting the *I. insolita* population at that time. During September 2003, *Ptychohyla spinipollex* remained in low population densities at the type locality stream, but was not found at the second stream. The other three species of frogs still could not be found in September 2003 at the former stream or at the second stream. The survey methods and number of man hours spent were similar in all visits to the locality.

FIG. 1. Adult male (KU 219987, top) and female (USNM 330193, bottom) of *Isthmohyla insolita* from the type locality.

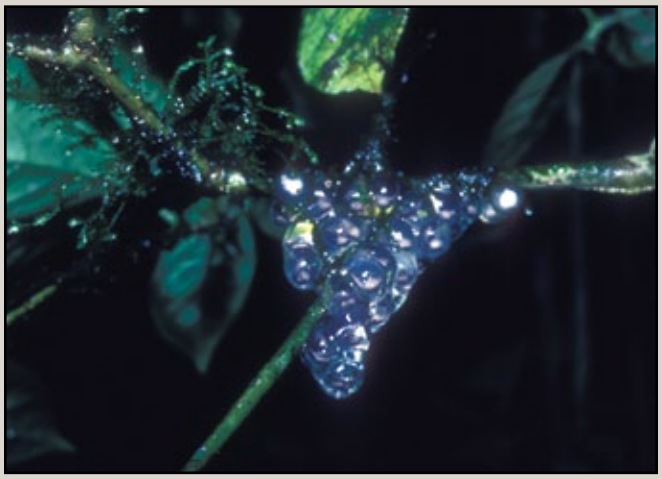

FIG. 2. Egg mass (USNM 330202) of *Isthmohyla insolita* from its type locality.

McCranie and Wilson (2002) used an Environmental Vulnerability Gauge in an effort to identify species that were most vulnerable to population declines. The higher the score for a given species, the more likely it is for that species to be vulnerable. *Isthmohyla insolita* scored a 15, just below the highest attained score (16). Wilson and McCranie (2003a, 2003b) modified that gauge with the highest attained score becoming 17. *Isthmohyla*

insolita scored 16 in that revised gauge. Thus, it is evident that continued monitoring of this species and additional natural history studies are urgently needed.

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Live Fast, Die Young? A Six-Year Field Study of Longevity and Survivorship in Blanchard's Cricket Frog (*Acris crepitans blanchardi*)

Tetrapods typically have overlapping generations and are long-lived organisms; however, some remarkable exceptions to this pattern are known. For example, Karsten et al. (2008) recently documented a chameleon from Madagascar with a post-embryonic life span of only 4–5 months. Among frogs, a recent review of the literature found that some species can be quite long-lived under natural conditions, especially in the temperate zone (up to 37 years; Bell and Pledger 2010; Wells 2007). Relatively small-bodied species tend to have shorter life spans (~ 3–5 years). For example, Spring Peepers (*Pseudacris crucifer*) have been estimated with skeletochronology to survive a maximum of four or five years (Lykens and Forester 1987; Zimmitti 1999) and typically begin breeding in their third spring (as two year olds). In contrast, a number of tropical frogs are known to be short-lived (1–2 years; e.g., Galatti 1992; Kluge 1981; Lehtinen 2009; Ramirez et al. 1998). However, in environments with little seasonality, much of the year is presumably suitable for activity, permitting rapid growth and attainment of reproductive maturity. Thus, the apparent greater longevity of temperate frogs may in part reflect the reduced opportunities for growth and the necessity of dormancy during unsuitable times of the year.

One temperate frog species that is thought to have a very short life span is Blanchard's Cricket Frog (*Acris crepitans blanchardi*). Pyburn (1961) provided the first evidence of a short lifespan when he reported fall breeding populations in Texas that consisted almost entirely of known young of the year (see also Pyburn 1958). Similarly, Bayless (1969) found evidence of fast growth rates in Blanchard's cricket frogs, such that metamorphs could likely grow to reproductive maturity and breed within the same year they metamorphosed. Burkett (1984) captured over 3500 individuals in populations near Lawrence, Kansas and estimated that the average lifespan was only 4 months with complete population turnover occurring in approximately 16 months. More recently, McCallum et al. (2011) summarized data on the seasonal distribution of body sizes which also was suggestive of rapid growth and a short life span. Thus, a number of previous studies have been suggestive of a short life span in Blanchard's Cricket Frogs, yet none of these studies was explicitly focused on the determination of longevity and most were of relatively short duration. Given that an annual life history in a temperate frog would be highly unusual, additional confirmatory data are needed. This is particularly important at present, as this species is thought to be in decline over much of the northern portion of its range (Gray et al. 2005; Lannoo 1998; Lehtinen 2002; Lehtinen and Skinner 2006). Here, we use individual recapture histories and seasonal variation in body size from a six-year field study to provide data on longevity of this species under natural conditions.

Methods.—The study site consisted of seven ponds at or adjacent to St. Marys Fish Hatchery in Grand Lake St. Marys, Auglaize County, Ohio, USA (40.517°N, 84.417°W). Twenty-six site visits spanned 2004–2009 (Table 1) where from one to eight persons attempted to capture all post-metamorphic (or nearly metamorphosed) Blanchard's Cricket Frogs encountered. Most site visits occurred during daylight hours and frogs were captured by hand with the assistance of dip nets. We focused our sampling activity along the pond margins, where cricket frog activity is concentrated (Burdick and Swanson 2010; Martinez-Ortiz 2004; Pyburn

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1958; Smith et al. 2003) but also regularly checked adjacent grassland and woodland habitats. Ponds were sampled by walking in a single direction around the pond to avoid recapturing recently marked individuals (and thus artificially inflating recapture rates). All captured individuals were sexed externally (by the presence of breeding coloration in the throat of males - this was only possible during the breeding season) and measured (snout-vent length, SVL) using Mititoyo SC-6 digital calipers to the nearest 0.1 mm. All captured individuals were classified into one of three size categories: adult (≥ 23 mm SVL), subadult (17–22 mm SVL) and metamorph (10–16 mm SVL). These categories were based on the size at which we first observed secondary sexual characteristics and the observed range of sizes at metamorphosis (individuals with the tail not yet fully resorbed). This population of Blanchard's cricket frogs has tested positive twice for the fungal pathogen *Batrachochytrium dendrobatidis* (hereafter *Bd*): once in 1999 (see Zippel and Tabaka 2008) and again in 2006 (Steiner and Lehtinen 2008).

From 2004 to 2007, all captured cricket frogs received a year-specific toe clip (one toe only) to indicate the year in which they were first marked such that a minimum known lifespan could be established for recaptured individuals. Toes were clipped using scissors, which were sterilized with 95% ethanol after each use (Ferner 2007). In 2008, we more intensively sampled this population and used visual implant elastomer (VIE, Northwest Marine Technology Inc., Shaw Island, Washington, USA) to give individual marks to each adult captured. Only adults were marked in 2008 and 2009 as we sought to more rigorously assess both within-season mortality and inter-annual survival in adults. This method was used in favor of using multiple toe clips to uniquely mark individuals because some research has suggested that clipping more than one toe can decrease survival (McCarthy and Parris 2001, 2004). Two colors of elastomer were used (fluorescent pink and orange). Six ventral body locations were used as elastomer injection sites (upper arms and upper and lower legs) using 0.3-cc syringes. A deep-violet flashlight (λ = 405 nm) was used to aid in the detection of elastomer marks if the marks could not initially be detected under ambient light. In 2009, site visits were concentrated in May and June to attempt to recapture adults marked in the previous breeding season.

Kruskal-Wallis tests were used to test for significant differences in SVL among months (data pooled for all years). Sequential Mann-Whitney tests were then used as post-hoc tests to identify which groups differed significantly from one another. For these comparisons, the level of significance was adjusted with the Bonferroni procedure (α = 0.0033). Parametric procedures could not be used with the SVL data as test assumptions were strongly violated. An independent-samples *t*-test (assumptions checked using Kolmogorov-Smirnov, Shapiro-Wilk and Levene tests) was used to assess sexual size dimorphism in adults. Too few recaptures were obtained to estimate population sizes; therefore, we examined trends in abundance with a linear regression of catch-per-unit-effort (number of frogs captured per person-hour of sampling effort) versus time. Because of the goals of the study and the nature of the resulting data (see Results), longevity estimates were estimated empirically from recaptured individuals; we did not employ capture-mark-recapture models.

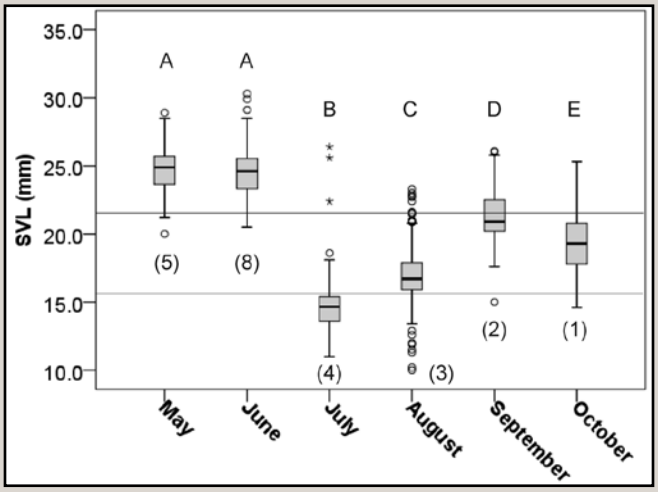

FIG. 1. Boxplot of cricket frog SVL versus month of collection (N = 961). Each box represents 50% of cases; the line across the box is the median value. The whiskers extending from each box represent the minimum and maximum values for that month (circles are outliers, asterisks are extreme outliers). Months that share letters above the boxes are not significantly different. The solid horizontal lines indicate the approximate boundary between metamorph and juvenile body size (below) and juvenile and adult body size (above). The number of site visits in each month is given in parentheses below each box. Note that body size data in this figure is pooled over all years and therefore mixes data from multiple cohorts together.

TABLE 1. Summary of 2004–2009 mark-recapture data from *Acris crepitans blanchardi*. CPUE = catch per unit effort (# frogs captured per person-hour of effort).

				Recaptures						
Year Marked	# Site Visits	CPUE	# Marked	2004	2005	2006	2007	2008	2009	Between-year Recapture Rate
Adults, subadults, and metamorphs marked										
2004	3	12.0	564	3	2	0	0	0	0	0.004
2005	5	2.5	64	-	0	0	0	0	0	0.000
2006	3	5.1	116	-	-	1	2	0	0	0.017
2007	3	1.9	51	-	-	-	2	3	0	0.059
Only adults marked										
2008	10	1.9	125	-	-	-	-	38	0	0.000
2009	2	10.5	41	-	-	-	-	-	0	0.000

Results and Discussion.—Previous studies have suggested that Blanchard's cricket frogs grow and attain sexual maturity quickly and have a short life-span (e.g., Bayless 1969; Burkett 1984; Pyburn 1961). However, all of these prior studies were relatively short-term (< 1–3 years) and most were conducted in southern portions of the geographic range. This left open the possibility that a longer-term study or one in a more strongly temperate climate might reveal different patterns. On the contrary, our data confirmed the patterns previously documented. A total of 961 individuals were captured and marked over the course of our study. Of these, 51 were recaptured (5.3% recapture rate, including individuals recaptured multiple times; Table 1). Forty-four of the recaptures occurred within the year the individual was initially marked (86%). The remaining seven recaptures (14% of total, Table 1) were all originally marked in the previous year. No individuals were recaptured that had been marked two or more years previously. The seven inter-annual recaptures were not necessarily two year olds because from 2004 to 2007 all individuals received the same year-mark and these individuals may have been marked initially as metamorphs. To further examine whether adults return to breed in a subsequent year, we marked only adults in 2008 (N = 125). None of these were recaptured in 2009 (Table 1). Within-season recapture rates were especially high in 2008, which we attribute to a larger number of sampling sessions that were more closely spaced in time. Thus, based on our six years of mark-recapture data, we found no convincing evidence of any individuals that survived to be more than one year old.

Our data on body size patterns are consistent with these conclusions. Blanchard's Cricket frogs showed a significant difference in SVL among sampled months (Kruskal-Wallis Test: $\chi^2 = 541.0$, df = 5, $P < 0.001$). Post hoc tests revealed that body size did not differ significantly between May and June but that all other months were significantly different from one another (Fig. 1). In May and June of all years, captured individuals were always adult-sized and in breeding condition. But by July, we were unable to find any adult-sized individuals (other than the three adults found in July 2008). Individuals captured in July and August were exclusively metamorphs and juveniles (the mean SVL dropped from 24.8 mm in June to 15.0 mm in July; Fig 1) indicating a shift from a strictly adult-based age structure to one dominated almost entirely by juveniles (i.e., complete population turnover—no overlapping generations). This result cannot be explained simply as adult emigration from ponds after breeding since no frogs were ever found in other habitats and we have no evidence that any individuals returned to breed in any subsequent year. Subadults were only found in August, September and October but never in May, June or July. Some individuals from September and October were beginning to approach full adult body size (Fig. 1). Note that in Figure 1 individuals captured in October are smaller on average than those captured in September. This is an artifact of pooling data among years (2 samples were available from September (2006 and 2007) but only one from October (2004)). Breeding adult Blanchard's cricket frogs showed a significant sexual dimorphism in body size ($t = 6.686$, d.f. = 89, $P < 0.001$), with females being 10.2% larger on average than males (male mean 23.7 ± 1.7 SD, female mean 26.4 ± 1.9 SD).

While these data and that from other studies (see citations above), have suggested that Blanchard's Cricket Frogs are short-lived, other evidence suggests that this is not always the case. For example, using mark-recapture methods Gray (1983) found a few cricket frogs that had survived two winters. Using skeletochronological methods McCallum et al. (2011) documented a two-year old individual from Texas, and unpublished skeletochronological data from central Indiana has documented three-year old individuals (S. Perrill, pers. comm.). Zippell and Tabaka (2008) reported Blanchard's Cricket Frogs surviving nearly four years in captivity (using individuals collected from the same study site as we report on here). Thus, from these studies it seems clear that Blanchard's Cricket Frogs are physiologically capable of surviving longer than a single year and yet our study and others (Burkett 1984; Gray 1983) indicate that this rarely occurs under natural conditions.

So, why is survivorship so low? At our study site, it was not obvious that any likely predators were particularly abundant and indeed, we never witnessed any predation events. It is possible that infection with *Bd* is directly or indirectly involved in the short lifespan and low survivorship observed in our study. However, this also seems unlikely to us for several reasons. First, previous studies on Blanchard's cricket frogs have reported similar results to ours (see above) and some of these studies were probably conducted before any *Bd* was present (although this is impossible to ascertain for certain). Secondly, while Steiner and Lehtinen (2008) reported the St. Marys population to be positive for *Bd*, the infection rate was only 14% (based on PCR amplification of skin swabs from 42 individuals in 2006) and in six years of work at this site, we never observed any dead or dying frogs. Thirdly, if the frogs collected by Zippel and Tabaka (2008) were infected with *Bd* when collected (which seems likely), they survived a remarkably long time with the infection. Lastly, while catch-per-unit-effort is a rather crude measure of abundance, a linear regression analysis showed no significant linear trend in catch-per-unit-effort versus year ($F = 0.013$, $P = 0.914$, $r^2 = 0.03$). Thus, we found no evidence of decline in overall numbers during the study period and the nature of the high mortality rates remains unexplained.

Like other previous studies, our data suggest that newly recruited individuals grow rapidly and can be near adult size by the time the activity season ends (Fig. 1). In this population, most individuals metamorphose in July or August and breeding begins the following May. Therefore, sexual maturity appears to be attained in 9–10 months after metamorphosis (and an appreciable proportion of this time is spent over-wintering; Irwin et al. 1999). Compared to many other temperate hylids, this is an extremely rapid attainment of sexual maturity. For example, Lykens and Forester (1987) showed that male and female *Pseudacris crucifer* breed for the first time in their third spring (as two-year olds) and can live up to five years. Freidl and Klump (1997) found *Hyla arborea* to reach reproductive maturity in two years with a maximum documented longevity of six years. Two chorus frog species (*Pseudacris nigrita* and *P. ornata*) from the southeastern US reach reproductive maturity at a similarly rapid pace to that documented here (Caldwell 1987). However, some individuals were found to survive to breed more than once (maximum annual survivorship at her study sites was 33% and 11% for *P. ornata* and *P. nigrita*, respectively). Our mark-recapture and body size data suggest that Blanchard's Cricket Frogs grow to reproductive maturity in less than one year and that the first reproductive attempt is likely the last. However, as other studies have found older individuals and captive individuals are known to live nearly four years, this seems like less of an evolved life history strategy (i.e., semelparity) and more of a situation where extremely high extrinsic mortality is present.

This "facultative annual" life history of Blanchard's Cricket Frogs may be a factor in its decline in the northern part of its range. More long-lived species can potentially put off reproduction in bad years but given the short life span, this may not often be possible in Blanchard's Cricket Frogs. While a variety of factors have been implicated in the decline (see Gray et al. 2005 and Lehtinen and Skinner 2006 for summaries), a demographic structure such as the one confirmed here would seem to predispose this species to rapid population dynamics and frequent turnover events. To separate natural population fluctuations and local extinctions from human impacts, monitoring efforts for this species would likely benefit from a adopting a monitoring strategy on a large spatial and temporal scale.

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Colonization of Hawaii Island by the Brown Anole (*Anolis sagrei*)

The Brown Anole (*Anolis sagrei* Dumeril and Bibron 1837) is a potent invasive lizard species. Native to Cuba and the islands of the Bahamas, it has been introduced to Florida, Hawaii, Taiwan, Jamaica, and Granada (Williams 1969; Campbell 1996; reviewed by Campbell, 2003). Florida introductions are the product of multiple colonization from across the native range of *A. sagrei* (Kolbe et al. 2004), and these highly admixed populations have further spread across the southeastern US displacing the native Green Anole, *A. carolinensis* (Voigt 1832) (Lee 1985; Tokarz and Beck 1987; Gerber and Echternact 2000; Campbell, 2003). In addition, molecular evidence indicates that Florida populations are the probable source of geographically widespread introductions to St. Vincent (Eales and Thorpe 2010), Hawaii, Grand Cayman, Taiwan, and Granada (Kolbe et al. 2004).

On the Hawaiian archipelago, *Anolis sagrei* was first reported from Oahu in 1992 and subsequently from Kauai and Maui (Kishinami and Kishinami 1996; Kraus 2003; 2006). McKeown (1996) observed this species in 1980 in a small residential neighborhood in Lanikai on windward Oahu, and further noted that, at that time, it had spread to adjacent towns and to the leeward side into Waikiki. Kraus (2002) reported establishment of additional satellite populations that included Pearl Harbor. He also noted that, where present, *A. sagrei* achieves high-density populations.

We report here that *Anolis sagrei* has new established populations on Hawaii Island. WJM first observed and collected *A. sagrei* on 29 May 2010 in irrigated ornamental vegetation on the grounds of a beach-front resort at Kahuwai Bay, a site (GPS 19.82828°N, 155.99130°W, WGS84, elev. 3 m) on the northwest coast of Hawaii Island approximately midway between Kona and Kawaihae. On 20 July 2010, we conducted a two-observer walking survey on the paths of this resort and an adjacent resort to the north (GPS 19.83006°N, 155.98877°W, WGS84, elev. 2 m). We conducted our survey during mid-day conditions with clear skies and light wind. We surveyed the more southerly resort between 1005 and 1150 h (105 min of continuous observation by two individuals), and observed 26 *A. sagrei*, 2 *A. carolinensis*, 4 Gold Dust Day Geckos (*Phelsuma laticauda*), and 1 Snake-eyed Skink (*Cryptoblepharus poecilopleurus*). We observed both juvenile and adult *A. sagrei* indicating that an established breeding population existed at the site. This resort is characterized by an open canopy with heavily irrigated, low ornamental shrubs and forbs along paved walkways, and scattered trees among the resort residences. At the adjacent resort to the north between 0935–1000 and 1340–1450 h (95 min total survey time), we observed 0 *A. sagrei*, 4 *A. carolinensis*, 6 *P. laticauda*, and 20 *C. poecilopleurus*. Although there was no apparent physical barrier to inhibit lizard movement between the two resorts (the two properties share a boundary), the northerly site is a cultivated xeriscape with a canopy of kaiwe (*Prosopis pallida*, a kind of mesquite), ironwood (*Casuarina glauca*), and ornamental palm trees with an open understory of scattered shrubs such as oleander (*Nerium oleander*).

Further to the south, a third resort at Kukio Bay offers irrigated habitat similar to the *Anolis sagrei*-inhabited resort, but is separated by an extension of a golf course that narrows to 50 m at the coast and expands inland. A second walking survey by one of us (WJM) on 2 December 2010 indicated that *A. sagrei* have not yet crossed this exposed, open grass barrier. Walks on three paths from the beach into the Kukio Bay resort (GPS 19.82127°N, 155.99661°W, WGS84, elev. 3 m) from 1053–1134 h (25 min observation time by one individual) in heavily irrigated habitat revealed 2 *P. laticauda* and 4 *C. poecilopleurus*, but no *A. sagrei*. Between 1150 and 1245 h, two segments of walking survey at the irrigated Kahuwai Bay resort (total 29 min observation time) yielded 4 *A. sagrei*, 1 *A. carolinensis*, 1 *Phelsuma laticauda*, and 1 *C. poecilopleurus*, while a 21-min survey of the northern xeriscaped resort between 1134–1150 h yielded 1 *A. carolinensis*, 1 *P. laticauda*, and 6 *C. poecilopleurus*. The three resorts at Kukio and Kahuwai Bay are collectively isolated from other suitable habitat for these *Anolis* lizards by extensive lava flows. These uncultivated lava flows are relatively young (1500–5000 yr B.P, based on USGS Misc. Investigations Series Map 1-2524-A), barren of trees and large shrubs, and receive less than 50 mm of annual rainfall (Juvik and Juvik 1998). We presume that *A. sagrei* cannot cross them without human assistance.

Another Hawaii Island colonization of *Anolis sagrei* has recently been reported from an eastern Hawaii Island residential neighborhood (19.68342°N, 155.08233°W, WGS84, elev. 102 m) in Hilo (Krysko and Granatosky 2010). On 27 January 2011, WJM surveyed this site and found that this species was distributed among a network of six residential streets south and west of the point of observation by Krysko and Granatosky (2010). The survey yielded 62 adult and juvenile *A. sagrei* and 2 Metallic Skinks (*Lamprophollis delicata*) over 47 min of walking where *A. sagrei* were present. The survey extended about 200 m beyond the last *A. sagrei* observation on any street direction away from the population center. GPS locations at the seven terminal points of *A. sagrei* observations yielded a circumscribed population with a minimum polygon area of 10.3 ha centered at 19.68218°N, 155.08287°W. No *A. carolinensis* were observed during the survey, although they are not uncommon in Hilo, and a resident confirmed that the newly introduced *A. sagrei* look different from the less abundant *A. carolinensis* typically seen among yard foliage.

Acting on the hypothesis that plant nurseries with inter-island wholesale plant outsourcing could be a pathway for anoles colonizing Hawaii Island, we visited two large retail nurseries in Hilo. *Anolis sagrei* was present in ornamental vegetation just outside one of these at the intersection of Railroad Avenue and

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Makaala Streets (19.69844°N, 155.05820°W, WGS84, elev. 27 m). Voucher specimens of the three separate populations of *A. sagrei* have been deposited with the Bishop Museum in Honolulu: BMNH 36981–36984.

The populations of *Anolis sagrei* on Hawaii Island are likely very recent colonists, presumably from established populations on other islands in the state. While *A. sagrei* may have arrived at Kahuwai Bay and Hilo in imported ornamental plants, they pose an immediate threat of future, human-mediated expansion. The presence of both young and adult lizards at both sites confirms that these are already established breeding populations, and the species is clearly proficient at such stratified diffusion expansion as documented by Campbell (1996) for *A. sagrei* spreading through Florida to Georgia, Louisiana, and Texas. If its populations expand on Hawaii Island, we might expect *A. sagrei* to partially or completely displace *A. carolinensis*, as it has in Florida. As *A. sagrei* achieves remarkably high density populations where present on Oahu (Kraus 2002) and in our lizard counts on Hawaii Island, the species, alone or in combination with other invasive lizards, might pose a more significant threat to native arthropod species than *A. carolinensis* has in the past. Given the current limited distribution of *A. sagrei* on Hawaii Island, we strongly recommend that immediate action be taken to eradicate it before it can spread further.

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The Harvest of *Antaresia maculosa* (Pythonidae) from West Papua, Indonesia

New Guinea is the largest tropical island in the world. It hosts 5–7% of the world's biodiversity (Dinerstein and Wikramanayake 1993; Myers et al. 2000) and 5% of the world's reptile species (Allison 2007). The island is politically divided between Indonesia and Papua New Guinea (PNG). The Indonesian provinces of West Papua (in the west) and Papua (in the east bordering PNG) were virtually closed to research through the latter part of the 21st century. As such, there are nearly 30% fewer reptile species recorded from Indonesian Papua compared to neighboring PNG (excluding islands in the Bismarck and Solomon Archipelagos), a difference likely explained by biases in search effort between the two countries (Allison 2007).

One family of large enigmatic snakes, the Pythonidae, has, however, been well documented. Australasia is home to the greatest diversity of python species in the world, with 12 species being known from mainland New Guinea (O'Shea 1996; Schleip 2008). Pythons are large bodied, non-venomous constrictors and are often brightly or contrastingly colored. As a result, they have been heavily exploited for the international pet trade, with large numbers of individuals being taken from West Papua each year to meet ever-growing domestic and international demand (Yuwono 1998).

Despite the relative conspicuousness of these snakes compared to other reptile species it was not until the year 2000 that O'Shea et al. (2004) discovered the genus *Antaresia* near the

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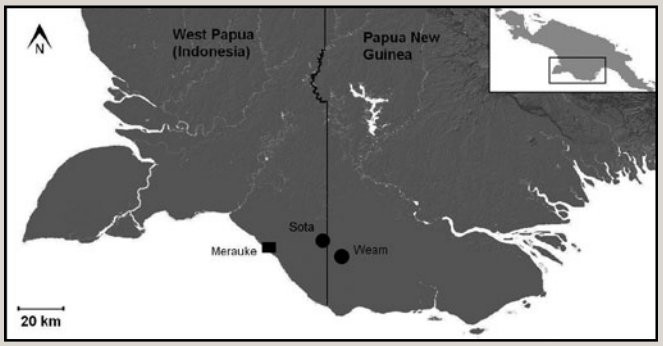

FIG. 1. Locality records of *Antaresia maculosa* in southern New Guinea (●) and the nearby port town of Merauke (■).

FIG. 2. An *Antaresia maculosa* from the vicinity of Sota, Papua, Indonesia.

village of Weam in southern PNG (Fig. 1). *Antaresia* is a genus of small, widespread python species common in many habitats in neighboring Australia (Wilson and Swan 2008). O'Shea et al. (2004) tentatively identified the species as *A. maculosa* (Spotted Python). Wuster et al. (2003) suggested that woodland species may have utilized two routes of migration between New Guinea and Australia (one from Queensland and another from the Northern Territory). *Antaresia maculosa* and *A. childreni* inhabit each area, respectively. Thus, further work is needed to validate the relationship of New Guinea specimens to those in Australia.

It is not currently known whether the lack of specimens collected in New Guinea is due to limited distribution, small population size, or merely limited collection effort in suitable habitat. Herein we report the first records of *Antaresia maculosa* from West Papua and discuss the implications of trade for the conservation of this python in New Guinea.

Observations.—While in the field between December 2010 and March 2011 we recorded four *Antaresia maculosa* individuals from the south of Papua (Fig. 2). These were collected by local people at three separate locations within a 5 km radius of the village of Sota (8.4280°S, 140.9916°E; WGS84) near the Indonesian/PNG border (Fig. 1). All pythons were found opportunistically; two were found at night while crossing a road. The snakes were collected by villagers and sold to two reptile traders in the nearby port town of Merauke. From Merauke, traders shipped the pythons to reptile dealers in the Indonesian capital, Jakarta, and we were told that they were destined for the international pet trade.

Discussion.—This is the first record of *Antaresia maculosa* from Papua. However, it is not surprising that the species occurs in the vicinity of Sota due to the habitat similarity with Weam in PNG (DJDN and JAL, pers. obs.). There are significant areas of suitable tropical woodland habitat in southern New Guinea (Bowe et al. 2007), so it is probable that the distribution of *A. maculosa* is considerably greater than the few records suggest.

Allison (2006) identified the conservation status of *Antaresia maculosa* from New Guinea as being of concern due to its restricted distribution and potential for exploitation by the pet trade. Of concern is that the genus was not previously known to occur in Papua, but has apparently been traded for at least the last five years. All Indonesian pythons are currently listed under Appendix II of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), which regulates their export. In Indonesia the CITES management authority (PHKA) sets harvest quotas for Appendix II listed species with guidance from the Indonesian Institute of Science (LIPI). Species that are not assigned a quota cannot be harvested and because *A. maculosa* has not previously been recorded in Indonesia it does not have a harvest quota so cannot be legally traded. Traders indicated that the snakes were highly sought after for the international pet trade fetching up to US $80 each in Jakarta. It is not currently known whether they were, in fact, exported from Indonesia; however, given that the Indonesian domestic demand for reptiles is in its infancy this is highly likely. Because *A. maculosa* is currently unknown to the Indonesian CITES Management Authority any export from Indonesia is illegal.

The international trade in exotic pets is a growing threat to the world's biodiversity (Nijman 2010). Large numbers of reptiles from Indonesian Papua are harvested annually (DJDN and JAL, pers. obs), however, the effects of this trade have not been determined. At present, the status of *A. maculosa* in Papua is unknown. Now that the species has been confirmed as occurring in the region, surveys are needed to establish the sustainability of the trade in these pythons. We suggest that until the non-detriment findings required under Article IV of CITES for Appendix II species has been undertaken, no quota be set for the wild harvest and trade of these snakes.

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Putative Predation and Scavenging of Two Sea Turtle Species by the American Alligator, *Alligator mississippiensis*, in Coastal Southeastern United States

The food habits of the American Alligator (*Alligator mississippiensis*) are well documented in many freshwater systems (salinity < 5 ppt) throughout its native range (Barr 1997; Delany and Abercrombie 1986; Gabrey 2010; Rice 2004). In marine (salinity > 25 ppt) and estuarine (variable salinity between 5 ppt and 25 ppt) habitats, however, the dietary interactions and food habits of *A. mississippiensis* have received little attention by researchers; limited data exist from Louisiana (Gabrey 2010; McNease and Joanen 1977; Wheatley 2010), Wassaw Island, Georgia (Tamarack 1988, 1993), and Cumberland Island, Georgia (Shoop and Ruckdeschel 1990). To date, no comparative analysis among marine or estuarine populations has been performed. The aforementioned studies indicate that *A. mississippiensis* foraging in marine and estuarine environments consume a variety of prey items including crustaceans (e.g., blue crab, shrimp, crayfish), horseshoe crab, teleost fishes (e.g., mullet, gar, shad, top-minnows), small mammals (e.g., nutria, raccoon, mink), and multiple species of wading birds. Here we report the first accounts of *A. mississippiensis* consuming marine reptiles: Green Sea Turtle (*Chelonia mydas*) and Loggerhead Sea Turtle (*Caretta caretta*).

Observations.—The most recent incident occurred on 25 September 2010 when a sea turtle flipper tag (# TTF-850) was recovered from the stomach of harvested adult male *A. mississippiensis* (total length [TL] = 352 cm, mass = 243 kg). This *A. mississippiensis* was harvested near the mouth of the New River, South Carolina, USA (32.100139°N, 81.088088°W), during a recreational hunt. The flipper tag was subsequently mailed to the Archie Carr Center for Sea Turtle Research (ACCSTR) to report the finding and to collect a returned tag reward.

During a sea turtle nesting survey along South Ponte Vedra Beach, Florida, USA on 17 September 2010 the carapace of a juvenile *Chelonia mydas* (straight carapace length [SCL] = 20.5 cm, straight carapace width [SCW] = 17.3 cm) was found in the sand along the surf (30.07329°N, 81.334190°W, Guana Tolomato Matanzas National Estuarine Research Reserve [GTM-NERR] catalog # 978). No plastron accompanied the carapace.

Eight conical puncture wounds were located laterally along the posterior of the carapace (Fig. 1). The puncture pattern was determined to be bite marks from an adult *A. mississippiensis* (K. Vliet and P. Gignac, pers. comm.). Verification was made chiefly due to the spacing between puncture wounds and the diamond-shaped indentations left when teeth did not fully perforate the bone, typical of crocodilian dentition (P. Gignac, pers. comm.). Given the size and spacing of the puncture wounds in the *C. mydas* carapace, we estimate that the *A. mississippiensis* involved was approximately 2 m TL. Additionally, markings on the turtle carapace indicate that the *A. mississippiensis* adjusted and manipulated the prey item in its mouth in an attempt to break up and swallow the *C. mydas* (Fig. 1).

Four observations of dead *C. caretta* being scavenged by *A. mississippiensis* were made on three separate Georgia barrier islands during ongoing sea turtle nesting surveys sponsored by the Georgia Department of Natural Resources (GADNR) and the U.S. Fish and Wildlife Service (USFWS). The most recent of these observations occurred at 2011 h on 10 May 1999. Caretta Research Project (CRP) personnel found the remains of a moderately decomposed sub-adult *C. caretta* (SCL = 55.0 cm, SCW = 45.9 cm, straight plastron length = 32.3 cm, straight plastron width = 37.9 cm, GADNR biopsy specimen # GA99051001-WASI) on the north end of Wassaw Island, Georgia (31.90395°N, 80.93882°W). CRP personnel pulled the carcass further up the beach toward the dunes so that it would not wash out later that night during high tide. Later that night, at 2300 h, the same personnel encountered a large *A. mississippiensis* (TL 2.7–3.0 m) investigating the aforementioned turtle carcass. The patrol left the *A. mississippiensis* and *C. caretta* carcass at 2330 h. The following day at 1200 h, CRP personnel traveled back the location of the carcass to take photographs of the specimen for GADNR documentation. Upon arrival, they found tracks from an adult *A. mississippiensis* originating at the stranding site and leading westward toward the dunes. The only remaining evidence of the turtle carcass at the stranding site was a depression where the turtle had been placed, two costal scutes, and the right front flipper. Pieces of the decomposing turtle were present along the alligator's route, which was

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indicated by tracks leading into the dunes. The parts included three scutes (with epibiota still attached), five ribs, two hyoplastra, the upper and lower tomia, marginal, and pygal bones, horse-shoe crab claws (presumably stomach contents from the turtle), and portions of the esophagus with visible papillae. Turtle parts and alligator tracks led directly to an alligator hole located on the eastern edge of Beach Pond (31.90500°N, 80.94000°W) approximately 150 m away from where the stranded carcass had originally been placed.

Researchers on other Georgia barrier islands have observed three similar instances of sea turtle scavenging. An *A. mississippiensis* was seen scavenging a *C. caretta* carcass on Blackbeard Island (31.46732°N, 81.21866°W) in 1998 (D. Keineth, pers. comm.). Additionally, two instances occurred on Little St. Simons Island (31.26932°N, 81.30078°W) in 1995 and 1996, in which *A. mississippiensis* were observed carrying decomposing *C. caretta* carcasses down the beach to freshwater wetlands located behind the dunes (M. Robinson, pers. comm.).

Discussion.—Two other crocodilian species have been reported to consume sea turtles. *Crocodylus porosus* (Estuarine Crocodile) on Crab Island, Queensland, have been observed patrolling beaches to capture nesting *Natator depressus* (Flatback Sea Turtle) and *Lepidochelys olivacea* (Olive Ridley Sea Turtle) as female turtles search for suitable locations to dig nests and oviposit (Limpus et al. 1983; Sutherland and Sutherland 2003). It was estimated that during sea turtle nesting season *C. porosus* will consume a minimum of one adult turtle per week in this location (Sutherland and Sutherland 2003). Additional records of *N. depressus* predation by *C. porosus* are reported from Papua New Guinea (Hirth et al. 1993). In Costa Rica, *Crocodylus acutus* (American Crocodile) were recorded consuming nine adult *L. olivacea* (Ortiz et al. 1997) following nesting events.

In freshwater systems, *A. mississippiensis* have been documented to prey upon several freshwater turtle species within the genera *Apalone*, *Deirochelys*, *Kinosternon*, *Pseudemys*, *Sternotherus*, and *Trachemys* (Barr 1997; Delany and Abercrombie 1986; Gabrey 2010; McNease and Joanen 1977; Wolfe et al. 1987). In three Florida lakes, Delany and Abercrombie (1986) found turtles to be the most common prey type recovered from the stomachs of adult male alligators greater than 3.0 m total length. With regard to the information reported here, only two of the six observations potentially represent predation of marine turtles; the other four most certainly represent scavenging of dead turtle carcasses by *A. mississippiensis*.

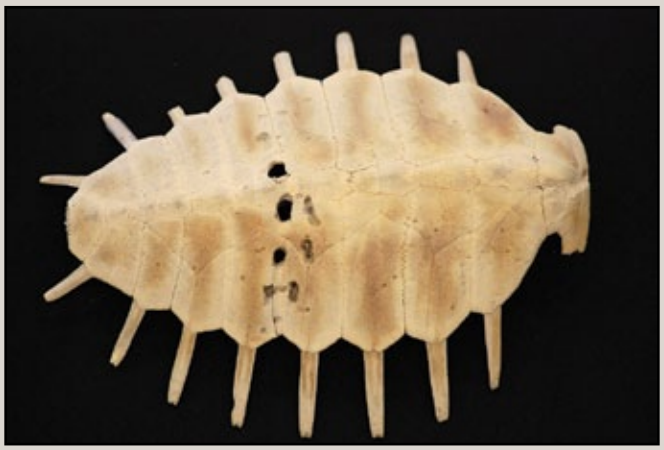

FIG. 1. Photograph of the carapace of a *Chelonia mydas* with bite marks identified as those of an *Alligator mississippiensis* measuring ca. 2 m TL.

Following the discovery of a flipper tag in the stomach of an adult *A. mississippiensis* on 25 September 2010, ACCSTR personnel found the tag had originally been applied to the right front flipper of a *Caretta caretta* that had been reared in captivity by the National Marine Fisheries Service Lab in Galveston, Texas, during 2005–2006. The turtle was used in the testing of turtle excluder devices and subsequently released off Sebastian Inlet State Park in Brevard County, Florida, on 6 July 2006. The last measurements taken in 2006 (SCL = 43.4 cm, SCW = 35.5 cm, mass = 10.63 kg) indicate that the turtle may have been >70 cm SCL in 2010 (P. Eliazar, ACCSTR, pers. comm.). At this size the *C. caretta* would have been far too large for an adult *A. mississippiensis* to consume whole (Erickson et al. 2003). Therefore, three plausible explanations exist for the presence of the flipper tag in the stomach of the harvested *A. mississippiensis*: 1) the alligator consumed the right flipper of the live turtle; 2) the alligator scavenged portions of the turtle after it had died; or 3) the alligator consumed the flipper tag after it had already fallen off the turtle. The type of flipper tag attached to this particular turtle (i.e., inconel metal) can remain attached for up to 5 or more years (P. Eliazar, pers. comm.) and it is highly resistant to corrosion. Thus, it is most likely that the flipper was removed from a live or stranded turtle and that the appendage was digested by the *A. mississippiensis*, leaving only the indigestible tag behind.

The second observation of potential predation was the finding of a *C. mydas* carapace on 17 September 2010. At the estimated size of 2 m TL, the alligator responsible for the bite wounds could not have swallowed the turtle whole. It is possible that the *A. mississippiensis* consumed the plastron, viscera, head, and appendages and then abandoned the remainder of the carcass, as these portions were missing from the turtle. We were unable to determine if the *C. mydas* was captured alive and killed by the *A. mississippiensis* or if the turtle was found stranded dead.

We speculate that one of two scenarios accounts for the *C. mydas* carapace on the beach. More probable, an adult *A. mississippiensis* crossed the 100–250 m of beach scrub habitat and FL-A1A from Guana Lake within the Guana Wildlife Management Area (GWMA) to access the beach shoreline. Guana Lake, a 10 mile long man-made impoundment (30.074216°N, 81.337261°W), is home to a large resident *A. mississippiensis* population as indicated from ongoing mark-recapture and GPS telemetry studies (J. Nifong, unpubl. data). Although rarely reported, *A. mississippiensis* have been observed on multiple occasions traversing FL-A1A and roaming in the surf along South Ponte Vedra Beach (J. Ellenberger, pers. comm.). Alternatively, the predation event could have taken place within the Intracoastal Waterway and the turtle remains subsequently carried out to sea through the nearby St. Augustine Inlet.

For sea turtle species that return to nesting beaches along the southeastern coast of the United States, peak nesting occurs in summer from June–August (S. Eastman, pers. comm.). Many of these nesting beaches are located within the home ranges of *A. mississippiensis* which occupy dune swales and coastal freshwater wetlands. *Alligator mississippiensis* using these coastal habitats regularly travel to estuarine and marine habitats in search of prey (Tamarack 1988), some spending as much as 87% of their time in fully marine waters as determined from GPS telemetry studies (J. Nifong, unpubl. data). During nesting season it is likely that *A. mississippiensis* encounter adult sea turtles along nesting beaches in shallow water or on-shore, providing the opportunity

for capture. In deeper open water, adult sea turtles would most likely evade capture by *A. mississippiensis*. Furthermore, a number of estuaries along this coast serve as nursery grounds for juvenile sea turtles such as *C. mydas* (S. Eastman, pers. comm.). Given that *A. mississippiensis* use the same habitat for foraging, it is possible that *A. mississippiensis* encounter juvenile sea turtles in these nursery areas while in search of prey. Although the observations reported here are widely separated both geographically and temporally (i.e., 15 years) we believe the predation of sea turtles by *A. mississippiensis* may occur regularly yet remain undetected in most cases.

Sea turtle strandings are often used to estimate the annual mortality of sea turtle species in the United States, even though two studies have questioned the practice (Shoop et al. 1998; Shoop et al. 1999). Because many factors influence the likelihood of a dead sea turtle washing ashore, the possibility exists that strandings represent only a fraction of the overall annual mortality actually occurring in near-shore waters. Additionally, because *A. mississippiensis* may removed a small percentage of beached turtles via scavenging, researchers are potentially underestimating the true number of dead turtles washing ashore, especially in coastal habitats supporting high alligator densities. More information is needed to determine the frequency of these scavenging events before we can accurately assess the effect of *A. mississippiensis* scavenging on the real number of dead turtles washing ashore annually along the southeastern Atlantic and Gulf coasts.

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CONSERVATION

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A Review of the Chile Mountains False Toad, *Telmatobufo venustus* (Amphibia: Anura: Calyptocephalellidae), with Comments on its Conservation Status

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Sandwiched between the Andes Mountains to the east, the Pacific Ocean to the west, and the Atacama Desert to the north, a narrow strip of southern Chile houses temperate humid forest (Aravena et al. 2002). These forests are biologically unique owing to their isolation. The temperate humid forests of southwest South America have been isolated since the Tertiary Period (Aravena et al. 2002; Villagrán and Hinojosa 1997) and house significant numbers of endemic plants and animals (Aravena et al. 2002; Armesto et al. 1996; Arroyo et al. 1996). Not surprisingly, the amphibian fauna is largely endemic. There are minimally 37 anurans unique to these forests, constituting no less than 85% of the regional amphibian fauna including three endemic genera and an endemic family to Chile (*Calyptocephalella*, *Insuetophrynus*, *Telmatobufo*, and the Calyptocephalellidae, respectively) (Díaz-Páez et al. 2008; Vidal et al. 2008). One of the amphibians found only in these southern forests is the Chile Mountains False Toad, *Telmatobufo venustus* (Figs. 1A–C).

In 1899, Philippi described *Bufo venustus* from four specimens collected in the Andean foothills of southern Chile. In 1952, Schmidt erected the genus *Telmatobufo*. Formas and Veloso reassigned *Bufo venustus* to *Telmatobufo venustus* in 1982. The genus contains three other species: *T. australis* (Formas 1972), *T. bullocki* (Schmidt 1952), and *T. ignotus* (Cuevas 2010). All known *Telmatobufo* are endemic to southern Chile. Formas et al. (2001) discussed taxonomic relationships among the then-recognized three species of *Telmatobufo*. Hypothesized phylogenetic relationships between *Telmatobufo* and *Calyptocephalella* (=*Caudiverbera*) have been proposed (e.g., Correa et al. 2006; Formas and Espinoza 1975; Frost et al. 2006; Lynch 1978; Núñez et al. 2000). Correa et al. (2006) indicated that the closest living lineage of frogs to *Telmatobufo* and *Caudiverbera* (now *Calyptocephalella*) (tribe Calyptocephalellini) are Australian myobatrachids and limnodynastids. The Calyptocephalellini may be ancient. Núñez and Formas (2000) indicated that the lineage that led to the Calyptocephalellini diverged around 35 million years ago and that the extant species of *Telmatobufo* emerged approximately 20–25 million years ago. Donoso et al. (2010) suggested that the Calyptocephalellidae may represent a relict lineage of Gondwanian origin.

Telmatobufo venustus is known from the western slopes of the Chilean Andes from 28.5° to 38.5°S, and between 1500 and 1700 m elevation (Díaz et al. 1983; Stuart et al. 2008). There are three known historical areas where *T. venustus* has been reported: Cordillera de Chillán, Provincia de Ñuble (VIII Región), Ralco, Provincia del Bío-Bío (VIII Región), and Altos de Lircay, Provincia de Talca (VII Region) (Formas et al. 2001). We refer to "areas" rather than localities because in one of the three cases above, the exact locality is not known. The specific location of the type locality within the Cordillera de Chillán was not included in the description of the species, but is simply referred

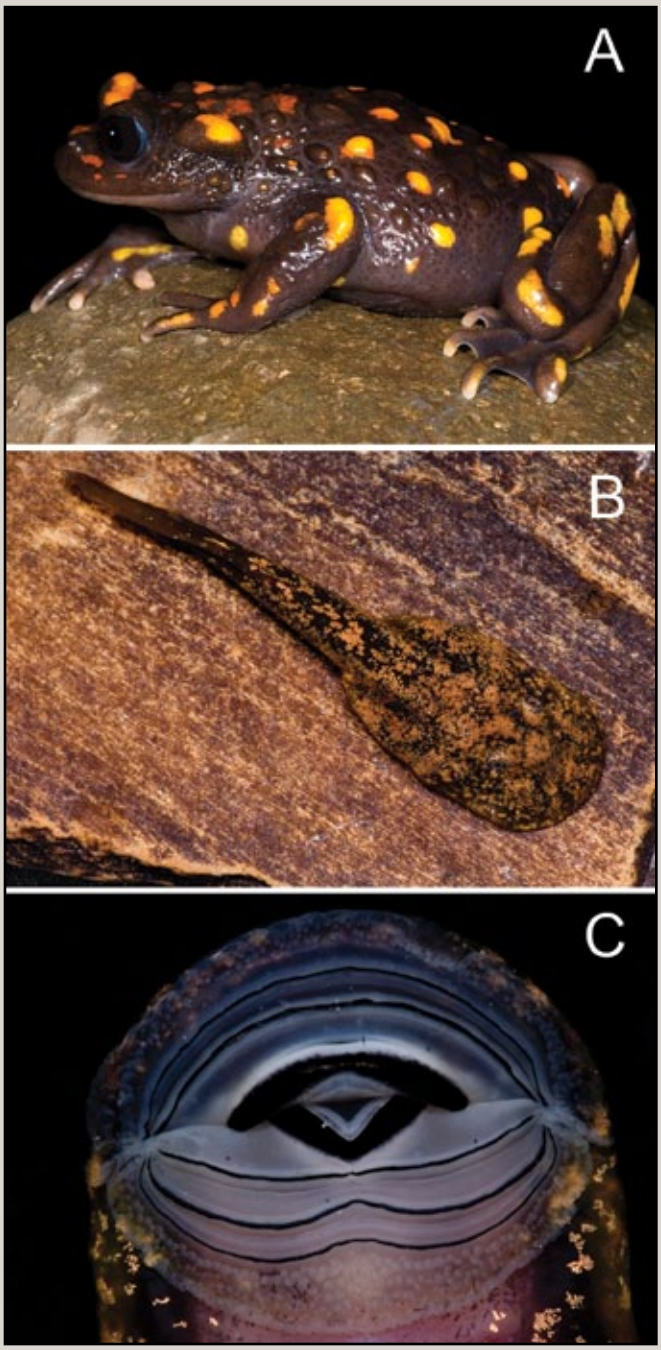
to as the Andean foothills of southern Chile, east of Chillán and Cautín (Philippi 1899). No observation of the species has been reported from that area since. One tadpole was reported from Ralco Province and no further observations have been reported there (Díaz et al. 1983); further, the locality now lies beneath a lake created by a dam that went in after the tadpole was observed there. The only locality for which recent observations have been made by the authors here and in the literature is Altos de Lircay, Provincia de Talca (VII Region) (Fig. 2).

The Chile Mountains False Toad inhabits temperate *Nothofagus* (Southern Beech) forests (Stuart et al. 2008). It has been proposed that a stream-adapted tadpole is a shared character among all *Telmatobufo* (Cuevas and Cifuentes 2009; Formas et al. 2001). This has been observed in *T. venustus* (Díaz et al. 1983) and in *T. australis* and *T. bullocki* (pers. obs.). Veloso et al. (2004; see also Stuart et al. 2008) indicated that "reproduction is unknown, though it probably takes place by larval development in water." The statement is partly inaccurate as the tadpole of *T. venustus* had already been described by Díaz et al. (1983) as a stream-adapted "mountain type larvae" with an oral disk that serves as an anchor in fast flowing mountain streams (Figs. 1B, 1C).

Telmatobufo venustus is secretive and all species of *Telmatobufo* appear to be seldom encountered. Cuevas (2010) indicated that "Since the description of this genus (Schmidt 1952), specimens of only 20 adults of the three species have been collected. These have been from Cabrerias, Llancahue, Cerro Pûschel (*T. australis*); Parque Nacional Nahuelbuta, Rucapehuen (*T. bullocki*); and Altos de Vilches (*T. venustus*)." Adult *T. venustus* were recorded for the first time in 100 years in 1999 (Stuart et al. 2008; Veloso et al. 2004). The larval form was not described until 1983, 84 years after the species' description. Veloso (2006) reported that only adult specimens, not juveniles or subadults, have been observed. During our recent (2011) surveys we encountered several specimens of the even rarer *Telmatobufo bullocki* (Figs. 3, 4) in *Nothofagus* forests of the Butamalal River drainage system (Fenolio et al., in prep.).

Habitat loss, particularly conversion of *Nothofagus* forests to pine and eucalyptus, is affecting *Telmatobufo* (Cuevas 2010; Rabanal and Núñez 2009; Stuart et al. 2008; Veloso et al. 2004). Cuevas and Cifuentes (2009) argued that the life history of frogs like *Telmatobufo*, having a stream-adapted tadpole with specific habitat requirements, puts them at risk owing to anthropogenic environmental changes in south Chile. One example concerns heavy sediments and siltation of the streams from human activities in the areas where *Telmatobufo* are found; siltation could adversely affect the larval stages of these ancient amphibians (Sánchez 2010). Forest fire comprises another significant threat to *T. venustus* (Veloso 2006). More survey work is needed to determine population status (Stuart et al. 2008; Veloso et al. 2004).

We performed visual surveys of streams in the Reserva Nacional Altos de Lircay, in the Región del Libertador Bernardo O'Higgins, Chile, from January through April of 2010 and 2011, for *T. venustus*. Fifty person-hours were spent searching two streams within the park; due to concerns about illegal collecting, the exact locations are not included here. We encountered 10 adults, all at night along mountain streams, on boulders, and in spray zones (Figs. 2, 5–7). Skin swabs from eight of the ten specimens were sent to the lab of one of the authors (M.G.L.). No frogs were removed from the wild. The swabs tested negative for amphibian chytrid fungus (*Batrachochytrium dendrobatidis*, or *Bd*). Amphibian chytrid fungus is a concern as it was first reported in Chile by Solís et al. (2010) in an invasive amphibian (*Xenopus laevis*) and subsequently by Bourke et al. (2010, 2011) in native species.



PHOTOS BY DANTE FENOLIO

FIG. 1. (A) An adult *Telmatobufo venustus* at rest on a streamside boulder; note the developed webbing between the toes. (B) *Telmatobufo* tadpoles are dorsoventrally flattened and have a suctorial disk (C) for attachment to the substrate in flowing waters.

Methods for detecting *Bd* were as follows: Frogs were collected and swabbed using a new set of vinyl gloves per specimen. Frogs were individually swabbed using sterile polyester tipped applicators (Puritan Medical, Guilford ME). Polyester tipped applicators were gently wiped on the gular region, the flank region, the bottoms of the hands and feet, and along the ventral surface for 12 passes per body region. When dry, the tips of the swabs were transferred to individual sterile tubes and stored at 4°C until

PHOTO BY ANDRÉS CHARRIER

FIG. 2. *Telmatobufo venustus* is known only from the Lircay River system.

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FIG. 3. *Telmatobufo bullocki*, critically endangered, is one of the rarest amphibians in the world. Until its recent rediscovery it was thought to be extinct.

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FIG. 4. Obstacles to finding *Telmatobufo bullocki* include difficult terrain and the frog's habit of burying itself deep under large logs. This adult female was found after hours of searching.

extracted and assayed. The tip of the polyester applicator was transferred to a 2 ml cryovial, 100 µl of Prepman Ultra (Applied Biosystems, Foster City, California) was added followed by 50 mg 0.5 mm glass beads for extraction. The tubes were vortexed and homogenized for 1 min in a Mini BeadBeate (Biospec Products), then placed in boiling water for 10 min, cooled for 1 min, centrifuged at 14,000 rpm for 3 min in a Marathon 16KM centrifuge (Fisher Scientific) after which the liquid was transferred using a micropipette to clean 0.6 ml microcentrifuge tubes. The recovered supernatant was then stored at 4ºC until assayed using the quantitative real-time PCR protocol of Boyle et al. (2004) using 1 µl of the extract as the DNA template.

The apparent absence of *Bd* in one remaining population of *T. venustus* may not be conclusive owing to the problem faced by all field biologists working with rare or reclusive species—small sample sizes. Invasive species have done irreparable damage to native Chilean fauna (De Buen 1959; Jaksic, 1998; Jaksic and Fuentes 1991; Jaksic et al., 2002; Lobos and Jaksic, 2004; Lobos and Measey, 2002; Lobos et al. 1999, 2005). Our field team has surveyed streams for three species of *Telmatobufo*. Where trout

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FIG. 5. The upper reaches of the Lircay River are subject to sudden snowfall and sleet. Nonetheless there is amphibian activity during this period.

PHOTO BY DANTÉ FENOLIO

FIG. 6. *Telmatobufo venustus* select resting sites at night on boulders in the splash zone. All specimens of this species across the last 25 years have been found in headwater streams of the Lircay River.

are absent (one stream for *T. venustus*, one stream for *T. bullocki*, and one stream for *T. australis*), their tadpoles have been found. During the surveys in Reserva Nacional Altos de Lircay we have encountered adult *T. venustus* in two streams but found tadpoles in only one of them. Introduced salmonid fish (Rainbow Trout, *Oncorhynchus mykiss*) are common in the stream where we have been unable to locate tadpoles. A local park ranger and a former landowner indicated that trout were introduced to the first stream in the mid-1960s. Introduced trout could prey on the tadpoles, and in fact introduced fish have been implicated in other montane stream amphibian declines (e.g., Adams 1999; Collins and Storfer 2003; Kats and Ferrer 2003). If indeed successful recruitment has been dwindling, or has stopped altogether, we may have observed the last, aged individuals of a non-reproducing metapopulation at the first stream.

Based on these field surveys and an analysis of the literature, we make several recommendations for conservation measures with *Telmatobufo venustus*. This species is listed currently as EN, endangered (IUCN 2011) but it is now apparent that it meets two of the conditions for an elevated IUCN listing of CR, critically endangered (only one is required; IUCN 2011): 1) In category B, subcategory 1, of section V, this species has an estimated range of less than 100 km^2; Reserva Nacional Altos de Lircay is a small reserve of 12.163 hectares (= 0.12163 km^2) in size and encompasses the only known streams in the area where the species has been reported during the past 25 years. There are two subconditions: The first subcondition (category B, section 1, subsection a), is met in that if there are multiple remaining populations outside of Reserva Nacional Altos de Lircay, they are severely fragmented; however, we suspect that there is only a single location with viable populations of the species (Reserva Nacional Altos de Lircay). The second subcondition (category B, section 1, subsection b (iii)), is met in that the quality of larval habitat is degrading due to the presence of the introduced salmonid fish (Rainbow Trout, *O. mykiss*). Further habitat degradation may occur as a result of *Bd*, which has been reported in non-native *Xenopus* from Chile (Solís et al. 2010) and in native species from south Chile (Bourke et al. 2010, 2011).

2) Category A, subcategory 4, of section V, requires that a species have an observed, estimated, inferred, projected or suspected population size reduction of X ≥ 80% over any 10-year or three-generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (category A, section 1, subsection e): the effects of introduced species (Rainbow Trout, *O. mykiss*, in many of their breeding streams) and the potential arrival of an emergent infectious amphibian disease (*Bd*), now present in south Chile.

Second, based on significant and continuing habitat loss and on subsequent population fragmentation that all *Telmatobufo* species have suffered, we propose that ex-situ assurance colonies of *Telmatobufo*, including *T. venustus*, be established immediately within Chile. The National Zoo of Chile in Santiago and the Atlanta Botanical Garden have a four-year-old partnership that developed facilities to support a captive assurance colony of Darwin's Frogs, *Rhinoderma darwinii*, at the zoo. That facility is now operational, amphibian keepers have been trained and are in place, and the program has reproducing groups of *R. darwinii*. These stakeholders are looking to expand their program to support other threatened amphibians of Chile. Facilities exist now and permits have been obtained from the government of Chile for the immediate creation of assurance colonies of three species of *Telmatobufo* (*T. venustus*, *T. bullocki*, and *T. australis*). The goal is to create the assurance colonies before wild populations drop to numbers so low that assurance colonies cannot be created. Amphibian specialists from the Atlanta Botanical Garden's amphibian conservation program, with experience in captive breeding of endangered amphibians, will support the effort at the National Zoo of Chile in the same way that the zoo was supported while the Darwin's Frog facility was created and populated with groups of frogs. Fund raising is a joint venture. Involved stakeholders believe that retaining the assurance colonies within Chile provides the effort with local enthusiasm for the conservation of native and endangered amphibians, rendering a project that is likely to endure. Ensuring the future survival of the ancient Calyptocephalellidae requires an expansion of existing partnerships to involve the zoological community, amphibian conservation oriented programs (such as those at the Atlanta Botanical Garden), the Chilean Forestry industry, and governmental wildlife authorities and respective agencies. Only with support from all pertinent parties can work toward a comprehensive conservation program occur. Such a program could be modeled after a collaborative effort like Partners for Amphibian and Reptile Conservation (PARC; see Gibbons 2005; http://www.parcplace.org/).

PHOTO BY WILLIAM W. LAMAR

FIG. 7. Specimens of *Telmatobufo venustus* have been located at night perched beneath enormous streamside boulders.

Third, the remaining streams in which *T. venustus* has been observed are all within the Reserva Nacional Altos de Lircay. It would be presumptuous and inappropriate to mandate anything here but we recommend that the reserve consider the implementation of a program to control the trout in the headwater tributaries of these streams. The first step would have to include removal of the introduced salmonid fishes from the stream where surviving individuals of *T. venustus* have been observed. After this, fish exclusion devices would have to be implemented along lower regions of the streams, below the areas where frogs can still be found, to prevent recolonization of the headwaters by trout. Because these streams are the only remaining localities in which *T. venustus* has been recently observed, it is critical to take action within the reserve to protect remaining populations. A collaboration between the organizers of assurance colonies of *T. venustus* and the Reserva Nacional Altos de Lircay would be an ideal next step in that tadpoles could be released, post fish removal, in appropriate drainage systems to help bolster existing lineages (keeping careful track of and releasing appropriate genetic stocks per stream according to parentage). An additional step toward the conservation of *T. venustus* in Reserva Nacional Altos de Lircay might be signage for visitors to the reserve, making them aware of these unique natural treasures that are endemic to Chile and in fact, may now only be found within the boundaries of the reserve. Special funds pertaining to the conservation of Chile's critically imperiled amphibians, from the Chilean government, would also go a long way toward these ends.

Finally, we recommend regular monitoring of wild populations for emergent infectious amphibian disease such as *Bd* and ranavirus. Since monitoring of these diseases in wild populations of Darwin's Frogs already occurs via the partnership between the National Zoo of Chile and the Atlanta Botanical Garden, an expansion of that program to include regular disease monitoring in all *Telmatobufo* species is in progress.

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TECHNIQUES

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Using Spot Pattern to Identify Individual Long-Tailed Salamanders

The use of simple and inexpensive amphibian monitoring techniques is often necessary due to limited time and funds. When individuals can be uniquely identified, mark-recapture can be used to estimate abundance, other demographic variables (e.g., survivorship and recruitment), habitat use and individual growth rates (Donnelly and Guyer 1994). In comparison with other marking techniques, spot pattern recognition is less invasive and generally costs less than other methods. However, it is only useful when markings are variable and the pattern does not change ontogenetically (Donnelly et al. 1994; Plăiaşu et al. 2005).

Spot pattern recognition has been used successfully in a variety of studies for individual identification of amphibians (Ferner 2007, 2009; Schlüpmann and Kupfer 2009), and has been recommended as an ideal method for salamander identification by Ferner (2007) (e.g., Loafman 1991; Plăiaşu et al. 2005; Tilley 1980). Varying spot pattern recognition methods exist, but most rely on overall pattern, spot count, or a combination thereof. In this study, we tested whether head-spot counts can be used as a component of overall spot pattern recognition in order to identify individual Long-tailed Salamanders (*Eurycea longicauda longicauda*) in the field. We also employed digital photographs of Long-tailed Salamanders to determine if the number of head-spots was related to salamander size.

Methods.—Long-tailed Salamanders are found under rocks and woody debris near forested springs or streams (Petranka 1998). In southeastern Pennsylvania and northern Delaware, they are commonly found in springhouses because these houses are damp and dark and ideal substitutes for their natural habitat. These salamanders are yellowish-orange to yellowish-brown with black spots (Petranka 1998), which makes these salamanders an ideal study organism.

We captured Long-tailed Salamanders from four populations associated with springhouses in southeastern Pennsylvania and northern Delaware. We visited springhouses every 12–16 days during 2002–2006 during peak activity periods (April–May and August–November), and every 19–23 days during the summer (June–July). We waited until after dusk to search outside springhouses because Long-tailed Salamanders forage at night (Petranka 1998). Using aquarium nets inside springhouses and by hand when outside, we captured individuals and them placed into 25 × 25 cm zip lock bags containing paper towel moistened with water from the springhouse.

We measured, weighed, and determined the sex of each salamander, noting whether the individual was gravid or had any injury or deformity. For measuring, we placed salamanders into a 15 × 15 cm zip lock bag so they could easily be straightened and turned upside down without injury. We recorded snout–vent length (SVL) and tail length (TL) to the nearest 1 mm, noting broken or regenerating tails, and weighed each salamander to the nearest 0.01 g using a digital balance. We determined sex by checking for secondary sexual characteristics: specifically, enlarged teeth and a submandibular mental gland in males and the presence of white developing ova that can be seen through the skin lateral to the belly on females. After we documented physical characteristics, we digitally photographed each salamander in the dorsal orientation (Donnelly and Guyer 1994).

To identify individual salamanders, we counted each dorsal spot from the tip of the nose to the beginning of the forelimbs, ignoring the lateral spot pattern down the sides of the body (Fig. 1). We considered a spot to be any mark (oval or otherwise) that had a distinct black coloring. If a spot was faint or blurry, we classified it as a spot if we could see a definite black mark in the center as opposed to being uniformly faint throughout. This criterion was only used for faint or very small markings. If the marking was faint throughout but still large enough to be definitively seen as a spot, then we counted it. When two spots touched, we classified it as a single spot if the outline created was a generally continuously oval with minimal indentation where the spots conjoined. We classified two spots as independent if the outline created allowed for the two spots to have a major indentation at the point of contact. We counted spots if more than half of the total area of a spot fell anterior to the forearms.

We sequentially organized digital photographs from capture events for each study site. We then used this database to visually match more than 4000 photographs of newly caught individuals from subsequent capture events. Because it was not logistically feasible to inspect more than 4000 photographs, we took a random sample of the photographs. After identification, we sorted captures into seven 0.5-cm size categories based on SVL (range

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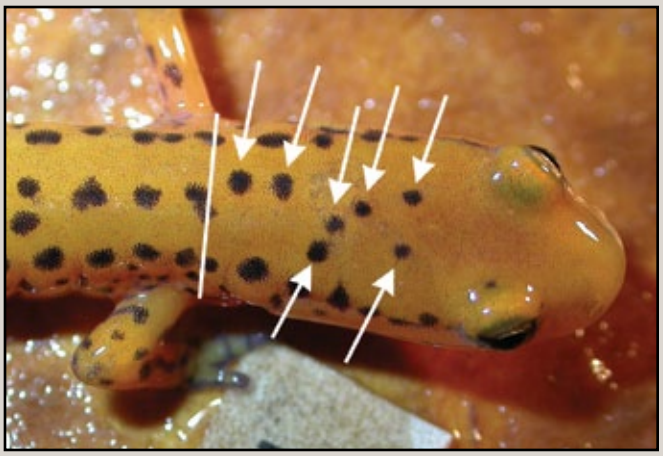

FIG. 1. Using digital photographs to determine spot number for an individual Long-tailed Salamander, we counted spots from the tip of the nose to the beginning of the forelimbs, ignoring the lateral lines running down the sides of the body. The solid line indicates where counting stopped.

3.5–6.9 cm). We established the seven categories by graphing the data to find natural breaks. For each study site, we randomly selected 40 individuals of each size group for a total of 926 individuals. We only selected unique individuals; recaptures were not included in the analysis. We used an ANOVA, blocked for site, to determine the relationship between spot number and size ($\alpha = 0.05$). When we detected differences, we used a planned Least Significant Differences mean separation test to determine differences among means (Sokal and Rohlf 1995). We did not use a linear regression because the relationship was curvilinear and the presentation of categories provided a clearer picture of the data as it related to our objectives.

Results.—Spot number increased with the size of salamander ($F_{6,925} = 20.87$, $p < 0.001$; range 13–21). The increase in number of spots was small (< 2) except for large salamanders (6.0–6.9 cm), which increased by 2.5–3 spots per size category. The number of spots was usually similar in adjacent size categories except for salamanders 6.0–6.4 cm and 6.5–6.9 cm, which were not similar to any other size categories (Table 1). Although spot number increased as a salamander grew, photographic analysis showed that the general pattern of spotting stayed the same. Identification of individual salamanders was possible because the addition or subtraction of a few spots did not deter recognition of the overall pattern (Fig. 2).

Discussion.—Head-spot counts varied by size groupings in *E. longicauda* suggesting that head-spot number changes over time; however, spot pattern recognition is still a useful technique. Approximately half (50.4%) of the salamanders caught were within groups 3, 4, or 5, which are the groups in which spot number remained similar. Therefore, half the captured salamanders had spot numbers that did not change among size groupings. When salamanders grew to 6.0–6.4 cm and 6.5–6.9 cm (groups 6 and 7, respectively), spot number increased. Because we did not determine the age of the salamanders, we cannot determine if spot addition is related to age or to size.

Despite an overall mean spot number increase, many potential points for identification existed so mismatches were unlikely to occur. Because we rarely observed spots disappearing and spots tended to appear rather than disappear, previous identification markers remained visible. As a result, the most important component to identification was overall pattern recognition despite the increase in mean spot number. These findings highlight the importance of understanding ontogenetic differences among salamander species before incorporating spot pattern recognition into a mark-recapture study. Our results challenge the assumption that pattern marks must stay constant in order for spot pattern recognition to be successful (Ferner 2009; Gill 1978) since changes in head-spot counts did not affect overall spot pattern recognition.

Many studies have successfully incorporated head-spot counts and spot pattern recognition techniques (Grant and Nanjappa 2006; Pliau et al. 2005; reviewed by Schlüpmann and Kupfer 2009). However, we recommend conducting a pilot study on head-spot counts to determine if data suggest spots remain constant through time for the species of interest. If head-spot counts do change, a pilot study could confirm that using overall

FIG. 2. Examples of three Long-tailed Salamanders that we recaptured after two years. Salamanders on top captured in 2004 (top) were recaptured again in 2006 (bottom). Note that addition or subtraction of a small number of spots does not deter recognition of overall pattern.

pattern recognition exclusively can still be a useful aid to individual identification.

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Very Small, Light Dipole Harmonic Tags for Tracking Small Animals

Tracking animals provides a detailed picture of their behaviour and can be important in understanding their ecology. Tracking is especially useful for elucidating the ecology of animals that are cryptic during all or parts of their life cycle (Heyer et al. 1994; Langkilde and Alford 2002; Reynolds and Riley 2002). Amphibians, for example, can be hard to study outside breeding aggregations, and wildlife telemetry can provide insight on otherwise unknown aspects of their biology (Heyer et al. 1994; Naef-Daenzer 1993; Naef-Daenzer et al. 2005; Rowley and Alford 2007a, b, c; Rowley et al. 2007).

Tracking devices should be small and unobtrusive (Hamley and Falls 1975; Heyer et al. 1994; Korpimaki et al. 1996; Ormingston 1985). Many guidelines recommend that the mass of tracking devices should not exceed between 5% (Wilson and McMahon 2006) and 10% (Blomquist and Hunter 2007; Gursky 1998; Richards et al. 1994) of the animal's body mass, particularly when tracking vertebrates. Package shape is also an important consideration; devices must not impede the tracked animal's movement (Blomquist and Hunter 2007; Greenwood and Sargeant 1973; Wilson and McMahon 2006). Finally, devices should have long useful lifespans, reducing the frequency of capture, handling, and other potentially stressful procedures (Langkilde and Alford 2002; Pereira et al. 2009). Tracking devices, therefore, typically reflect compromises among the needs for small size, low mass, long life, and high durability.

Two main approaches can be taken to track animals using radio signals. Tracking using tags containing active radio transmitters allows researchers to locate subjects and identify them individually (Heyer et al. 1994; Indermaur et al. 2008; Naef-Daenzer 1993; Naef-Daenzer et al. 2005; Rowley and Alford 2007a, b, c), and may enable the retrieval of additional information, such as the subject's physiological status and local environmental conditions (Reynolds et al. 2002), but the method is restricted to larger species or individuals, due to the relatively high weight of the battery, harness, and transmitter package (Langkilde and Alford 2002; Naef-Daenzer 1993; Naef-Daenzer et al. 2005; Rowley and Alford 2007c). Currently, minimum body mass of animals tracked using radio-transmitters is 2–4 g, based on a minimum package plus harness mass of 0.2 g for the smallest available transmitters and limitations to 5–10% of the body mass (Naef-Daenzer et al. 2005). These extremely light tags have extremely short battery lives, measured in days; this further restricts their usefulness in field studies, where animals may require some time to return to normal behaviour following tag attachment (Langkilde and Alford 2002; Rowley and Alford 2007c).

It is also possible to use tags that do not contain their own power sources. These tags fall into two categories: PIT (Passive Integrated Transponder) tags and harmonic radar tags. PIT tags,

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often used as implantable means of individual identification, eliminate the need for the battery by using an induction coil to provide the power to emit a very weak radio signal. However, the need for a powerful magnetic field and the very weak signal emitted limit their range and make them unsuitable for tracking applications (Ohashi et al. 2010; Vinatier et al. 2010). For tracking, the main alternative to self-powered transmitter tags is harmonic radar, also known as harmonic direction finding. The tracking devices used with this technology consist of a single diode with an attached antenna, weighing as little as 0.11 g (Pellet et al. 2006). They absorb radio waves emitted by a handheld transceiver, re-emitting some of the energy as radio signals at a harmonic frequency of the initial signal. The re-emitted signal is detected by the transceiver unit, using a directional antenna. Compared to typical radio transmitter tags, harmonic tags have some disadvantages. First, they do not emit individually identifiable signals, so individuals carrying tags have to be distinguished by means other than a signal ID (Rowley and Alford 2007c). Second, their maximum range is typically less than that of tags containing radio transmitters (Langkilde and Alford 2002; Rowley and Alford 2007c). Finally, harmonic direction finding is more difficult than radiotracking in environments in which radio signals are attenuated (i.e., dense vegetation may absorb signals), or in environments that naturally re-emit radio waves (i.e., some boulders and rocky outcrops; Rowley and Alford 2007c). The great advantages of harmonic direction finding are that (i) it allows tracking of vertebrates too small (typically approximately 2 g) for even the smallest available radiotransmitters, and (ii) tags are not limited by battery life, and so can be used as long as they remain attached to the subject (Rowley and Alford 2007c).

The small size of tags used in harmonic direction finding has allowed tracking of a variety of vertebrates (Pellet et al. 2006, Rowley and Alford 2007a, b, c; Rowley et al. 2007) and flying insects (Naef-Daenzer et al. 2005, O'Neal et al. 2004, Vinatier, 2010; Williams et al. 2004). Tags used with a harmonic direction finder are often constructed from Schottky diodes (Langkilde and Alford 2002; O'Neil et al. 2004; Rowley and Alford 2007c; Williams et al. 2004), which are commonly used in electronic circuits. Schottky diodes are semi-conductor diodes that lower the voltage in an electrical current, have a very low forward-voltage drop, and a fast switching action (hence their sensitivity to radio waves). In a harmonic direction finding tag, the diode receives a signal from a transceiver unit, such as the commercially available Recco™ transceiver, and re-emits a signal at a doubled frequency (Langkilde and Alford 2002; Rowley and Alford 2007c).

Many studies have used germanium Schottky diodes in standard cylindrical packages (Langkilde and Alford 2002; Rowley and Alford 2007c). Tags have typically consisted of one germanium diode with a single antenna soldered to the cathode (a monopole antenna). The diodes typically weigh approximately 0.2 g, and thus the minimum mass of an assembled tag is approximately 0.27 g, limiting the size of study animals to a minimum of 2.6–5 g depending on the particular rule for permissible package size that is followed (Blomquist and Hunter 2007; Gursky 1998; Richards et al. 1994; Rowley and Alford 2007c; Wilson and McMahon 2006).

We have developed a new design for harmonic tags that substantially reduces their size and mass while maximizing clarity and range of the signal. We use surface-mount diodes, which are smaller and lighter than germanium diodes but require a different tag assembly method (see Pellet 2008 for a technique using similar diodes). In contrast to Pellet and others (2008), we use a dipole antenna configuration that provides a strong signal using short, light antennae as well as a different attachment method (using a silicone belt integral to the package) allowing us to construct tags that weigh 0.13 g. These can be attached to animals weighing a minimum of 1.3–2.6 g. A previous study using monopole antennas (Rowley and Alford 2007c) found that detection distances were ca. 0.5 m when tagged animals were under rocks or in a few cm of water, and measured a maximum detection distance in the canopy of 12 m. Here our tags achieved ranges of more than 20 m when tested in open habitats, decreasing as antennae are trimmed further than the lengths described here. In addition to this, the anode antennae unique to our tag increases the range provided by submerged tags to 2–5 m depending on obstructions blocking the signal. Animals sheltering in shrubs and sub-canopy also benefited from the strongest signals as exposure of the antennae was maximised (very clear signal from animals 15+ m from the ground), but horizontal range close to the ground decreased rapidly when the animals moved away from the stream due to the density of the shrub layer at the study

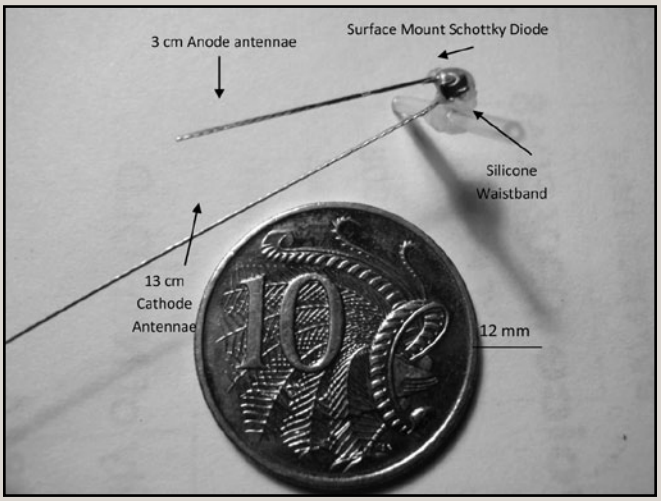

FIG. 1. A dipole harmonic tracking device with an Australian 10-cent coin (23 mm diameter) for scale.

FIG. 2. The Common Mistfrog, *Litoria rheocola*, exhibiting a natural posture directly after handling and the attachment of a harmonic direction finding tag. This individual is a male weighing approximately 1.9 g (package weight = 0.13 g).

sites (10–15 m from stream center, depending on steepness of edge and density of vegetation).

Our tags are based on surface-mount SOT-23 Low Distortion Attenuator Diodes (Manufacturer HSMS, model 205B-G Surface-Mount Schottky diode). The antennae are constructed from 9 lb. test fishing leader made up of seven individual strands of stainless-steel wire (any make but bare wire adheres better to the trace on diodes). We use fishing leader wire because it is very flexible and elastic, tending to remain straight rather than assuming a curled shape after being bent, as do many other forms of wire. The length, thickness and material of the antenna affect the resonance of the tracking device, and therefore dictate the strength and range of the signal (Langkilde and Alford 2002). We found that, with the fishing leader wire used here, the best combination of lengths was 13 cm for the cathode wire and 3 cm for the anode wire. Longer wires increased the range of the tag, but were impractical because of both size and weight when attaching the package to very small animals.

We used conductive epoxy (Chemtronics®, Circuit Works® - Conductive Epoxy CW2400) to attach the diode and antenna. Lead-based solder is impractical both because the tiny size of surface mount diodes makes it difficult to solder to them without heating them excessively and because the solder would add substantially to the mass of the final tag. In assembling tags, we first placed double-sided adhesive tape on the work surface, and attached the diode to the tape. We then applied the epoxy in very small amounts to one tip of each antenna wire, and placed this tip on the appropriate trace on the diode. Both antennas are attached to the diode such that they extend away from the same side of the diode in parallel to one another (Fig. 1). We left the assembly undisturbed for 24 h to allow the epoxy to cure, and then removed the assembled tag from the tape. To prevent contact between sharp metallic components or epoxy and the skin of the tracked amphibian, we coated the diode with silicone rubber (Selley's Glass Silicone Sealant®), in which is embedded a length of silicone tubing, oriented at 90° from the long axis of the tag as defined by the antennae; this is used as a harness to attach the tracking device to the frog (Fig. 1).

To minimize the weight of the assembled tag, the silicone in which the diode is embedded is trimmed after drying. We have found that when animals are located in the field, the distal end of the longer antenna is often easily visible, even if the individual is in a retreat site. The distal end of the antenna can be colour-coded using waterproof paint. We coated the color-bands on the antenna with a thin layer of silicone seal to prevent their removal by abrasion in the field.

Tags are attached to frogs by placing the silicone tube around the frog's inguinal region (or 'waist'). The tubing is trimmed so that it just reaches around the frog's waist, with its ends meeting on the ventral centerline. The attachment must be of the correct tightness, which can only be determined with some practice. If attached too loosely, the diode can rotate around the body of the frog to the ventral side, hindering the movement of the animal. If too tight, it can cause abrasion, eventually producing lesions on the frog's skin. Attachment is completed by passing a length of very fine, 100% cotton thread through the silicone tubing, placing the tag on the animal and tying off the thread so that it just draws the ends of the tubing into contact. Using extremely fine, 100% cotton thread ensures that the tag will eventually fall off as the thread deteriorates, in case the animal is not recovered for tag removal (the time taken for the thread to wear off and break is uncertain and would depend on humidity and abrasion).

We used tags constructed as above in densely vegetated habitats (low elevation rainforests of North Queensland, Australia) to track 26 individual frogs (*Litoria rheocola*, mass 0.95–3.30 g in the sampled population; only individuals weighing 1.8 g or more were tracked to meet ethical requirements) for periods of up to 5 days. Diurnally, frogs were found in retreat sites, with 51% found in water and 35% in vegetation near the ground. Apparently normal movement between diurnal retreats and nocturnal activity sites occurred: nocturnally, 100% of frogs moved to vegetation bordering the stream (from shrubs 1–2 m off the ground to some recorded in sub-canopy 12 m). Frogs appeared to climb, jump and swim as they did prior to tracking device attachment (Fig. 2). Tags constructed as we have just outlined have been used successfully by other researchers since our study, focusing on other species (*L. serrata and L. junguy*) as well as *L. rheocola* in lowland rainforests in the Wet Tropics.

Harmonic direction finding, using tags constructed as we outline here, makes it possible to track animals approaching the lower limits of adult vertebrate body size. Our construction method provides a sturdy and stable attachment method for tags that fulfil ethical requirements for tracking very small animals while maximizing the ability to relocate the tags at the greatest possible distances. The continued reduction in size and weight of tracking devices opens up many exciting new opportunities to describe habitat use and movement of particularly minute and discreet organisms, increasing our understanding of the ecology of these poorly understood animals.

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Assessment of Turtle Tracking Technologies in the Brazilian Amazon

Technological developments over the past two decades have contributed tremendously to the study of wildlife ecology, bringing new insights to the management and conservation planning of animal species. In the Amazon, study of Amazonian turtle species using traditional methods has been conducted for 20 years, but researchers have lacked data concerning where turtles go after nesting. The need for essential information not collected by dated methodology called for technological applications to answer specific ecological questions. This review was based upon experience acquired in three ongoing studies of the ecology of turtles in the Amazon Basin.

In this study, three technologies were applied to study freshwater turtles in the Amazon for the first time: Passive Integrated Transponder (PIT), Very High Frequency radio (VHF), and satellite radio. For decades, ecologists and wildlife biologists have used a technique called mark-recapture, in which animals are captured and then externally marked or tagged in some way with a personal identification number before being released (Gibbons and Andrews 2004). With the advent of PIT technology, animals may be internally tagged with the advantage of not being affected by external factors or not affecting intraspecific social interactions or altering behavior toward tagged individuals (Gibbons and Andrews 2004; Jackson and Bunger 1993). PIT tags are tiny identification chips which are injected into specimens for permanent identification and have been retrieved with great success for more than 20 years (Boarman et al. 1998). The tags are injected into the caudal musculature of the turtle and read by an external reader which bounces an electronic signal off the tags to identify them.

In VHF radio telemetry, a small electronic device is attached to an individual, allowing it to be accurately tracked and monitored using a receiving unit (Marshall et al. 1971; Schemnitz and Owen 1969). Over the years, the decrease in size of the electronic components, circuit boards, and batteries has resulted in transmitters smaller than 0.4 g, enabling the study of smaller species and even hatchlings (Warnock and Takekawa 2003).

The third and more recent technology used to track animals

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is the satellite system. This technology became an operational tool for tracking the long-range movements of animals in the 1980s. Applying satellite system technology initially represented a challenge because most animal species were smaller than the biggest pixel of public access satellites data (0.6 m) and the passage times of satellites over the equator in the Amazon were so infrequent that animal positions could not be determined. However, with the advents of ARGOS (Advanced Research and Global Observation Satellite), the tracking of animal movement patterns became more feasible (Gillespie et al. 2008).

These three technologies have been important in field studies driven by the need to answer new questions regarding the ecology of Amazonian turtles in order to develop rigorous conservation measures. However, these devices are generally designed and tested to work successfully in temperate climates where they have been developed. Conditions in the Amazon, a tropical rainforest environment, are sufficiently different to affect the use of these devices.

In this paper we report the use of technical equipment to identify and track freshwater turtles in the Amazon region and provides advice on how devices that may be designed for temperate areas can successfully be used in tropical climates. Advantages, disadvantages, problems, and possible improvements of using technologies to track animals in tropical areas are discussed.

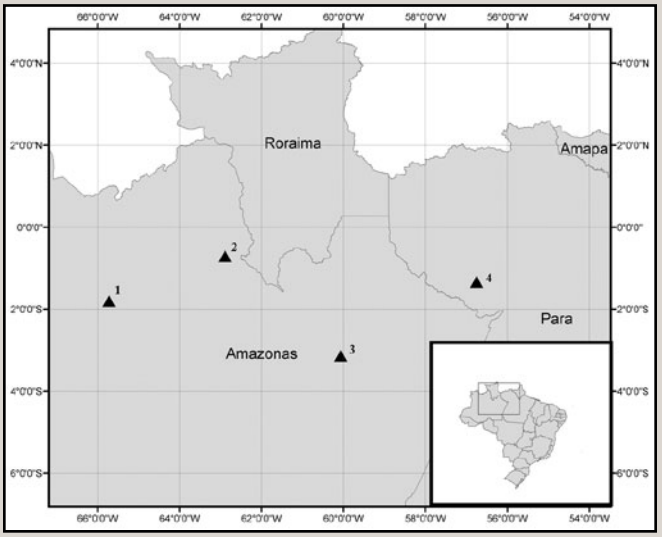

FIG. 1. Localization of the four study sites in the Amazon Basin with the Brazilian location on the right corner: (1) Mamirauá Sustainable Development Reserve, (2) Rio Quimicuri, (3) Reserva Florestal Adolpho Ducke, (4) Rio Trombetas.

MATERIAL AND METHODS

Study areas.—The Mamirauá Sustainable Development Reserve (MSDR; 01.8347°S, 65.7053°W) is located on the floodplain between the Middle-Solimões and Japurá rivers (Fig. 1). Mamirauá is a reserve covering an area of 1,124,000 ha (Raeder and Bernhard 2003). In this area, we conducted field work from 1996 to 2004 using PIT tags with *Podocnemis sextuberculata* and *Podocnemis unifilis.*

Rio Quimicuri (00.7069°S, 63.2325°W) is part of the Rio Negro Basin (Fig. 1) (De la Ossa 2007). The Quimicuri River is a blackwater river with well-defined high and low water seasons (Castillo et al. 2004). In this river, individuals of *Peltocephalus dumerilianus* were captured from 2001 to 2006 and fitted with VHF transmitters.

Reserva Florestal Adolpho Ducke (3.1333°S, 60.0667°W) is located 25 km E of Manaus (Fig. 1) and has gradually become isolated from adjacent forests by the development of villages and agricultural activities (Magnusson et al. 1997). In this reserve, VHF transmitters were used to monitor *Platemys platycephala* in 1993.

The Trombetas Biological Reserve (1.3333°S, 56.75°W) is in northwestern Pará state, northern Brazil (Fig. 1). The Trombetas meanders generally southward for 760 km and joins the Amazon River in Obidos at Oriximina (Goulding et al. 2003). This area was selected for its large population of *Podocnemis expansa*, which is now listed as Critically Endangered by the IUCN and is the most threatened turtle species in the Brazilian Amazon. In this river, *P. expansa* and *P. unifilis* were studied at different times between 1989 and 2009, when all three technologies were used.

Equipment and brands applied.—Devices and species studied are detailed in Table 1. PIT tags were purchased from AVID Northwest Marine Technology, Inc. PIT tags are glass-encased electronic transponder tags that are inserted into turtle muscle. PIT tags have been used for over 20 years to permanently identify individual animals. The tag has no battery so the microchip remains inactive until read with a scanner. The scanner sends a low frequency signal to the microchip within the tag providing the power needed to send its unique code back to the scanner and positively identify the animal. Passive tags are designed to last longer than the life of the animal, providing a reliable, long-term identification method.

VHF-monitored radio tracking equipment was purchased from AVM Instrument Company, Ltd. The system consisted of a handheld Yagi 4-element antenna and receiver to collect signals from deployed transmitters. The system remained fully operational 24 h a day while the batteries were working. The modulation format used in this study is AM (amplitude modulation). Expected transmission lifespans range from 10–14 months for the 120 g transmitters deployed on the turtles.

TABLE 1. Locations of this study, detailing the devices used to mark and track freshwater turtles species in the Brazilian Amazon.

Location	Equipment	Species	No. of devices
RDS Mamiraua	PIT tags	*Podocnemis sextuberculata*	240
Rio Quimicuri	VHF Transmitters	*Peltocephalus dumerilianus*	10
Rio Trombetas	PIT tags	*Podocnemis expansa*	8150
		Podocnemis unifilis	2000
	VHF Transmitters	*Podocnemis expansa*	53
	Satellite Radio	*Podocnemis expansa*	10
R.F. Adolpho Ducke	VHF Transmitters	*Platemys platycephala*	4
		Phrynops rufipes	8

FIG. 2. Insertion of a pit tag in a hatchling of *Podocnemis expansa* in Rio Trombetas. Tags were inserted right below the carapace of the turtles.

FIG. 3. Insertion of a pit tag in hatchling turtles. Applicator needles supplied by the pit tags companies are too large to be used, so a 2 mm hole was made by piercing the skin with the point of a blood collector.

TABLE 2. Battery life expected by the manufacturers and actual results obtained in this study in the Brazilian Amazon.

Technology	Expected Life	Average life obtained (min. – max.)
Satellite radio	12 months	8.2 months (6–10)
VHF radio	12 months	8.3 months (8–11)
PIT tags	unlimited	Over 15 years

Satellite monitored radio technology requires satellite transmitters, known as Platform Transmitter Terminals (PTTs). In this study the PTTs were purchased from Sir Track, Ltd., and the satellite data were transmitted via satellite using the ARGOS System. The ARGOS environmental satellite system currently consists of six polar satellites orbiting at altitudes of 740–850 km with 5000 km visibility circles (footprints). During the satellite orbit, this footprint sweeps in a wide swath around the earth, receiving signals from the PTTs. The number of daily passes over a PTT increases with latitude. At the earth's poles, a PTT is within the visibility circle of the six satellites approximately 80 times per day, whereas at the equator (e.g., the Amazon region), a PTT can be visible perhaps 20 times per day (ARGOS 2008). Our study recorded a maximum of six passes per day, which is every four hours.

Transmitters can be programmed to send signals to satellites at periodic intervals. In salt water, transmitters are activated only when the turtle is at the surface and deactivated when submerged by a saltwater switch. Now new technology has been developed which includes a freshwater switch as well, which will increase the battery life by many months, since the transmitter will only be activated when the turtle is at the surface. To increase the life of the transmitter in our initial use in freshwater, the PTTs remained active for 24 h only for the first three months, then were active from 0600–1200 h every four days. Expected transmission lifespans for the 1800 g transmitters we deployed on 10 turtles ranged from 10 to 12 months. ARGOS satellites pass over about once every 4 h and if the turtle is on the surface of the water, both temperature and position are recorded.

Attachment of the equipment.—The PIT tags were inserted dorsally into the base of the tail just below the carapace in adult and juvenile turtles, using the injecting applicator needle supplied with the tags (Fig. 2). However, these applicator needles are too large to be used with hatchling turtles. Instead, a 2-mm hole was made by piercing the skin with the point of a blood collector (Fig. 3). The tag was inserted through the hole deep into the tail musculature using a fine tipped Inox 25 forceps. All material was sterilized first in an ethyl alcohol bath. After inserting a tag in an animal, the local area was cleaned using iodine and protected by liquid band aid.

Transmitters, both VHF and satellite, were glued to the carapace of the turtle with Turbolit, a marine product used for patching holes underwater in marine vessels. Two resins are mixed together with wet hands to form a uniform pliable paste. The turtle shell is prepared by scrubbing with soap and water and then roughened with sandpaper to ensure that the glue will hold the transmitter onto the turtle. The paste is then molded onto the front of the turtle shell, followed by pressing the transmitter into the paste and folding the paste over the transmitter to make a secure bond. The turtle is kept out of water for 24 h to make sure the gel has dried before release (Fig. 4). Prior to the discovery of Turbolit in 2005, VHF transmitters were first glued to the turtle carapace on the 9th–10th marginal scutes with epoxy quick-drying cement. When fixed in place, four 3-mm holes were drilled in these scutes, two on each side of the transmitter, and the transmitter was secured with 2 mm diameter stainless steel wire looped through the holes and around the transmitter. A cover of duropoxy was used to form a cap over the transmitter and wire such that it appeared as a tumor on the shell of the turtle with no jagged edges to catch on branches.

RESULTS

The devices used in this study were functional. However, because of the tropical rainforest environment of the Amazon, the high temperature decreased battery life. Regardless of the equipment efficiency, we also found problems with the discarding of equipment by poachers who caught turtles for illegal sale as food. Table 2 displays real battery life time in the Amazon environment compared to expected battery life, showing that the battery life obtained for VHF radio and satellite radio equipment was much lower than expected.

PIT tags.—The efficiency of PIT tag technology was difficult to analyze because it was impossible to distinguish unmarked

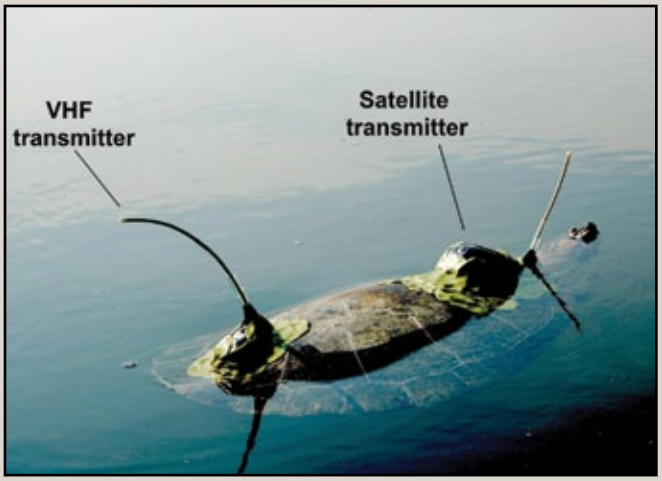

FIG. 4. Satellite and VHF Transmitters glued on the carapace of the turtle (*Podocnemis expansa*) with Turbolit. The paste is molded onto the turtle shell, followed by pressing the transmitter into the paste and folding it over the transmitter to make a secure bond. In this picture the turtle has just been released.

FIG. 5. *Podocnemis expansa* recaptured at the nesting beach with satellite transmitter attached four years after deployment, demonstrating the bonding potential of Turbolit glue. The PTT was easily pried off the turtle shell, leaving the carapace undamaged.

turtles from turtles whose PIT tags had ceased to function. However, from the 2000 PIT tags implanted in *P. unifilis* hatchlings in Rio Trombetas, seven were recovered still functioning. Three were found 13 years following implantation and four after 15 years. In addition, five PIT tags were encountered by people while eating cooked turtles. The tags no longer functioned, suggesting that the heat used in cooking the turtle meat destroyed the tags.

VHF radio.—A total of 76 VHF radios with a putative 12-month battery life were attached to turtles. Of these 76 VHF radios, eight were removed from the study by poachers. Eight were lost because of long-distance migration immediately following release and 16 either failed after three months operation or because turtles moved out of range. Most of the transmitters stopped working because the battery died: 36 after eight months, two after nine months, four after 10 months, and two after 11 months (Table 2).

In the study of *Peltocephalus dumerilianus*, two VHF radios worked for nine months and four for 11 months. All four VHF radios attached to *Platemys platycephala* worked for 10 months. With *Podocnemis expansa* in Rio Trombetas, of a total of 52 non-poached turtles monitored by VHF radios, seven were lost after three months because of the turtles entering deep into the flooded forest. Thirty-six VHF radios functioned for eight months. Finally, eight *P. expansa* were lost within five days after they had a VHF radio attached, by migrating far downstream from the nesting areas, moving up to 45 km in two days.

Satellite radio.—Of the 10 satellite transmitters used in this study, two were removed by turtle hunters almost immediately and one following eight months of use. Of the seven not discarded by local people, six suffered a reduced battery life, six failed to provide location signals after eight months, and one failed after 10 months (Table 2).

Two transmitters were recovered at the nesting beach four years later, still attached to turtles, demonstrating the bonding potential of Turbolit. Upon recapture, the PTTs were easily pried off the turtle shells with a Swiss army knife blade, leaving the carapace undamaged (Fig. 5).

DISCUSSION

Technology plays an important role in the monitoring of animal species. The choice of the technology to be applied depends mainly on the range of the species, its habitat, and the objectives for which the technology is used. Any decision to invest in and implement a technology should be based on an analysis of costs and benefits for a project to be successful. Any technology used must be appropriate for the operating conditions. This is true for the technology design, the resources required to implement it, and its ability to withstand challenging conditions. High temperatures and high humidity in remote field locations in areas such as the Amazon affect electronic devices negatively. Impacts of field conditions, such as dust, heat, humidity, water, and energy should be considered.

We strongly suggest that when choosing identification markers one consider consistency, standardization, and availability of a common database between researchers and organizations studying the same animal groups or animals studied. In addition, tag frequencies, manufacturers, and tag readers may not always be compatible. We suggest always using products compatible with those used in previous studies.

However, even though the VHF radios did not function for 12 months, the transmitters functioned satisfactorily until the batteries died, giving constant signals with an acceptable signal range.

The reduced lifespan of the satellite transmitters also was due to the high temperatures which reduced battery life. This could be improved by using devices which only give signals when they can be captured by the satellite and are more adapted to high temperatures. For this study the amount of energy consumed by the transmitter had not been calculated correctly, even though it was known that the transmitters consume more energy in hot climates. The transmitters were programmed based on ocean-going animals where the water is much colder than in the Amazon. It was not realized that the current drain would be so much higher in the Amazon heat. Now, reprogramming the two recovered transmitters on a different cycle with new batteries will enable them to function with the same number of batteries for the full 12 months or longer. This type of transmitter was used for the first time in a freshwater ecosystem and in the tropics. New transmitters can be programmed differently, using new calculations based on temperatures in the tropics, so that

they can produce signals for the entire year. There is also now available a freshwater on/off switch, such that the transmitter is only activated when it is at the surface out of the water, which will greatly conserve battery life.

We recommend that researchers collect data 24 h a day at the initiation of each study. After the movement patterns and activity patterns are determined, the transmitters may be programmed to operate only during the optimal time to send signals to satellites. If the turtles are relatively stationary for a period of time, battery life may be optimized by only activating the transmitter 6 h a day every four days, allowing for the collection of data for a longer time. The discarding of equipment by poachers complicates use of technology, because one cannot ascertain whether loss is due to emigration, equipment failure, or poaching. In this study we documented some transmitters that were disabled by poachers because some were recovered where the poachers had discarded them. The PTT was cut off the turtle and probably destroyed or thrown into the water, from which signals cannot be received. Local fishermen told us of one PTT that was recovered from where it was taken off a turtle. If the battery dies, signals will not be received either, but both the VHF signal and the satellite transmitter are not likely to die at the same time.

In the case of VHF radios applied to *Podocnemis expansa*, seven turtles were simultaneously marked with VHF and satellite technology. VHF signals were lost when these individuals entered flooded forest, while satellite technology continued to provide data.

APPLICATIONS AND RECOMMENDATIONS

Satellite radio versus VHF radio.—Locations derived from satellite tracking helped to delineate the reproductive, flooded, and dry season ranges of turtles to migration sites. Such information is essential to establish where females observed at a given beach live during the remainder of the year. For long-distance migrants, satellite tracking is a useful tool for monitoring migration routes. However, for species with limited migration or dispersal distances, satellite tracking may not be productive, while a VHF radio tracking system would provide better data

For some species the use of both methods might be appropriate, using satellite tracking to study their ranges, habitat use, and migratory routes and the VHF system to study habitat patch utilization and other fine-scale ecological interactions. When working with both technologies simultaneously, the satellite radio provides coordinates that facilitate approximating the general location of the individual so that the VHF radio may yield its exact position.

For an animal that does not move often, VHF is more precise and cheaper than satellite tracking. This system successfully collects continuous presence and absence data and turtle mortality data from local people and also estimates the amount of time that turtles spend on or near nesting beaches.

In the Amazon, the satellite system has shown high performance in tracking animals. However, Mantovani et al. (2003) reported that this method is not appropriate for tracking animals in fragmented areas and small rivers like those in the southeast region of Brazil. This was not a problem in tracking turtles in the Amazon Basin because, although there may be errors of hundreds of meters in their exact locations, the large size of rivers in the Amazon makes up for any error in the tracking location.

PIT tags versus plastic tags.—This study has confirmed that PIT technology is a reliable and promising method for identifying and monitoring individuals over long periods of time and is very efficient as a tool to study capture-recapture, movement, abundance, survival, and recruitment. In addition, the use of passive tags for animal identification and research provides many benefits, including the reduction of error in recording data, rapid data collection, and long-term reliability. They allow researchers to permanently mark animals internally without altering external appearance and eliminating negative impact on animals as they have little or no influence on growth rate, behavior, health, and predator susceptibility.

Previous experience indicates plastic tags were not as successful as the PIT tag system because plastic tags were lost faster and within four years of being marked. No turtles were recaptured with a plastic tag after four years.

Disadvantages and limitations.—Satellite and VHF-monitored radio tracking: The use of the satellite system is worth the expense because there is no need to track the animals in the field by boat or airplane which increases the costs. However, because turtles are a source of traditional local cuisine, they are heavily harvested by locals and consequently some of our equipment attached to these turtles is destroyed. Since a VHF radio is cheaper, it is therefore recommended if the species can be tracked and the signal received within the turtle's home range. In addition, VHF works better in fragmented areas, as already reported by Mantovani et al. (2003).

Passive Integrated Transponders.—The primary disadvantage of this technique is the cost (approximately US $4 per tag plus the cost of the tag reader). The standard version of this type of tag is 10–14 mm long and as the tag is inserted into the caudal musculature, experience and care are required in this procedure. However, when compared to plastic markers, PIT tags are still worth the cost.

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Using Tattoos to Mark *Apalone ferox* for Individual Recognition

Researchers use numerous methods to mark turtles for individual recognition (Ferner 2007; Plummer 1979). The most widely used method for hard-shelled turtles is shell notching (Cagle 1939) or a variant thereof. Other techniques used for marking hard-shelled turtles include passive integrated transponders (PIT; Buhlmann and Tuberville 1998; Rowe and Kelly 2005; Runyan and Meylan 2005) and metal tags attached to the carapace (Obbard and Brooks 1981) or flippers (Balasz 1985). Techniques that have been employed for soft-shelled turtles include hole punching (Doody and Tamplin 1992), inserting plastic spaghetti tags (Dreslik 1997), branding (Woodbury and Hardy 1948), notching the edge of the carapace (Breckenridge 1955; Plummer 1977, 2008), and tattooing (Breckenridge 1955). Overall, few studies have examined the effectiveness of tattooing as a marking technique for reptiles but there are reports of limited success in snakes (Woodbury 1948) and turtles (Balazs 1978; Breckenridge 1955).

In 2007, we began capturing and marking the soft-shelled turtle *Apalone ferox* in a spring-run complex located in Wekiwa Springs State Park, Florida, USA. Turtles were captured by snorkeling or with baited hoop nets during biannual, five-day sampling sessions. Captured individuals were tattooed with numbers (beginning with "1") on the underside of the carapace posterior to each rear leg (Fig. 1). The areas to be marked were dried, blotted with alcohol, and tattooed using a battery-operated tattooing gun (Permanent Marker Cordless Tattoo'r). After tattooing, the areas were rinsed with alcohol, allowed to dry, and then coated with a thin layer of antibiotic ointment. The tattooing process required ca. 10 minutes to complete. Tattooed turtles were kept dry for ca. 1 h before release. The process caused minimal bleeding (Fig. 1), which stopped before turtles were released. Touch-up tattoos were reapplied to all individuals recaptured during subsequent sampling sessions. Photographs of individuals were taken and in 2009 we began PIT tagging turtles to verify tattoo effectiveness.

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Fig. 1 illustrates typical changes as observed in the tattoo of one turtle. The initial tattoo was dark (Fig. 1A) and when the individual was recaptured during the same five-day sampling session, it exhibited a dark and legible tattoo (Fig. 1B). Seven months after original marking, the tattoos had faded, but a clearly-visible scar reflecting the number remained (Fig. 1C). Touch-up tattoos were reapplied and the turtle was released. Five months after remarking, the tattoo had again faded but the scar remained clearly visible (Fig. 1D). (Marks were more apparent in the field than is shown in photographs.) To date, 39 individuals have been tattooed, of which 12 were recaptured and remarked during a second (subsequent) sample, five were recaptured and remarked during a third sample, and two were recaptured and remarked during a fourth sample. Table 1 summarizes the time elapsed (in days) between marking and recapture. All recaptured individuals exhibited a visible tattoo or scar and the numbers have always been discernable. The long-term effectiveness of tattoos is supported by four recaptures ca. 1 year after marking, one recapture ca. 2 years after marking, and one recapture ca. 2.5 years after marking (Table 1). The most faded tattoos observed during the study were similar to the marks in Figs. 1C and 1D. PIT tags have aided in the verification of eight recaptures (Table 1) during later sampling sessions. In one instance (turtle 18), a PIT tag was lost or malfunctioned and the animal had to be re-tagged. The tattoo, along with body measurement data and previous photographs, positively identified this turtle.

Using body measurements, photographs, and PIT tags, we consider it unlikely that any turtles were misidentified. While fading of tattoos may make tattoos inappropriate for studies with long periods (several years) between samples, our data indicate that studies with at least annual sampling can employ tattoos.

During this study, *A. ferox* with carapace damage sufficient to obscure marks from notching or hole punching have been observed. To minimize mark loss, animals were tattooed twice in locations which are subjected to minimal wear. Breckenridge

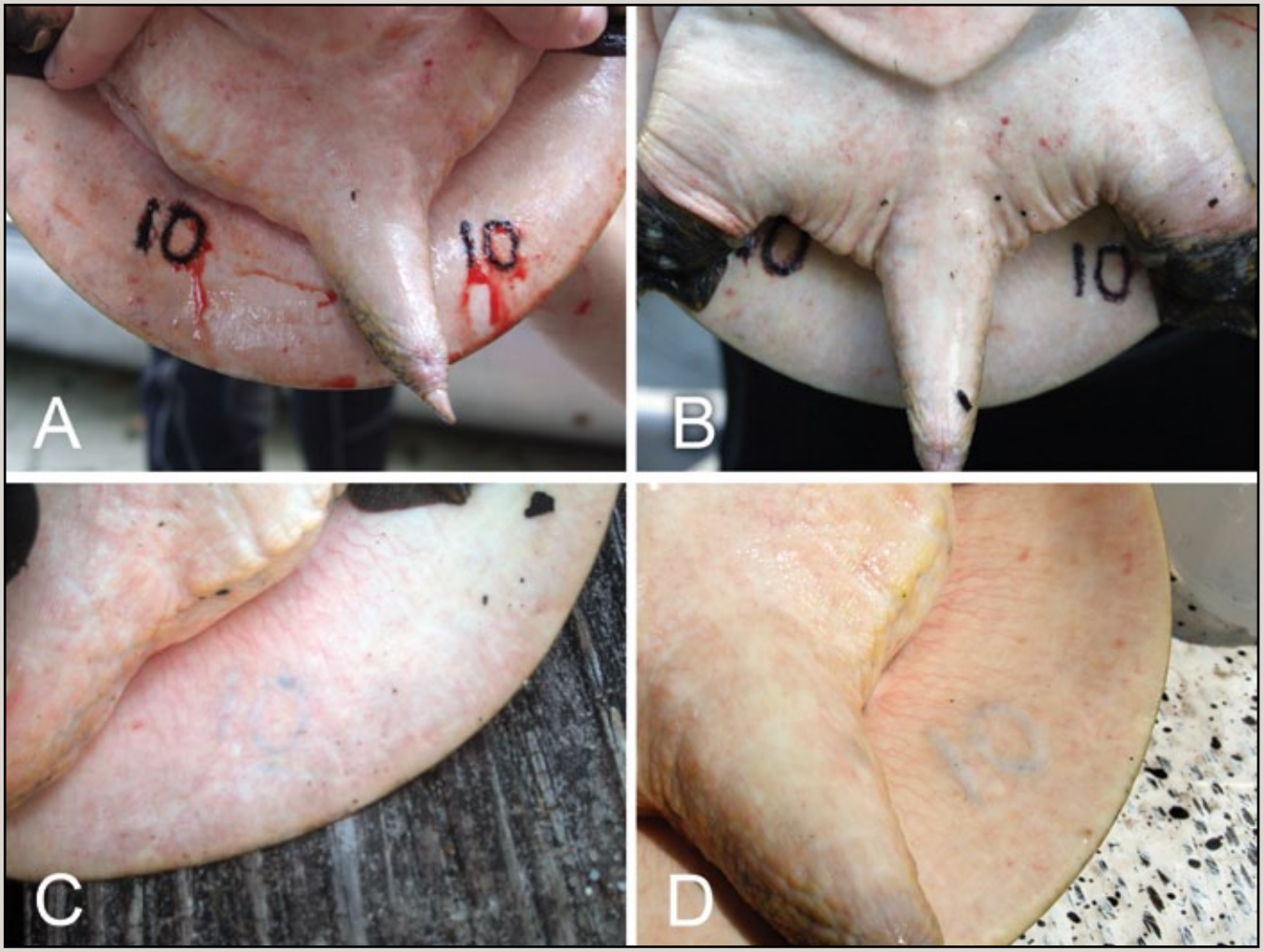

FIG. 1. Appearance of a tattoo mark in *Apalone ferox* A) immediately after the initial tattooing process; B) after recapture ca. 24 h after the initial tattooing process; C) 213 days after the initial tattooing process; and D) 349 days after the initial tattoo process and 136 days after its secondary tattoo.

(1955) placed tattoos in a high-wear area, the plastron. This may, in part, explain why he never recognized any recovered individuals as marked.

Tattooing does not require the removal of tissue, making it less intrusive than carapace notching or hole punching (Breckenridge 1955; Doody and Tamplin 1992; Plummer 1977, 2008). Tattooing is less expensive to employ than PIT tagging, which can cost ca. US $400 for a scanner (Rowe and Kelly 2005; Runyan and Meylan 2005) and ca. US $4–6 for each tag. The tattooing device used in this study cost ca. US $50 and required only new batteries, ink, and needles (which came with the device).

Apalone ferox is still a relatively little-known species compared to other North American freshwater turtles. We attribute this, in part, to the difficulty of marking these animals. Our method provides researchers with an inexpensive, effective technique for marking soft-shelled turtles. We hope this method will encourage more research on soft-shelled turtles.

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TABLE 1. The number of days that have passed between tattooing and subsequent recapture and tattoo reapplication for individual *Apalone ferox*. Asterisks (*) denote recaptures whose identity was verified through use of PIT tags.

Turtle Number	Number of days that have passed since Original Tattoo	First Reapplication	Second Reapplication
3	946		
4	209		
10	213	136	
12	213		
13	726		
14	350	373*	232*
15	213		
18	138	233	140*
21	233*	142*	
22	374*		
23	377*	138*	
24	239		
No. recaptures	12	5	2

of this manuscript. Special thanks go to Jessica T. Weber and Bradford A. Cox for the photographs used herein and to Shawn Roden for his advice using the tattoo wand. We would also like to express our gratitude to Brittany Taylor, Jessica Munscher, Philip Berry, Emily and Joel Kuhns, Heather Mosley, Jessica Wright, Megan Keserauskis, Graham Williams, and the many other individuals who have aided this research. Additional thanks go to Deborah Shelley and Marsha Butler from the Wekiva River Aquatic Preserve, as well as Friends of the Wekiva River and the Wekiva River Wild and Scenic Committee. All turtles were collected and handled in accordance with American Society of Ichthyologists and Herpetologists guidelines for animal care and use in research. This study was conducted under Florida Department of Environmental Protection permit number 06240913 and Florida Fish and Wildlife Conservation Commission permit number LSSC-09-0411.

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An Effective Method for Transporting Hellbenders (*Cryptobranchus alleganiensis*)

The Eastern Hellbender (represented by two subspecies, *Cryptobranchus alleganiensis alleganiensis* and *C. a. bishopi*) is an impressively large, strictly aquatic salamander endemic to eastern North America (Petranka 1998). Hellbenders can grow to 74 cm in total length and are gray, brown, or dark green with a dorsoventrally flattened body and a laterally compressed, keeled tail. Although hellbenders have lungs, they are cutaneous respirators and require pristine, cool, swiftly moving streams and rivers with high levels of dissolved oxygen that equates to approximately 100% saturation (Nickerson et al. 2002). Cutaneous respiration is aided by the hellbender's conspicuous, undulating vascular lateral skin folds, which increase surface area for gas exchange.

Populations of hellbenders have declined throughout their range (Foster et al. 2009; Petranka 1998; Wheeler et al. 2003) because of habitat alteration resulting from mining and agricultural activities, collection for the pet and bait trades, and potentially from chemical contamination (Foster et al. 2009; Petranka 1998). As a result, the species is listed as Near Threatened by the IUCN and is listed as Special Concern in New York State. The New York State Department of Environmental Conservation (NYSDEC) has acknowledged that without intervention, the hellbender in New York is expected to continue its decline (Bell et al. 2010). In an attempt to address this, a statewide recovery plan has been written by a team of experts from within and outside the NYSDEC (Bell et al. 2010); the plan includes headstarting of wild-collected hellbender embryos. The NYSDEC and the Buffalo Zoo have spearheaded an effort to develop captive rearing or headstarting efforts for the Eastern Hellbender in New York State. The Wildlife Conservation Society (WCS)/Bronx Zoo was presented with the opportunity to help with this effort through fostering a portion of the larvae, which will be reared in captivity for two years at the Bronx Zoo prior to their return to their natal river in western New York State. However, we had to find a safe and effective way to transport them from Buffalo, New York to the Bronx (an approximately 640 km journey) in July, the hottest month of the year in the New York Metropolitan Area with an average monthly high temperature of 29°C (National Climatic Data Center; www.ncdc.noaa.gov).

The particularly high oxygen needs of this species required that we manufacture a reliable system for maintaining low

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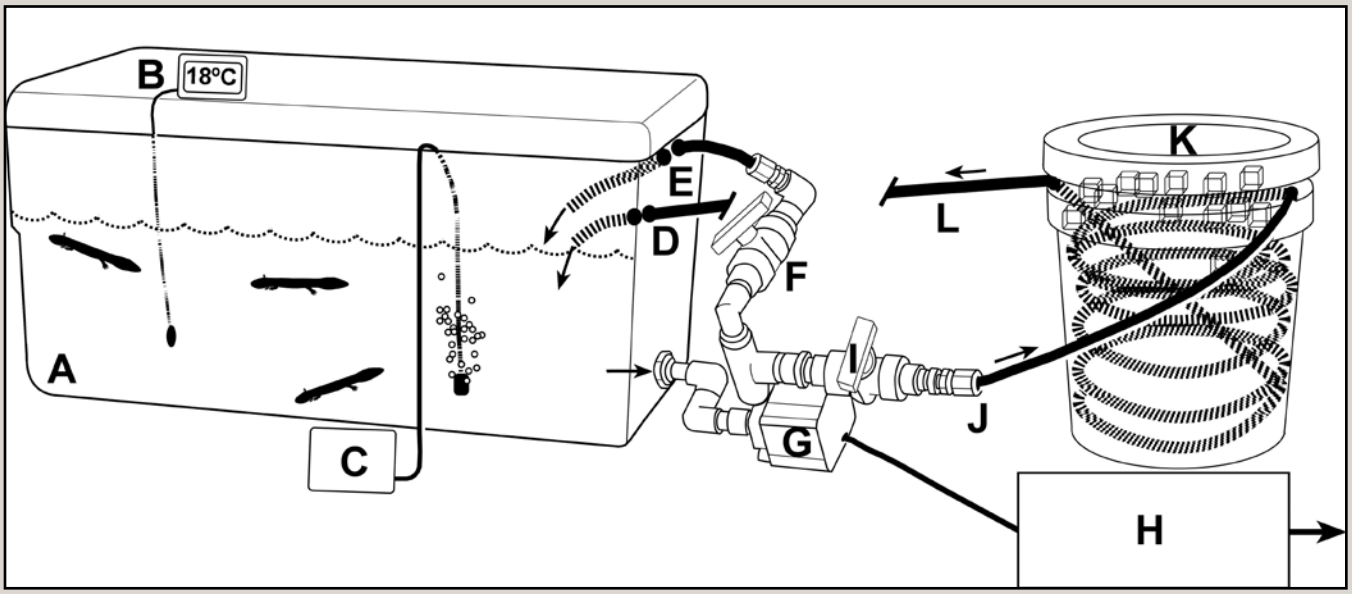

FIG. 1. The hellbender transportation device. Note that parts are not drawn to scale. Product brands are provided in the text. A) A 114 liter-capacity beverage cooler. Approximately 20 nine-month old juvenile hellbenders were transported in each container with the cooler lid closed during transport to keep the water cold. B) An external digital thermometer with an internal probe. The probe was secured underwater to the wall of the cooler with a suction cup that is provided with the product. C) A battery-operated aerator with an air stone; two were used for each cooler. D) The return hose from the heat exchanger, which passes through the wall of the cooler. E) The return hose from the pump, which passes through the wall of the cooler. F) The tank circulation valve, which can be closed completely to form a closed loop between the heat exchanger and the tank. To make the tank water warmer, this valve should remain fully open, while Valve I is shut off completely, thus shunting water flow to the heat exchanger and maintaining water current and oxygenation of the system. G) A 115-volt water pump. The pump is connected to a power converter (H). The power converter converts 12-volt DC power to 115-volt AC power, allowing us to run the AC water pump off of the vehicle's battery via the cabin power source or cigarette lighter. I) The heat exchanger valve. This valve can be completely opened or closed or closed partially to regulate the rate of flow of the water through the heat exchanger. The more open this valve is, the more quickly the water will cool. J) The outflow tube leading to the heat exchanger. K) The heat exchanger consists of a 431.8 cm long, 1.27 cm outer diameter HDPE plastic tube that is coiled inside a five gallon bucket filled with ice. The lid is placed tightly onto the bucket. The greater the number of hose coils inside the heat exchanger, the greater the surface area and efficiency of the heat exchanger; however hose length is negatively correlated with flow rate. L) The return or outflow hose from the heat exchanger to the hellbender tank. For illustrative purposes, the hose here is shown as an incomplete line but in reality it is continuous with D.

temperatures and high dissolved oxygen during transport. Although there are many published reports and accounts on the monitoring of wild *C. alleghaniensis* populations and proven methods of capture (e.g., Foster et al. 2008; Humphries 2007; Nickerson and Krysko 2003; Williams et al. 1981), there are very few notes and published reports on how to manage their safe transport and captive care (Indiviglio 2010). Moreover, although there are commercially produced refrigerated devices for transporting fish, they are prohibitively expensive. Herein we describe a simple and cost-effective method we developed to transport hellbender larvae.

Transporting cool-loving hellbenders in the middle of a North American summer presents logistical challenges. Originally, we investigated the possibility using a commercial airline to transport the hellbenders from Buffalo to the Bronx. However, because they breathe through their skin and through external gills as larvae, ground transportation was the safest option as when aboard a plane, it would have been impossible to observe them and to intervene in order to provide supplemental oxygen if needed. Only by driving the hellbenders could we carefully monitor their progress and troubleshoot oxygen levels if necessary. This problem necessitated the planning and manufacture of an efficient transportation container that could simultaneously cool and oxygenate the animals for their relatively long journey to the Bronx Zoo.

We constructed two transportation devices, which each housed approximately half of the 41 gilled hellbender larvae. Each hellbender transportation container was manufactured with a Coleman® Xtreme 114 liter-capacity cooler. Each cooler was filled with approximately 70 liters of water, which was brought from the filtered water supply at the Bronx Zoo. The water system at the Bronx Zoo's Amphibian Recovery Center (ARC) incorporates ozone treatment, carbon and cloth-bag filters, removes chlorine and chloramines, and reduces phosphate levels from the New York City municipal water. Water temperatures in the hellbender room at the zoo are maintained at 18°C during the summer. In order to acclimate the hellbenders during their ride to the Bronx Zoo, our goal was to maintain transportation containers at 18°C throughout the round trip.

Each cooler (A) was plumbed with a pump (Model 5® utility pump, 115 volt AC; Aquatic Ecosystems, Inc.), which was connected with PVC piping to the drain spigot of the cooler with a 2cm (3/4") exterior bulkhead and internal strainer (Fig. 1). The pump was powered with the transportation vehicle's battery, which is accessed with a voltage transformer (DC to AC voltage transformer with 12 volt DC input and 120 volt AC output with a power output of 700 watts or 5.8 amps; McMaster-Carr) connected to the vehicle's dashboard power source. The pump (G) circulated the water from the cooler to a heat exchanger and through the cooler. The heat exchanger (K) was made from a

20-liter plastic bucket filled with ice. Through this bucket, a 430 cm-long, coiled HDPE plastic hose (1.27 cm outer diameter) circulated the hellbenders' water. Our heat exchanger had five coils of water-circulating hose inside the bucket. Two PVC ball valves regulated the flow of the water through the system. Valve F continuously regulated the flow rate of water through the cooler. The other valve (I) regulated flow through the heat exchanger. The temperature of the water holding the hellbenders was regulated by adjusting Valve I. When Valve I was shut off completely, then water flow was only circulated through the cooler through Valve F and gradually became warmer. In contrast, when Valve I was fully open, it allowed maximum flow through the ice-filled heat exchanger, and decreased the temperature of the water inside the cooler (A). Thus, through closing or opening Valve I partially or completely, we could manage the water temperature very effectively, to within one or two degrees of our target temperature. The Coleman® beverage cooler also insulates very well and is highly efficient at maintaining stable temperatures. In each transportation container, two battery-powered aerators (Penn-Plax® Silent Air B10), each with airline hose and an airstone, were used to further aerate the water (C). The coolers were placed onto a sheet of insulating foam to help buffer them from the van's hot floorboards and also to prevent them from sliding on the floor of the van.

On 13 July 2010, two of us (JP and JW) traveled to the Buffalo Zoo, New York to transport 41 hellbender larvae to the Bronx, New York. The round trip was made the same day and was approximately eight hours in each direction including rest stops. The highest outdoor ambient temperature along the route that day was 29°C. The van's cabin was air conditioned with the ambient temperature fluctuating from 21°C to outdoor ambient. On our way to pick up the hellbenders we let the system run in order to make any necessary adjustments and to ensure that the optimal temperature could be maintained throughout the trip. Prior to their release into the water of the transport device, the hellbenders were suspended in plastic tropical fish bags for at least twenty minutes until the temperature inside the bag was at equilibrium with that of the transport container.

Both on the trip to Buffalo, New York, and during our return to the Bronx, we were able to maintain a nearly constant (~18°C) water temperature inside the transport containers. Approximately two, 2.2 kg bags of commercially prepared ice were used to fill the heat exchanger described above. The ice, purchased from convenience stores, was changed out twice during each leg of the trip.

Upon arrival at the Bronx Zoo, the hellbenders were transferred immediately from the coolers to their new 75-liter (20-gallon long) aquaria (1–2 hellbenders per aquarium) in a biosecure room in the Amphibian Recovery Center. The water temperature of their new aquaria was nearly identical to that of the water in which they were transported. All 41 hellbenders made the trip safely and are, as of publication, doing well at the zoo. This method was very effective for the transportation of hellbenders and may prove useful in the transport of other aquatic amphibians, particularly montane species such as frogs of the genus *Telmatobius*. The number of animals that can be carried in each device is dependent upon the dissolved oxygen (DO) needs and body mass of the particular species. It is recommended that users of this device research the physiological parameters required of the species being transported. In this case, we set up our device, allowed it to run for several hours, and used a digital meter to determine the DO levels in each to ensure that they would be within reasonable limits for transporting 41, 7 cm-long larvae.

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Captive Management and Reproductive Biology of Latifi's Viper (*Montivipera latifii*) (Squamata: Viperidae) at Razi Institute and Tehran University in Iran

Latifi's Viper or Lar Mountain Viper (*Montivipera latifii*) is a small, mountain-dwelling venomous snake occurring in Iran in Tehran Province (lar Damavand, Ab-Ask, Firuzkuh, Gajere, Gachsar and Afjeh) (Rastegar-pouyani et al. 2008). This species is found only in Iran and has been considered at risk since 1979, when there was concern about the possible extinction of this viper (Andén and Nilson 1979). Construction of an enormous earthen dam called Lar Dam inundated the habitat in the late 1970s and it appeared that the snake was forever lost. In 2000 an isolated population was found in the upper Lar Valley in the Elburz Mountains. In 1983 the snake was listed as Endangered and its future has not improved (Groombridge 2010; Red List of IUCN 2010).

In older Iranian literature on venoms and snakebites many *Vipera* species, including *M. latifii*, were referred to *Vipera xanthina* or *V. xanthina* ssp. (Mallow et al. 2003). Nilson et al. (1999) erected the subgenus *Montivipera* within the genus *Vipera*, which later was elevated to genus rank (Joger 2005). Nine taxa are contained in *Montivipera* including *M. latifii*. All are high-altitude mountain dwellers. We consulted Andrén (1986), Andrén and Nilson (1979), Latifi (1985), Mallow et al. (2003), Mertens et al. (1967), Nilson and Brodmann (1987), and Phelps (2010) for descriptions of *M. latifii*, especially color and pattern morphs (Fig. 1). Color photographs showing three of these morphs are available (U.S. Dept. of Defense Intelligence Document 1991).

Andrén and Nilson (1979) characterized the habitat of *M. latifii* as high alpine steppe located at an elevation of 2000–4000 m. The Lar Valley is surrounded by high mountains and is essentially closed. Adults were found in well-drained, sparsely vegetated rock habitats. We measured air temperatures in July 1973 and June 1976 (daytime 28–35°C, 10–13°C immediately after sundown, 0–5°C at night). Most of the time, the snakes were underground, perhaps in response to low temperatures. Behrooz (2009) described the habitat: mountainous areas, grasslands, rocky outcrops, and shrubland (Fig. 2).

The maximum length is 79 cm and the length of the tail is 5 cm (Farzanpay 1989; Latifi 1991). Andrén and Nilson (1979), Mallow et al. (2003), and Mertens et al. (1967), described four distinct color and pattern morphs and two are shown here from Latifi (1985; Fig. 1). Litter size varies from 3–10 neonates (Andrén and Nilson 1979; Latifi 1985; Mertens et al. 1967). The diet for this species in the wild consists of insects, grasshoppers, lizards, and mice (Behrooz 2009).

Today this species is highly threatened and has vanished from many parts of its range due to both the destruction of its natural habitat (Behrooz et al. 2009) and the overcollecting of snakes for the production of antivenin (Nilson 2008). The Razi Institute started in 1958 to produce antivenin and the first serum was issued for therapeutic use two years later; venom was extracted from 9397 vipers (Latifi 1978). In 1984 Latifi described venom extraction from nearly 8750 (additional?) snakes and described antivenin production at Razi Institute the following year. Mallow et al. (2003) describe the production of antivenin in detail. There are three main reasons for setting up a colony of *M. latifii* at Razi Institute: to eliminate the need to purchase snakes from local collectors for antivenin production, to increase numbers by improved captive management and expanded captive breeding, and to decrease mortality rates. At Tehran University 12 specimens are currently maintained to study reproductive biology and will be released after studies have been completed.

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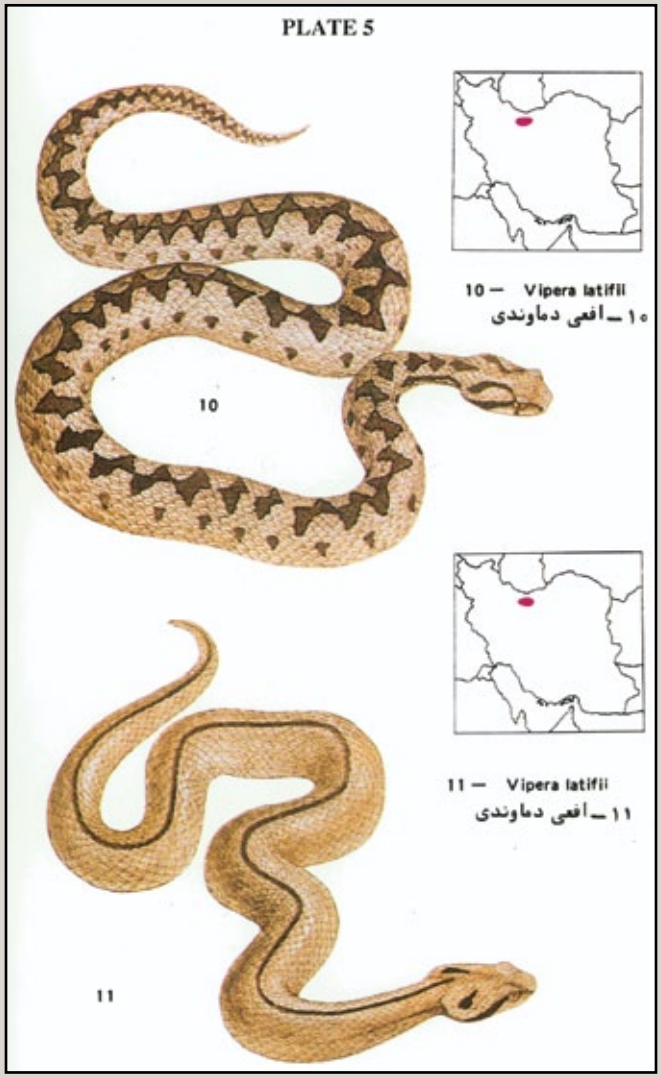

FIG. 1. Drawing of Latifi's Viper (*Vipera latifii,* now *Montivipera latifii*) from Mahmoud Latifi's *Snakes of Iran* published in 1985. Shown here are two pattern morphs: zig-zag pattern above and narrow vertebral line below.

PHOTOS BY ROOZBEH BEHROOZ

FIG. 2. Three views of habitat of Latifi's Viper (*Montivipera latifii)* in Lar Valley, Iran, now a national park. This viper is at risk due to increased human visitation and collection by snake hunters. The Razi Institute continues to produce antivenin to counteract potential snakebites.

CAPTIVE MANAGEMENT

Very little information is available on reproduction and growth under laboratory conditions. One of the reasons may be due to the low number of specimens in captivity. Mamet and Kudrjavtsev (1995) have published information on the breeding of *Montivipera latifii* at the Moscow Zoo.

In 2008 and 2009, 26 Latifi's Vipers were captured in the Lar Valley (Alborz Mountain, Kakamega Forest, Damavand District, Tehran Province, Iran) to form the nucleus for a captive breeding program at Razi Institute and Tehran University. The first group was collected in 2008 and consisted of eight female specimens that appeared to be gravid. The second group was collected later that year and consisted of six specimens (two females and four males). The snakes in these two groups were held at Razi Institute. The next year 12 individuals (six females and six males) were collected and maintained at Tehran University.

Our snakes had coloration and pattern variation as described by Andrén and Nilson (1979; Table 1); the markings were most often vertebral lines and zig-zags (Fig. 1). Variants were found with light grayish-yellow ground color with mid-dorsal dark brown spots and two diagonal dark brown to black stripes on each side of head. A few had pale yellow ground coloration with a pattern of black and white small spots.

TABLE 1. Parturition in captive Latifi's Vipers (*Montivipera latifii*) in 2008.

Number of neonate	Beginning emergence of neonates / egg masses from cloaca	Complete emergence of neonates / egg masses	Total time between initial appearance and total emergence of neonates/egg masses (min)	Intervals between births and egg mass extrusions (min)
1 (Neonate with spinal defect)	0950 hr	1000 hr	10	—
2 (Infertile egg mass)	1006 hr	1012 hr	6	6
3 (Infertile egg mass)	1022 hr	1028 hr	6	6
4 (Healthy neonate)	1103 hr	1122 hr	19	35
Mean			10.25	11.75
Total time = 102 min				

Data are presented here reflecting our two-year study on behavior, reproduction, and growth under laboratory conditions. Ettling and Marfisi (2002) described male-male combat behavior in *Montivipera wagneri* and *M. raddei*. Although many male *M. latifii* were maintained in the same enclosures during our study, we did not observe this behavior. Greene et al. (2002) described parental behavior in *Vipera berus*: "Some authors have claimed that Adders (*Vipera berus*) aggregate with their young for up to several days after birth, and that the young seek cover under the female when approached closely…Conversely, several experienced researchers at the conference on which this volume is based have not observed female *V. berus* attending their young (S. Anderson, C. Andrén, T. Madsen, and R. Thorpe, pers. comm.)." We have not observed this parental behavior in *M. latifii*.

The 26 individuals captured from the wild were housed in special vivaria with environmental parameters (temperature and humidity) similar to the native habitat as described below.

The enclosures.—In August 2008, two adult pairs were housed in one glass vivarium measuring 120 cm L × 45 cm W × 50 cm H with aluminum mesh on the top and front. Two males were put into another glass enclosure of the same size with aluminum mesh on the top and rear. In 2009, five enclosures were redesigned to increase space and improve ventilation (120 cm L × 60 cm W × 50 cm H).

Two of the new vivaria with increased floor space were used to house four adult pairs and two adult pairs, respectively. The substrate was peat moss. Pieces of broken flower pots were available as hiding places.

Temperature, humidity and lighting.—An incandescent light bulb (40 watt) was used as a heat and light source with an automatic timer set to duplicate daylight cycles. The thermal gradient ranged from 30–32°C beneath the lamp to 26–28°C at the far end. Every week the enclosures were sprayed with warm water. The humidity level prior to the spraying was 35% and increased to 50% after spraying was done. The relative humidity averaged 40–50%.

Disinfection and quarantine.—With any new animals coming into captivity, care must be taken to prevent cross contamination and any infectious disease should be treated in a timely manner (Murphy and Armstrong 1978). Quarantine procedures were strictly followed. The incoming vipers were quarantined for a minimum of four weeks, strictly following established protocols, as recommended by Ross and Marzec (1990), but we note here that due to the danger of Ophidian Paramyxovirus, recommendations today stress that quarantine should be extended to a minimum of 90 days (Elliott Jacobson, pers. comm.). To eradicate ectoparasites, the vipers were dusted with Opigal powder, a product used in Iran to treat fowl for mites, ticks, and lice.

Sex determination and marking.—The sexes of the animals were tentatively assigned based on tail length/body length ratio initially and later validated by probing male copulatory organs as described by Laszlo (1975) and Toriba and Hirabayashi (1995). The variation of unique and distinct markings among individual animals was used to keep track of males and females during the hibernation period and for tracking the feeding history of each snake. In addition, nail polish was painted on tails to track individual snakes; this approach was used as it was easily implemented, clearly distinguishable, and was not harmful to the marked individual (see Murray and Fuller 2000 for discussion on marking techniques).

Food and feeding.—Laboratory rodents were the most commonly available food items and were selected to decrease the risk of endoparasitic infection (Chanhome et al. 2001). Newborn and adult mice (*Mus musculus albinus*), and newborn rats (*Rattus norvegicus berkennhout*) were offered once a week; the vipers did not accept the lizards (*Mesalina watsonana, Eumeces schneiderii*) that were offered. In 2009 the food items were supplemented with the multivitamin "Rep-Cal Herptivite Multivitamin" (Rep-Cal Research Lab, Los Gatos, California). There was competition during feeding. In some cases snakes struck each other during predatory episodes.

Generally, gravid snakes lose normal body weight during the reproductive cycle due to birth of young and long periods without food during gestation. Body weight and accumulation of fat is necessary to enable the process of follicular maturation and neonate production. In 2008 the newly captured snakes did not accept food and the body weight of males and females declined; hence, females likely had no fat reserves for reproduction. The next year snake weight increased because the vipers were feeding with regularity. In 2009 the newly captured gravid viper started to take food earlier than usual, which indicated a need to increase the required body weight and fat for the next breeding cycle as described by Vyas (2002).

Availability and diversity of food are important for captive reproduction (Ambu et al. 1986; Kudrjavtsev et al. 1993). When food items were supplemented with multivitamins in 2009, this change had a positive effect on weight gain and resulted in more complete shedding of snakes (Grubant et al. 1973; Igolkina et al. 1989; Mamet and Kudrjavtsev 1995).

Nursery cage and neonatal husbandry.—Neonates were placed into separate plastic boxes that were ventilated by drilling holes on each side and lid. The box size was 30 × 10 × 10 cm and contained an inverted flowerpot (as a hiding place), paper substrata, and a water bowl. The temperature in one part of the box was kept at 28–30°C during the daytime by using an incandescent bulb (20 watt). The other part was kept at 26–27°C, and the

temperature and humidity at night corresponded to the seasons. The temperature was 22–24°C at night, accomplished by simply opening the windows. Spray-misting was done as needed in the cooler parts to ensure that the humidity remained at 40–50%.

Ecdysis.—Successful shedding depends largely on environmental temperature and the amount of food intake. The time between the onset of milky blue eyes and complete shedding averaged one to two weeks. Intervals between shedding ranged from one to several months. Shedding seemingly depended on temperature but might also have been influenced by the amount of moisture to which the snake was exposed. Adequate moisture was provided by spraying water into cages as needed. When snakes did not shed properly, they were soaked for ca. 20 minutes in water to facilitate ecdysis.

Hibernation.—According to some authors the most important aspect contributing to successful reproduction in captivity is artificial hibernation (Buzhansky and Kudryavtsev 1982; Grubant et al. 1973; Mamet and Kudryavtsev 1995; Strelkov 1986). Because this viper is found in mountainous areas where the temperatures remain seasonally cold, hibernation seems necessary for this species. In Lar Valley, the snake is found near bodies of water in the spring and summer where the temperature is higher than in other parts of the range and where slope and rocky habitat provides shelter (Behrooz 2009). In the lab after the vipers had been offered food for several months, the animals were placed into hibernation. On 15 October 2008 males and females were separated; the snakes were no longer offered food but water was provided. After a period of seven weeks the temperature of the cages was decreased to 10°C and the lamp was extinguished. The cooling period was 76 days. The temperature remained between 8–10°C throughout this time span. On 19 February 2009 the lamp was turned back on and natural sunlight penetrated the room; light was gradually increased from zero to three hours per week. After four weeks light was at 12 hours. On 20 March 2009 males and females were placed together.

In April 2009 we collected 12 additional vipers from Lar Valley that had emerged from hibernation in the wild. These snakes were sent to Tehran University where they were hibernated the following autumn, kept at temperatures ranging between 6 and 8°C. In March they emerged from hibernation.

RESULTS

First birth.—Of the eight gravid females collected on 22 July 2008 for Razi Institute, all but one had reproductive complications: stillborn young or infertile egg masses. On 30 August 2008, a lined-pattern gravid female was coiled at the center of the cage near the water container. During parturition muscular contractions of the posterior trunk were evident. The tail showed noticeable movements in an upward and downward plane. The first snake born had a lined pattern and died 2.5 h after birth because of a spinal chord defect. The second and third masses passed were infertile. The fourth neonate had a zig-zag pattern. Thus only one young snake was normal and healthy. Periods of time between births and passage of egg masses varied. Table 1 indicates the time for the entire process of parturition which lasted 102 min. After birth the spent female crawled to the cleaner corner of the cage, possibly to avoid the afterbirth. The young one crawled around the cage, shed on the fifth day, and started to feed soon after ecdysis. Newborn dead mice were the first prey items accepted. Tare and Renapurkar (1992) observed parturition in captive Russell's Viper (*Daboia russelii*) which was similar to what we observed with this female.

Second Birth.—On 24 April 2009, a group of 12 specimens were collected and housed at Tehran University. Of the six females collected in April 2009, one of the zig-zag patterned females spent almost all of the time under the heat lamp and was inactive. The posterior 1/3 of female's body was enlarged, indicating gravidity. On 21 August 10, neonatal vipers were born, and were weighed and measured: weight (3.8–4.9 g, mean = 3.8 g, variance = 0.1316); length (16.0–18.4 cm, mean = 17.5 cm, variance = 0.4921). Our snakes were smaller and lighter than those recorded by Mamet and Kudrjavtsev (1995), likely because our litter was larger. All had zig-zag patterns. Eight of ten neonates shed their skin in 5–7 days and two others shed after two months. After the first shedding none of the neonates accepted food readily so they often had to be stimulated to eat or forcibly fed. Moving food in front of the snake with long forceps stimulated a feeding response (see Murphy and Campbell 1987 for details). Neonates could be encouraged to accept small mouse parts such as a tail or leg. This was done by lightly touching the tip of the snake's snout or tail with the food item until a strike was induced whereupon feeding commenced. After one year the snakes accepted newborn mice without intervention by the caretakers. The survival ratio of neonates after one year was 50%.

In November 2009 the snakes were placed in hibernation. After emergence from hibernation on 30 March 2010 they were placed together to elicit courtship and copulation. During May courtship behavior by the male was noted but although copulation was not observed we are hopeful that future captive reproductive events will occur.

In summary, we conclude that artificial hibernation, type and diversity of food, vitamins, adequate fat reserves in females, and laboratory conditions based on environmental features duplicating the natural habitat of this species contributed to growth and courtship in the laboratory.

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AMPHIBIAN DISEASES

Herpetological Review, 2011, 42(4), 540–542.

Ranavirus Prevalence in Amphibian Populations of Wise County, Virginia, USA

Several factors have been linked to catastrophic amphibian declines, including habitat alteration and pathogens (Semlitsch 2003; Stuart et al. 2004). Ranaviruses (Family: Iridoviridae; Genus: *Ranavirus*) are one particular group of pathogens linked to massive amphibian die-offs (Daszak et al. 1999; Gray et al. 2009a; Green et al. 2002). Despite the evidence of ranaviruses becoming an emerging disease (Storfer et al. 2007), we still know relatively little concerning its geographic distribution among amphibian species. Rather, most recent amphibian pathogen studies center on *Batrachochytrium dendrobatidis* (Ohmer and Bishop 2011). However, *B. dendrobatidis* should not be the only pathogen that warrants investigative attention, as others are quite capable of exerting deleterious effects upon amphibian populations (Duffus 2009). Herein, we examine the occurrence of ranavirus infections in amphibians (including urodeles and anurans) present in the southern Appalachian Mountain areas. Ranaviruses have been associated with some mortality events in this region (Green et al. 2002), yet much of this area (and, much of North America in general) remains unsurveyed despite it being a hotspot for urodele diversity and endemism (Petranka 1998).

We sampled for ranavirus by collecting toe clips from dipnet and hand-caught amphibians of Wise County, Virginia, USA, from April to September 2010. Wise County is located in southwest Virginia (Fig. 1). Wise County covers approximately 1050 km^2, including approximately 3 km^2 of water coverage. Being in the midst of the Appalachian Mountains, Wise County has tremendously heterogeneous habitats along elevation gradients. Sample collections were conducted in the preferred habitats of all the amphibian species known to occur within the county (see Mitchell and Reay 1999 for complete amphibian species occurrence list) at various times of the day/night to increase the probability of capture success. We surveyed several regions of Wise County, including both private (with permission of landowner) and public land. However, the majority of sampling occurred on public-use land—mostly in various regions of the Jefferson National Forest. Indeed, a large portion of Wise County is part of the Jefferson National Forest. Our surveyed regions include: Cave Springs Recreation Area and Stone Mountain Trail (both near Big Stone Gap, Virginia); Guest River Gorge Trail, the Clinch River (and its numerous branches), and Little Stony Falls (all near Coeburn, Virginia); High Knob Recreation Area and Flag Rock Recreation Area (both near Norton, Virginia); Red Fox Trail and Pound Lake (both near Pound, Virginia); Cane Patch Recreation Area, Phillips Creek Recreation Area, and the main campus of the University of Virginia's College at Wise (all near Wise, Virginia). We are not reporting exact locations due to the vulnerability of these endemic urodele species in the area. No individual was sampled more than once during our approximately 121 person-hours in the field.

FIG. 1. Map of Wise County, Virginia, USA.

In order to minimize cross contamination between collected toe clip samples and between field sites, all equipment and instrumentation used were rinsed in a 10% bleach solution, followed by a dechlorinated tap water rinse between every use/sample acquisition. In addition, nitrile gloves were worn and replaced between each collected and handled amphibian. Individual toe clips were immediately preserved and stored in 1.0 ml of 70% ethanol in a 2.0 ml screw-cap vial. DNA extractions were completed using Promega® Wizard Genomic DNA Purification Kits (Promega® Corporation, Madison, Wisonsin, USA), as per manufacturer's instructions. Extracted DNA products were amplified using Fisher® BioReagents exACTGene PCR Kits (Fisher Scientific®, Fair Lawn, New Jersey, USA), using PCR primers #4 and #5 described in Mao et al. (1996 and 1997) that amplify an approximately 500 bp region of the ranavirus major capsid protein. PCR was performed using the following protocol slightly modified from Greer and Collins (2007) and Greer et al. (2009): an initial denaturation at 94°C for 5 min; denaturation

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TABLE 1. Ranavirus prevalence in the amphibians of Wise County, Virginia, USA.

Species	No. infected / total sampled	Prevalence of infection (95% confidence interval)
Caudata		
Desmognathus fuscus	7 / 12	0.58 (0.32–0.81)
Desmognathus monticola	8 / 12	0.67 (0.39–0.86)
Desmognathus ochrophaeus	0 / 1	0 (0–0.79)
Desmognathus quadramaculatus	3 / 3	1 (0.44–1)
Eurycea cirrigera	10 / 21	0.48 (0.28–0.68)
Eurycea longicauda	2 / 3	0.67 (0.21–0.93)
Eurycea lucifuga	1 / 4	0.25 (0.05–0.7)
Notophthalmus viridescens	1 / 9	0.11 (0.02–0.44)
Plethodon cinereus	0 / 3	0 (0–0.56)
Plethodon glutinosus complex	4 / 15	0.27 (0.11–0.52)
Plethodon richmondi	0 / 5	0 (0–0.43)
Anura		
Anaxyrus americanus	0 / 6	0 (0–0.39)
Hyla chrysoscelis	0 / 9	0 (0–0.3)
Pseudacris crucifer	0 / 2	0 (0–0.66)
Lithobates catesbeianus	2 / 10	0.2 (0.06–0.51)
Lithobates clamitans	0 / 1	0 (0–0.79)
Lithobates palustris	1 / 2	0.5 (0.09–0.9)
Lithobates sylvaticus	0 / 1	0 (0–0.79)
Total	39 / 119	0.33

at 94°C for 1 min, annealing at 55°C for 1 min, and extension at 72°C for 1 min, each cycled 35 times. PCR products, including a positive control and negative controls (an extraction control and a DNA-free PCR mixture control) for each gel, were visualized on 1.0% agarose gel stained with ethidium bromide in 1X TAE buffer under ultraviolet (UV) light. All DNA extractions were amplified and run in duplicate. A positive test was recorded only if each sample duplicate yielded the targeted ~500 bp fragment. If sample duplicates had conflicting results (i.e., a positive and a negative) or if both duplicates yielded a negative result, its respective sample DNA was re-extracted and PCR was conducted in duplicate twice more. All equipment and materials used for DNA extraction and PCR amplification were sterilized under UV light prior to and between uses.

A total of 119 samples were collected from 18 amphibian species in Wise County, Virginia, USA (Table 1). Overall, 39 of 119 (approximately 33%) samples tested positive for *Ranavirus*, of which 36 of 39 (approximately 92%) were caudates and 3 of 39 (approximately 8%) were anurans. However, no sampled individual showed external signs of ranavirus infection, such as erythema or edema. Three samples (two *E. cirrigera* and one *Lithobates catesbeianus*) were excluded from analysis after multiple extractions and amplifications still yielded mixed PCR results. However, other samples from these two species tested positive.

Our data are the first to show the presence of ranavirus infections in amphibian populations of Wise County, Virginia, USA. In addition, we show *Desmognathus fuscus*, *Eurycea cirrigera*, *E. longicauda*, *E. lucifuga*, and the *Plethodon glutinosus* complex as new plethodontids capable of acting as ranavirus hosts. However, it is not the first report of ranavirus in southern Appalachian Mountain amphibians. Gray et al. (2009b) reported the first occurrences of ranavirus infections in lungless salamanders (Plethodontidae) from Tennessee, with a prevalence of 81%. While our data do not suggest nearly as high prevalence among plethodontids (approximately 44%), our low sample size per species (thus, our subsequently large confidence intervals; Table 1) coupled with the use of toe-clips from numerous field locales may warrant caution when discussing true prevalence. Toe-clips have a false-negative rate of ~12% relative to livers in field samples (St-Amour and Lesbarreres 2007) and recent infections can be difficult to detect in peripheral tissues (Greer and Collins 2007), so we likely underestimate true prevalence. However, unless dead individuals were found in the field (and they were not), we did not desire to euthanize any amphibians—particularly some of the salamanders because of their endemism or due to ongoing mark/recapture studies.

In summary, we report the first occurrence of ranavirus in Wise County, Virginia, USA. Continual monitoring of ranavirus occurrence and possible infection in amphibian populations of the southern Appalachians should be part of future efforts because that region houses several endemic amphibians, particularly plethodontid species. In addition, we report five new plethotontids (*D. fuscus*, *E. cirrigera*, *E. longicauda*, *E. lucifuga*, and the *P. glutinosus* complex) as ranavirus hosts. To date, only 15 plethodontids, including our new accounts, have been reported as ranavirus hosts (see Gray et al. 2009b for other known plethodontid hosts). With more than 370 described plethodontid species, additional work investigating which species can act as ranavirus hosts is warranted and encouraged. In addition to investigating possibly new locations and new amphibian host species for ranaviruses, emphasis should also be placed on assessing ranavirus pathogenicity (Duffus 2009). Pathogenicity is not often addressed in amphibian disease investigations despite its importance to amphibian population dynamics (Duffus 2009). Studies addressing this knowledge gap are essential for furthering our understanding of amphibian host-virus interactions and molecular characteristics of potentially novel ranaviruses in these hosts.

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Detection of *Batrachochytrium dendrobatidis* on Amphibians in Pursat Province, Cambodia

Cambodia, along with other Southeast Asian countries, has an enormously diverse flora and fauna, but past turmoil has had a significant and disparaging impact on wildlife (Loucks et al. 2009). Despite the struggles and hardships faced by the country, some of the country's wildlife, particularly reptiles and amphibians, are still being discovered. A recent survey of amphibians and reptiles in the east of Cambodia, for example, has led to the discovery of various new species of frogs, snakes, and lizards (Stuart et al. 2006). New herpetofauna, particularly anurans, were also discovered in southwest Cambodia where surveys yielded new species in isolated areas of the Cardamom Mountains, implying the species had no prior exposure to humans and thus were not directly impacted by their activities prior to their classification (Grismer et al. 2007, 2008; Ohler et al. 2002). Global declines of amphibians have been linked to human activities resulting in habitat destruction and alteration (Alford and Richards 1999), accelerated global environmental change (Gibbs and Breisch 2001), or interspecific competition and hybridization (Kiesecker and Blaustein 1997), as well as to the emerging infectious disease chytridiomycosis caused by the fungus *Batrachochytrium dendrobatidis* (*Bd*) (Berger et al. 1998). The presence of *Bd* has been confirmed worldwide (www.Bd-maps.net), including Southeast Asia (Fisher et al. 2009b). The first studies on *Bd* in Southeast Asia have been performed within the last decade starting with island states or countries such as Hong Kong, Indonesia, Taiwan,

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Fig. 1. Location of Pursat province, Cambodia, where amphibians were sampled for *Batrachochytrium dendrobatidis* at creeks and other small pools of water in the village of Pramouy (12.3036°N, 103.1008°E), alongside a forest road about 10 kilometers outside Pramouy (12.1017°N, 103.1041°E), and within an isolated forest atop Mount Tumpor in the Cardamom Mountains (12.3740°N, 103.0568°E).

Table 1. Amphibians sampled for *Batrachochytrium dendrobatidis* (*Bd*) from the village of Pramouy (Village), alongside a forest road ~10 km outside Pramouy (Forest Road), and within an isolated forest atop Mount Tumpor in the Cardamom Mountains in Pursat province, Cambodia. Conservation status from www.icun.org: LC (least concern), VU (vulnerable), DD (data deficient). * indicates frogs that are likely a different species from those found in non-mountainous areas.

Location	Amphibian species	Conservation status	No. *Bd*-positive individuals /total no. samples
Village	*Duttaphrynus melonstictus*	LC	2/15
	Fejervarya limnocharis	LC	13/24
	Microhyla butleri	LC	0/1
	Microhyla fissipes	LC	0/3
	Microhyla pulchra	LC	3/5
	Occidozyga lima	LC	0/5
	Polypedates leucomystax	LC	5/11
Forest Road	*Fejervarya limnocharis*	LC	0/1
	Kalula pulchra	LC	1/1
	Microhyla heymonsii	LC	0/1
	Occidozyga lima	LC	0/1
	Occidozyga martensii	LC	0/1
	Polypedates leucomystax	LC	8/13
Mount Tumpor	*Limnonectes gyldenstolpei*	LC	1/6
	Microhyla berdmorei	LC	0/3
	Philautus cardamonus	DD	7/15
	*Polypedates cf. leucomystax**	DD	1/3
	Quasipaa fasciculispina	VU	0/2
	Rana faber	LC	7/16
	Rhacophorus bipunctatus	LC	5/8
	Rhacophorus bisacculus	LC	6/9

and Japan (Fisher et al. 2009b; Kusrini et al. 2008; Lehtinen et al. 2008; Rowley et al. 2007), eventually including detection from mainland countries like Thailand, South Korea, and China (Bai et al. 2010; McLeod et al. 2008; Wei et al. 2010; Yang et al. 2009). Consequently, the reported detection of *Bd* in the continent of Asia is a very recent event, and thus literature on this subject currently remains preliminary given the amphibian biodiversity.

The goal of our study was to increase the knowledge of the distribution of *Bd* in mainland Southeast Asia. We sampled amphibians for *Bd* occurrence in the Cardamom Mountains, in and around the small village of Pramouy in Pursat province, Cambodia (Fig. 1), with three levels of urbanization. The level of human influence was categorized as high (areas where people frequently congregate), medium (areas with minimal human disturbance), or low (areas where humans very rarely visit). Sample locations included creeks and other small pools of water in the village of Pramouy (high, 12.3036167°N, 103.1008333E; 240 m elev.), alongside a forest road about 10 km outside Pramouy (medium, 12.10175°N, 103.10405°E; 400 m elev.), and within an isolated forest atop Mount Tumpor in the Cardamom Mountains (low, 12.3740333°N, 103.05675°E; 1100 m elev.).

We sampled 144 amphibians at the three locations (village of Pramouy, N = 64; Forest Road, N = 18; Mount Tumpor, N = 62) during a five-day period starting on 25 April 2010 (Table 1). All captures were performed either at dawn or dusk using small nets. No amphibians showed clinical symptoms of chytridiomycosis (e.g., lethargy, lack of righting reflex, excessive sloughing of skin). For each individual, a sterile cotton swab was run ten times over each of the four feet, the medial and ventral area of the rear legs, on each of the sides from groin to armpit, and on the ventral surface of the body of each individual (Kriger et al. 2006). Swabs were placed in 2-mL cryotubes and kept at 4°C prior to molecular analyses.

DNA was extracted from cells on swabs using the Wizard Genomic DNA Purification kit (Promega, Madison, Wisconsin) in accordance with the protocol for extraction from animal tissue, and *Bd* was detected and quantified using a TaqMan quantitative real-time PCR (*q*PCR) assay according to Boyle et al. (2004). Samples were tested in triplicate, using 20-µL reactions containing 10 µL *q*PCR Fast-Mix™ (Quanta Biosciences, Gaithersburg, Maryland), PCR primers ITS1-3 Chytr and 5.8S Chytr at 900 nM, probe Chytr MGB2 at 250 nM, and a single µL of template DNA. A single µL of sterile water facilitated the negative control for each reaction (also performed in triplicate). Analyses were performed in an Eppendorf *realplex*^{2} thermocycler (Eppendorf, Hauppauge, New York) using a 50°C incubation for 2 min, followed by 95°C for 10 min, and finally 50 cycles of 95°C for 15 s and 60°C for 1 min (Boyle et al. 2004). Quantification of *Bd* was based on a standard curve created using a serial dilution of a standardized DNA control with known copy number (CSIRO Livestock Industries, Geelong, Australia).

We detected *Bd* on 59 of 144 (41%) individuals tested (Table 1). Of amphibians captured within the village (high human impact), along the forest road (medium human impact), and atop Mount Tumpor (low human impact), 36%, 50%, and 44% of the amphibians were *Bd*-positive, respectively. These values were statistically not different from each other (Pearson's Chi-squared test in R 2.11.1; $\chi^2 = 1.4475$, p = 0.48). The number of *Bd* genomic equivalents (GE) per individual ranged from 0 to 373.4 GE, and averaged 27.9 GE. The average (± SE) numbers of *Bd* GE on amphibians from the village, along the forest road, and atop Mount Tumpor were 25.2 GE (± 40.6), 22.3 GE (± 31.2), and 31.9 GE (± 56.0), respectively.

We demonstrate that *Bd* was prevalent in amphibians regardless of the perceived level of human influence among the environments, revealing approximately half of the amphibians tested from each environment were infected with the fungus. However, none of the amphibians had identifiable symptoms of chytridiomycosis. The dynamics and consequences of *Bd* infection are complex, and not well understood. Whereas there are numerous studies describing how introduction of *Bd* can quickly decimate a population of amphibians (Daszak et al. 1999; Lips et al. 2006; Pounds et al. 2006), there are also studies that show amphibians can be infected with the fungus with no apparent detrimental effects. In those cases the infected frogs act as asymptomatic carriers; examples of such carriers include the American Bullfrog, *Lithobates catesbeianus,* and the African Clawed Frog, *Xenopus laevis* (Daszak et al. 2004; Weldon et al. 2004), two species that have been introduced to non-native habitats in many parts of the world. In addition, it has been speculated that the fungus could have sub-lethal effects, for example it may stunt the growth of amphibians, or amphibians may be temporarily affected (Kriger et al. 2007; Walker et al. 2010). The potential

seasonality of infection rates have been noted (Gaertner et al. 2009; Kriger and Hero 2007). We sampled during the dry season which might have influenced *Bd* detection rates in our study. It is also possible that the genotypes of *Bd* were hypovirulent and thus less lethal than others (Fisher et al. 2009a), or that the critical threshold density for *Bd* on amphibians was not reached and thus amphibians were not showing symptoms of chytridiomycosis (Vredenburg et al. 2011). Also, it is known that amphibians have innate immune defenses to counter pathogens like *Bd* in the form of antimicrobial peptides secreted on the skin (Ramsey et al. 2011; Rollins-Smith et al. 2003; Rollins-Smith and Conlon 2005; Woodhams et al. 2007). Studies have indicated that immune-suppressed amphibians are more susceptible to acquiring diseases from their environment due to inhibited or decreased production of peptides during periods of stress or from pesticide use (Davidson et al. 2007; Rachowicz et al. 2005). We did not assess either sublethal effects on individuals or the stress levels of the amphibians in this study.

Anthropogenic influence appears to have played a significant role in the global distribution of *Bd* (Fisher et al. 2009b; Skerratt et al. 2007). Recently, it has been suggested that trade of American Bullfrogs for human consumption might be a key component in the dissemination of *Bd* in China as well as across the globe (Bai et al. 2010). The concept of pathogen pollution refers to anthropogenic movement of pathogens into new geographic locations via domestic and wild animals, products and materials (Daszak et al. 2001). This might explain how amphibians collected from the village and forest road were positive for *Bd* as human interaction with fauna may be frequent, however, it does not adequately explain how amphibian populations sampled atop Mount Tumpor first encountered the pathogen. Mount Tumpor, at least the area where we collected, is free of human influence, except for scientific expeditions (the nearest settlement being >1 km). However, *Bd* transmission pathways across landscapes are little understood. Previous studies have shown amphibians living in pristine environments have undergone population declines associated with *Bd* (Kolby et al. 2010; Lips et al. 2004; Puschendorf et al. 2006). Other studies indicate *Bd* prefers habitats at higher altitudes, cooler climates, and rainy or wet environments, which parallel the environmental conditions on Mount Tumpor (Drew et al. 2006; Rohr and Raffel 2010; Ruiz and Rueda-Almonacid 2008). If *Bd* were introduced as a novel pathogen to our study area in Cambodia by anthropogenic pathways at an earlier time, it might have spread to achieve its current distribution by other vectors of transmission.

In summary, we have reported the incidence of *Bd* in Cambodia across three environments that have different levels of human influence. We found there to be no difference in *Bd* infection with respect to the predicted level of human activity among the three sampling areas. To date *Bd* has been detected in almost every country bordering Cambodia (Bai et al. 2010; McLeod et al. 2008; Wei et al. 2010; Yang et al. 2009), suggesting that *Bd* has probably crossed the borders of Laos, Vietnam, and Myanmar despite the current absence of detailed reporting from those nations. Future studies are needed to both: 1) address the prevalence of *Bd* in these countries (Rowley et al. 2010), as well as in other Asian countries, in order to fully understand the dissemination of this pathogen and to maintain the well-being of amphibians worldwide, and 2) monitor these amphibian populations long-term in case their infection rates change and symptoms start appearing.

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Detection of *Batrachochytrium dendrobatidis* in Frogs from Different Locations in Cambodia

The recently emerged infectious disease chytridiomycosis caused by the fungus *Batrachochytrium dendrobatidis* (*Bd*) has been implicated as a significant contributor to amphibian population declines worldwide (Fisher et al. 2009; Kilpatrick et al. 2009; Schloegel et al. 2006). The presence of *Bd* has been confirmed for all continents with amphibians (Fisher et al. 2009), with a considerable number of reports available for Australia (Bell et al. 2004; Hero and Gillespie 1997; Kriger et al. 2007), Africa (Goldberg et al. 2007; Hopkins and Channing 2002; Lane et al. 2003), Europe (Bosch et al. 2001; Bovero et al. 2008; Garner et al. 2005; Walker et al. 2010), and North and South America (Bonaccorso et al. 2003; Davidson et al. 2003; Herrera et al. 2005; Ouellet et al. 2005; Rothermel et al. 2008) (see also www.Bd-maps.net). The presence of *Bd* also has been confirmed for Asia, however, reports are relatively recent and the surveys remain limited to a small number of countries (e.g., China, Indonesia, Japan and South Korea) (Bai et al. 2010; Goka et al. 2009; Kusrini et al. 2008; Yang et al. 2009).

We have recently demonstrated the presence of *Bd* on amphibians in the southwestern part of Cambodia, including an isolated area of the Cardamom Mountains, with comparable prevalence of infected amphibians observed in environments impacted by various degrees of human activities (Mendoza et al. 2011). With 40–50% of all amphibians from these environments being positive for *Bd*, prevalence of infection resembled that found in amphibians from South Korea (39%) (Yang et al. 2009), but were much higher than those reported for amphibians from natural environments in China, Japan and Indonesia with 15%, 4% and 3%, respectively (Bai et al. 2010; Goka et al. 2009; Kusrini et al. 2008). To validate our high prevalence of *Bd* infection, we expanded our sampling to sites throughout Cambodia, and included amphibians obtained from market environments that, as for those in pet shops (Goka et al. 2009), have been shown to display higher frequency of infection than those in natural environments (Bai et al. 2010). We also examined the pattern of *Bd* haplotypes among our samples.

Creeks and small pools of water were used as sampling sites in three locations which included the capital city Phnom Penh (11.5193167°N, 105.0100667°E), the Angkor Center for the Conservation of Biodiversity (ACCB) (13.67805°N, 104.0261°E), and the city of Kratie (12.4875333°N, 106.0159833°E). Market frogs were obtained from Sihanoukville (10.62325°N, 103.53285°E) (Fig. 1).

FIG. 1. Cambodia locations where amphibians were sampled for *Batrachochytrium dendrobatidis*, including Phenom Phen, ACCB, Kratie, and Sihanoukville Market.

A total of 238 amphibians were obtained across the four locations (Phnom Penh, N = 77; ACCB, N = 65; Kratie, N = 66; Sihanoukville Market, N = 30) during one-day sampling trips in 2009 (25 May, 8 June, 19 June, and 13 June, respectively) (Table 1). None of these amphibians showed symptoms of chytridiomycosis (e.g., lethargy, lack of righting reflex, excessive sloughing of skin). Individual amphibians were sampled with a sterile cotton swab following the instructions outlined in Kriger et al. (2006), and swabs placed in 2 ml cryotubes and kept at 4°C until DNA extraction with the Wizard® Genomic DNA Purification Kit (Promega, Madison, Wisconsin) using the protocol for extraction from animal tissue. A nested PCR approach was used to test for *Bd* (Gaertner et al. 2009). This approach was based on the initial amplification of the 5.8S rRNA gene and the flanking internal transcribed spacer (ITS) of all fungi (White et al. 1990). A portion of the purified amplification product of this reaction was then used as template in a second *Bd*-specific PCR reaction (Annis et al. 2004). These second reactions were then analyzed for the presence of 300-bp amplicons (Annis et al. 2004) using gel electrophoresis (2% agarose in TAE buffer) (Sambrook et al. 1989).

Of the 238 amphibians tested, a total of 86 (36%) were positive for the 300-bp fragment, indicating the presence of *Bd* (Table 1). At Phnom Penh, 9 amphibian species were caught, and *Bd* was detected on individuals from 5 species with an average

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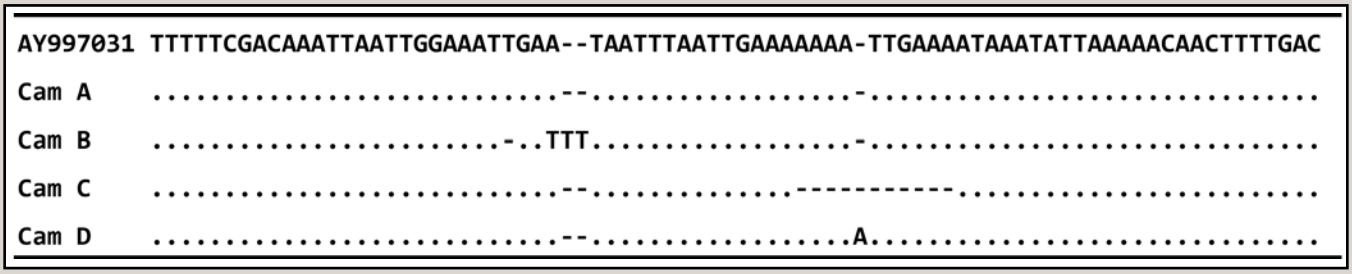

FIG. 2. Alignment of partial sequences of *Bd* isolate AFTOL-ID 21 (AY997031) and haplotypes Cam A to D, retrieved from frogs collected from different locations in Cambodia. The alignment covers bases 41 to 120 of the sequences (297 bp for *Bd* isolate AFTOL-ID 21 (AY997031), including primer sequences Bd1a and Bd2a), indicating only the differences in sequences among haplotypes CAM A to D and to *Bd* isolate AFTOL-ID 21 (James et al. 2006).

prevalence of infection of 35% (i.e., 27 of 77 individuals). A similar infection rate was obtained for Kratie (23 of 66 individuals) where 7 species were sampled and individuals of 5 species were found to be positive for *Bd*. A lower infection rate of 22% (14 of 65 individuals in 6 of 12 species) was obtained at ACCB, while market frogs all belonging to the species *Hoplobatrachus rugulosus* showed the highest prevalence of infection with 73% (22 of 30 individuals) (Table 1). These results demonstrate the presence of *Bd* in amphibians from different parts of Cambodia, revealing a similar detection prevalence compared to our previous study on amphibians from the southwestern part of Cambodia, including isolated areas in the Cardamom Mountains (Mendoza et al. 2011). The high prevalence of *Bd* in market frogs also confirms the previously reported trend of higher detection rates of *Bd*-infected amphibians in man-made environments such as pet shops or markets (Bai et al. 2010; Goka et al. 2009) which is likely a consequence of increased potential for cross-contamination due to the space limitations typically experienced by the large quantities of amphibians present.

TABLE 1. Detection of *Batrachochytrium dendrobatidis* (*Bd*) in frogs collected in Cambodia at Phnom Penh, the Angkor Center for the Conservation of Biodiversity (ACCB), Kratie, and Sihanoukville Market.

Species (no. samples)	*Bd*-positive samples (%)	Haplotypes (% of *Bd*-positive samples) A	B	C	D
Phnom Penh					
Bufo melanostictus (N=28)	39	64	9		27
Kaloula pulchra (N=5)	40	50			50
Occidozyga lima (N=2)	50	100			
Microhyla fissipes (N=8)	38	100			
Hylarana erythraea (N=23)	43	80	10		10
Four additional species (N=11)[1]	0				
Total (N=77)	**35**	**74**	**7**	**0**	**19**
ACCB					
Polypedates leucomystax (N=33)	24	50		25	25
Fejervarya limnocharis (N=7)	29	100			
Occidozyga lima (N=2)	50	100			
Bufo macrotis (N=5)	20	100			
Microhyla heymonsi (N=2)	50	100			
Microhyla pulchra (N=2)	50	100			
Six additional species (N=14)[2]	0				
Total (N=65)	**22**	**71**	**0**	**14**	**14**
Kratie					
Bufo melanostictus (N=36)	39	71		14	14
Kaloula pulchra (N=3)	33	100			
Fejervarya limnocharis (N=9)	44	100			
Occidozyga lima (N=8)	13	100			
Microhyla fissipes (N=8)	38	67		33	
Two additional species (N=2)[3]	0				
Total (N=66)	**35**	**78**	**0**	**13**	**9**
Sihanoukville Market					
Hoplobatrachus rugulosus (N=30)	73	59	27	14	
Total (N=30)	**73**	**59**	**27**	**14**	**0**

[1] *Polypedates leucomystax* (N = 2), *Fejervarya limnocharis* (N = 6), *Occidozyga martensii* (N = 2), and *Micryletta inornata* (N = 1)
[2] *Bufo melanostictus* (N = 2), *Kaloula pulchra* (N = 1), *Microhyla fissipes* (N = 5), *Microhyla butleri* (N = 1), *Occidozyga martensii* (N = 3), and *Hylarana mortenseni* (N = 2)
[3] *Polypedates leucomystax* (N = 1), and *Occidozyga martensii* (N = 1)

All 86 300-bp amplicons obtained in this study were purified, and then sequenced at the DNA Sequencing Facility of the Institute for Cellular and Molecular Biology at the University of Texas at Austin, Texas. Sequences were compared to GenBank/EMBL databases and aligned using BLAST (Pearson and Lipman 1988) and alignment functions in Geneious 4.8.3 (Drummond et al. 2009). Sequence diversity was limited with 4 haplotypes being discovered (Cam A, B, C, and D) (Table 1, Fig. 2). All haplotypes differed from each other by small sequence variation in the same region of the amplicon (Fig. 2). Compared to Cam A, haplotype Cam B differed by a 2-bp insertion and a single nucleotide substitution, while haplotype Cam C was characterized by a 10 bp deletion, and haplotype Cam D by one additional base. All haplotypes were represented by identical sequences of isolates in the GenBank/EMBL databases, except for Cam B where a 1-bp insertion in a different region resulted in only 99.6% similarity to the sequence of an isolate (Bd-08

[AB435218]). The sequence of Cam A was the most encountered in the database with sequences of more than 25 isolates being identical (e.g., AFTOL-ID21 [AY997031] or NE14 [EU779863]), while those of the remaining haplotypes were rare with sequences of 1 or 2 isolates being identical (Bd-04 [AB435214] for Cam C, and MF22879 [FJ232005], and MF22913 [FJ232007] for Cam D).

The prominence of haplotype Cam A in the databases was reflected by its detection frequency in our samples. Cam A was the most abundant haplotype at all locations representing 59-78% of all *Bd*-positive samples (Table 1). It was also present and most abundant on all amphibian species that tested positive for *Bd*. Haplotype Cam A is identical to "haplotype A" discovered in a large survey of *Bd*-infected amphibians in Japan (Goka et al. 2009). Similar to haplotype Cam A in our study, haplotype A was a major contributor to *Bd* infections, both in man-made and in natural systems, with most of the remaining 25 haplotypes B-Z recovered from Japan detected at much lower frequency. The distribution of haplotype A in Japan, however, was not as prominent as Cam A in our study. In Japan, only few species and individuals were infected per location, and large differences in prevalence amongst infected species was observed among locations (Goka et al. 2009). The remaining three haplotypes, Cam B, C, and D, were found in low frequency. Haplotype Cam C was identical to haplotype E identified in Japan, and Cam B was represented by haplotype I (though with one mismatch). For Cam D, however, no representative haplotype was found in that study (Goka et al. 2009). Consequent with their low frequency in detection, it is not surprising that these haplotypes were not present at all locations or for all amphibian species. Patterns of detection with Cam C absent at Phnom Penh, Cam B absent at ACCB and Kratie, and Cam D absent at Sihanoukville market (Table 1) might therefore entirely be due to the low frequency of detection. As this study only provides initial data for chytrid fungus and potential effects within Cambodia, any further statements about the significance of these distribution patterns would thus be highly speculative, and the matter requires additional studies.

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Chytrid Fungus in American Bullfrogs (*Lithobates catesbeianus*) along the Platte River, Nebraska, USA

Chytridiomycosis is an emerging infectious disease in amphibians that was discovered in the late 1990s (Berger et al. 1998; Longcore et al. 1999), with retrospective surveys indicating isolated cases dating to 1902 in Japan (Goka et al. 2009), 1938 in Africa (Weldon et al. 2004), and 1961 in North America (Ouellet et al. 2005). This disease is caused by the pathogen *Batrachochytrium dendrobatidis* (*Bd*), a species of chytrid fungus, and it is hypothesized to contribute to amphibian declines worldwide (Berger et al. 1998; Daszak et al. 1999; Lips et al. 2006; Collins 2010). *Bd* has been detected in amphibians on all six continents inhabited by amphibians, and large numbers of *Bd*-positive samples have been collected from various sites across North America (www.Bd-maps.net; accessed 7 June 2011). The central United States, however, has not been sampled extensively for *Bd*. To date, no published accounts of *Bd* exist for amphibians from Nebraska, USA, although two localities with *Bd* in Nebraska are noted online (www.Bd-maps.net; J. Krebs, Henry Doorly Zoo, Omaha, Nebraska, and Zimmerman Ranch, Dunning, Nebraska). Our objective was to determine whether *Bd* is present along the Platte River in south-central Nebraska.

We sampled anurans along the Platte River in Hall County, Nebraska, on land managed by Platte River Whooping Crane Critical Habitat Maintenance Trust, Inc., located on Shoemaker Island (40.7884°N, 98.4650°W). We prioritized capturing *Lithobates catesbeianus* (American Bullfrog) because they are nonclinical carriers of *Bd* (Daszak et al. 2004; Garner et al. 2006), are abundant in Nebraska (Fogell 2010), and are a concern for wildlife management worldwide due to their invasiveness (Ficetola et al. 2007). We targeted sampling along two sloughs (linear, water-filled depressions) surrounded by mesic, tall-grass prairie (Fig. 1; Slough 1 start: 40.7921°N, 98.4628°W; end: 40.7939°N, 98.4584°W; Slough 2: start: 40.7959°N, 98.4444°W, end: 40.7989°N, 98.4421°W). We also opportunistically collected *Anaxyrus woodhousii* (Woodhouse's Toad) and *Lithobates blairi* (Plains Leopard Frog) from these sloughs, as well as nearby point locations across the island, including isolated ponds, puddles, and roads (Fig. 1). Samples were collected 28 April, 5 June, 9 and 10 July, and 3 and 6 September 2010.

To minimize contamination, we captured amphibians by hand while wearing disposable vinyl gloves that we changed between each capture. We also captured some Plains Leopard Frogs with nets from ponds and puddles. Each animal captured was kept individually in plastic or cloth bags until processed in the field and then released; plastic bags were disposed after one usage whereas cloth bags were washed between samples. For each individual, we determined sex and visually examined for wounds and other abnormalities. We sampled for *Bd* following protocols of the Amphibian Disease Laboratory, Institute for Conservation Research at the San Diego Zoo and used their preferred sampling kits, comprised of plastic-handled, fine tip cotton swabs (Dryswab™; MW113; Medical Wire & Equipment Co. LTD., England) and screw-top storage tubes (Cryogenic Vials, Nalge Nunc International, New York). We swabbed the skin on ventral surfaces, targeting the pelvic patch, thighs, and toe webbing, making 5 passes on each surface with a single swab for each animal. The swab was air-dried, and the tip placed in an individually marked vial.

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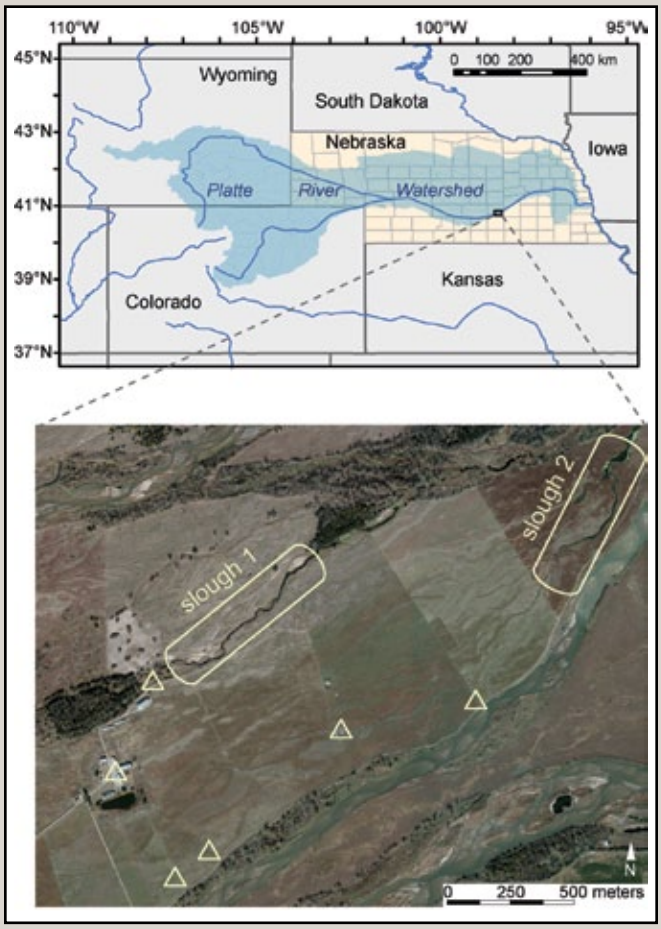

FIG. 1. Location of sampling sites along the Platte River in central Nebraska, USA. Locator map shows the study region within the Platte River watershed. Aerial photograph depicts Shoemaker Island (Hall County, Nebraska) where anurans were sampled. Most sampling occurred in sloughs 1 and 2, and opportunistic captures were collected from point locations (denoted by triangles). Aerial photograph was taken in October 2010.

Samples were shipped to the San Diego Zoo for processing where they were analyzed for *Bd* using real-time (Taqman) PCR to amplify the ITS1 region (Boyle et al. 2004). Results were reported as positive or negative. We examined associations among *Bd* presence, sex, sampling date, and sampling location with Pearson Chi-square tests in PASW Statistics version 18 (Chicago, Illinois, USA).

We captured a total of 118 amphibians, including 76 adult American Bullfrogs, 1 American Bullfrog tadpole, 20 Plains Leopard Frogs, and 21 Woodhouse's Toads. We detected *Bd* only in American Bullfrogs, with 31 adults (41%) testing positive. We did not detect an association between *Bd* infection and sex (χ^2 = 1.14, df = 1, P = 0.28) or sampling location (χ^2 = 1.81, df = 2, P = 0.40), but we found an association between *Bd* infection and sampling date (χ^2 = 14.12, df = 2, P = 0.001), with 67% of American Bullfrogs testing positive in April, 0% testing positive in June, and 39% testing positive in July. We observed infected American Bullfrogs in both sloughs; the one American Bullfrog sampled from an isolated pond located 600 m from the sloughs tested negative. No infected individuals were detected in the other two species, even in sloughs with infected American Bullfrogs (N = 2 Woodhouse's Toads collected from Slough 1, N = 18 Plains Leopard Frogs collected from Slough 1, and N = 1 Plains Leopard Frog from Slough 2).

We detected high prevalence of *Bd* (41%) in American Bullfrogs along the Platte River in central Nebraska. Other central USA accounts of *Bd* include surveys in the north-central United States (Iowa, Wisconsin, and Michigan), where *Bd* was detected in nine species, including American Bullfrogs (Sadinski et al. 2010); surveys in Colorado and Wyoming, where *Bd* was widely distributed (51% of sites examined) in Boreal Toads (*Bufo boreas boreas*), Western Chorus Frogs (*Pseudacris triseriata*), Northern Leopard Frogs (*Lithobates pipiens*), and Wood Frogs (*Lithobates sylvaticus*) (Young et al. 2007); and surveys along the Rocky Mountains, where *Bd* was detected in six species (Muths et al. 2008). Additional surveys of *Bd* throughout the central United States are warranted to gain baseline information about the presence of this pathogen, especially as it relates to species that have declined in recent decades for unknown reasons (e.g., Hayes and Jennings 1986).

Accumulating evidence supports the "novel pathogen hypothesis" to explain the recent worldwide invasion of *Bd* (Rosenblum et al. 2009). This specifically suggests that human-mediated movement of infected frogs, including the American Bullfrog, precipitated *Bd* range expansion (Fisher and Garner 2007; Schloegel et al. 2009a,b). In light of this, our results are a special concern for the region as American Bullfrogs were introduced to waterways throughout Nebraska in the 20th century and appear to be expanding their distribution (Fogell 2010). American Bullfrogs were not documented in surveys of herpetofauna in 1980 on an island adjacent to our study site (Jones et al. 1981), but they were abundant in our 2010 surveys. Expansion of American Bullfrogs could result in the introduction of *Bd* to the native amphibians in the region, notably Plains Leopard Frogs, Woodhouse's Toads, and Boreal Chorus Frogs. *Bd* infections already have been reported in Chorus Frogs (*Pseudacris maculata* and *P. triseriata*) and Northern Leopard Frogs (*Lithobates pipiens*) in Colorado and Wyoming (Young et al. 2007; Muths et al. 2008). Although we did not detect *Bd* in Plains Leopard Frogs or Woodhouse's Toads, a number of factors may have prevented this. Our sample size was small (Skerratt et al. 2008), and studies have shown lower prevalence of *Bd* during the summer (Longcore et al. 2007; Retallick et al. 2004; Voordouw et al. 2010). In our study, most positive detections of *Bd* were at the earliest sampling date (April) in American Bullfrogs, but we captured most Plains Leopard Frogs and Woodhouse's Toads at later sampling dates, thus we may have missed a seasonal peak in infection. In addition, recent work suggests that our collection method (swabbing) is less sensitive than other methods (toe clips and bag rinses) for detection (Voordouw et al. 2010).

Additional surveys of native anurans need to be conducted at this site to monitor potential cascading effects of transmission of *Bd* from invasive American Bullfrogs. Prevalence of *Bd* varies among American Bullfrog populations, but it is frequently high (Garner et al. 2006), and American Bullfrogs are often nonclinical carriers (Daszak et al. 2004; Garner et al. 2006). Despite high genetic similarity of isolates, different strains of *Bd* differ in virulence (Berger et al. 2005; Fisher et al. 2009; Rosenblum et al. 2009), yet there appears to be little host specificity (James et al. 2009; Rosenblum et al. 2009). Thus, *Bd* strains carried by American Bullfrogs likely are easily spread to other native species. Therefore, characterization of the strain of *Bd* in this region is needed because American Bullfrogs occur in the same water bodies with many native species and may threaten them, especially if carrying a lethal strain.

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Batrachochytrium dendrobatidis in *Plectrohyla arborescandens* (Anura: Hylidae) Larvae at a Montane Site in the Sierra Negra, Puebla, México

The amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) has been detected on all continents where amphibians occur (Berger et al. 1998; Bosch et al. 2001; Fisher et al. 2009; Hopkins and Channing 2003; www.Bd-maps.net, accessed 7 June 2011), causing a widespread cutaneous infection in young postmetamorphic and adult individuals that may result in death (Berger et al. 1999). Although anuran larvae do not seem to die from the infection, they nonetheless develop remarkable damage to their keratinized mouthparts (interrupted or misshaped tooth rows, and loss of pigmentation in these and jaw sheaths) and swelling and redness of the labial papillae and oral disc (Berger et al. 1998; Fellers et al. 2001).

During a field survey in June 1996, one of us (LCM) collected *Plectrohyla arborescandens* tadpoles in a stream in Zoquitlán, southeastern Puebla, México (18.3239°N, 97.01°W; 1860 m elev.), a geographic region known as the Sierra Negra (Fig. 1). Seven of 13 (54%) larvae lacked jaw sheaths and tooth rows (L. Canseco-Márquez, pers. obs.; specimens are retained at the herpetological collection of Benemérita Universidad Autónoma de Puebla, México; EBUAP 681–682). At that time, *Bd* was not yet described, its effects were yet unknown, and the cause of the missing jaw sheaths and tooth rows in larvae was not clear to the surveyors. Based on those original observations and more recent information regarding the existence and effects of *Bd*, our aim was to return to the region and sample *P. arborescandens* larvae for the presence of *Bd*.

Our study was conducted in Tilancingo, a stream located in the municipality of Coyomeapan, Puebla, Mexico (in the Sierra Negra; 18.3027°N, 97.0644° W; 2607 m elev., Fig. 1), where the vegetation (oak-pine forest) is relatively undisturbed. In June 2008, we collected four tadpoles (EBUAP 2114) of *P. arborescandens*, and took them to the laboratory to test for the presence of *Bd* using the wet-preparation technique (Frías-Alvarez et al. 2008). We also examined another 22 larval *P. arborescandens* (EBUAP 2109-13) for mouthpart abnormalities that were collected at the same site in March–June 2006.

To characterize the oral disc abnormalities in larvae, we examined mouthparts with a stereoscopic microscope. Individuals at Gosner stages 40–42 (Gosner 1960) were excluded from the analysis because during these stages atrophy of the oral disc is a natural process (Gosner 1960).

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The four tadpoles collected in 2008 (stages 26–37) were infected with *Bd*, which was determined by the presence of empty sporangia, sporangia with zoospores and septed sporangia. Further, these four tadpoles also had conspicuous oral disc abnormalities; loss of the jaw sheaths and tooth rows (with anterior and posterior mouthparts being affected in both cases). Of the specimens examined from 2006, 18 of 22 larvae (stages 26–35) had oral disc abnormalities. In total, the incidence of mouthpart abnormalities was 84.6% (N = 26).

The presence of *Bd* in Puebla State recently was documented by Frías-Alvarez et al. (2008) in *Ambystoma velasci*, so this represents the second report of the fungus in Puebla, and the first case associated with an anuran species. *Bd* occurrence in *P. arborescandens* is of particular concern because this is an anuran with conservation concerns. This frog is endemic to the Atlantic slopes of México, in the states of Tlaxcala, Puebla, and Veracruz, and is considered endangered and with a decreasing population trend (Stuart et al. 2008).

It warrants acknowledgment that other factors aside from *Bd* infection can cause loss of the keratinized mouthparts in anuran larvae. These include low temperatures, possibly related to decreased feeding (Rachowicz 2002), and DDT and corticosterone exposure (Hayes et al. 1997). However, the *Bd* pattern of loss presents differently. Whereas tadpoles infected with *Bd* show loss of jaw sheaths in form of 'gaps' (whitish areas on the jaw sheaths that are discontinuous, surrounded by darkened areas), those exposed to low temperatures experience a continuous reduction in tooth rows, and later in jaw sheath width (Rachowicz and Vredenburg 2004). On the other hand, tadpoles exposed to DDT and corticosterone lose the anterior jaw sheaths and tooth rows completely, with no posterior mouthparts being affected (Hayes et al. 1997). In our samples both anterior and posterior mouthparts were affected, about equally, and whitish gaps irregularly distributed in the jaw sheaths and tooth rows were found, which resembles the pattern described for tadpoles infected with *Bd* (Rachowicz and Vredenburg 2004). Additionally, although DDT or corticosterone may occur at the site (e.g., via aerial transmission), the area is surrounded by primary vegetation and direct applications of the chemicals are unknown. Moreover, tadpoles were collected in some of the warmest months, which reduces the possibility of mouthpart loss due to low temperatures. Based on these observations, we suggest that the fungus was the most likely proximate cause of the abnormalities reported herein.

The larvae we collected appeared healthy, as did the adults of *P. arborescandens* that we found (none dying or dead). However, the incidence of abnormalities in larvae was as high as other reports for anuran species inhabiting montane regions (Felger et al. 2007; Fellers et al. 2001; Lips et al. 2004), unlike lowland sites, where incidence is lower (Felger et al. 2007). This is consistent with reports on the prevalence of chytridiomycosis and *Bd* related declines; prevalence increases with altitude (Woodhams and Alford 2005), and declines due to the disease occur mainly

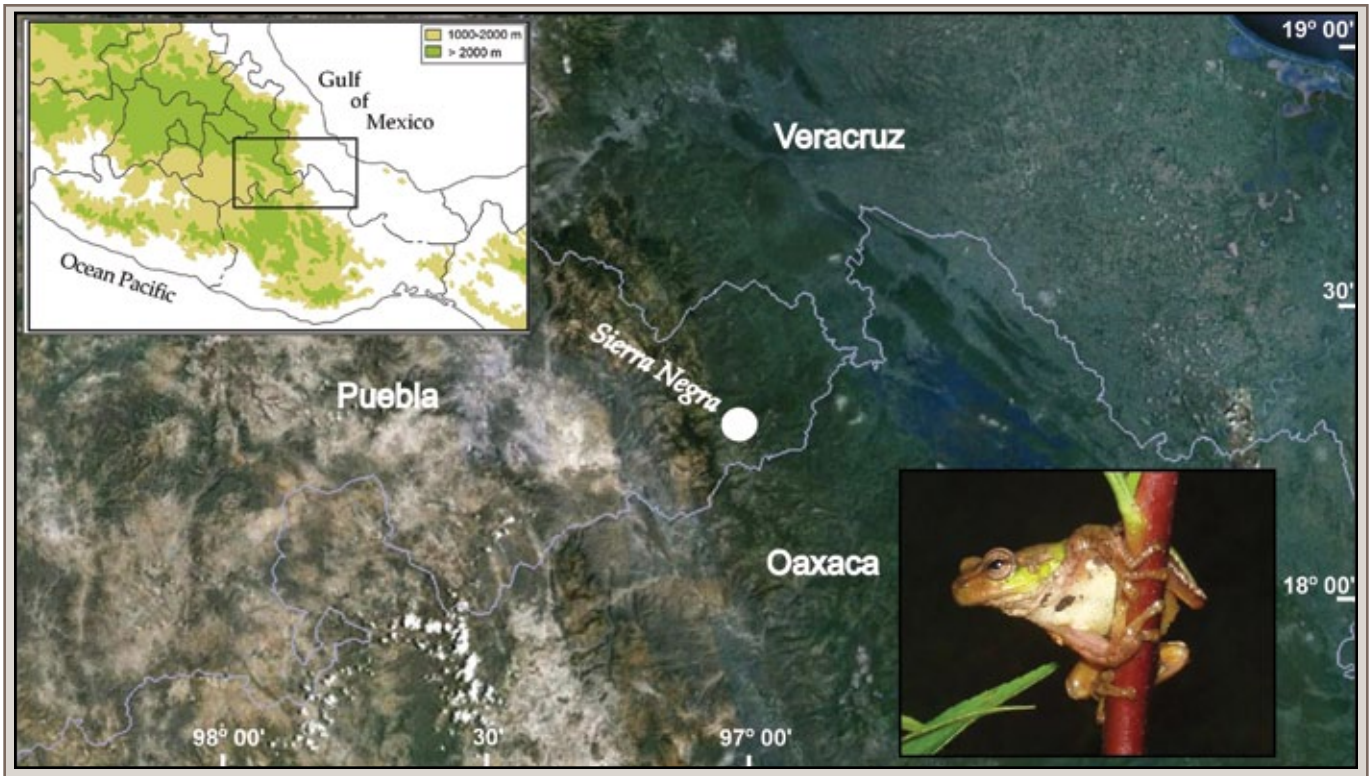

FIG. 1. Map of southeastern Puebla and adjacent states in México, showing the location of the Sierra Negra. White circle indicates Tilancingo stream, the area where *Batrachochytrium dendrobatidis* was detected on *Plectrohyla arborescandens* larvae. Also shown is an adult male *P. arborescandens* from this locality.

at montane sites (Berger et al. 1998; Lips 1999). *Bd* growth is favored at relatively cool environmental conditions, so this might explain the patterns described above (Daszak et al. 2003). Additionally, other factors, such as specific susceptibility to the fungus, length of larval period, and behavior of the tadpoles, might have an effect on the incidence of abnormalities in this life stage.

Because montane sites form a great proportion of the Sierra Negra, and many of its amphibian species are endemic to México (e.g., *Plectrohyla arborescandens, P. bistincta, Hyla euphorbiacea, Craugastor mexicanus*, and *Incilius occidentalis*) and some are endemic to this montane location in Puebla State (e.g., *Craugastor galacticorhinus* Canseco-Márquez and Smith 2004), studies are needed to evaluate the current distribution of *Bd* in the entire region, which species are affected, as well as its effects at both the individual and population level.

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Infectious Disease Screening of *Indirana* Frogs from the Western Ghats Biodiversity Hotspot

Amphibians are undergoing global declines, with 41% of amphibian species threatened with extinction (Hoffmann et al. 2010; Stuart et al. 2004). Emerging infectious diseases such as chytridiomycosis and *Ranavirus* have been implicated among the possible reasons for some of these declines (e.g., Collins and Storfer 2003; Daszak et al. 1999; Schloegel et al. 2010). Chytridiomycosis is a disease caused by the parasitic fungus *Batrachochytrium dendrobatidis* (*Bd*). It is known to cause mortality across a wide range of amphibian taxa by the disruption of cutaneous functions (Voyles et al. 2009). *Bd* infections were first reported in Panama and Australia in 1998, and are now known to affect amphibians across the globe, including species in North America, South America, Central America, Africa, Europe, New Zealand, and in parts of Asia (e.g., Berger et al.1998; Bradley et al. 2002; Changming et al. 2010; Garner et al. 2005; Kielgast et al. 2010; Lips 1999; Waldman et al. 2001). The viral amphibian pathogen *Ranavirus*, which is less well reported, also causes mass mortalities in the wild (Gray et al. 2009), in both common amphibian species and species thought to be in decline (e.g., Green et al. 2002). For example, it is known to cause mass mortalities in Eastern Tiger Salamanders (*Ambystoma tigrinum*) in North America (Bollinger et al. 1999; Collins et al. 2004; Jancovich et al. 1997) and in the Common Frog (*Rana temporaria*) in the United Kingdom (Cunningham et al. 1996). Furthermore, recent studies have shown that *Ranavirus* infection can cause long-term population declines in *R. temporaria* (Teacher et al. 2010).

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To the best of our knowledge, no screening for *Bd* or *Ranavirus* has been reported from the Indian sub-continent, representing a very large gap in our knowledge of the distribution of these diseases. This is also evident from the current global distribution map of *Bd* (www.bd-maps.net; accessed 2 May 2011).

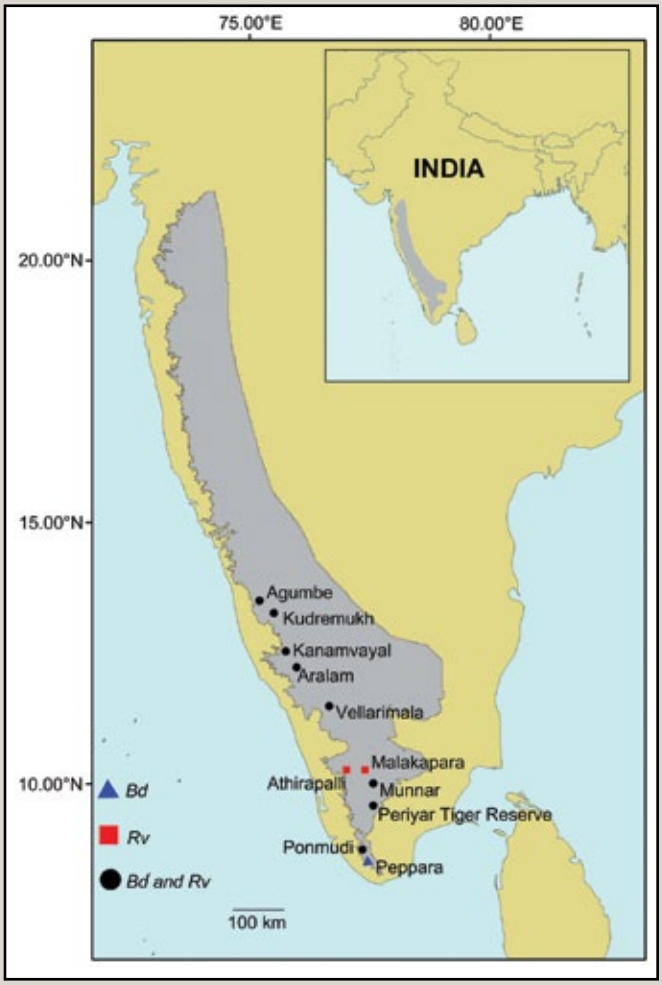

Fig. 1. Locations of the sites in India screened for *Batrachochytrium dendrobatidis* (*Bd*) and *Ranavirus* (*Rv*).

The Western Ghats in southwestern India is a biodiversity hotspot (Myers et al. 2000) which has a high diversity of amphibians with many endemic families and genera (Biju and Bossuyt 2003; Bossuyt et al. 2004; Daniels 2005; Dutta 1997). Currently, there are approximately 132 known amphibian species that are unique to the Western Ghats (Dinesh et al. 2009). We investigated the presence of *Bd* and *Ranavirus* in several species of *Indirana* frogs endemic to the Western Ghats biodiversity hotspot. In addition, *Bd* screening was performed for *Hylarana temporalis*, *Fejervarya keralensis*, and *Micrixalus fuscus* from the Peppara Wildlife sanctuary in Kerala, India.

Field surveys were conducted in the southern part of the Western Ghats between 2008–2010, including the states of Kerala and southern Karnataka (Fig. 1). Specimens were identified using published taxonomic information (Daniels 2005; Inger et al. 1984). For the *Ranavirus* screening, 138 samples were collected from 10 locations, including five known and one unknown species within the genus *Indirana* (Table 1). *Indirana beddomii*, *I. semipalmata*, *I. diplosticta*, and *I. brachytarsus* were collected from heavily littered trek paths in tropical evergreen and semi evergreen forests in Peppara, Ponmudi, Malakapara, and the Periyar Tiger Reserve. *Indirana beddomii* frogs were also collected along streams in low altitude sholas in Kudremukh National Park and Agumbe rainforest, as well as from trek paths in moist deciduous forests in Kanamvayal and Aralam. *Indirana leptodactyla* were collected along streams in shola forests in Munnar, and *Indirana* frogs of unknown species (*Indirana* sp.) were collected in semi-evergreen forests in Vellarimala. Toe clips (N = 68 for *I. beddomii*, N = 22 for *I. brachytarsus*, N = 24 for *I. leptodactyla*, N = 5 for *I. semipalmata*, N = 3 for *I. diplosticta*, N = 16 for *Indirana* sp.) were taken from adult specimens and stored in 95% alcohol. Swabs for *Bd* screening were taken from four species of frogs (N = 41 for *I. brachytarsus*, N = 20 for *M. fuscus*, N = 51 for *H. temporalis and* N = 30 for *F. keralensis*) from Peppara Wildlife Sanctuary. All specimens were caught using dip-nets and placed temporarily in separate plastic bags with ventilation. Latex gloves were used and changed every time a new specimen was handled in order to avoid cross contamination among individuals. All frogs were released at the site of capture after collecting the toe-clips and swabs. No physical abnormalities were detected, and there were no indications of unusual mortalities in any of the regions sampled.

For *Ranavirus* screening, total genomic DNA was extracted from the toe clips following the protocol used in St-Amour and Lesbarrères (2007), using the Qiagen DNeasy Blood and Tissue kit (Qiagen, New Delhi, India), following the manufacturer's instructions. DNA isolated from the infected cells of two *Ranavirus* isolates (one from *Bufo bufo*, and one from *R. temporaria*, obtained from the Institute of Zoology, London, UK) were used as positive controls. PCR amplifications were performed twice for each sample using FV3-specific primers (forward: 5'-GTCTCTGGAGAAGAAGAA-3', reverse: 5'-GACTTGGCACTTATGAC-3') which amplify a 420 base pair fragment of the major capsid protein (Gantress et al. 2003; Mao et al. 1996). The PCR amplifications were performed in 15 µl reactions consisting of 3 µl of 5x PCR buffer, 0.12 µl dNTPs (25 mM), 0.5 µl of each primer, 0.15 µl of Phire hot start DNA polymerase (Finnzymes, Finland), 9.23 µl of dH_2O and 1.5 µl of template DNA (10-20 ng). The following thermo cycling conditions were used for amplifications: 98°C for 30 s, followed by 40 cycles of 98°C for 5 s, annealing at 60°C for 15 s, extension at 72°C for 20 s, followed by a final extension step at 72°C for 1 min. The final PCR products were checked on 2% agarose gels, and a sample was considered positive if both the repeat PCR samples showed bands that matched the size of the band (420 base pairs) from the two positive controls.

For *Bd* screening, DNA was extracted from the swabs using a bead beating extraction method with 0.5 mm silica microbeads following the protocol described in Boyle et al. (2004). Some of the toe clip extractions also were screened for *Bd* (Table 1) following methods in Changming et al. (2010). The PCR amplifications were performed in 25 µl reactions using primers ITS-1 (forward): 5'-CCTTGATATAATACAGTGTGCCATATGTC-3' and 5.8S (reverse): 5'-AGCCAAGAGATCCGTTGTCAAA-3' (Boyle et al. 2004). Quantitative Real Time PCR (qPCR) was performed using a Taqman

TABLE 1. The results of *Batrachochytrium dendrobatidis* (*Bd*) and *Ranavirus* (*Rv*) screening for frogs from the Western Ghats in India. +ve = No. *Bd*-positive or *Rv*-positive frogs; N = total sample size; GE = genomic equivalent; SE = standard error; WLS = Wildlife Sanctuary. a) and b) refer to replicates of the same original sample. *Indirana* sp. = probable undescribed species.

Locality	Coordinates	Species	Tissue type	*Bd* (+ve/N)	Mean GE	*Rv* (+ve/N)
Kudremukh/Agumbe	13.2186–13.5227°N, 75.0889–75.1831°E	*Indirana beddomii*	Toe clip	0/5	—	0/22
Aralam/Kanamvayal	11.9316–12.2942°N, 75.4842–75.8358°E	*Indirana beddomii*	Toe clip	0/5	—	0/24
Athirapalli	10.2928°N, 76.565°E	*Indirana beddomii*	Toe clip	—	—	0/22
Periyar	09.4908°N, 77.1361°E	*Indirana semipalmata*	Toe clip	0/5	—	0/5
Periyar	09.4908°N, 77.1361°E	*Indirana diplosticta*	Toe clip	0/3	—	0/3
Munnar	10.1442°N, 77.0381°E	*Indirana leptodactyla*	Toe clip	0/5	—	0/24
Vellarimala	11.4463°N, 76.0789°E	*Indirana* sp.	Toe clip	0/10	—	0/16
Ponmudi/Periyar	08.7663–09.4908°N, 77.1094–77.2175°E	*Indirana brachytarsus*	Toe clip	1/5	a) 2.92 ± 3.1 b) 0.30 ± 0.1	0/12
Malakapara	10.2880°N, 76.8414°E	*Indirana brachytarsus*	Toe clip	—	—	0/10
Peppara WLS	08.5619–08.5981°N, 77.1647°E	*Indirana brachytarsus*	Swab	0/41	—	—
Peppara WLS	08.5619–08.5981°N, 77.1647°E	*Hylarana temporalis*	Swab	0/51	—	—
Peppara WLS	08.5619–08.5981°N, 77.1647°E	*Fejervarya keralensis*	Swab	0/30	—	—
Peppara WLS	08.5619–08.5981°N, 77.1647°E	*Micrixalus fuscus*	Swab	0/20	—	—

assay following Boyle et al. (2004) on a 7300 Real Time PCR system (Applied Biosystems, California). We used *Bd* zoospore genome equivalents of 100, 10, 1, and 0.1 to construct the standard curves. All the samples were replicated twice with negative controls on each plate. The genomic equivalents (GE) of the positive samples were derived from the standard curves. A GE score of above 0.1 in each replicate was considered as a positive signal of *Bd* presence. Samples that tested positive in one or both of the replicates were re-tested at Imperial College, London, by an independent researcher in order to confirm the *Bd* infection.

All 138 samples tested for the *Ranavirus* infections were negative: no bands matching the positive control bands were detected (Table 1). Although toe clip extractions have shown to be a good alternative to lethal sampling methods (liver extracts) for the screening of *Ranavirus* (St-Amour and Lesbarrères 2007), the possibility of false negatives cannot be excluded as St-Amour and Lesbarrères (2007) had only 88% success rate in detecting *Ranavirus* from known positive toe-clip extracts.

The 142 samples (DNA extracted from swabs) that were screened for *Bd* infection from Peppara Wildlife Sanctuary were negative for *Bd* infection. From the additional samples that were tested (toe clip extracts), one sample tested *Bd*-positive from *I. diplosticta*, but the replicate was negative for this sample. Another sample of *I. brachytarsus* tested *Bd*-positive and was also positive in the replicate (mean GE = 2.92). These two samples were again amplified with replicates, and tested at Imperial College, London. The *I. diplosticta* sample was found to be negative in both the replicates, and the *I. brachytarsus* sample was positive in both the replicates (Table 1).

From Asia, chytridiomycosis was first reported from captive amphibians in Japan (Une et al. 2008), and *Bd* infections have been reported subsequently from China, Indonesia, and South Korea (e.g., Changming et al. 2010; Kusrini et al. 2008; Yang et al. 2009). To date, we are not aware of any study that has screened for *Bd* or *Ranavirus* in India. In our study, we found one *Bd*-positive *I. brachytarsus* sample from Ponmudi, Western Ghats. The qPCR method is a very specific and sensitive technique for detecting *Bd* infection (Boyle et al. 2004; Kriger et al. 2006), although the infection detected in our study was at a very low level, it was replicable. Rowley et al. (2007) highlighted potential problems associated with contamination due to possible aerosolization of DNA. We believe that aerosol contamination is unlikely in our case, as we performed negative controls and replicated the positive result in a separate laboratory. Similar low-level infections of *Bd* (≤ 1 zoospore equivalent) in wild populations of native amphibians also have been reported from Indonesia and China (Changming et al. 2010; Kusrini et al. 2008). The occurrence of *Bd* infection in individuals with no apparent physical abnormalities is not unusual (e.g., Changming et al. 2010; Kielgast et al. 2010).

Amphibian trade and introductions are prominent hypotheses for the spread of *Bd* in many parts of the world (Fisher and Garner 2007). For example, the introduction of the North American Bullfrog (*Lithobates catesbeianus*) for trade and human consumption is likely to have contributed to the spread of *Bd* in Asia (Changming et al. 2010; Garner et al. 2006). China and Indonesia are well known for amphibian farming and the export of amphibians to Europe, the United States, and many regions in Asia (Kusrini and Alford 2006; Warkentin et al. 2009). Such exports could have facilitated the spread of *Bd* to other regions in southeast Asia. Amphibian trade in India has been banned since 1987 (Warkentin et al. 2009) but illegal trade in amphibians cannot be ruled out as a possible route for introduction of *Bd* to India. A recent study by Goka et al. (2009) also reported the presence of endemic strains of *Bd* in Japanese giant salamander, *Andrias japonicus*, with no disease symptoms. These strains were also present in stored specimens of *A. japonicus* collected in 1902 (Goka et al. 2009), suggesting a much wider and ancient presence of *Bd* in southeast Asia than was previously believed.

Chytrid infections are implicated to have caused extinctions of several species in central Panama even before the scientific description of the species in question were complete (Crawford et al. 2010). The Western Ghats mountains have high endemic amphibian diversity and several new amphibian species have recently been described from this area (e.g., Biju and Bossuyt 2009). Hence, it is highly likely that further new species will be described from this region in future (Biju 2001). In view of our results, and in consideration of the fact that 40% of the amphibian species in the Western Ghats are already threatened with extinction (Biju et al. 2008), we suggest that more organized and extended efforts need to be put into the screening of emerging infectious diseases of amphibians from the entire range of the Western Ghats biodiversity hotspot, and throughout India.

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Batrachochytrium dendrobatidis Detected in Amphibians of the Central Andean Cordillera of Colombia

Land use change, overexploitation, introduced species, global warming, pollution, and emerging infectious diseases are all proposed as causes of the world-wide decline and extinction of amphibians (Alford and Richards 1999; Blaustein and Kiesecker 2002; Collins and Storfer 2003; Fisher et al. 2009). In Latin America, the decline of amphibian populations has been observed from sea level (30 m) to the snow line (5300 m) (Díaz et al. 2007; Puschendorf et al. 2006; Seimon et al. 2007; Whitfield et al. 2007). The emergence of the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) has been implicated in several of these declines (Cheng et al. 2011), and it is responsible for the extinction of several species worldwide (Fisher et al. 2009; Skerratt et al. 2007; Lips et al. 2006). In Colombia, *Bd* has been found infecting frogs in the Hylidae, Dendrobatidae, Leptodactylidae, Centrolenidae, and Bufonidae based on histological examination of museum specimens collected in the Eastern and Western Cordilleras (Ruiz and Rueda-Almonacid 2008; Velásquez-E et al. 2008). Here we report the occurrence of *Bd* in amphibians sampled in montane wet forests of the Central Cordillera of Colombia. To the best of our knowledge, this report corresponds to the first and northernmost record for *Bd* for the Central Andean Cordillera in Colombia.

Our field survey was conducted in Belmira, Antioquia, a region located in northwestern Colombia (Fig. 1). This region has an area of approximately 279 km^2, and is mainly covered by pastures and agricultural fields (60%), forests (18%), and shrub/paramo vegetation (21%) (Rodriguez et al. 2007). The forests in the region have been heavily disturbed by mining, cattle grazing, and forest clearance for timber or fuel wood (Corantioquia 2005). Four sites in the region were sampled (Fig. 1), located between 2550 and 2853 m elevation. The region has a bimodal precipitation regime with annual precipitation ranging from 2000 to 2500 mm, with peaks during the months of April–May and October–November (IGAC and IDEA 2007). The sampling sites are classified in the lower montane wet-forest life zone (bmh-MB) (Holdridge 1967). Two of the sites surveyed (Golondrinas and Quebradona) are old forest fragments of approximately 12 ha each. The other two sites (Salema and Santa Rita) are second-growth forest patches of approximately 2 ha each.

Amphibian species were sampled via visual encounter surveys between December 2008 and February 2009 (Table 1). In order to detect *Bd*, 111 individuals of five species were swabbed using methods described by Hyatt et al. (2007). Cross contamination was prevented using a new pair of disposable gloves every time that a new individual was handled. All samples were preserved in 70% ethanol and kept at low temperature (3°C) until quantitative PCR analyses were conducted.

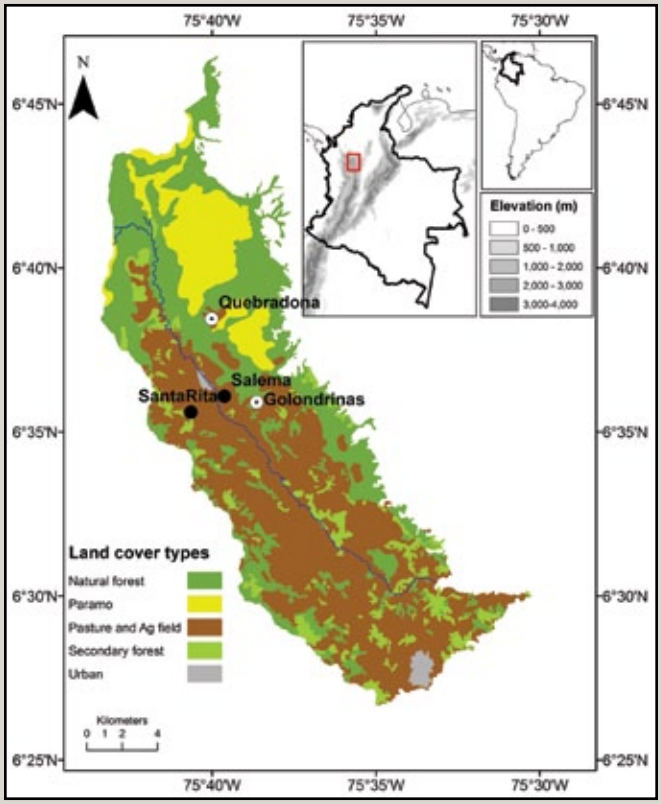

FIG 1. Sampling locations for *Batrachochytrium dendrobatidis* on amphibians in the Central Cordillera, Colombia (South America). White dots = *Bd*-positive locations; Black dots = *Bd*-negative locations.

Bd extraction and quantitative PCR analysis were conducted at the Institute of Zoology, Zoological Society of London, following Boyle et al. (2004). Prevalence of infection was calculated as the ratio between the number of individuals that tested positive for *Bd* and the total number of individuals sampled per species. *Bd* prevalence was estimated with 95% Clopper-Pearson binomial confidence intervals for each species per site. The number of *Bd* zoospores in each swab was estimated as the number of genomic equivalents (GE) per swab by multiplying the number of zoospores detected in each sample by 80, accounting for the number of dilutions between the extraction and the final sample. The number of *Bd* genomic equivalents (GE) is an estimate of the number of zoospores, or the intensity of infection.

We detected *Bd* infection in 32 of 111 amphibians sampled (Prevalence = 28%, CI [95%] = 21–38). However, our low sample

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TABLE 1. *Batrachochytrium dendrobatidis* occurrences in amphibians sampled at four sites in Belmira, Antioquia, Colombia. CI = 95% Clopper-Pearson binomial confidence interval for prevalence (%).

Species	Sites (elevation, m)	Coordinates	No. *Bd*-positive / Total no. samples (%)	CI	Mean no. zoospores/ individual (Low, High)
Bolitoglossa ramosi	Golondrinas (2693)	6.5956°N, 75.6406°W	0/10	0–25	0 (0–0)
	Santa Rita (2565)	6.5905°N, 75.674°W	0/45	0–7	0 (0–0)
Pristimantis dorsopictus	Salema (2550)	6.5986°N, 75.6569°W	0/2	0–63	0 (0–0)
Pristimantis piceus	Quebradona (2853)	6.6379°N, 75.6634°W	1/1 (100)	22–100	1263.4 (1263.4–1263.4)
Pristimantis uranobates	Golondrinas (2693)	6.5956°N, 75.6406°W	2/13 (15)	0–43	34.9 (0-389.7)
	Salema (2550)	6.5986°N, 75.6569°W	0/1	22–39	0 (0-0)
Hyloscirtus larinopygion	Quebradona (2853)	6.6379°N, 75.6634°W	29/39 (74)	59–86	459.6 (0–5319.3)

sizes at sites and per species may have precluded *Bd* detection if infection prevalence was low (Skerratt et al. 2008). *Bolitoglossa ramosi,* the only salamander surveyed in this study, was negative for *Bd* at the two sites where the species was found. *Pristimantis dorsopictus* was also negative for *Bd*. At the two second-growth forest sites, no individuals were positive for *Bd* (Table 1). Infected individuals belong to three species (*Hyloscirtus larinopygion*, *Pristimantis uranobates* and *P. piceus*) (Table 1). Intensity of infection ranged between 0 and 5319 zoospores (Table 1). Infected individuals did not show clinical symptoms of the disease.

Hyloscirtus larynopygion had the highest prevalence of the infection (74%), and the highest intensity of infection (Table 1). This high intensity may respond to a larger area of skin sampled in *H. larinopygion* whose size is larger than the other species studied, although we followed a standardized swabbing protocol. This species is listed as IUCN "Near Threatened" (NT), with habitat loss and pollution as the main threats (Bolívar et al. 2008). The absence of historical data on the populations studied here makes it difficult to understand the effects of *Bd* on these populations. However, the high *Bd* prevalence and high intensity of infection documented for *H. larinopygion* in our study suggest that it is imperative to identify whether chytridiomycosis should be considered as a major threat for the species. Monitoring of these populations is needed to better understand their susceptibility to chytridiomycosis. Also, identifying whether other populations in the region are being affected by *Bd* is relevant in order to inform species and land managers. A low number of individuals of *Pristimantis uranobates* and *P. piceus* were positive for *Bd*. These species are listed as "Least Concern" (LC) and although both species are considered adaptable and tolerant to disturbed habitats (Castro et al. 2004), after this study we suggest to consider the presence of *Bd* as one of the causes that can affect their populations even those located in protected areas.

Our study extends the known distribution of the chytrid fungus to the Central Andean Cordillera of Colombia, and to the best of our knowledge, represents the northernmost record for the chytrid fungus for this Cordillera. The results of this study support the hypothesis of habitat loss as a predictor of lower pathogen prevalence (Becker and Zamudio 2011). In our study, all individuals living in second-growth forest sites were negative for *Bd* while the prevalence for individuals from old forests was higher. This may suggest an effect of the structure of the forest on the *Bd* presence even for neighboring populations through changes in microclimatic conditions (Becker and Zamudio 2011), or potentially habitat heterogeneity with reduced pooled water sources that might serve as *Bd* reservoirs. However our modest sample sizes highlight the importance of continued monitoring in the area to include more species and individuals that allow evaluation of this hypothesis. Our new *Bd* report raises conservation concerns considering the high anuran endemism of forests in the northern central Andes (Duellman 1999).

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GEOGRAPHIC DISTRIBUTION

CAUDATA — SALAMANDERS

***AMBYSTOMA MACULATUM* (Spotted Salamander)**. USA: TENNESSEE: Haywood Co.: North of Hwy 70 at the Stanton city limits (35.2816°N, 89.2356°W; NAD 83). 4 April 2010. Robert Colvin and Amy Colvin. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19065). First county record (Scott and Redmond 2008. Atlas of Amphibians in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/amatlas [updated 13 October 2010; accessed 16 December 2010]. Voucher image made under the authority of the Tennessee Wildlife Resources Agency; field work supported by State Wildlife Grant (SWG) funding under the authority of the U.S. Fish and Wildlife Service.

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***AMBYSTOMA TIGRINUM* (Eastern Tiger Salamander)**. USA: INDIANA: Howard Co.: Howard Township: 4379 E. CR 300 N (40.494031°N 86.043407°W; WGS 84). 23 March 2011. Matthew D. Schultz-Finkler and Michael S. Finkler. Verified by Robert Brodman. Indiana State Museum (INSM 71.7.0520). Five specimens (four live, one road-kill) found on roadway adjacent to drainage ditch. One live specimen collected as voucher. New county record (Minton 2001. Amphibians & Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Fills gap in distribution in north-central Indiana.

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***NECTURUS MACULOSUS* (Mudpuppy)**. USA: NORTH CAROLINA: Macon Co.: Cullasaja River at Wells Grove, RM 0.9, 3.0 km airline SW Franklin (35.16452911°N, 83.35967785°W; WGS 84). 9 August 2011. Lori Williams, John Groves, David Strickler, Craig Pelke, and Dennis McNamara. Verified by Jeffrey C. Beane. North Carolina State Museum of Natural Sciences photo voucher 12705. First vouchered specimen at this location (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 from the French Broad River basin, Transylvania County, 60.7 km airline ENE (North Carolina Natural Heritage Program 2011, *op. cit.*). Adult male [TL = 18.5 cm, SVL = 12.0 cm, mass = 20 g] captured while conducting visual encounter surveys. Tissue sample collected. Substantiates an unvouchered record for this drainage obtained during electrofishing surveys in this drainage on 24 July 2000 by Bill McLarney, Cal Yonce, and Will Cobb.

LORI A. WILLIAMS, North Carolina Wildlife Resources Commission, 177 Mountain Laurel Lane, Fletcher, North Carolina 28732, USA (e-mail: lori.williams@ncwildlife.org); **BILL McLARNEY**, Little Tennessee Watershed Association, 93 Church Street, Suite 214, Franklin, North Carolina 28734, USA; **JOHN D. GROVES** and **DAVID STRICKLER**, North Carolina Zoological Park, 4401 Zoo Parkway, Asheboro, North Carolina 27205, USA; **CRAIG PELKE** and **DENNIS McNAMARA**, Virginia Zoological Park, 3500 Granby Street, Norfolk, Virginia 23504, USA.

***PSEUDOTRITON RUBER RUBER* (Northern Red Salamander)**. USA: TENNESSEE: Warren Co.: Hoover Branch of West Fork Hickory Creek, tributary to Caney Fork River. Accessed from Beacon Light Road 0.5 km W of King Road (35.588574°N, 85.912957°W; NAD 27). 6 April 2011. Matthew D. Wagner, Mark S. Hoger, and Andrew S. Riggs. Austin Peay State University Museum of Zoology (APSU 19125, color photo). Verified by A. Floyd Scott. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. [Hard copy and Internet versions, the latter of which includes links to information on Tennessee amphibians having appeared since 1996, http://www.apsu.edu/amatlas/, accessed 3 August 2011]). One juvenile caught in seine.

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ANURA — FROGS

***ANAXYRUS AMERICANUS* (American Toad)**. USA: INDIANA: Vigo Co.: Fayette Township: (39.54589°N, 87.42184°W; NAD 83). 10 May 2011. Sarabeth Klueh and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2011m). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii–404 pp.) Individuals were calling from a flooded agricultural field along with *Anaxyrus fowleri*. This species occurs commonly throughout most of Indiana but appears to be largely absent from a pocket of counties in the southwest part of the state (Minton, *op cit.*). This record partially fills a gap in the range of this species in southwest Indiana.

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***CHIROMANTIS SIMUS* (Assam Tree Frog)**. BANGLADESH: MOULVIBAZAR DISTRICT: Sreemangol, Lawachara National Park (25.8907694°N, 088.8502083°E, WGS 84), 13 June 2011. Verified by Ghazi S. M. Asmat. Digital voucher image, Herpetology Museum Laboratory, Ichamoti College, Dinajpur, Bangladesh (MHLB-CS01). First record for Moulivibazaar District. Species described from Assam, India (Annandale 1915. Rec. Indian Mus. 11:341–347); first report from Bangladesh was Chittagong (Asmat et al. 2003. Univ. Rajshahi J. Zool. 2003:141–143).

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***DISCOGLOSSUS GALGANOI* (West Iberian Painted Frog)**. PORTUGAL: ÉVORA: ca. 38.5269°N, 08.0168°W (WGS84). 17 November 2011. Luis Ceríaco. Photographic vouchers deposited at Colecção Fotográfica of the Museu de Ciências Naturais da Escola Secundária André de Gouveia (MCN/MB/F/A/10). Verified by Ana Pires. Species previously unrecorded from region, nearest population being at least 10 km S (Cruz and Rebelo 2010. *In* Loureiro et al. [eds.], Atlas dos Anfíbios e Répteis de Portugal, pp. 104–105. Esfera do Caos Editores, Lisboa). Photographed in water canal, in Herdade da Mitra, at ca. 2330 h.

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***ENGYSTOMOPS PUSTULOSUS* (Túngara Frog, Sapillo Túngara)**. HONDURAS: YORO: 5 km S of San Patricio (15.400000°N, 86.916667°W, WGS84; 250 m elev.). 5 October 2010. James R. McCranie and Leonardo Valdés Orellana. Verified by Steve W. Gotte. USNM 578911. First record for Yoro, with the closest known locality being ca. 35 km SE at El Díctamo, Olancho (McCranie 2006. Smithson. Herpetol. Inform. Serv. 137:1–38). The frog was calling at night in a rain pool on a dirt road in an area of badly degraded thorn forest.

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***FEJERVARYA ASMATI* (Bangladeshi Cricket Frog)**. BANGLADESH: NILPHAMARI DISTRICT: Darwny Textile Mills, Shokher Bazar (25.890769°N, 88.850208°E; 43–44 m elev.; datum: WGS 84). 13 June 2011. Collected by Md. Abdur Razzaque Sarker. Two specimens (MHLB-FA01, and MHLB-FA02). Museum of Herpetology Laboratory, Ichamati College, Dinajpur, Bangladesh. Verified by Ghazi S. M. Asmat. Species described from Chittagong, Bangladesh (Howlader 2011. Zootaxa 2761:41–50). Current population 1.83 km from Darwny Textile Mills Market and >600 km N of type locality. Adults collected on banks of pond. Habitat includes several *Cynodon dactylon* plantations, in addition to Bambuseae, *Bromus tectorum*, adjacent to a field of *Corchorus capsularis*.

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***FEJERVARYA PIERREI* (Pierre's Cricket Frog)**. BANGLADESH: NILPHAMARI DISTRICT: Berakuthi, Barua (25.821925°N, 88.8284°E, 43 m elev.; WGS 84), 29 August 2011. Verified by Ghazi S. M. Asmat. Collected by Md. Abdur Razzaque Sarker. Museum of Herpetology Laboratory, Ichamati College, Dinajpur, Bangladesh (MHLB-FP01). First record from Nilphamari District, northern Bangladesh, and previously recorded from Chittagong (Hathazari), Coxes bazaar (Himchari), Noakhali (Hatia Island), and Barisal (Sundargaon), southeast Bangladesh (Rasel et al. 2007. Bannoprani- Bangladesh Wildl. Bull. 4:1–2). Current population found near a Berakuthi, Barua, a primary school, >14 km S from Nilphamari and > 484 km NW of the Chittagong (Hathazari), < 570 km NW of Cox's Bazaar (Himchari), < 400 km NW of Noakhali (Hatia Island), and < 377 km NW fof Barisal (Sundargaon). Adult collected beside playground. Habitat includes *Cynodon dactylon* plantations, beside paddy field.

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***FEJERVARYA TERAIENSIS* (Terai Cricket Frog)**. BANGLADESH: MOULVIBAZAR DISTRICT: Sreemangol, Lawachara National Park (25.8907694°N, 088.8502083°E, WGS 84), 13 June 2011. Verified by Ghazi Asmat. Digital voucher image, Herpetology Museum Laboratory, Ichamoti College, Dinajpur, Bangladesh (MHLB-FT01). First record for Moulivibazaar District. Only reports from Bangladesh is Chittagong, Cox's Bazaar, Barisal, and Nokhali Districts (Rasel et al. 2007. Bannoprani-Bangladesh Wildl. Bull. 4:1–2).

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***HYLA GRATIOSA* (Barking Treefrog)**. USA: TENNESSEE: Benton Co.: 4185 Divider and Natchez Road (35.5943°N, 88.0905°W; NAD 83). 26 April 2011. Brian Elkins. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19130). First county record (Scott and Redmond 2008. Atlas of Amphibians in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/amatlas [updated 13 October 2010; accessed 12 September 2011].

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

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***HYLARANA LEPTOGLOSSA* (Long-tongued Frog)**. BANGLADESH: SYLHET DIVISION: Golapganj (24.8583°N, 90.0208°E, WGS 84; > 200 m elev.). 1 June 2009. Md. Mukhlesur Rahman Khan. Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh, Bangladesh. Specimen deposited at Institute for Amphibian Biology, Hiroshima University, Japan (IABHU 3784). Verified by Mitsuru Kuramoto. First locality record for Sylhet Division and only northeastern record for Bangladesh. Other records from Madhupur National Park, Mymensingh Division (ca. 210 km to W) (Mahony and Reza 2007. Herpetol. Rev. 38:350) and Chittagong Division (ca. 285 km to N), with no locality details, photograph, or voucher (Asmat et al. 2003. Univ. J. Zool., Univ. Rajshahi 22:141–143). Supported by Grant-in-Aids for Scientific Research (C) (17570082 and 20510216) to M. Sumida from the Ministry of Education, Culture, Sports, Science and Technology, Japan.

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Biology, Hiroshima University, Hiroshima 739-8526, Japan (e-mail: msumida@hiroshima-u.ac.jp).

HYPSIBOAS FABER. BRAZIL: BAHIA: Municipality of Mucugê: 12.59°S, 41.23°W (SAD 69), 985 m elev. 05 March 2010. M. Freitas and D. França. Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP 142498, collected in rupestrian field areas domain in "Chapada Diamantina" complex). Municipality Rui Barbosa: 12.13°S, 40.371°W. 530 m elev. 15 March 2010. M. Freitas and D. França. MZUSP 142569–71, collected in the estacional ciliar forest. Both verified by M. Rodrigues. Municipality of Senhor do Bonfim: 10.23°S, 40.11° W. 600 m elev. 10 June 2002. M. Freitas. Museu de Zoologia da Universidade Estadual de Feira de Santana, Bahia, Brazil (MZUEFS 1374, collected in the estacional ciliar forest). Verified by F. Juncá. This species is known from Paraguay, Argentina (Misiones), and Brazil (from Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Minas Gerais and east of Goiás, and coastal northeast region to Bahia, Sergipe, Alagoas, Pernambuco, and Paraíba state) (AmphibiaWeb 2011. Available: http://amphibiaweb.org/, accessed 8 January 2011; Frost 2011. Amphibian Species of the World: an Online Reference. Version 5.5 (17 April 2011). Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia/, accessed 17 April 2011. American Museum of Natural History, New York). First record for Mucugê, Rui Barbosa, and Senhor do Bonfim municipalities within Bahia State, extending the species range ca. 300 km W from Ilhéus municipality, Bahia (AmphibiaWeb 2011, *op. cit*).

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LITHOBATES CLAMITANS MELANOTA **(Northern Green Frog)**. USA: INDIANA: Howard Co.: Howard Township: 3680 E. CR 250 N. (40.513381ºN, 86.56.057004ºW; WGS 84). 23 March 2011. Michael S. Finkler. Verified by Robert Brodman. Indiana State Museum (INSM 71.7.0519). Live male found on roadway. New county record (Minton 2001. Amphibians & Reptiles of Indiana, 2nd ed. Indiana Academy of Science, Indianapolis. 404 pp.). Fills gap in distribution in north-central Indiana.

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LITHOBATES SPHENOCEPHALUS **(Southern Leopard Frog)**. USA: TENNESSEE: Marshall Co.: Lick Creek, ca. 0.5 km W of Mt. Vernon Rd and Hwy TN 90 intersection (35.666306°N, 86.672414°W; WGS 84). 19 October 2010. M. Anderson and D. Estabrooks. Herpetology Collection at Middle Tennessee State University (MTSU 351A). Maury Co.: Unnamed first-order stream that enters Negro Creek of the Duck River watershed (35.5958°N, 86.9244°W; WGS 84). 24 October 2010. M. Anderson, D. Estabrooks, and R. Johnston. MTSU 355A. Williamson Co.: Dry unnamed third-order tributary of the Harpeth River, ca. 0.5 km E of the intersection of Southall Rd and Carl Rd (35.8997°N, 86.9673°W; WGS 84). 24 October 2010. M. Anderson and R. Johnston. MTSU 354A. All three records verified by B. T. Miller. All represent new county records (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Internet version [<http://www.apsu.edu/amatlas>http://www.apsu.edu/amatlas] contains links to information regarding Tennessee distribution of amphibians recorded since 1996; accessed 19 and 26 October 2010).

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PSEUDACRIS CRUCIFER **(Spring Peeper)**. USA: GEORGIA: Lumpkin Co.: Chattahoochee National Forest near Dick's Creek Falls (34.67222°N, 83.90388°W; WGS 84; elev. 479 m). 08 May 2011. Leslie Phillips. Verified by John Jensen. UTADC 6940 photo voucher. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. of Georgia Press, Athens. 575 pp.); previously documented in all adjacent counties with the exception of Fannin. Specimen was heard calling from the opposite side of the road from Dick's Creek at ~0130 h near the bridge at Corbin Crossing and found calling from a holly leaf.

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TLALCOHYLA LOQUAX **(Rana Trepadora Sonorense; Mahogany Treefrog)**. HONDURAS: SANTA BÁRBARA: SW corner of Lago de Yojoa (14.800004°N, 88.000015°W, WGS84; 650 m elev.). 1 October 2010. James R. McCranie and Leonardo Valdés Orellana. Verified by Steve W. Gotte. USNM 578910. First record for Santa Bárbara, with the closest known locality being ca. 5 km E at 1.6 km N of Pito Solo, Comayagua (McCranie 2006. Smithson. Herpetol. Inform. Serv. 137:1–38). The frog was calling at night from low secondary vegetation surrounding a rain-filled swampy area.

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CROCODYLIA — CROCODILIANS

ALLIGATOR MISSISSIPIENSIS **(American Alligator)**. USA: GEORGIA: Miller Co.: Mayhaw Wildlife Management Area (31.198069°N, 84.792064°W, WGS 84; elev. 48 m). 6 August 2011. Robert L. Hill. Verified by John Jensen. UTADC 6941. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.); has been documented in adjacent Baker, Early, and Seminole counties. Has been previously observed in Miller Co., though this represents the first vouchered record. Two specimens observed from 0955–1035 h in water-filled borrow pit at entrance to Mayhaw Wildlife Management Area on Griggs-Lucille Rd ~2.23 km W of junction with Hwy 27.

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TESTUDINES — TURTLES

APALONE FEROX **(Florida Softshell)**. USA: SOUTH CAROLINA: Allendale Co.: County road SSR-292 (33.02096°N, 81.27335°W;

WGS 84) adjacent to Stony Lake, 2.5 km NE Allendale. 5 May 2010. J. D. Camper. Verified by S. Miller. Clemson University Vertebrate Collections (CUSC 2820). Dead adult male on road next to a Carolina Bay. New county record (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington D.C. 578 pp.).

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***APALONE SPINIFERA* (Spiny Softshell)**. USA: LOUISIANA: Vernon Parish: Kisatchie National Forest, Mill Creek Rd and Whiskey Chitto Creek crossing (31.0822°N, 93.14789°W; WGS 84). 11 July 2007. Stephen M. Ecrement. Florida Museum of Natural History, University of Florida (UF165499). Verified by Kenneth L. Krysko. First parish record; extends distribution N from Beauregard Parish, W from Rapides Parish, and S from Sabine and Natchitoches parishes as mapped by Dundee and Rossman (1989. The Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge. 300 pp.).

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***CHELYDRA SERPENTINA SERPENTINA* (Eastern Snapping Turtle)**. CANADA: ONTARIO: Kenora District: Woodland Caribou Provincial Park: S of Talon Lake (50.6550°N, 94.7795°W). 10 August 2009. Jeff King and Matt Butts. This specimen and all others listed below are photographic vouchers verified by Ross D. MacCulloch. Royal Ontario Museum. The GPS datum for all records is WGS 84. One adult (ROMdm 00255) was filmed basking on rocky shoreline. Nearest record is 38 km N from a small unnamed lake near Hammerhead Lake (Ontario Herpetofaunal Summary database [OHS] entry number 212801). Aubrey Township: near Aubrey Lake ca. 10 km E of City of Dryden (49.7667°N, 92.9833°W). June/July 2007. Ray Schott. One adult (ROMdm 00256) found in grassy area. First township record. Nearest record is 24 km SE from Godson Lake on Highway 502 (NMC 24616, OHS 101519). MacNicol Township: Dixie Lake Rest Area, ca. 30 km E of City of Kenora on Highway 17 (49.8337°N, 93.9467°W). 13 July 2008. Graham Suffield. One adult (ROM dm 00264) swimming along rocky lakeshore. First township record. Nearest record 51 km E near Trial Lake in Buller Township (OHS 258765). Stokes Township: Gullwing Creek, ca. 12 km N of City of Dryden (49.8500°N, 92.9500°W). June/July 2007. Ray Schott. One adult (ROMdm 00257) found on cobbled bank. First township record. Nearest record 30 km SE from Godson Lake on Highway 502 (NMC 24616, OHS 101519). Unorganized township: Trap Lake, ca. 10 km S of City of Dryden (49.6500°N, 92.7833°W). June/July 2007. Ray Schott. One adult (33 cm CL, ROMdm 00258) caught in a trap net during fisheries work. New locality record. Nearest record 5 km S from Godson Lake on Highway 502 (NMC 24616, OHS 101519).

Rainy River District: Lake of the Woods Municipality (former Morson Township): Village of Morson, S end of Lake of the Woods (49.095056°N, 94.320681°W). 16 May 2008. Cheryl Gauthier. One adult (ROMdm 00262) on beach in small bay. First township record. Nearest record 13 km NE at Walden Island (OHS 59429). Quetico Provincial Park: Pickerel River between Pickerel and French Lakes (48.654°N, 91.177°W; WGS 84). 09 August 2008. Graham McGuire. One adult (ROMdm 00263) swimming in river. New locality record. Nearest record is ca. 5 km N from Eva Lake (OHS 111040). Unorganized township: Niobe Lake, near Village of Sapawe (48.732094°N, 91.319192°W). August 2004. Jeffrey N. Robinson. One adult (ROMdm 00266) caught in net during fisheries study. New locality record. Nearest record is 12 km E from Eva Lake (OHS 111040).

Thunder Bay District: Devon Township: Highway 593 N of Highway 61 and S of Highway 588 (48.083983°N, 89.802704°W). June 2004. Jeffrey N. Robinson. One juvenile (ROMdm 00267) captured in center of the highway. First township record. Nearest record 82 km E from Sibley Provincial Park (OHS 111265). Lybster Township: Village of Nolalu, near bridge on Old Mill Road (48.291972°N, 89.808882°W). July 2008. Robert Kamstra and Stephen J. Hecnar. One adult (18.7 cm CL, 1478 g; ROMdm 00265) found dead on roadside. Specimen photographed and placed in Lakehead University Biology collection (LUB 00227). First township record. Nearest record 74 km E from Sibley Provincial Park (OHS 111265). Inwood Township: Highway 17 ca. 4.8 km E of Town of Upsala (49.021372°N, 90.442424°W). 31 May 2008. Brent Gibbons. One adult female (29 cm CL) (ROMdm 00260) attempting to cross highway between lakes was captured and moved to other side. Specimen subsequently oviposited on sandy beach of Inwood Park Lake. First township record. Nearest record 64 km SW from Eva Lake (48.69539°N, 91.16547°W; OHS 111040). Laurie Township: near Matawin River ca. 3.8 km SW of Shabaqua railway crossing (48.545059°N, 89.928092°W). 13 June 2007. Herbert Bax. One adult (ROMdm 00261) found on log haul road near coniferous forest cutover. First township record. Nearest record 27 km E from Gravel Lake in Hardwick Township (OHS 266100).

Algoma District: Dahl Township. Highway 17 ca. 30 m from Normandy Lodge Road. (48.2987°N, 84.9659°W). 02 September 2005. F. Neil Dawson. One adult on shoulder of highway (ROMdm 00259). First township record. Record lies in a large gap between northwestern and northcentral Ontario records and may extend range to NE. Nearest records are 98 km W in Pukaskwa National Park (Ontario Herpetofaunal Summary, entry number 20279) and 37 km S in Wawa, Ontario (COSEWIC 2008. COSEWIC Assessment and Status Report on the Snapping Turtle *Chelydra serpentina* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa. vii + 47 pp.). These two records were suspected introductions but the new record suggests that the gap may be an artifact of insufficient sampling in the region. The specimens we report are significant because they represent new localities from areas of limited sampling near the presumed northern range limit for the species in the boreal region of Ontario (Schueler 1976. Blue Jay 34[1]:18–25).

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***CHELYDRA SERPENTINA SERPENTINA* (Eastern Snapping Turtle)**. USA: HAWAII: OAHU: Honolulu Co.: Kaneohe: Kamooalii Stream, within the Ho'omaluhia Botanical Garden (21.3840°N, 157.8025°W; WGS 84). 25 May 2011: Bishop Museum (BPBM 37715). Collected by Tag N. Engstrom. Verified by Allen Allison (BPBM). First vouchered record of a wild-caught

Chelydra serpentina from the state of Hawaii (Yamamoto and Tagawa 2000. Hawai'i's Native and Exotic Freshwater Animals. Mutual Publishing, Honolulu, Hawaii. 200 pp.). A mature male was captured in a funnel trap in the small reservoir above Lehua Dam in Kamooalii stream, in the Ho'omaluhia Botanical Garden. A previous, unconfirmed report of a snapping turtle in a different body of water in the botanical garden suggests that there may be an established population at this location. Introduction of another large non-native predator to the aquatic ecosystem of Hawaii could have major negative effects.

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***GRAPTEMYS BARBOURI* (Barbour's Map Turtle)**. USA: Georgia: Coweta and Spalding Cos.: Two adult females observed and photographed basking on a log in Line Creek (which forms the boundary between the two counties) at the Georgia Highway 16 bridge (33.256694°N, 84.497399°W; NAD 83). 7 July 2011. John B. Jensen. Verified by Sean Graham. AUM AHAP-D 317, photographic voucher. First county and creek records, as well as an upstream (Flint River drainage) and northerly range extension of approximately 15 river-km from a Flint River record in Meriwether Co. (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.).

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***GRAPTEMYS GEOGRAPHICA* (Northern Map Turtle)**. USA: GEORGIA: Floyd Co.: 1.15 km W Black Buff Road. Multiple individuals were observed and photographed in the Coosa River near Rome (34.20591°N, 85.29058°W; NAD 83). 5 August 2011. Grover Brown and Owen Kinney. Verified by Kenneth L. Krysko. UF 165620. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). This record conservatively fills a 475 km distribution gap between previous Coosa River drainage records upstream in the Conasauga River in Whitfield Co., Georgia (GMNH 19514) and the only other Coosa River record, a vague record downstream in Coosa Co., Alabama (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Univ. Agric. Exp. Stat. 347 pp.).

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***KINOSTERNON LEUCOSTOMUM* (White-lipped Mud Turtle; Pochitoque)**. HONDURAS: SANTA BÁRBARA: SW corner of Lago de Yojoa (14.800004°N, 88.000149°W, WGS84; 650 m elev.). 1 October 2010. James R. McCranie and Leonardo Valdés Orellana. USNM 578922. First record for Santa Bárbara, with the closest known locality being from ca. 15 km NE at Agua Azul, Cortés (AMNH 70545–47, TCWC 19232). YORO: 5 km S of San Patricio (15.40000°N, 86.916667°W, WGS84; 250 m elev.). 5 October 2010. James R. McCranie and Leonardo Valdés Orellana. USNM 578921. First record from Yoro, with the closest known locality being from ca. 40 km N at La Ceiba, Atlántida (USNM 62981–90). Both vouchers were verified by Steve W. Gotte. The Santa Bárbara turtle was active at night on the bottom of a muddy, rain-filled flood plain. The Yoro turtle was active at night in a small lagoon formed by a small tributary of the Río Aguán in an area of badly degraded thorn forest.

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***KINOSTERNON LEUCOSTOMUM* (White-lipped Mud Turtle; Pochitoque)**. HONDURAS: El PARAÍSO: Mapachín (13.9830°N, 86.4910°W, WGS84; 830 m elev.). 8 July 2010. Alexander Gutsche, James R. McCranie, and Leonardo Valdés Orellana. USNM 578923–24. Verified by Steve W. Gotte. First records for El Paraíso with the closest known locality being ca. 65 km to the NE, 7 km E of Azacualpa, Olancho (UF 90019). The turtles were active at night in a man-made pond in an area of denuded pine forest. Fieldwork of A. Gutsche was supported by the Adolf and Hildegard Isler Foundation.

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***MACROCHELYS TEMMINCKII* (Alligator Snapping Turtle)**. USA: GEORGIA: Clayton Co.: Flint River, 0.35 km S of McDonough Road (33.45604°N, 84.38425°W; NAD 83). 21 July 2011. John B. Jensen and Sean P. Graham. UF 165542. Coweta Co.: Hutchins Lake, 0.24 km NW Rockaway Road (33.31982°N, 84.54592°W; WGS 84). August 2010. Clint Freeman. UF 165217. Fayette Co.: Flint River 0.29 km N of McDonough Road (33.46100°N, 84.38306°W; NAD 83). 21 July 2011. John B. Jensen and Sean P. Graham. UF 165541. Spalding Co.: Flint River, 0.76 km SW of Georgia Highway 16 (33.23941°N, 84.43340°W; NAD 83). 15 July 2011. John B. Jensen and Kristina Sorensen. UF 165533. Each record reported herein is a first record for their respective county (Jensen et al. [eds.] 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp). All specimens were verified by Kenneth Krysko.

During summer 2010, one of us (JBJ) was sent a photograph of a large, adult male alligator snapper from an impounded tributary (Keg Creek; Hutchins Lake) of the Flint River, which represented a significant upstream and northerly range extension well into the Piedmont physiographic province. This discovery led us to trap two other Piedmont stretches of the Flint River drainage to determine how widespread *M. temminckii* might be in what has largely been dismissed by biologists and former commercial trappers as habitat too far upstream and away from the Coastal Plain to harbor the species. In fact, Al Redmond, perhaps the most well-known commercial trapper of this species in Georgia, considered the Flint River near Reynolds, approximately 100 air-km S of our northernmost record and within the Coastal Plain physiographic region, to be the northern limit of the species' Georgia range (pers. comm. to P. Pritchard *in* Pritchard 2006. The Alligator Snapping Turtle: Biology and Conservation. Krieger Publishing Co., Malabar, Florida. 140 pp.). Our trapping effort yielded 13 alligator snappers in 19 trap-nights (TN), for a catch per unit effort (CPUE) of 0.68 turtles/TN. Of the 13 alligator snappers captured, eleven were juveniles. In a statewide status survey of this species from 1997–2001, Jensen and Birkhead

(2003. Southeast. Nat. 2:25–34) had a total CPUE of 0.20 turtles/TN in 281 TN, with the best stream producing a CPUE of 0.45 turtles/TN. Additionally, captures as part of the previous study resulted in a 4:1 adult:juvenile ratio. Clearly, the recently trapped Piedmont portion of the Flint River drainage appears to have a relatively dense and successfully recruiting population of this state "Threatened" species, perhaps because commercial trappers did not think they occurred there.

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***MACROCHELYS TEMMINCKII* (Alligator Snapping Turtle)**. USA: LOUISIANA: Vernon Parish: Louisiana Ave. and Bundick Creek crossing 100 m S of the Rt. 10 & LA Ave. jct. (31.03372°N, 93.19202°W; WGS 84). 27 June 2007. Stephen M. Ecrement. Florida Museum of Natural History, University of Florida (UF165500). Verified by Kenneth L. Krysko. First parish record, extending distribution N from Beauregard Parish and W from Rapides Parish as mapped by Dundee and Rossman (1989. The Amphibians and Reptiles of Louisiana. Louisiana State University Press, Baton Rouge. 300 pp.).

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***RHINOCLEMMYS PULCHERRIMA* (Painted Wood Turtle; Casco Rojo)**. HONDURAS: EL PARAÍSO: Mapachín (13.9830°N, 86.4910°W, WGS84; 800 m elev.). 7 October 2010. James R. McCranie and Leonardo Valdés Orellana. USNM 578920. Verified by Steve W. Gotte. First record for El Paraíso, with the closest known locality being ca. 40 km W at El Zamorano, Francisco Morazán (AMNH 70569). The turtle was active during the day in a tomato field in an badly degraded ecotone between thorn scrub and pine forest.

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***STERNOTHERUS ODORATUS* (Eastern Musk Turtle)**. USA: ARKANSAS: Calhoun Co.: vic. Calion, ~6 km N of Ouachita River off US 167 (33.388195°N, 92.496846°W; WGS 84). 28 August 2011. M. B. Connior.Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ photo voucher 31831). New county record partially filling a distributional hiatus in southern Arkansas (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.). An intact carapace and plastron were collected along the bank of a small slough from the Ouachita River.

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***TERRAPENE CAROLINA* (Eastern Box Turtle)**. USA: ALABAMA: Coosa Co.: County Road 22, 0.8 km W of the intersection with County Road 9 (32.867369°N, 86.101247°W; WGS84/NAD83). 28 May 2011. B. Scott. Found alive on road. Digital images AHAP-D-310 311. Verified by Craig Guyer. New county record (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. xi+347 pp.). *T. carolina* is assumed to occur statewide, however verified records are lacking for many Alabama counties.

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***TERRAPENE CAROLINA* (Eastern Box Turtle)**. USA: ALABAMA: Russell Co.: Hwy 51 approximately 1.1 km N of the intersection with Hwy 26 in the town of Hurtsboro (32.255020°N, 85.416470°W; WGS84/NAD83). 22 Sept. 2011. R. Birkhead. Found dead on road, AUM 39694. Verified by Craig Guyer. New county record (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. xi+347 pp.).

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***TERRAPENE CAROLINA* (Eastern Box Turtle)**. USA: GEORGIA: Calhoun Co.: County Road 153, 1.12 km S of the intersection with State Route 37 near the town of Morgan (31.526898°N, 84.599696°W; WGS84/NAD83). 24 August 2011. W. S. Birkhead and Ricky Batts. Found alive on road. Digital vouchers AHAP-D-319a–e. Verified by Craig Guyer. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). *T. carolina* is assumed to occur statewide, however verified records are lacking for many Georgia counties (Jensen et al. 2008, *op. cit.)*. This individual likely represents an intergrade between *T. c. carolina* and *T. c. triunguis* as it has three toes on the hind feet and the peak of the carapace is located posteriorly; however, it also has bright coloration on the head, legs, and carapace similar to *T c. carolina.*

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***TERRAPENE CAROLINA CAROLINA* (Eastern Box Turtle)**. USA: INDIANA: Jennings Co.: North Vernon, County Road 75 West & County Road 115 South, 0.45 miles S (38.966°N, 85.625°W; WGS 84; elev. 216 m). 24 October 2010. John B. Iverson. Verified by Dana J. Ehret. Florida Museum of Natural History (UF 165391). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. 404 pp.)

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***TERRAPENE ORNATA* (Ornate Box Turtle)**. USA: NEBRASKA: Box Butte Co.: Alliance, east side of town on US Hwy 2 (42.09695°N, 102.85501°W; NAD 83). 8 July 2010. Shane Keane. Photographic voucher. Verified by Curtis J. Schmidt. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas (FHSM 15599). 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 distributional gap in northwestern Nebraska among Sheridan, Sioux, Scottsbluff, and Morrill counties. Female photographed on shoulder of highway near the western edge of the Sandhill Region of Nebraska.

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***TRACHEMYS STEJNEGERI* (Central Antillean Slider)**. USA: PUERTO RICO: Isla de Culebra (18.31°N, 65.28°W; WGS 84), 3–26 m elev. Twenty-six live *Trachemys stejnegeri* (10 males, 13 females, 2 juveniles, 1 unknown) were observed along a small, forested stream on the south side of Culebra Island by M. T. Jones and L. L. Willey. 1–2 January 2011. Verified by M. E. Seidel. Museum of Comparative Zoology (digital image MCZ R-188664).

Trachemys stejnegeri utilizes a variety of wetlands on Great Inagua (Bahamas), Hispaniola, and Puerto Rico. Of three subspecies, the nominate race *T. s. stejnegeri* occurs throughout the island of Puerto Rico. Seidel (1988. Am. Mus. Novit. 2918:1–41) cited anecdotal reports of *T. stejnegeri* from both Isla de Culebra and neighboring Isla de Vieques, located 30 and 10 km from the eastern shore of Puerto Rico, respectively. Subsequent authors (e.g., Ernst et al. 2010. Turtles of the World online database: *Trachemys stejnegeri* [http://nlbif.eti.uva.nl/bis/turtles.php?menuentry=soorten&id=327]; Iverson et al. 2010. EMYSystem: *Trachemys stejnegeri* (http://emys.geo.orst.edu/collection/species/Trachemysstejnegeri/Trachemysstejnegeri.htm) have indicated that the species is present on Culebra and Vieques, citing Siedel's (1988, *op. cit.)* unverified report.

Our findings confirm the presence of an established population of *T. stejnegeri* on Culebra. We observed *T. stejnegeri* in a variety of habitats: basking on rocks, submerged in shallow pools along the stream and one turtle in a stone cistern about 15 m from the stream channel. All sliders observed were consistent with the nominate subspecies *T. s. stejnegeri*, native to Puerto Rico.

Female SCL_{min} averaged 194 mm (N =12; range = 162–267 mm). Male SCL_{min} averaged 156 mm (N = 9; range = 124–184 mm). Five of nine males were melanistic, which is typical for the species (Seidel 1988, *op. cit.).*

We observed courtship in a shallow (20 cm) pool on 2 January 2011. Combined with the presence of juveniles, this suggests that the population is reproducing. Channel slope (= stream gradient) averaged 3.1%. Streamflow averaged 0.0112 m^3/sec. The stream may now be augmented by discharge from a municipal water facility located in its headwaters, but the channel is clearly visible in aerial images (U.S. Geological Survey) taken in 1994, before the facility existed. Total dissolved solids in the stream at 20 m elev. (4.6 ppt) indicate brackish origin, but within the range tolerated by *Trachemys* and *Pseudemys* in the Cayman Islands and Florida (Dunson and Seidel 1986. J. Herpetol. 20[2]:237–245).

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SQUAMATA — LIZARDS

***ACANTHODACTYLUS BOSKIANUS* (Bosc's Fringe-toed Lizard)**. IRAN: KHUZISTAN PROVINCE: ca. 30 km N of Dezful, around Vahdati village (32.6333°N, 48.5833°E; 220 m elev.; datum WGS 84). Collected by Roman Nazarov and Mehdi Rajabizadeh. International Center for Science, High Technology and Environmental Sciences Zoological Museum, Kerman (ICSTZM 6H1285). Verified by Nasrullah Rastegar-Pouyani. Associated with annual grasses, *Amygdalus* and Graminaceae as dominant vegetation in lowland sandy hills. First confirmed record for Khuzistan Province, and 500 km S of only record (Rastegar-Pouyani 1999. Asiatic Herpetol. Res. 8:85–89). Our specimens fit diagnosis and color pattern given in Anderson (1999. The Lizards of Iran. Society for the Study of Amphibians and Reptiles, Ithaca, New York. 415 pp.).

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***ASPIDOSCELIS LAREDOENSIS* (Laredo Striped Whiptail)**. USA: TEXAS: Kinney Co.: Rancho Rio Grande, 10–110 m from the Rio Grande (29.159721°N, 100.757492°W; datum WGS84, elev. 250 m), 6.08 km SW (all distances in straight lines) from the nearest point on US Hwy 277 (29.191475°N, 100.706570°W; WGS 84; elev. 268 m). 14 June 2000. James E. Cordes. University of Arkansas "Department of Zoology" (UADZ) 6731 (65 mm SVL), 6734 (78 mm SVL), 6738 (79 mm SVL). Verified by Mark A. Paulissen. First county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A & M Univ. Press, College Station. 421 pp.).

With reference to previous sites reported for *A. laredoensis* in the northern part of its range (Walker 1987. Texas J. Sci. 39:313–334), the new site is ca. 25 km SE of Del Rio, Val Verde Co., and ca. 56 km NW of Eagle Pass, Maverick Co., and fills in an apparent disjunction in the range (Walker 1987, *op. cit.*) . Based on collection data obtained on Rancho Rio Grande by JEC in May and June 2000, gonochoristic *A. gularis* was euryecious (present throughout the ranch), ubiquitous (regularly observed), and readily collectible (N = 118), whereas diploid parthenogenetic *A. laredoensis* B was stenoecious (restricted to a few areas influenced by the river) and rarely encountered or collected (N = 7).

Specimens were collected under authority of Texas Parks and Wildlife Department (TPWD) permit SPR-1090-298 to James E. Cordes. David H. Riskind and Mark Lockwood of TPWD made it possible for us to conduct herpetological studies in Texas. Research on the private ranch was enabled by consent, advice, and/or guidance provided by Bill Moody (owner), John and Elizabeth Kincaid (ranch foreman and spouse), Aurelio Castillo (ranch hand), and Bubba and the other federal Tick Riders (livestock disease abatement) who ply the border on horseback.

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***ASPIDOSCELIS NEOMEXICANA* (New Mexico Whiptail)**. USA: NEW MEXICO: Roosevelt Co.: 0.48 km E of De Baca-Roosevelt counties boundary in highly disturbed habitat near US Hwy 84/60 and BNSF railroad grade (34.450833°N, 103.942500°W; WGS 84; elev. 1288 ± 2 m WAAS). 10 July 2011. James E. Cordes. University of Arkansas "Department of Zoology" (UADZ 8898). SVL 71 mm. Verified by Harry L. Taylor. New county record. (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque, 431 pp.). This location for this allodiploid parthenogen is ~27.8 km straight-line east of the nearest locality in Fort Sumner (34.479722°N, 104.228889°W; WGS84; elev. 1260 m), De Baca Co. (Taylor 2002. Herpetol. Rev. 33:223–224; Manning et al. 2005. Am. Mus. Novitat. 3492:1–56; Manning and Walker 2006. Am. Midl. Nat. 155:411–416), situated farther east in New Mexico than the records for the species at Conchas Lake (35.377222°N, 104.184444°W; WGS84; elev. 1271 m), San Miguel Co. (Leuck et al. 1981. Southwest. Nat. 26:72–74; Manning et al., *op. cit.*), and also inhabited by gonochoristic *A. sexlineata* with which it hybridizes (Cordes, unpubl.). Discovery of *A. neomexicana* in Roosevelt Co. also provides another detail of distribution for consideration in the controversy on whether the species is naturally occurring in De Baca, San Miguel, and Roosevelt counties (Walker et al. 1992. Southwest Nat. 37:82–86; Taylor, *op. cit.*; Manning et al., *op. cit.*) or the result of introductions of individuals (Leuck et al., *op. cit.*; Persons and Wright 1999. Herpetol. Rev. 30:207–209) well east of the main distribution area in the Rio Grande Valley in New Mexico.

Collections were made under authority of New Mexico Game and Fish permit number 1850 to James E. Cordes.

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***BLANUS CINEREUS* (Iberian Worm Lizard)**. PORTUGAL: ÉVORA: ca. 38.5256°N, 08.0211°W (WGS84). 25 July 2011. Luis Ceríaco. Photographic vouchers deposited at Colecção Fotográfica of the Museu de Ciências Naturais da Escola Secundária André de Gouveia (MCN/MB/F/R/22). Verified by Ana Pires. Species previously unrecorded from region, nearest population being at least 10 km SW (Ribeiro 2010. *In* Loureiro et al. [eds.], Atlas dos Anfíbios e Répteis de Portugal, pp. 160–161. Esfera do Caos Editores, Lisboa). Specimen was found under rock, in Herdade da Mitra, at ca. 1130 h.

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***CHALCIDES BEDRIAGAI* (Bedriaga's Skink)**. PORTUGAL: ÉVORA: ca. 38.5220°N, 08.0106°W (WGS84). 25 July 2011. Luis Ceríaco. Photographic vouchers deposited at Colecção Fotográfica of the Museu de Ciências Naturais da Escola Secundária André de Gouveia (MCN/MB/F/R/8). Verified by Ana Pires. Species previously unrecorded from region, nearest population being at least 30 km east, in Reguengos de Monsaraz region (Silero 2010. *In* Loureiro et al. [eds.], Atlas dos Anfíbios e Répteis de Portugal, pp. 156–157. Esfera do Caos Editores, Lisboa). Specimen was found under rock, in Herdade da Mitra, at ca. 1200 h.

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***CTENOSAURA HEMILOPHA* (San Esteban Island Iguana)**. MÉXICO: SONORA: Municipality of Hermosillo: Isla Alcatráz (28.813289°N, 111.96685°W; WGS84). 24 July 2005. Víctor Hugo Reynoso and Georgina González Monfil. Verified by Eugenia Zarza Franco. CNAR-IBH-RF 34-35. First record from Isla Alcatráz, extending its known range 35 km NE of Isla Cholludo (Grismer 2002. Amphibians and Reptiles of Baja California: Including its Pacific Islands and the Islands in the Sea of Cortez. Univ. of California Press, Berkeley. xiii + 399 pp.). This species is probably of recent introduction. One lizard was found in a hole on a cliff and the other on the ground below large rocks; both were in an arid environment.

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***CTENOSAURA SIMILIS* (Gray's Spiny-tailed Iguana)**. USA: FLORIDA: Monroe Co.: Big Pine Key 1.08 km SE of jct. Gulf Boulevard and Key Deer Boulevard (24.71265°N, 81.38109°W; WGS 84; elev. <3 m). 19 May 2011. Chad Anderson. Verified by Kenneth L. Krysko. Florida Museum of Natural History photo voucher (UF 165529). New island record and second island record from the Florida Keys (Enge et al. 2006. Herpetol. Rev. 37:494). Adult photographed at 1144 h by a Wildgame™ passive infared camera positioned near the carcass of a Key Deer (*Odocoileus virginianus clavium*) in pine rockland habitat. The sighting was 5.2 km W of a *C. similis* sighting on adjacent No Name Key, where a reproducing population apparently exists (Enge et al., *op. cit.*).

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***GONATODES ALBOGULARIS* (Yellow-headed Cecko; Geco Cabeza Amarilla)**. HONDURAS: EL PARAÍSO: Mapachín (13.9830°N, 86.4910°W, WGS84; 800 m elev.). 8 July 2010. James R. McCranie and Leonardo Valdés Orellana. Verified by Steve W. Gotte. USNM 578912–14. First records for El Paraíso, with the closest known locality being ca. 45 km NNW at Villa San Francisco, Francisco Morazán (USNM 578915–16). The lizards was found during the day in stacked roofing tiles in the yard of a resident.

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***HEMIDACTYLUS TURCICUS* (Mediterranean House Gecko)**. PORTUGAL: SETÚBAL: ca. 38.5167°N, 08.9047°W (WGS84). 24 July 2011. Luis Ceríaco. Photographic vouchers deposited at Colecção Fotográfica of the Museu de Ciências Naturais da Escola Secundária André de Gouveia (MCN/MB/F/R/16). Verified by Ana Pires. Species previously unrecorded from region, nearest population being at least 90 km E, in Évora region (Mateus and

Jacinto 2010. *In* Loureiro et al. [eds.], Atlas dos Anfíbios e Répteis de Portugal, pp. 130–131. Esfera do Caos Editores, Lisboa). Specimen observed on wall near dock, at ca. 2130 h. Presence of species in Setubal may be due to human-mediated dispersal, a common dispersal mode for species (Locey and Stone 2006. J. Herpetol. 40:526–530).

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: ALABAMA: Shelby Co.: University of Montevallo's Regional In-Service Education Center, 2790 Pelham Parkway, Pelham (33.30904°N, 86.80465°W; WGS84/NAD83). 1 April 2011. R. Birkhead. Verified by Craig Guyer (digital image vouchers AUM AHAP-D 312–313). Two desiccated specimens removed from glue traps set for pest control. New county record.

Hemidactylus turcicus has been documented in many of the larger cities in Alabama (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. xi+347 pp.). The geckos were captured in a warehouse where packaging and refurbishing kits for the Alabama Math Science and Technology Initiative (AMSTI) occurs. A total of four traps were examined and all contained at least one *H. turcicus*. It is reasonable to assume that the warehouse harbors a breeding population and geckos are quite likely making into the crates of material being packaged and delivered to all the K-8 schools in the area.

Thanks go to Sean Graham for reviewing this note.

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***HEMIDACTYLUS TURCICUS* (Mediterranean Gecko)**. USA: OKLAHOMA: Comanche Co.: Lawton: exterior wall at 1709 NW Cache Rd, the Deluxe Inn Motel (34.623889°N, 098.416111°W; WGS 84). 04 July 2011. Cameron University Museum of Zoology (CUMZ 215). Collected by Jared W. White. Verified by Stanley F. Fox. New county record (Sievert and Sievert 2011. A Field Guide to Oklahoma's Amphibians and Reptiles, 3rd ed. Oklahoma Department of Wildlife Conservation. Oklahoma City, Oklahoma. 211pp.). Numerous adults and juveniles were found within a five-block radius of the specimen collection site. The nearest documented population is 82.3 km S in Wichita Co., Texas (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station. 419 pp.). Several counties in eastern and central Oklahoma have documented populations, but all are greater than 100 km distant (Sievert and Sievert 2011, *op. cit.)*

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***LEIOCEPHALUS CARINATUS* (Northern Curly-tailed Lizard)**. USA: FLORIDA: Pinellas Co.: Indian Rocks Beach, 9th Ave. N, 0.03 km W of Gulf Blvd. (27.8914°N, 82.8498°W; WGS 84). 29 July 2011. J. Steve Godley. Verified by Kenneth L. Krysko. (UF 165670 and 165671, and USNM 562740 and 562741). New county record. On the west coast of Florida this species has been reported from Collier Co. (McCoid 2002. Herpetol. Rev. 33:322) and Lee Co. 166.7 km to S (Campbell and Klowden 2003. Herpetol. Rev. 34:384;), an unpublished UF record (UF 159751, K. L. Krysko, pers. comm.) from Pasco Co., 36.5 km to N (review of Pasco Co. locality suggests the specimen was a waif with no established population). The Indian Rocks Beach population (ca. 10 adults of multiple size classes) seemed restricted to a two-block area. An expanded search of 2.2 km of Gulf Blvd. yielded no additional animals. Residents first noticed the species in ca. 2006 after city workers mulched beach access flower beds.

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***LIOLAEMUS CRISTIANI* (Cristian's Lizard)**. CHILE: IX REGION DE LA ARAUCANIA: Malleco Province: Malalcahuello-Nalcas Nacional Reserve, Sendero Piedra Santa (38.439250°S, 71.576880°W, WGS84; 1769 m elev.). 27 January 2009. G. Escobar H. Museo de Zoología de la Universidad de Concepción, Concepción, Chile (MZUC 32771, adult male; MZUC 32772–73, adult females) Verified by P. Victoriano. The species was known only from VII Maule Region and VIII Bío-Bío Region, Chile (Navarro et al. 1991. Bol. Mus. Nac. Hist. Nat., Chile 42:79–88; Torres-Pérez et al. 2009. Biol. J. Linn. Soc., London 96:635–650). New region record and southern boundary of the distribution, extends known range 215 km S of Cerro El Peine, Altos de Vilches in the Andean area (Navarro et al. 1991, *op. cit.*).

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***PHELSUMA MADAGASCARIENSIS* (Madagascar Day Gecko)**. USA: FLORIDA: Monroe Co.: Ramrod Key, near junction of West Indies Drive and Cayman Lane (24.65154°N, 81.40447°W, WGS84; elev. < 1 m). 5 July 2011. Kenneth L. Krysko, Catherine A. Smith, and Andrew P. Borgia. Verified by Anthony T. Reppas. Florida Museum of Natural History (photographic voucher UF 165521). New island record and ninth known island in the Florida Keys from which this species has been independently introduced (Krysko and Hooper 2007. Gekko 5:33–38; Krysko and Sheehy 2005. Carib. J. Sci. 41:169–172).

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***PLESTIODON LATICEPS* (Broad-headed Skink)**. USA: TENNESSEE Madison Co.: Lowell Thomas Drive behind TWRA Region 1 office (35.3744°N, 88.4330°W, NAD 83). 10 May 2011. Robert Colvin. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19129). First county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 26 July 2011; accessed 12 September 2011].

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

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***SCINCELLA LATERALIS* (Little Brown Skink)**. USA.: INDIANA: Jackson Co.: Knobstone Glade Nature Preserve (38.82692°N, 86.06776°W; NAD 83). 1 June 2011. Sarabeth Klueh and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2011k). New county record (Minton 2001. Amphibians and Reptiles of Indiana, 2nd ed., revised. Indiana Academy of Science. vii–404 pp.) One adult out in the open in leaf litter.

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STROBILURUS TORQUATUS. BRAZIL: MINAS GERAIS: UHE Barra do Braúna (ca. 21.4451°S, 42.4288°W, datum SAD69). J. P. Barbosa. 11 May 2009. Museu de Zoologia João Moojen, Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil (MZUFV 860, SVL = 74 mm; MZUFV 861, SVL = 79 mm). Verified by D. Loebmann. This apparently rare lizard is known to occur in the Atlantic Forest of the Brazilian states of Ceará, Pernambuco, Alagoas, Bahia, and Espírito Santo, inhabiting both undisturbed and secondary forests (Borges-Nojosa and Caramaschi 2003 *In* L. R. Leal et al. [eds.], Ecologia e Conservação da Caatinga, pp. 463–512. Universidade Federal de Pernambuco, Recife, Brazil; Jackson 1978. Arq. Zool. 30[1]:1–79; Rodrigues et al. 1989. Rev. Brasil. Genet. 12[4]:747–759). The present note establishes the westernmost record of *S. torquatus*, and the first report of this species for the state of Minas Gerais, about 270 km straightline southwest from Aracruz, state of Espírito Santo, the closest known locality (Jackson 1978, *op. cit.*).

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***TARENTOLA MAURITANICA* (Moorish Gecko)**. PORTUGAL: TORRES VEDRAS: ca. 39.0197°N, 0.25779°W (WGS84). 24 July 2011. Collected by Mariana Marques. Colecção de Animais em formol of Museu de Ciências Naturais da Escola Secundária André de Gouveia (MCN/MB/AC/V/46). Species previously unreported from region, nearest population being at least 10 km S, in Mafra region (Perera et al. 2010. *In* Loureiro et al. [eds.], Atlas dos Anfíbios e Répteis de Portugal, pp. 132–133. Esfera do Caos Editores, Lisboa). Specimen collected from wall in urban environment, at ca. 2200 h. Many other individuals sighted in urban areas of Torres Vedras, where it is abundant. ÉVORA: ca. 38.5708°N, 07.9083°W. 27 May 2011. Luis Ceríaco. Photographic vouchers (MCN/MB/F/R/11). Species previously unreported from region, nearest population being at least 15 km SW (Perera et al. 2010, *op. cit.*). Specimen photographed on wall in urban environment, at ca. 2230 h. Many individuals sighted in urban areas of Évora, where it is abundant and occurs sympatrically with *Hemidactylus turcicus*. All specimens were verified by Ana Pires.

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***TRETIOSCINCUS ORIXIMINENSIS* (Oriximina Lizard)**. COLOMBIA: VAUPÉS: Serranía del Taraira (1.063875°S, 69.532764°W; datum Bogotá WGS 84). 01 August 1993. I. Stephen Ayala. Colección de Reptiles, Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Colombia (ICN 7094). Mitú (1.1944167°S, 70.2399167°W). 14 July 2010. M. Calderón-Espinosa. ICN 12072. Verified by Juan E. Carvajal-Cogollo. This lizard was known from Venezuela in the Territorio Federal of the state of Amazonas at the confluence of Rio Mavaca and Rio Orinoco, upper Rio Mavaca and Rio Mawarinuma localities, and in Brazil in Amazonas state in Rio Negro, Tapurucuara locality and Oriximiná, Para state (in lower Rio Trombetas locality) (Ávila-Pires 1995. Lizards of Brazilian Amazonia [Reptilia: Squamata]. Zoologisches Verhandelingen, Leiden 299:1–706; Ávila-Pires 2005. *In* Hollowell and Reynolds [eds.], Checklist of the Terrestrial Vertebrates of the Guiana Shield. Bull. Biol. Soc. Washington 13:25–42). Avila-Pires (1995, 2005, *op. cit.*) suggested that this species might occur in Colombia and the present specimens confirm this prediction. These are the first records for Colombia, extending the known range to "Amazonía de Colombia," 450 km SW from nearest locality (Oriximiná, Pará, Brazil, the type locality; Avila-Pires 1995, *op. cit.*).

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SQUAMATA — SNAKES

***BOTHROPS ASPER* (Terciopelo)**. MÉXICO: HIDALGO: Municipality of Huehuetla; Barrio Aztlán (98.0822°N, 20.4666°W; WSG84), 566 m elev. 21 August 2008. Froylán Ramírez and Nallely Morales. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH-CIB 1635). First municipality record, extending its range in the state ca. 91 km SE from its closest known locality at Molango, Acayuca (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 snake was found in tropical deciduous forest. Fieldwork was funded by CONACyT- 95828.

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***CHIRONIUS FLAVOLINEATUS* (Liana Snake)**. BRAZIL: RONDÔNIA: Pimenta Bueno (11.39°S, 61.11°W, SAD 69; 195 m elev). 26 May 2007. S. de Albuquerque. Coleção Herpetologica da Universidade Federal do Acre-Campus Floresta, Cruzeiro do Sul, Acre, Brazil (UFACF 1280). Verified by A. J. Suzart Argôlo. Specimen was found in patches of "cerrado" areas inside the Amazonian domain. This species is known in Brazil from west Pernambuco and Ceará states, Mato Grosso, Tocantins, Pará, Goiás, Minas Gerais; central and northeastern litoral of the Bahia state, and Central São Paulo state; also known from northeastern Paraguay; and central Bolivia (Borges-Nojosa and Lima 2009. Herpetol. Rev. 40:237; Cunha and Nascimento 1978. Publ. Avul. Mus. Paraense Emílio Goeldi 32:1–218; Dixon et al. 1993. Revision of the Neotropical Snakes Genus *Chironius* Fitzinger [Serpentes, Colubridae]. Museo Regionale di Scienze Naturali – Torino, 279 pp.; Freitas and Silva 2007. Herpetofauna das Caatingas e Áreas de Altitudes do Nordeste Brasileiro, USEB, Pelotas, 388 pp.). In Brazil, the western limit of the species range is central Mato Grosso state (Dixon et al., *op. cit.*). First state record, extends the species range 400 km N from Mato Grosso State (Dixon et al., *op. cit.*).

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CONOPHIS VITTATUS **(Striped Road Guarder)**. GUATEMALA: HUEHUETENANGO: Municipio de Nentón: Miramar, Finca Los Cimientos (15.881439°N, 91.807961°W; WGS84), 685 m elev. 23 November 2007. M. Acevedo and Q. Dwyer. Verified by Enio Cano. Colecciones Zoológicas de Referencia, Museo de Historia Natural, Universidad de San Carlos de Guatemala (MHN-USAC 1129). First record for Guatemala, with the closest known localities being in adjacent Chiapas, México (Köhler 2008. Reptiles of Central America, 2nd ed. Herpeton, Verlag E. Köhler, Offenbach, Germany. 400 pp.). The snake was found in an area containing subtropical dry forest.

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CROTALUS AQUILUS **(Qureteran Dusky Rattlesnake)**. MÉXICO: HIDALGO: Municipality of Atitalaquia: La Cantera (98.1863°N, 20.055°W; WGS 84), 2163 m elev. 15 September 2010. Melany Aguilar López. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH-CIB 3403). First municipality record, extending the range in the state ca. 46 km SE and 70 km S from the closest known localities at Mineral del Chico, Presa Jaramillo (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.) and Ixmiquilpan, el Banxu (Fernández-Badillo and Goyenechea 2010. Rev. Mex. Biodiversidad 81:705–712), respectively. The snake was found in oak forest. Fieldwork was funded by CONACyT- 95828.

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CROTALUS ATROX **(Western Diamond-backed Rattlesnake)**. MÉXICO: HIDALGO: Municipality of Eloxochitlán: Hualula (98.6719°N, 20.7077°W; WGS 84), 1460 m elev. 8 March 1995. Rodolfo García Collazo. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH-CIB 191). First municipality record, extending the range in the state ca. 32 km N and ca. 47 km NE from the closest known records at Meztitlán, Río Venados (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.) and Ixmiquilpan, San Juanico (Fernández-Badillo and Goyenechea 2010. Rev. Mex. Biodivers. 81:705–712), respectively. Fieldwork was funded by CONACyT- 95828.

IRENE GOYENECHEA (e-mail: ireneg28@gmail.com), **NALLELY MORALES-CAPELLAN**, and **LEONARDO FERNÁNDEZ-BADILLO**, Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A.P. 1-69 Plaza Juárez, Pachuca, Hidalgo, México.

CROTALUS HORRIDUS **(Timber Rattlesnake)**. USA: ARKANSAS: Lonoke Co.: vicinity of Austin, AR Hwy 319; 8 km W US167 (35.055503°N, 92.039536°W; WGS 84). 27 August 2011. V. Wilson. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (photo voucher ASUMZ 31830). New county record partially filling a distributional hiatus in central Arkansas (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.). This adult individual was discovered in a residential backyard and was subsequently released unharmed.

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CROTALUS HORRIDUS **(Timber Rattlesnake)**. USA: GEORGIA: Dodge Co.: 8.8 km NNE Rhine, Wallace Ross Road (32.058699°N, 83.155414°W; NAD83). 22 April 2010. D. Hilliard and R. Little. Verified by Kenneth L. Krysko. UF 16585. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp).

DELTON HILLIARD, P.O. Box 72, Rhine, Georgia 31077, USA; **RAYMOND LITTLE**, 2523 Mine 18 Road, Strunk, Kentucky 42649, USA; **DIRK J. STEVENSON**, The Orianne Society, Indigo Snake Initiative, 414 Club Drive, Hinesville, Georgia 31313, USA (e-mail: dstevenson@oriannesociety.org)

CROTALUS MITCHELLII PYRRHUS **(Southwestern Speckled Rattlesnake)**. USA: NEVADA: Lincoln Co.: Rainbow Canyon, near Elgin (37.31957°N, 114.4912°W; WGS 84). 20 May 2010. Tim Warfel and Mathew Cage. Verified by Jesse Meik. Brigham Young University (BYU 49910). Campbell and Lamar (2004. The Venomous Reptiles of the Western Hemisphere. Comstock Publishing Associates, Ithaca, New York. 870 pp.) show a large gap in distribution between southwestern Utah and northwestern Arizona in the distribution of *C. mitchellii* and *C. stephensi*. We collected a small female *C. mitchellii* (TL 508 mm; mass 72 g). The nearest specimens are BYU 42847 (59 km SE), MVZ 13102 (138 km W), and CAS 192745 (125 km S) (www.herpnet.org; accessed 27 April 2011). DNA sequencing confirmed species assignment to *C. mitchellii* (J. Meik, pers. comm.). In 1999, two other individuals were observed in this area but were not collected. Although not a new county record, this find represents a substantial range increase and helps fill a major distributional gap. Tissue is available by request from the authors.

BRYAN HAMILTON, 100 Great Basin National Park, Baker Nevada 89311, USA (e-mail: Bryan_Hamilton@nps.gov); **TIM WARFEL,** 4573 South Simms Court, Morrison, Colorado 80465, USA; **MATHEW CAGE**, 13714 Saint Paul Street, Thornton , Colorado 80602, USA.

CROTALUS MOLOSSUS **(Black-tailed Rattlesnake)**. MÉXICO: HIDALGO: Municipality of Chapantongo: Rincón de las Víboras (99.5360°N, 20.2879°W, WGS 84; 2520 m elev.). 28 October 2009. Víctor Vite Silva and Alejandro Ramírez Pérez. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH-CIB 2516). First municipality record, extending the range in Hidalgo ca. 46.5 km N from the closest known locality in the Municipality of Tepeji del Río (Ramírez-Bautista et al. 2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Universidad Autónoma del Estado de Hidalgo, Pachuca, and CONABIO, México, D.F. 104 pp.). The snake was found in an oak forest. Fieldwork was funded by CONACyT - 95828.

IRENE GOYENECHEA (e-mail: ireneg28@gmail.com), **NALLELY MORALES-CAPELLAN**, and **LEONARDO FERNÁNDEZ-BADILLO**, Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo, A.P. 1-69 Plaza Juárez, Pachuca, Hidalgo, México.

***CROTALUS MOLOSSUS* (Black-tailed Rattlesnake)**. USA: NEW MEXICO: Valencia Co.: Monte Largo Canyon, Manzano Mts. (34.60445°N, 106.47569°W; NAD83/WGS84; elev. 2090 m). 29 October 2010, 1253 h. Ralph Morris and Ian W. Murray. Verified by J. Tomasz Giermakowski. University of New Mexico Museum of Southwestern Biology (MSB 78227). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.). The specimen was basking within the shadow of a large rock. Ground surface temperature within the shade was 23°C, ground surface temperature in full sun was 37°C, and shaded air temperature was 29°C. During October 2009, RM found an adult *C. molossus* about 400 m W of this location, but it was not collected. A *C. molossus* (SDNHM 3197) collected in 1930 is listed as being collected in Valencia Co., but the collection locale, near Laguna, New Mexico, is in Cibola Co. This discrepancy results from the 1981 creation of Cibola Co., which occupies a large portion of land that was formerly within Valencia Co.

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***CROTALUS STEJNEGERI* (Long-tailed Rattlesnake)**. MÉXICO: SINALOA: Municipio de San Ignacio: Cerro del Burro, 6 km (airline) SE El Carmen (23.815389°N, 106.463778°W; 482 m elev.). 28 January 2010. Pedro Uriarte Garzón and Ana Morales-Villareal. Verified by Jonathan Campbell. UAZ 57312-PSV. New municipality record, extending the known range 51.4 km W of the closest known locality, 16.09 km (by Hwy 40) NE of Concordia, Municipality of Concordia, Sinaloa (LACM 37718). The snake was found in tropical deciduous forest.

ROBERT A. VILLA, 811 N. 10th Ave, Tucson, Arizona 85705, USA (e-mail: cascabel1985@gmail.com); **PEDRO URIARTE-GARZÓN,** Laboratorio de Recursos Naturales, Escuela de Biología, Universidad de Occidente, Unidad Guasave, Avenida Universidad S/N, Guasave, Sinaloa, México (e-mail: uriartegp@hotmail.com).

***DIADOPHIS PUNCTATUS* (Ring-necked Snake)**. USA: ALABAMA: Fayette Co.: Found under rocks along road cut on Hwy 13 (33.66620°N, 87.65127°W; WGS84/NAD83). 28 March 2011. R. Birkhead. AUM 39448–39449. Franklin Co.: along highway 13/43 north of Russellville (32.832150°N, 85.204133°W; WGS84/NAD83). 29 March 2011. R. Birkhead. AUM 39451–39452. Found in trash pile at abandoned home site. All specimens verified by Craig Guyer. New county records (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. xi+347 pp.).

Diadophis punctatus is assumed to occur statewide in Alabama; however, verified records are lacking for some counties. These specimens likely represent intergrades between *D. p. punctatus* and *D. p. stictogenys*. All four have complete neck rings. AUM 39448 and 39452 have belly patterns which anteriorally resemble *D. p. punctatus* but posteriorally resemble *D. p. stictogenys*. In addition, the two Fayette Co. individuals have distinct red tails while the Franklin Co. individuals have only a reddish tint to the tails. Thanks go to Sean Graham for reviewing this note.

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***DIADOPHIS PUNCTATUS* (Ring-necked Snake)**. USA: NEBRASKA: Hamilton Co.: 1.6 km N, 5.6 km W Marquette, Griffith Prairie and Farm (41.01874°N, 98.07371°W; NAD 83). 8 September 2010. Anthony E. Bridger. Verified by Curtis J. Schmidt. Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas (FHSM 15598). 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 east-central part of the state where few record exist. Nearest prior records are from Sherman, Howard, Buffalo, and Platte counties Found under a wooden cover board in a mixed grass prairie about 30 m from the Platte River.

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***HETERODON PLATIRHINOS* (Eastern Hognose Snake)** USA: COLORADO: Prowers Co.: 38.028067°N, 102.068322°W (WGS 84), elev. 1027 m. 29 July 2011. Joshua and Timothy Warfel. Verified by Travis Taggart. Fort Hays State University, Sternberg Museum of Natural History, FHSM-H 15744. First documented record for the state of Colorado (Hammerson 1999. Amphibians and Reptiles in Colorado, 2nd ed. University Press of Colorado & Colorado Division of Wildlife, Niwot, Colorado. xxiv + 484 pp.) A single road killed adult was found at 1638 h.

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***LAMPROPELTIS GETULA NIGRA* (Eastern Black Kingsnake)**. USA: ALABAMA: Marion Co.: County Road 22 at the intersection of County Road 13 and Flat Creek Road between Haleyville and Bear Creek (34.24666°N, 87.67567°W; WGS84/NAD83). 22 June 2011. R. Birkhead. Found DOR (AUM AHAP-D 314–316 digital photo vouchers). Verified by Craig Guyer. New county record (Mount 1996. The Reptiles and Amphibians of Alabama. University of Alabama Press. xi+347 pp.). *Lampropeltis getula* is presumed to occur statewide; however, verified records are lacking for many northwest Alabama counties. Thanks go to Sean Graham for reviewing this note.

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***LAMPROPELTIS GETULA NIGRA* (Eastern Black Kingsnake)**. USA: INDIANA: Clay Co.: Sugar Ridge Township (39.386306°N, 87.088889°W; NAD 83). 10 May 2011. Sarabeth Klueh and Jason Mirtl. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2011l). New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Academy of Science. vii+404 pp.). The snake was found DOR.

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***LAMPROPELTIS ELAPSOIDES* (Scarlet Kingsnake)**. USA: SOUTH CAROLINA: Richland Co.: Harbison State Park (34.1011°N, 81.117583°W). 16 March 2010. Theresa Stratmann.

Verified by Steve Bennett (SCDNR). Campbell Museum of Natural History (CUSC 2794 photo voucher). New county record (Beane et al. 2010. Amphibians and Reptiles of the Carolinas and Virginia. University of North Carolina Press, Chapel Hill. 288 pp.).

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***LAMPROPELTIS TRIANGULUM TRIANGULUM* (Eastern Milk Snake)**. USA. SOUTH CAROLINA: Richland Co.: Riverbanks Park at the confluence of the Saluda and Broad Rivers (34.008356°N, 81.07255°W). 19 May 2010. Scott Pfaff. Verified by Steve Bennett. Campbell Museum of Natural History (CUSC 2793 photo voucher); Riverbanks Zoo and Gardens living collection (RZG 10776). New county record. *Lampropeltis t. triangulum* has been recorded only in the mountainous areas of North Carolina, South Carolina, and Georgia (Beane et al. 2010. Amphibians and Reptiles of the Carolinas and Virginia. University of North Carolina Press, Chapel Hill. 288 pp.; Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, Georgia. 575 pp.). This specimen, an adult male, approximately 900 mm TL, represents a significant range extension for this species in South Carolina.

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***LEPTOPHIS NEBULOSUS* (Yellow-Lipped Parrot Snake)**. PANAMÁ: COCLÉ: Omar Torrijos National Park (8.66°N, 80.61°W, WGS 84; 700 m elev.). 20 January 2007. Julie M. Ray. Verified by Andrew Hein. UTADC 6849–6850. First record for Coclé and fills a distributional gap between the Cordillera de Tilará, Puntarenas, Costa Rica (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois. xx + 934 pp.) and Panamá Province, Panamá (Jaramillo and Ibáñez 2003. Herpetol. Rev. 34:265). The snake was found at 2025 h next to Río Guabal in an area covered by mature secondary (≥ 40 yrs since last cutting) cloud forest.

I thank A. González and J. A. Santana, Omar Torrijos National Park, the Smithsonian Tropical Research Institute, Autoridad Nacional del Ambiente for issuing collecting permit (SE/A-44-06), NSF for funding (IBN-0429223, IBN-0429223, IOB-0519458), and researchers of the TADS Project for field assistance.

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***MASTIGODRYAS CLIFTONI* (Clifton's Lizard Eater)**. MEXICO: ZACATECAS: Municipality of Teúl de González Ortega: Cañón del Río Patitos (21.351111°N, 103.566389°W; 1700 m elev.). 22 July 2010. P. Carrillo-Reyes, R. Ramírez-Delgadillo, and E. Ruiz-Sánchez. Verified by Uri Omar García-Vázquez. UAZ 57311-PSV. First record for Zacatecas, extending its known range 100 km E from the vicinity of Santa María del Oro, Nayarit (Ponce-Campos and Huerta-Ortega 1998. Herpetol. Rev. 29:176.). The snake was found in riparian vegetation at the bottom of a canyon surrounded by oak-juniper woodland.

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***NERODIA ERYTHROGASTER* (Plain-bellied Watersnake)**. USA: NEW MEXICO: Quay Co.: Pond at Horse Creek, 3.2 air mi ENE (5.16 km at 85°) Nara Visa (35.611172ºN, 103.043786ºW; WGS84). 23 May 2009. D. Burt (received from Ted L. Brown, New Mexico Herpetological Society). Verified by Tomas Giermikowski. MSB 75841 (female; 263 mm SVL, 86 mm tail). New county record (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque. 431 pp.). A second snake was photographed by WGD as it swam in the same pond,1030 h on 24 May 2009. This location is ca. 358 km NNE of the nearest record from along the Pecos River in Eddy Co., New Mexico (Degenhardt et al. 1996, *op. cit.*); however, these records are only ca. 21.8 km (at 221°) SW of a locality along Punta de Agua Creek in Hartley Co., Texas (Werler and Dixon 2000. Texas Snakes Identification, Distribution, and Natural History. University of Texas Press, Austin. xv + 437 pp.).

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***OPHEODRYS AESTIVUS AESTIVUS* (Northern Rough Greensnake)**. USA: TENNESSEE: Madison Co.: Lowell Thomas Drive behind TWRA Region 1 office (35.3747°N, 88.4257°W; NAD 83). 11 May 2011. Steve Henderson. Verified by A. Floyd Scott. Austin Peay State University Museum of Zoology (APSU 19127). First county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. http://www.apsu.edu/reptatlas [updated 20 July 2011; accessed 12 September 2011].

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

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***PANTHEROPHIS GUTTATUS* (Red Cornsnake)**. USA: GEORGIA: Early Co.: Hilton Damascus Rd (CR 279) ~1.4 km NE of jct with CR 205 at Hentown (31.28944°N, 84.79865°W; WGS 84), elev. 54 m. 6 August 2011. Robert L. Hill. Verified by John Jensen. UTADC 6942 photo voucher, DOR. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens. 575 pp.). This species has been documented in the adjacent counties of Baker, Miller, and Calhoun (Hill 2011. Herpetol. Rev. 42:395).

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***PHIMOPHIS GUERINI* (Argentine Pampas Snake)**. BRAZIL: ALAGOAS: Municipality of Campo Alegre: Fazenda Pindoba (09.758889°S, 36.235833°W, SAD69; elev. 121 m). 17 April 2007. I. C. S. Tiburcio and others. Verified by U. Gonçalves. Setor de Zoologia, Coleção Herpetológica do Museu de História Natural,

Universidade Federal de Alagoas, Brazil (MUFAL 8743; collecting license IBAMA/RAN 204/06). First state record. The species was previously recorded from Argentina (Arzamendia and Giraudo 2002. Cuad. Herpetol. 16[1]:15–32) and the Brazilian states of Amazonas, Goiás, Mato Grosso, Mato Grosso do Sul, Bahia, and São Paulo (Carvalho and Nogueira 1998. Cad. Saú. Públ. [14]:753–763; França et al. 2006. SNOMNH Occas. Pap. [17]:1–13; Recorder and Nogueira 2007. Biot. Neotrop. 7[3]:267–278; Sawaya et al. 2008. Biot. Neotrop. 8[2]:129–151; Valdujo et al. 2009. Check List 5[3]:405–417). The new record extends the known geographic distribution of species about 1027 km NE from the municipality of Cocos, Bahia state, and represents a new eastern boundary of this distribution.

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***PITUOPHIS CATENIFER* (Gopher Snake)**. USA: WISCONSIN: Polk Co.: River Rd., 5 m S of junction with Evergreen Ave. (45.59223°N, 92.70636°W; WGS 84.). 11 June 2011. Road-kill collected by Erik R. Wild (UWSP 4209). Verified by Joshua M. Kapfer. New county record (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Publ. Mus., Milwaukee, Wisconsin. 87 pp.; WDNR Wisconsin Natural Heritage Inventory data; *Herpetological Review* 1996–present). Additional specimens represented by photographs (UWSP Herp Photo 0112–0122) and shed skin (UWSP 4218) were also found. Extends northern range of species in Wisconsin southward by 11 miles (Casper 1996, *op. cit.*). Specimens collected under Wisconsin Department of Natural Resources Permit SCP-131-WCR-C-11.

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***RHADINAEA FLAVILATA* (Pine Woods Littersnake)**. USA: SOUTH CAROLINA: Florence Co.: Lynches River County Park (34.05053°N; 79.78098°W; WGS 84) 11 km S Florence. 29 May 2011. J. D. Camper. Verified by S. Miller. Clemson University Vertebrate Collections (CUSC 2841). New county record (Martof et al. 1980. Amphibians and Reptiles of the Carolinas and Virginia. University of North Carolina Press, Chapel Hill. 264 pp.). Adult female collected under wood coverboard in open woodland along the edge of a sandhill.

JEFFREY D. CAMPER, Department of Biology, Francis Marion University, Florence, South Carolina 29506, USA; e-mail: jcamper@fmarion.edu.

***SENTICOLIS TRIASPIS* (Green Rat Snake)**. MÉXICO: HIDALGO: Municipality of Huasca de Ocampo: 98.5127°N, 20.2766°W (WGS84), 1938 m elev. 17 April 2011. Nallely Morales-Capellán and Leonardo Fernández-Badillo. Verified by Jesús M. Castillo. Colección Herpetológica, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo (CH-CIB 4137). First municipality and elevation records, extending the range in the state ca. 53.5 km SE from the closest known locality at Meztitlán, Laguna de Meztitlán, 1260 m elev. (Altamirano-Álvarez et al. 1993. Bol. Soc. Herpetol. Mex. 5:6–8). The snake was found in xerophytic shrubland. Fieldwork was funded by CONACyT- 95828.

NALLELY MORALES-CAPELLAN, **LEONARDO FERNÁNDEZ-BADILLO**, 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.

***STENORRHINA DEGENHARDTII* (Degenhardt's Scorpion-eating Snake; Alacranera de Degenhardt)**. HONDURAS: SANTA BÁRBARA: El Cedral (14.916677°N, 88.066884°W, WGS84; 1700 m elev). 2 October 2010. James R. McCranie and Leonardo Valdés Orellana. USNM 578917. Verified by Steve W. Gotte. First record for Santa Barbara, with the closest known locality being ca. 40 km SSE near the peak of Cerro San Juanillo, Comayagua (McCranie 2011. The Snakes of Honduras. Systematics, Distribution, and Conservation. SSAR Contrib. Herpetol. 26: x + 714 pp.). The snake was lying motionless and stretched out in leaf litter during the afternoon on a coffee farm carved from broadleaf cloud forest.

JAMES R. McCRANIE, 10770 SW 164th Street, Miami, Florida 33157–2933, USA (e-mail: jmccrani@bellsouth.net); **LEONARDO VALDÉS ORELLANA**, Gerente General de "Hondufauna," Investigador Privado, Colonia América, Bloque 9, Casa 1806, Comayagüela, MDC, Honduras (e-mail: leovalor@hotmail.com).

***TANTILLA SCHISTOSA* (Red-bellied Earth Centipede Snake; Pequeña Traga-cienpiés)**. HONDURAS: SANTA BÁRBARA: El Cedral (14.916677°N, 88.066884°W, WGS84; 1700–1750 m elev.). 2–3 October 2010. James R. McCranie and Leonardo Valdés Orellana. Verified by Steve W. Gotte. USNM 578918–19. First records for Santa Bárbara, and highest elevation records from Honduras, with the closest known locality being ca. 60 km NNW at El Cusuco, Cortés (McCranie 2011. The Snakes of Honduras. Systematics, Distribution, and Conservation. SSAR Contrib. Herpetol. 26: x + 714 pp.). The snakes were found under logs and in leaf litter on a coffee farm carved from broadleaf cloud forest.

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***TRIMORPHODON LAMBDA* (Sonoran Lyresnake)**. USA: ARIZONA: Coconino Co.: Marble Canyon and vicinity. Three photographic vouchers deposited in the University of Arizona (UAZ) collection. The first voucher (UAZ 57324-PSV) is from the Echo Cliffs, on Hwy. 89 ca. 2 km E of the junction of Hwys. 89 and 89A (36.63720°N, 111.63054°W; NAD 27; elev. 1636 m). 4 June 2005. B. O'Connor and R. Gassaway. We report a second voucher (UAZ 57325-PSV) from Jackass Canyon and a third voucher (UAZ 57326-PSV) from near confluence of the Paria and Colorado Rivers. All vouchers verified by George Bradley. We also report an unvouchered sighting of a specimen found dead in the bed of Soap Creek, ca. 1.3 km upstream (N) of Hwy. 89A (36.754668°N, 111.75551°W, NAD27; elev. 1275 m) on 13 June 2005 by B. T. La Forest.

Collectively, these represent the first vouchers from Marble Canyon and vicinity (Brennan and Holycross 2006. A Field Guide to Amphibians and Reptiles in Arizona. Arizona Game and Fish Department, Phoenix. 150 pp.). They extend the range of this species 121 river km (75 river miles) upstream along the Colorado River in Grand Canyon from the nearest vouchered locality at the mouth of 75 Mile Canyon (GCNP 22079; Holycross, unpubl. data).

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***VIPERA LATASTEI* (Lataste's Viper)**. PORTUGAL: ÉVORA: ca. 38.5372°N, 08.0033°W (WGS84). 25 July 2011. Luis Ceríaco. Photographic vouchers deposited at Colecção Fotografica of Museu de Ciências Naturais da Escola Secundária André de Gouveia (MCN/MB/F/R/5). Verified by Ana Pires. Species previously recorded from ca. 40 km SE, in Portel region (Brito 2010. *In* Loureiro et al. [eds.], Atlas dos Anfíbios e Répteis de Portugal, pp. 178–179. Esfera do Caos Editores, Lisboa). Specimen observed on rock, near Castelo do Giraldo, a Roman archeological site, at ca. 1040 h.

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County Records for Reptiles and Amphibians from Hayes County, Nebraska, USA

In Nebraska, USA, many species of reptiles and amphibians reach their distributional limits, and for some species, such limits are well documented (see Lynch 1985). For other species, distributional limits still are not well defined, and records of observation within known ranges are patchy (see Lynch 1985). This lack of records for some species is not a reflection of species abundance, but rather of a lack of intense survey efforts throughout many areas of the state. Few manuscripts have been published in recent decades involving herpetofauna in Nebraska, and until recently, work compiled by Lynch (1985) served as the standalone comprehensive account for their distributions. Within the last year, two field guides (Ballinger et al. 2010; Fogell 2010) have been published which provide an updated synopsis of the life history and distribution of amphibians and reptiles in Nebraska. Our manuscript originally was submitted prior to the completion of both of these recent publications.

Herein, we present detailed accounts of eight county records for Hayes County in southwestern Nebraska that contribute to the aforementioned field guides by providing details on localities of captures. All records were collected during a 24-h survey in July 2009. Voucher specimens with preserved tissues were deposited in Sternberg Museum of Natural History (FHSM), Fort Hays State University, Hays, Kansas. All specimens were verified by Curtis J. Schmidt. All are new county records supported by Lynch (1985). Coordinates were taken with handheld GPS units and are based on North American Datum 1983 (NAD83).

All specimens were collected under authorization of the Nebraska Game and Parks Commission (Scientific and Educational Permit No. 1031).

ANURA – FROGS

***ANAXYRUS COGNATUS* (Great Plains Toad)**. Hayes Co.: 5.8 km W, 5.9 km S Wellfleet (40.6994°N, 100.7978°W). 21 July 2009. Greg D. Wright, Angelina E. Graham, and Keith Geluso. MHP 14697. Fills in distributional gap among Frontier, Chase, and Lincoln counties.

***ANAXYRUS WOODHOUSII* (Woodhouse's Toad)**. Hayes Co.: 5.8 km W, 5.9 km S Wellfleet (40.6994°N, 100.7978°W). 21 July 2009. Greg D. Wright, Angelina E. Graham, and Keith Geluso. MHP 14694.

***LITHOBATES CATESBEIANUS* (American Bullfrog)**. Hayes Co.: Hayes Center State Wildlife Management Area (40.58485°N, 100.92707°W). 22 July 2009. Greg D. Wright, Angelina E. Graham, and Keith Geluso. MHP 14699. Fills a distributional gap between Hitchcock and Lincoln counties.

SQUAMATA – LIZARDS

***PLESTIODON OBSOLETUS* (Great Plains Skink)**. Hayes Co.: 5.8 km W, 5.9 km S Wellfleet (40.6994°N, 100.7978°W). 21 July 2009. Greg D. Wright, Angelina E. Graham, and Keith Geluso. MHP 14701. Fills in distributional gap at northernmost limit in southern Nebraska.

***SCELOPORUS CONSOBRINUS* (Prairie Lizard)**. Hayes Co.: 14.1 km S, 12.8 km W Wellfleet (40.6262°N, 100.88145°W). 22 July 2009. Greg D. Wright, Angelina E. Graham, and Keith Geluso. MHP 14707. Fills in gap among Lincoln, Chase, Hitchcock, and Frontier counties.

SQUAMATA – SNAKES

***COLUBER CONSTRICTOR* (North American Racer)**. Hayes Co.: 16.6 km S, 13.7 km W Wellfleet (40.60403°N, 100.89215°W). 22 July 2009. Keith Geluso, Angelina E. Graham, and Greg D. Wright. MHP 14678. Fills in distributional gap among Lincoln, Chase, and Frontier counties.

***LAMPROPELTIS TRIANGULUM* (Milksnake)**. Hayes Co.: 5.8 km W, 5.9 km S Wellfleet (40.6994°N, 100.7978°W). 21 July 2009. Angelina E. Graham, Keith Geluso, and Greg D. Wright. MHP 14677.

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THAMNOPHIS SIRTALIS **(Common Gartersnake)**. Hayes Co.: 5.8 km W, 5.9 km S Wellfleet (40.6994°N, 100.7978°W). 21 July 2009. Keith Geluso, Angelina E. Graham, and Greg D. Wright. MHP 14674. Fills in distributional gap among Lincoln, Chase, and Frontier counties. Individual was a gravid female containing 28 young.

Acknowledgments.—We thank Tad and Teresa Wright for assistance in the field and allowing us to search for herpetofauna on their property.

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New Amphibian and Reptile County Records for the Florida Panhandle

Despite recognition of the Florida panhandle as one of the most biologically rich regions in North America (Blaustein 2008), distribution records apparently do not exist for many amphibian and reptile species in Santa Rosa, Okaloosa, or Walton counties (Ashton and Ashton 1988a, 1988b, 1988c), which make up nearly half of this important area. These counties encompass Eglin Air Force Base (EAFB), an area containing the largest remaining tract of old-growth Longleaf Pine (*Pinus palustris)* forest, an ecosystem renowned for its high diversity and endemism of amphibians and reptiles (Guyer and Bailey 1993). The region has been subject to surveys targeting species of conservation concern; however, most of these remain unpublished reports to state agencies or non-profit organizations. A few recent articles reported species lists or research pertaining to amphibians and reptiles and specify county of capture (Bishop et al. 2006; Enge 2005; Palis 1998). We considered these as formal documentation for a particular species for a county, although museum records may not have been created or specimens vouchered. Here, we present 30 new county records for this region's herpetofauna that have not been previously published elsewhere. All new records are deposited as digital photos (denoted AHAP-D) or specimens in the Auburn University Herpetological collections (AUM), were geo-referenced using Google Earth (WGS 84), and verified by C. Guyer.

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ANURA – FROGS

ELEUTHERODACTYLUS PLANIROSTRIS **(Greenhouse Frog)**. Santa Rosa Co.: Multiple males observed (30.444672°N, 86.857625°W). 15 July 2009. B. Rincon and K. Jones. AUM AHAP-D 255.

TESTUDINES – TURTLES

APALONE SPINIFERA **(Spiny Softshell)**. Santa Rosa Co.: Sweetwater Creek and State Forest Rd 21, 2.41 air km S Munson (30.837485°N, 86.870571°W). 04 June 1982. J. Godwin. AUM 30578.

CHELYDRA SERPENTINA **(Snapping Turtle)**. Okaloosa Co.: AOR RR 636 (30.466111°N, 86.670278°W). May 1995. J. Jensen. AUM AHAP-D 232.

DEIROCHELYS RETICULARIA **(Chicken Turtle)**. Okaloosa Co.: Okaloosa Co. Rd. 4, 1.85 rd km SE jct. Okaloosa Co. Rd 4 and Okaloosa Co Rd 4-A (30.808380°N, 86.705953°W). 02 August 1981. J. Godwin. AUM 30114. Walton Co.: 12.07 km S Paxton at Merrifield Ponds (30.882931°N, 86.27252°W) 16 May 1969. R. Hall. AUM 12394.

LEPIDOCHELYS KEMPII **(Kemp's Ridley Sea Turtle)**. Okaloosa Co.: Dead, stranded specimens washed onto beach (30.389437°N, 86.779533°W). 28 April 2009. D. Varble and K. Jones. AHAP-D 263; (30.3883308°N, 86.536340°W). 04 May 2009. D. Varble. AHAP-D 265. Santa Rosa Co.: (30.384598°N, 86.826456°W). 30 December 2009. D. Varble. AHAP-D 264. Range maps in Moler (1992) and Hipes et al. (2000) show Okaloosa and Santa Rosa County as part of the range of *L. kempii*, however, it is unclear whether these maps are based upon actual documentation, sightings, or a presumed pan-Gulf/Atlantic distribution. The range maps of Ashton and Ashton (1988b), based upon museum records, show only a few recorded county occurrences of these turtles, and none for the counties we cover. We include these vouchered photographs to eliminate ambiguity.

MACROCHELYS TEMMINCKII **(Alligator Snapping Turtle)**. Okaloosa Co.: East Bay River just downstream from RR 259 bridge (30.431389°N, 86.774722°W). 12 May 1994. P. Moler, B. Mansell, and J. Jensen. AUM AHAP-D 239.

***PSEUDEMYS CONCINNA* (River Cooter)**. Okaloosa Co.: 8.45 air km WSW Blackman on Blackwater River (30.914452°N, 86.723748°W). 22 April 1984. J. Godwin and L. Malo. AUM 32486. Santa Rosa Co.: Yellow River, 3.7 km N Blackwater Bay (30.619346°N, 87.026330°W). 22 May 1971. L. Childers. AUM 20697.

***TRACHEMYS SCRIPTA ELEGANS* (Red-eared Slider)**. Okaloosa Co.: adults and subadults found in Fort Walton Beach (30.41764°N, 86.598194°W). 30 June 2009. K. Jones and S. Jones. AUM AHAP-D 256. Subsequent visits to this site revealed two hatchlings.

SQUAMATA – LIZARDS

***OPHISAURUS MIMICUS* (Mimic Glass Lizard)**. Okaloosa Co.: AOR RR 668 1.5 km E jct. RR 259 (30.418333°N, 86.771944°W). 18 April 1995. J. Jensen. AUM AHAP-D 240.

***OPHISAURUS VENTRALIS* (Eastern Glass Lizard)**. Okaloosa Co.: captured in funnel trap along drift fence (30.418333°N, 86.767778°W). 15 November 1993. J. Jensen. AUM AHAP-D 241. Santa Rosa Co.: 18.91 air km NE Milton (30.7185397°N, 86.8759099°W). 25 May 1982. J. Godwin. AUM 30530.

***PLESTIODON ANTHRACINUS* (Coal Skink)**. Okaloosa Co.: juvenile captured in funnel trap along drift fence. 21 March 1995 (30.418333°N, 86.767778°W). J. Jensen. AUM AHAP-D 233. Walton Co.: observed in seepage bog (30.609331°N, 86.225916°W). 25 April 2009. K. Jones and K. Roth. AUM AHAP-D 258–260.

***PLESTIODON EGREGIUS* (Mole Skink)**. Santa Rosa Co.: adult captured in pitfall trap (30.603167°N, 86.803167°W). 02 September 2009. D. Steen and M. Baragona. AUM AHAP-D 262.

***PLESTIODON LATICEPS* (Broad-headed Skink)**. Walton Co.: Morrison Springs, 9.66 km SE of Ponce De Leon (30.657499°N, 85.905047°W). 13 May 1972. R. Russell. AUM 21479.

SQUAMATA – SNAKES

***AGKISTRODON CONTORTRIX* (Copperhead)**. Okaloosa Co.: observed under cover object (30.933247°N, 86.612486°W). 04 April 2009. K. Jones and N. Friedman. AUM AHAP-D 254.

***CROTALUS ADAMANTEUS* (Eastern Diamond-backed Rattlesnake)**. Okaloosa Co.: observed DOR on Rattlesnake Bluff Rd (30.681750°N, 86.598278°W). 16 May 2009. D. Steen. AUM AHAP-D 237. Santa Rosa Co.: captured within box trap (30.560028°N, 86.847389°W; WGS 84). 06 July 2009. D. Steen. AUM AHAP-D 236.

***FARANCIA ERYTROGRAMMA* (Rainbow Snake)**. Okaloosa Co.: Blackwater River at Kennedy Bridge Rd; 9.5 air km W Blackman (30.933421°N, 86.735653°W). 29 May 1981. Collector unknown. AUM 29778.

***HETERODON PLATIRHINOS* (Eastern Hog-nosed Snake)**. Santa Rosa Co.: AOR (30.482449°N, 86.832121°W). 01 May 2009. K. Jones. AUM AHAP-D 257.

***LAMPROPELTIS GETULA* (Common Kingsnake)**. Okaloosa Co.: captured in funnel trap along drift fence (30.418333°N, 86.767778°W). 17 April 1995. J. Jensen. AUM AHAP-D 238.

***LAMPROPELTIS ELAPSOIDES* (Scarlet Kingsnake)**. Okaloosa Co.: captured under bark of dead, standing *Pinus palustris* just south of RR 668 between RRs 253 and 259 (30.425547°N, 86.771944°W). 29 March 2009. J. Jensen. AUM AHAP-D 231. Santa Rosa Co.: Captured in pitfall trap (30.573139°N, 86.843139°W). 18 August 2009. D. Steen. AHAP-D 222.

***MICRURUS FULVIUS* (Harlequin Coralsnake)**. Walton Co.: 14.48 km S Paxton, along U.S. Hwy 331 near swampy area (30.859637°N, 86.250497°W). 15 April 1969. M. Pridgeen. AUM 12397.

***TANTILLA CORONATA* (Southeastern Crowned Snake)**. Okaloosa Co.: 8.21 air km WNW Cannon Town (30.901740°N, 86.740125°W). 16 April 1983. J. Godwin. AUM 32181.

***THAMNOPHIS SIRTALIS* (Common Gartersnake)**. Okaloosa Co.: captured in funnel trap along drift fence (30.425955°N, 86.771645°W). 12 March 1996. J. Jensen. AUM AHAP-D 242.

***STORERIA OCCIPITOMACULATA* (Red-bellied Snake)**. Okaloosa Co.: 30.93435°N, 86.613979°W. K. Jones and N. Friedman. 04 April 2009. AUM AHAP-D 261.

Acknowledgments.—We obtained all relevant state and federal permits associated with collection of animals noted above. DAS was supported by the Strategic Environmental Reseach and Development Program (SERDP) Project Number: SI-1696.

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NATURAL HISTORY NOTES

CAUDATA — SALAMANDERS

***AMBYSTOMA BARBOURI* (Streamside Salamander). TERRESTRIAL BREEDING SITES.** Adult *Ambystoma barbouri* typically inhabit upland deciduous forests in the vicinity of ephemeral first- and second-order streams with exposed limestone bedrock. These low-order streams have relatively few predatory fish and are typically used as breeding sites by *A. barbouri*, with females laying eggs in a monolayer on the undersurface of flat limestone rocks in streams (Niemiller et al. 2006 Am. Midl. Nat. 156:394–399; Petranka 1998. Salamanders of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 587 pp.). However, *A. barbouri* also breeds in ponds or roadside ditches. In these habitats, females attach eggs to the undersurface of rocks or logs, or attach them singly to vegetation (Petranka 1988, *op. cit.*). Although known to occur in the Central Basin of middle Tennessee since 1998, *A. barbouri* has only recently been reported breeding in first-order streams located in cedar glade habitats (Niemiller et al. 2011. Herpetol. Cons. Biol. 6:135–149). Herein, we report on unusual oviposition sites of *A. barbouri* in cedar glades of middle Tennessee.

Cedar glades are a fragile and imperiled ecosystem characterized by shallow soiled (< 20 cm in depth) treeless openings perched on Ordovician-aged limestone and surrounded by Eastern Red Cedar (*Juniperus virginiana*) or cedar-hardwood forests (Quarterman 1950. Bull. Torrey Botany Club 77:1–9). These openings are often strewn with bedrock fragments of varying size. Because of their association with karst topography, cedar glades lack perennial streams, and ephemeral streams are scant. Rainwater often flows in sheets across the surface of the glades before entering into a subterranean stream or the rare ephemeral first-order surface stream. Because of their unusual hydrology, cedar glades vary from very wet during the winter and spring to very dry during the summer and fall.

On 12 Feb 2011 we found eggs and early stage embryos of *A. barbouri* attached in a monolayer to the undersurface of a rock in the middle of a cedar glade located in Cedars of Lebanon State Forest in Wilson Co., Tennessee, USA (Fig. 1). We initially suspected that an adult confused the sheets of water flowing across the surface of the glades as a stream, and we believed the embryos would soon succumb to desiccation. However, on 25 Feb 2011, we found the egg mass in this glade to be in good condition despite the desiccation of several *A. barbouri* egg masses in a nearby streambed. On 25 March 2011, we again checked the status of the egg mass in the glade and discovered that the eggs had hatched and larvae were swimming in the waters moving across the glade. Furthermore, on 9 April 2011 we found not only late stage embryos attached to the undersurface of rocks in a nearby glade, but we also found newly hatched larvae in small puddles beneath the rocks. Although not visited daily, we now assume that the surface beneath the rocks in the glades remained wet through the late winter and early spring. Small first-order ephemeral streams are located near each of these glades and *A. barbouri* used each stream for breeding during the winter and spring of 2011. We are not certain if the larvae hatching in the glade are able to grow and complete metamorphosis beneath the rocks, or if they can move to a more stable body of water. Thus, we are not certain if our discovery of eggs on land represent ill-fated attempts at reproduction or an alternate breeding site for

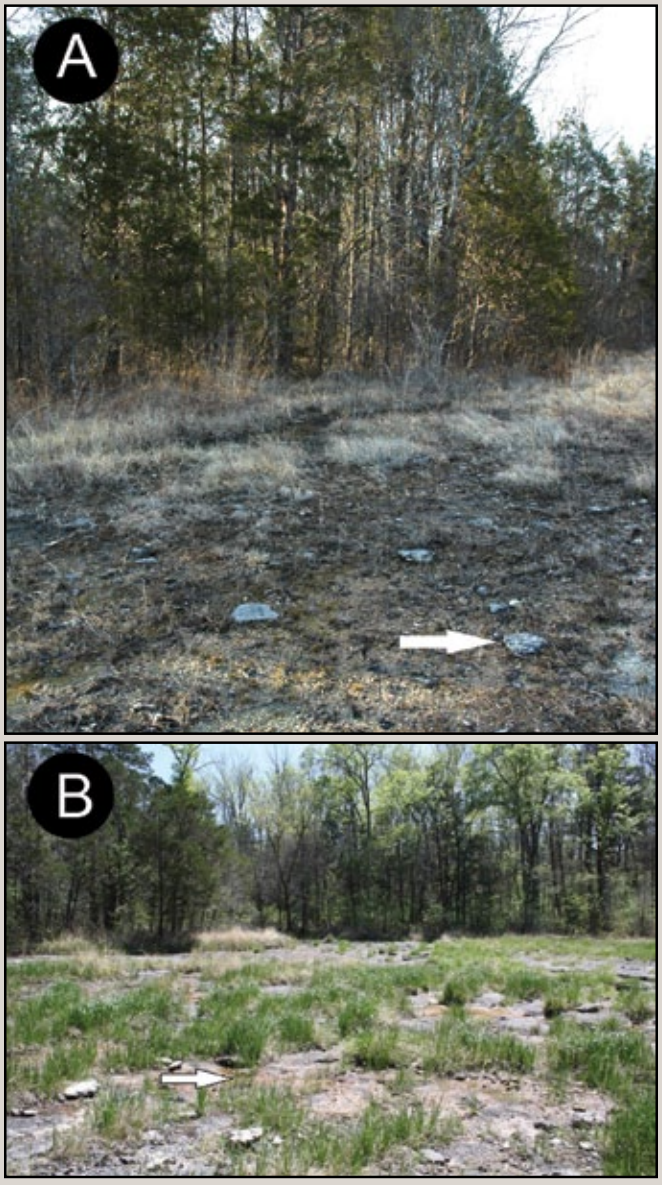

FIG. 1. Breeding sites for the Streamside Salamander (*Ambystoma barbouri*) in cedar glade habitat in middle Tennessee sites. The arrows depict rocks (A) or puddles (B) where egg masses or larvae were found.

A. barbouri in regions where streams are limited and natural ponds non-existent.

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***AMBYSTOMA TALPOIDEUM* (Mole Salamander). OVIPOSITION MODE AND TIMING.** *Ambystoma talpoideum* breeds in ephemeral, permanent, and semi-permanent depressional wetlands, often exhibiting facultative paedomorphosis in long-hydroperiod ponds (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Inst. Press, Washington, DC. 587 pp.). Depending on regional variation in annual rainfall patterns, peak migration and breeding of terrestrial adults typically occur between November and February throughout most of this species' range; paedomorphic adults are thought to breed as much as six weeks earlier than their terrestrial migrating counterparts (Gibbons and Semlitsch 1991. Guide to the Reptiles and Amphibians of the Savannah River Site. Univ. Georgia Press, Athens, Georgia. 131 pp.; Krenz and Sever 1995. Herpetologica 51:387–393; Patterson 1978. Copeia 1978:649–655; Petranka 1998, *op. cit.*; Scott 1993. Amer. Midl. Nat. 129:397–402; Semlitsch 1985. Copeia 1985:477–489). Oviposition occurs in late winter or early spring shortly after the peak in breeding activity (Semlitsch et al. 1993. J. Anim. Ecol. 62:344–340).

The Mole Salamander displays geographic variation in egg deposition mode, as well as other reproductive traits. Compared to eastern populations, individuals in the western parts of this species' range (Louisiana and Mississippi) deposit eggs in small clumps, with smaller overall clutch sizes and larger hatchlings. In some eastern populations (e.g., South Carolina), females produce larger clutches of smaller hatchlings, on average, and lay eggs singly (Petranka 1998, *op. cit.*). Such variation suggests the potential for genetic differentiation within this species, yet no subspecies are currently recognized (Petranka 1998, *op. cit.*). We provide additional information on the timing and mode of oviposition in *A. talpoideum* to aid in further understanding the geographic scope of variation in this species' reproductive traits.

From 30 March to 3 April 2009, we sampled 15 ponds at St. Marks National Wildlife Refuge, Wakulla Co., Florida, USA, for larval and paedomorphic *A. talpoideum*. Ponds ranged from short hydroperiod, isolated sink-hole ponds in sandhill and Long-leaf Pine (*Pinus palustris*) savanna habitat to longer hydroperiod ponds dominated by cypress (*Taxodium* sp.), blackgum (*Nyssa* sp.), and titi (*Cyrilla* sp. and *Cliftonia* sp.). We sampled each pond with four modified commercial crayfish traps (Johnson and Barichivich 2004. J. Fresh. Ecol. 19:263–269) (2.5 cm mesh, Lee Fisher International, Tampa, Florida, lined with 4-mm Vexar ®). Traps were placed in ≤ 0.5–0.6 m of water, for two trap nights per pond. On 31 March, 1 and 2 April 2009, this area received 33.5, 90.2, and 30 mm of rainfall, (total of 153.7 mm over the 3 d period). This total was the highest 3-d cumulative amount of precipitation that accrued since 1 Sept 2008, which corresponds to the earliest-documented date of migration for this species elsewhere in the Coastal Plain (Semlitsch et al. 1993, *op. cit.*). It also represented 21% of the total rainfall measured at this locality between 1 Sept 2008 and the time of our observations. On 2 April 2009, we captured an adult metamorphosed female *A. talpoideum* (i.e., there was no swollen cloaca typical of breeding males), 50 mm SVL, in one of our crayfish traps placed in 0.6 cm of water (pond W2: 84.4416°N, 30.0489°W; 0.24 ha in area). On 3 April 2009, in a separate, nearby pond (pond W3: 84.4416°N, 30.0489°W; 0.68 ha in area), we found a newly-deposited egg mass (< 24 h old; ≤ Harrison Stage 12, Rugh 1962. Experimental Embryology Techniques and Procedures, 3rd ed. Burgess, Minneapolis, Minnesota. 501 pp.). The mass contained 14 embryos and was attached to the mesh of the trap in the mouth of one of the funnels leading into the trap. These embryos were collected and returned to the laboratory where, upon hatching, we positively identified them as *A. talpoideum*. It is unknown whether these eggs were produced by a metamorphosed adult or by a paedomorph; the latter commonly occur in long hydroperiod ponds at our study site (pers. obs.).

In northwestern Louisiana, Hardy and Raymond (1980. J. Herpetol. 14:327–335) documented immigration by *A. talpoideum* as late as early March, and captured a terrestrial female with oviducal eggs on 2 March 1978 (Hardy and Raymond 1990. Herpetologica 46:371–382). In South Carolina, a few sexually mature females (metamorphosed and paedomorphic combined) may still have enlarged ova and presumably be capable of reproducing as late as March and April (Semlitsch 1985. Oecologia 65:305–313). In Florida, the latest date of new oviposition of which we are aware is 14 February, as reported by Carr (1940. A Contribution to the Herpetology of Florida. Biological Science Series III[1], Univ. Florida, Gainesville, Florida). To our knowledge, our observation of a new egg mass on 3 April is the latest reported date of new oviposition for this species on the Coastal Plain.

In contrast to populations in the Atlantic Coastal Plain, where females deposit eggs singly, our observation also reveals that individuals of *A. talpoideum* in the panhandle region of Florida produce egg masses, similar to populations of this species in western parts of its range (i.e., Mississippi and Louisiana: Raymond and Hardy 1990, *op. cit.*; Semlitsch and Walls 1990. Herpetol. Rev. 21:14–15). This observation suggests that the faunal break between populations that lay eggs singly, versus those that produce egg masses, is much farther east than has been previously reported and closer to the likely geographic point of separation between populations of the two egg-laying modes. Interestingly, a map of frequencies and distributions of mitochondrial DNA (mtDNA) haplotypes reveals extensive population subdivision in this species, with the greatest genetic diversity (i.e., two major haplotype clades abutt each other) occurring in the panhandle of Florida, where we made our observations (Donovan et al. 2000. Evolution 54:1449–1456). Donovan et al.'s results (2000, *op. cit.*) beg for closer scrutiny of egg-laying mode and other reproductive characteristics in populations throughout this species' range, but particularly from areas of the Gulf and Atlantic Coastal Plains that are adjacent to our study area. Such information would be informative for understanding the extent of geographic variation in reproduction and help pinpoint the location of a faunal break between populations of the two egg laying modes in this species.

Fieldwork was supported by the U.S. Geological Survey Amphibian Research and Monitoring Initiative (ARMI). This research was conducted with permits from the Florida Fish and Wildlife Conservation Commission (permit number WX08477), St. Marks National Wildlife Refuge (permit number 41640-2009-09), and the USGS Institutional Animal Use and Care Committee (approval number USGS/FISC 2006-04). We thank Jennifer Staiger and Mike Randall for assistance in the field. This is contribution 386 of the United States Geological Survey's Amphibian Research and Monitoring Initiative (ARMI).

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***CRYPTOBRANCHUS ALLEGANIENSIS ALLEGANIENSIS* (Eastern Hellbender) and *DESMOGNATHUS QUADRAMACULATUS* (Black-bellied Salamander). PREDATOR/PREY.** The diet of *Cryptobranchus alleganiensis* consists mostly of crayfish and small fish, although other invertebrates, tadpoles, a toad, aquatic reptiles, and a small mammal have been documented (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. p. 144).

On 13 April 2011, I observed what likely was a predation event on a large adult *Desmognathus quadramaculatus* (ca. 94 mm SVL) by a juvenile *Cryptobranchus alleganiensis* (ca. 130 mm SVL) during a survey of Eastern Hellbenders in Cooper's Creek Wildlife Management Area within the Chattahoochee National Forest of Union County, Georgia, USA (34.75752°N, 84.08403°W; WGS 84). While turning over a rock in Cooper's Creek with subsequent dip netting, the aforementioned animals were both discovered in the net. Upon transfer from the net into temporary holding boxes, it was discovered that the *D. quadramaculatus* was freshly dead (i.e., not decomposed) and bore recent lacerations consistent with the mandibles and maxillae of the *C. alleganiensis* specimen (Fig. 1B).

It seems likely that the turning of the rock interrupted a predation event, causing the *C. alleganiensis* to release the *D. quadramaculatus*. I believe this is the first recorded occurrence of predation on an adult *D. quadramaculatus* by a *C. alleganiensis* and note that the presumed prey item was nearly as large as the predator. The C. *alleganiensis* was measured and released at the site of capture (Fig. 1A). The specimen of *D. quadramculatus* is deposited at the University of Texas at Arlington (UTA A-61186).

PHOTOS BY ROBERT L. HILL

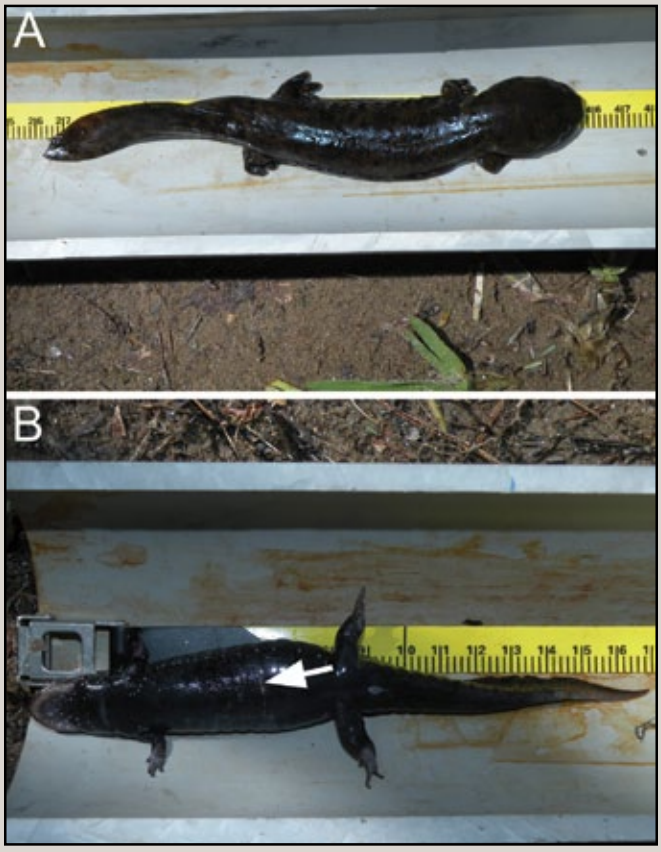

FIG. 1. A) Juvenile *Cryptobranchus a. alleganiensis* believed to have been attempting to ingest a large adult *Desmognathus quadramaculatus*. B) Arrow denotes ventral laceration that matches closely to the jaws of specimen depicted in 1A. Images near to scale.

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***EURCYEA CHAMBERLAINI* (Chamberlain's Dwarf Salamander). HABITAT.** Since the description of *Eurycea chamberlaini*, little additional natural history information for the species has become available, and distribution records outside of the Carolinas have accumulated slowly (Graham et al. 2009. Herpetol. Rev. 39:476; Jensen et al. 2008. The Amphibians and Reptiles of Georgia. Univ. Georgia Press, Athens. 575 pp.). Only very general information on this species' preferred habitat is currently available (e.g., seepages, streams, or ponds; Harrison and Guttman 2003. Southeast. Nat. 2:159–178), and this may make attempts to locate and study this animal difficult. We developed a general picture of the habitat preferences of *E. chamberlaini* while attempting to determine its distribution in Georgia and Alabama. We have located *E. chamberlaini* at 19 sites, one of which was in the Piedmont physiographic province, and one of which was in the Dougherty Plain region of the Coastal Plain physiographic province (Wharton 1978. The Natural Environments of Georgia. Georgia Geological Survey Bull. 114, Atlanta, Georgia. 227 pp.). The rest of the sites were within the Fall Line Sandhills or Fall Line Red Hills regions of the Coastal Plain physiographic province (Wharton 1978, *op. cit.*). Of these, nine (47%) could be categorized as bay swamps (Wharton 1978, *op. cit.*). Bay swamps contain an overstory of Sweetbay (*Magnolia virginiana*), a dense shrub layer of Doghobble (*Leucothoe axillaris*), greenbrier (*Smilax* spp.) vines, and often thick accumulations of sphagnum moss (Wharton 1978, *op. cit.*). These wetland forests occur in areas associated with first order streams and seepage flow at the base of sandhills, and are especially common in sites along the Fall Line. Three *E. chamberlaini* sites were along the edge of beaver ponds, which often exhibit similar microhabitats, including mats of sphagnum moss. Two sites were along the margins of isolated ephemeral wetlands, and four sites were along first order streams without readily apparent bay swamps, seepage, or sphagnum moss. One individual was found under a log in a xeric longleaf pine-turkey oak forest at least 100 m from the nearest source of water. The specific microhabitat occupied by *E. chamberlaini* was sphagnum moss mats at nine of the sites (47%). At the rest of the sites, salamanders were found either in wet leaf litter, washed-up accumulations of coarse woody debris, or under small logs.

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***PLETHODON CINEREUS* (Eastern Red-backed Salamander). COLOR VARIATION.** Two common color forms of *Plethodon cinereus*—redback and leadback—are known to occur through-

out eastern North America (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, DC. 592 pp.). This species is one of the most common vertebrates in New England, including central Massachusetts, where it is found in both color phases (DeGraaf and Yamasaki 2000. New England Wildlife: Habitat, Natural History, and Distribution. University Press of New England. 496 pp.).

While conducting field work at Cooks Pond, Worcester Co., Massachusetts, USA, on 19 October 2010, a salamander with unusual coloration was found under a decaying log (42.28607°N, 71.85545°W; NAD83). The dorsal surface was dark overall with small blue speckles (Fig. 1A). The anterior ventral surface was a pale cream color with variable speckles becoming darker and blue towards the posterior (Fig. 1B). This adult individual was found less than one meter from another log under which two redback form *P. cinereus* were found. Juvenile salamanders, one with the unusual color form and others with the redback form, were found during a subsequent survey in the same area on 20 October 2010.

We propose this color form is an undocumented variation of the leadback form of *P. cinereus*. The ventral markings of this individual are somewhat similar to both the leadback and redback form of *P. cinereus*; however, the blue speckles on the dorsal surface are a characteristic not found in either the leadback or redback form. The typical leadback form is primarily black or gray on the dorsal surface, while the redback form features a red or orange stripe along the dorsal surface (Conant 1975. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin Co., Boston, Massachusetts. 429 pp.). This individual was distinguished from species with similar appearance such as *Ambystoma jeffersonianum* and *Ambystoma laterale* by the number of costal grooves present, overall color pattern, body shape, and geographic range.

FIG. 1. Dorsal (A) and ventral (B) views of the undocumented color variation of *Plethodon cinereus* in Worcester Co., Massachusetts.

Climate change, habitat degradation (Gibbs and Karraker 2006. Cons. Biol. 20[3]:913–917), and predator defense (Venesky and Anthony 2007. Herpetologica 63[4]:450-458) might influence the variable color phases of *P. cinereus*. Whether these processes or genetic mutation are triggering the color variation at Cook's Pond has not been determined. The discovery of adults and juveniles of these two color phases within the same population of *P. cinereus* suggests that interbreeding is occurring, thereby supporting the possibility of genetic mutation as the cause.

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***PLETHODON CINEREUS* (Eastern Red-backed Salamander). TENACITY AND HOMING.** Homing behavior is the ability or tendency for an individual to return to a particular site or home range after moving or being displaced from that site (Jaeger et al 1993. J. Herpetol. 27:236–239; Ousterhout and Liebgold 2010. Herpetologica 66:269–275). The home range of an individual can be defined by, but is not limited to, the area traveled to forage, mate, and raise offspring (Burt 1943. J. Mammal. 24:346–352). While salamanders might expand and occasionally shift ranges due to external pressures, the home range provides a suitable microhabitat to which the individual may return (Kleeberger and Werner 1982. Copeia 1982:409–415). Certain species of plethodontid salamanders have been known to establish and defend territories under cover objects (e.g., rocks and logs) and the surrounding areas which provide renewable resources, including prey and refugia (reviewed in Mathis 1995. Amphibian Biology 2:633–676; Jaeger 1976. Copeia 1976:686–691; Peterson et al. 2000. Ethology 106:781–794). Although territorial behavior has been well documented in *Plethodon cinereus*, less is known about geographic and phenotypic variation in territorial behavior. For example, most studies of territorial behavior in *P. cinereus* have been conducted on New York and Virginia populations and the effect of color morphology has not been addressed in these studies.

We tested whether striped and erythristic *P. cinereus* from Ohio exhibit homing behavior, a key component of territorial behavior. Between 22 Sept and 3 Nov 2010, we displaced 69 individuals (adults >32 mm SVL; 55 striped, 14 erythristic) 5 m from their original cover object. At least one week passed between displacement dates and recapture dates. Individuals were identified using digital photographs (Nikon D100; Sigma 50mm macro) of their unique dorsal spotting patterns (Anthony et al. 2008. J. Anim. Ecol. 77:646–653). Each cover object was checked at least once, and up to three times after salamanders were displaced.

Of the striped individuals, 12.7% (N = 7) were recaptured under their original cover object. The erythristic morphs had a recapture rate of 14.3% (N = 2). Homing behavior in the red morph has not been documented in previous *P. cinereus* studies and based on these observations the erythristic morph's homing tendency is similar to that of the striped morph. The recapture rate of the striped morph parallels results observed in other plethodontid studies, specifically Jaeger et al. (1993, *op. cit.*) where the

recapture rate of one group was 16.3%. This is the first report of homing behavior in *P. cinereus* from Ohio.

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***PLETHODON GLUTINOSUS* (Northern Slimy Salamander). ARBOREAL HABITAT USE.** *Plethodon glutinosus* is a common, terrestrial plethodontid salamander found broadly across the eastern United States from New York westward to Illinois and south to Alabama and Georgia. Habitat types for this species vary widely but have been reported primarily as beneath logs, stones, and humus in mature hardwood forests. Refugia in shale banks and cave/bluff systems have also been reported for this species (Beamer and Lannoo 2005. *In* M. Lannoo [ed.], Amphibian Declines: the Conservation Status of United States Species, pp. 808–811. Univ. California Press, Berkeley). *Plethodon glutinosus* is well known for using moist crevices in karst cave or bluff systems and typically exhibits stratification with sympatric Green Salamanders (*Aneides aeneus*). The superior competitive abilities of *A. aeneus* and inferior climbing abilities in *P. glutinosus* have been cited as factors that restrict *P. glutinosus to* lower portions of rock faces (Cliburn and Porter 1986. J. Mississippi Acad. Sci. 31:91–96.). However, *P. glutinosus* has not been shown to exhibit arboreal habitat use, similar to *A. aeneus*, when occurring in bluff systems. Here we report such arboreal habitat use in *P. glutinosus* on two separate occasions from sandstone canyon systems in northern Alabama.

In April 2010, an adult *P. glutinosus* was observed ca. 4 m above ground on a standing, live Canadian Hemlock (*Tsuga canadensis*) within Clear Creek Canyon in Winston Co., Alabama (34.03193°N, 87.37403°W; WGS 84). This individual was using a crevice beneath the outer bark layer of the tree as a refugium, with bark needing to be removed from the tree to gain access to the salamander. On 14 May 2010, a second adult *P. glutinosus* was observed ca. 2.75 m above ground on a standing, live Tulip Poplar (*Liriodendron tulipifer*) within Dismal's Canyon in Franklin Co., Alabama (34.32253°N, 87.78186°W; WGS 84). This individual was observed within a hollow portion of the standing tree and was located directly outside what appeared to be a maintained burrow within the tree. Other encountered salamander species sympatric with *P. glutinosus* at the aforementioned sites include *Eurycea cirrigera, E. guttolineata, Aneides aeneus*, and *Notophthalmus viridescens.*

To our knowledge, these are the first recorded observations of arboreal habitat use in *P. glutinosus*, despite this species' known climbing ability. However, our observations are consistent with other species, such as *A. aeneus*, which have been shown previously to use refugia in standing dead or live trees. Both of the trees observed in our cases were older, mature individuals with large diameters and well-developed crevice systems capable of holding moisture. We observed no salamanders on smaller and/or younger trees within these canyon systems. Both of the aforementioned individuals were also found on the sides of trees facing bluff walls. The sides of trees facing bluff walls within these canyon systems remain consistently wetter than those facing away, providing a near constant source of moisture that may allow for arboreal habitat use in this species. The widespread nature of such habitat use in *P. glutinosus* is questionable and deserves further study, although moisture availability might be a limiting factor in the utilization of arboreal refugia in this species.

Photographic vouchers for the behavioral observations listed above were deposited in the Auburn University Herp Atlas Project - Digital (AHAP-D 301, 302). The observation from Winston Co., Alabama was obtained during research funded by Legacy, Partners in Environmental Education.

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***PLETHODON NETTINGI* (Cheat Mountain Salamander). PREDATION.** *Plethodon nettingi*, a federally protected species, is a small-sized terrestrial salamander endemic to the spruce forests of the Allegheny Mountains of West Virginia, USA. To date, no natural predators have been documented, though many are suspected (Petranka 2010. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington D.C. 492 pp.). On 26 May 2010, while surveying a study site in Pendleton Co., West Virginia, USA, we captured a young male *Thamnophis s. sirtalis* (Eastern Gartersnake), ca. 45 cm in total length, under a rock on top of Spruce Mountain (1457 m elev.). *Thamnophis s. sirtalis* is a medium-sized terrestrial snake that is a generalist in nearly all aspects of its natural history, including habitat, diet, distribution, and temperature tolerance. The species is known to ingest earthworms, leeches, slugs, snails, millipedes, isopods, spiders, crayfish, insects, salamanders, frogs, toads, small snakes, nestling birds, mice, fish, and carrion (Ernst and Ernst 2004. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 680 pp.). Salamander prey consists of 11 genera including *Plethodon*. The *T. s. sirtalis* had an obvious food bolus that was palpated until regurgitation (Fig. 1). The food bolus was a recently eaten adult *P. nettingi*, ca. 45–55 mm in total length. The prey item was doubled over on itself to accommodate the stomach. A juvenile *P. cinereus*, ca. 15–20 mm, was also present but was exceptionally small. This observation,

PHOTO BY KEVIN MESSENGER

FIG. 1. *Thamnophis sirtalis* regurgitating *Plethodon nettingi.*

long considered and expected but never documented, marks another entry on the list of prey items accepted by *T. s. sirtalis*. This observation also marks the first documentation of natural predation on *P. nettingi*.

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ANURA — FROGS

BUFO STOMATICUS **(Marbled Toad). DEFENSIVE BEHAVIOR.** *Bufo stomaticus* is widely distributed in the Indian subcontinent (Chanda 2002. Handbook of Indian Amphibians. ZSI, Kolkata, India; Daniel 2002. The Book of Indian Reptiles and Amphibians. BNHS and Oxford Univ. Press, India; Dutta 1992. Amphibians of India and Sri Lanka, Checklist and Bibliography, Odyssey Pub. House, Orissa, India). It is abundant in the vicinity of the Central Aravalli foothills (Sharma et al. 2010. Flora and Fauna 244–248). In spite of its common and wide distribution, little is known about its ecology and behavioral patterns, particularly the defensive behavior when disturbed or attacked by any predator.

On 23 Sept 2010 at 1400 h, during our visit to the Central Aravalli foothills, Rajasthan, India, (26.2666°N, 74.50°E) we observed an interesting defensive behavior when a subadult *Bufo stomaticus* was disturbed. Initially the individual tried to escape but when surrounded from all sides, it suddenly raised its body on its legs and inflated its body (Fig. 1). When the disturbance (a camera) was removed the individual resumed a normal posture, although it resumed the defensive posture when it was again disturbed by the camera.

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PHOTO BY VIVEK SHARMA

FIG. 1. *Bufo stomaticus* showing defensive behavior.

CYCLORAMPHUS LUTZORUM **(Lutz's Frog). REPRODUCTIVE MODE.** The cycloramphid frog *Cycloramphus lutzorum* has a restricted geographic range in southern Brazil. The call and tadpoles of this endemic species were recently reported by Lima et al. (2010. J. Herpetol. 44:360–371), and karyotypic evolution relationships have been investigated (Noleto et al. *in press*. Zool. Anz.). Nevertheless, the reproductive mode of the species remains uncertain, despite data presented by Lima et al. (2010, *op. cit.*). On 28 Nov 2010 an egg clutch was found at the municipality of Morretes, Parana State, Brazil (25.59055°S, 48.815°W). The eggs were laid at a site lacking daylight, in a moist rock crevice ca. 2 cm high and 50 cm deep under a waterfall along the Brejamirim River. No evidence of clutch attendance was observed. The eggs were counted, measured, and collected for a determination of the state of development. Thirty-six eggs were laid, with a diameter of 0.92 ± 0.04 cm. Eggs were Gosner Stage 18 and tadpoles hatched within 12 days in the lab. These tadpoles matched the description of *C. lutzorum*, which allows inference that the species fits the reproductive mode 19 of Wells (2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 1148 pp.). These data support the notion that *C. lutzorum* is an endemic stream-dwelling species and reinforce the need for conservation of their habitat.

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LEPTODACTYLUS FRAGILIS **(Mexican White-lipped Frog). DIET.** *Leptodactylus fragilis* is a lowland species that occurs from southernmost Texas throughout Middle America to northern and west-central Colombia and northern Venezuela (Heyer et al. 2006. Cat. Amer. Amphib. Rept. 830:1–2). This species is reported to feed on arthropods (Rand and Myers 1990. *In* Gentry [ed.], Four Neotropical Rainforests, pp. 386–409. Yale Univ. Press, New Haven, Connecticut; Savage 2002. The Amphibians and Reptiles of Costa Rica. A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois), but no information exists on food habits of this species. Herein we provided detailed informaton on the diet of *L. fragilis* from Reserva Rio Manso (5.666°N, 74.77417°W; ca 220 m elev.), municipality of Norcasia, Departament of Caldas, Colombia.

We examined the stomach contents extracted by stomach-flushing of 63 individuals of *L. fragilis* sampled by GGD and SEL from 12–20 May 2010, between 1900 and 2200 h, around ponds in pasture lands. We identified each prey item to order or family and measured the length and width of each item to the nearest 0.1 mm using a manual caliper. We estimated prey volume using the formula for a prolate spheroid.

Of the 63 individuals examined, 42 (66.7%) contained prey items. These individuals ranged from 24.4 to 58.4 mm SVL (mean 41.88 ± 7.92). Insects and spiders composed the overall diet. Spiders and beetles were numerically and volumetrically the prey most represented. Numerically, long-toed water beetles (Dryopidae) were the most important prey, followed by orb-web spiders (Araneidae) and wolf spiders (Lycosidae) (Table 1). Volumetrically, lycosids were the most important prey, followed by dryopids and crickets (Gryllidae) (Table 1). Dryopids, araneids, and lycosyds also were common prey in many individuals. The value of dietary niche breadth, measured with the Shannon-Wiener diversity index (H'), was 2.46.

We used the Spearman Rank Correlation for analysis of morphology and diet in the specimens with identifiable prey. A

TABLE 1. Types of prey in the diet of *Leptodactylus fragilis* from "Reserva Rio Manso," Norcasia, Caldas, Colombia. Volume in mm^3.

Prey	Number (%)	Volume (%)	Frequency of occurrence
Arachnida			
Acari	1 (<1.0)	0.004 (<0.01)	1
Araneae			
Araneidae	13 (12.6)	178.14 (5.49)	9
Ctenidae	1 (<1.0)	209.94 (6.47)	1
Lycosidae	12 (10.7)	1273.05 (39.25)	12
Insecta			
Blattodea			
Blatiidae	8 (7.8)	402.93 (12.42)	8
Coleoptera			
Dryopidae	27 (26.2)	343.23 (10.58)	13
Elateridae	5 (4.9)	31.55 (0.97)	4
Staphylinidae	1 (<1.0)	29.26 (0.90)	1
Trogossitidae	4 (3.9)	7.55 (0.23)	3
Diptera			
Culicidae	1 (1.0)	0.01 (<0.01)	1
Drosophilidae	4 (3.9)	2.90 (0.09)	4
Psychodidae	1 (<1.0)	0.02 (0.00)	1
Hemiptera			
Cicadellidae	6 (5.8)	20.12 (0.62)	4
Hymenoptera			
Formicidae	6 (5.8)	19.35 (0.60)	5
Evaniidae	1 (<1.0)	18.85 (0.58)	1
Orthoptera			
Acrididae	2 (1.9)		2
Gryllidae	1 (<1.0)	393.17 (12.12)	1
Larvae	8 (7.7)	208.90 (6.50)	3
Diplopoda	1 (<1.0)	99.57 (3.07)	1
Mollusca	1 (<1.0)	4.69 (0.14)	1
TOTAL	104	3243.19	

positive and significant correlation exists between SVL and mouth width (MW) ($r_s = 0.83$, $p < 0.001$). The number of prey ingested was negative and significantly correlated with predator SVL ($r_s = -0.37$, $p < 0.02$) but not with MW ($r_s = -0.30$, $p > 0.05$). The prey volume ingested was positive and significantly correlated with both SVL ($r_s = 0.36$, $p < 0.02$) and MW ($r_s = 0.36$, $p < 0.02$). These results indicate that each individual consumes fewer prey as the SVL increase, but these are voluminous as well (e.g. spiders, dryopids, cockroach, and crickets). In each individual, the average of consumed prey of great size varied between 1 and 2.1 (Table 1).

The consumption of arthropods, mainly insects, by *L. fragilis* is typical due to their insectivorous diet (Rand and Myers 1990, *op. cit.*; Savage 2002, *op. cit*), additionally insects are plentiful and easily found in most terrestrial habitats (Triplehorn and Johnson 2005. Borror and Delong's Introduction to the Study of Insects. Thomson/Brooks Cole, Belmont; Parmelee 1999. Sci. Pap. Nat. Hist. Mus. Univ. Kansas 11:1–59). The notable presence of aquatic insects like the dryopids is important because it associates *L. fragilis* with lentic bodies of water (Savage 2002, *op. cit.*). Unfortunately, we do not know if other *Leptodactylus* associated with lentic waters also prey upon dryopids as the reports only identify prey to order and not family as in our study.

The numeric and volumetric presence of beetles and spiders reported here is not different from the diet of other *Leptodactylus* (Cuevas and Martori 2007. Cuad. Herpetol. 21:7–19; Duré and Kehr 2004. Herpetologica 60:295–303; França et al. 2004. Stud. Neotrop. Faun. Envir. 39:243–248; Maneyro et al. 2004. Iheringia, Sér. Zool. 94:57–61; Rodrigues et al. 2004. Rev. Esp. Herp. 18:19–28; Sanabria et al. 2005. Rev. Peru. Biol. 12:472– 477; Solé et al. 2009. Herpetol. Notes 2:9–15. Teixeira and Vrcibradic 2003. Cuad. Herpetol. 17:111–118; Winter et al. 2007. Herpetol. Rev. 38:324). Ants and termites also have been reported as numerically important prey (n > 22) in *L. bufonis*, *L. latinasus*, *L. ocellatus*, and *L. podicipinus* (Duré and Kehr 2004, *op. cit.*; Maneyro et al. 2004, *op. cit.*; Rodrigues et al. 2004, *op. cit.*; Sanabria et al. 2005, *op. cit.*; Teixeira and Vrcibradic 2003, *op. cit.*), but here ants only were represented by six prey items and termites were not found. The low rates of consumption of other prey types might be as a result of limited availability or they may be patchy in the habitat (Rodrigues et al. 2004, *op. cit.*).

Parmelee (1999. Sci. Pap. Nat. Hist. Mus. Univ. Kansas 11:1–59) suggested that body size and the head width in frogs determine the maximum size of prey consumed. Thus, the ability of gaping in relation to the size of the frog is a limiting factor in the selection of prey (Toft 1981. J. Herpetol. 15:139–144). In this study, the SVL determined the number and volume of prey consumed by *L. fragilis* and the MW determined positively the volume of ingested prey. The above suggests that both the SVL and MW are influencing the type of prey ingested by *L. fragilis*. The wide range of prey types and sizes found in *L. fragilis* indicates the species is a generalist/opportunistic feeder with a "sit-and-wait" strategy for obtaining prey (Taigen et al. 1982. Oecologia 52:49–56), like other *Leptodactylus* species. The previous idea is also corroborated with the high value of dietary niche breadth.

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***LEPTODACTYLUS MACROSTERNUM* (Miranda's White-lipped Frog). PREDATION.** Amphibians are an important component of the trophic chain in natural ecosystems, being common prey for a variety of vertebrates (fishes, reptiles, birds, and mammals), arthropods (ants, beetles, water bugs, spiders, and crabs), and even carnivorous plants (Duellman and Trueb 1994. Biology of Amphibians. Baltimore and London, The Johns Hopkins Univ. Press; Toledo 2005. Herpetol. Rev. 36:395–400; Toledo et al. 2007. J. Zool. 271:170–177).

Members of the family Belostomidae are predaceous aquatic insects from medium to large size that colonize aquatic habitats in tropical and temperate regions (Lauck and Menke 1961. Ann. Ent. Soc. Amer. 54:644–657).Water bugs are cited by many authors as predators of larval and adult frogs (Martins et al. 1993. Amphibia Reptilia 14:307–309; Eterovick and Sazima 2000. Amphibia-Reptilia 21:439–461; Toledo 2003. Phyllomedusa 2[2]:105–108; Toledo 2005, *op. cit.*), acting to help regulate anuran communities through predation (Duellman and Trueb 1994, *op. cit.*). Here, we report the predation of a juvenile *Leptodactylus macrosternum* by the water bug, *Lethocerus* sp.

On 21 Apr 2011 at 1700 h, in a stream at the Fazenda São Bernardo, municipality of Sambaiba, state of Maranhão, Brazil,

a water bug nymph was observed preying upon an adult *L. macrosternum*. When observed the water bug was grasping the dead frog on its ventral region. When disturbed by our presence the water bug left the prey and dove into the water.

We suggest that such predator/prey interactions could be common when these species are found at the same environment, such as streams and permanent, semi-permanent, or temporary ponds.

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***LEPTODACTYLUS TROGLODYTES* (Caçote). LARVAL CANNIBALISM.** Bragg (1964. Herpetologica 20:17–24) reported that cannibalism occurs in the larvae of some frogs; Heyer (1975. Biotropica 7(2):100–111) described cannibalism in *Leptodactylus* larvae. During the night of 17 April 2009 in a permanent pond (ca. 30 × 18 m) in an urban area of the municipality of Natal (S5.838889, W35.205000) state of Rio Grande do Norte, Brazil, we observed the first record of cannibalism in tadpoles of *Leptodactylus troglodytes*. Tadpoles (ca. 12 mm SVL, Gosner Stage 25; Gosner 1960 Hepetologica 16:183–190) being consumed by larger congeners (20 mm SVL Gosner Stage 30) were near the vegetation on the edge of the pond when first observed. They were caught by the larger tadpoles and taken to the bottom of the pond, where parts of the head and abdomen were eaten. Identification of tadpoles was verified by M.N.C. Kokubum.

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***LITHOBATES JOHNI* (Moore's Frog). HABITAT AND MICROHABITAT USE.** Very little is known about the life history of *Lithobates johni* (Blair 1947. Amer. Mus. Nat. Hist. 1353:1–18; Ramírez-Bautista et al. 2010. Lista Anotada de los Anfibios y Reptiles del Estado de Hidalgo, México. Universidad Autónoma del Estado de Hidalgo, CONABIO. 104 pp.). Herein we report habitat and microhabitat use by *L. johni* from the tropical rain forest of Río Blanco (20.24646°N, 98.05434°W; WGS 84; elev. 601 m), Municipality of Huehuetla, Hidalgo, México. *Lithobates johni* are thought to be fully aquatic, however no studies have reported the habitat and microhabitat use of this species. On 15 March 2011, during 2000–2300 h, we found seven (CIB 4114–4120) *L. johni* in tropical rain forest (Fig. 1). These individuals were perched in a cave under a waterfall. Environmental and microhabitat temperatures were 18°C and 16°C. It appears the species prefers non-polluted waters as we did not find individuals in places where the river is polluted.

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PHOTO BY C. B. ISLAS

FIG. 1. A) Female *Lithobates johni* (photo by L.V. Saldaña); B) habitat of *L. johni*; C) habitat and microhabitat inhabited by *L. johni*, and D) microhabitat of *L. johni*, arrows indicate the microhabitats used by frogs.

***LITORIA COOLOOLENSIS* (Cooloola Sedge Frog). AMPLEXUS.** In many anurans, males vocalize to attract females but may grasp any female that comes within reach and retain their hold unless displaced by a rival male (Bruning et al. 2010. Biol. Lett. 6:322–324). The male's clasping response may, at times, not discriminate between species, and at the height of breeding, sometimes involves inanimate objects (Brown 1977. J. Herpetol.; Storm 1960. Herpetologica 16:251–259), non-reproductive and reproductive females (Marco and Lizana 2002. Ethol. Ecol. Evol. 14:1–8; Cheong et al. 2008. Anim. Cells Syst. 12:93–96), and even dead frogs (Marco and Lizana 2002. *op. cit.*).

In the Australian subtropical frog *Litoria cooloolensis*, breeding occurs in coastal wetlands in spring, summer, and autumn, where males call from reeds and emergent vegetation over or near water (Meyer et al. 2006. National Recovery Plan for the wallum sedge frog and other wallum-dependent frog species. Queensland Parks and Wildlife Service, Brisbane, report to Department of the Environment and Water Resources, Canberra; pers. obs.). Amplexus is axillary and eggs are laid in clumps in the water amidst vegetation (Meyer et al. 2006, *op. cit.*).

On 3 October 2010 at ca. 1915 h KL observed a male *L. cooloolensis* amplecting a *L. olongburensis* (presumably female) in Great Sandy National Park (Cooloola section), Queensland (Fig. 1). The *L. olongburensis* made no attempt to go to the water to commence egg deposition, nor did it attempt to dislodge or escape from the male. Both species were heard vocalizing during the survey, along with *L. fallax* and *Crinia tinnula*. Environmental air and water temperatures were 19.3°C and 20.1°C. Cloud cover was ca. 50% with no moon, thus a low level of illumination. Humidity was 91.9%, barometric pressure was 1014 hPa. The average pH of the wetland was 3.65 and salinity was 32.76 ppm.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. Axillary amplexus between a male *Litoria cooloolensis* and *Litoria olongburensis*.

FIG. 2. Inguinal amplexus between a male *Litoria cooloolensis* and *Litoria rubella*.

A second observation was made on 7 Jan 2011 at ca. 1945 h, where a male *L. cooloolensis* was in amplexus with *L. rubella* (Fig. 2), also in Great Sandy National Park (Cooloola section), Queensland. In this instance, the *L. rubella* was climbing higher up the vegetation and appeared to be attempting to dislodge the unwanted male. Again, both species were heard vocalizing during the survey, along with *L. nasuta, L. tyleri, C. tinnula, Uperoleia fusca, Limnodynastes peroni,* and *Limnodynastes terraereginae*. Environmental air and water temperatures were 23.1°C and 25°C. Cloud cover was 100%, thus a low level of illumination, with some rain that evening. Humidity was 92.8%, barometric pressure was 1001 hPa. The average pH of the wetland was 3.86 and salinity was 21.97 ppm. No release vocalizations were heard from either of the interactions. In both observations the amplected frog was larger than the male, most significantly in *L. rubella*, where the male had to modify its amplexus technique—from axillary to inguinal. Both of these observations were made at the beginning of breeding season in two different wetlands.

In any sexually reproducing species, determining which individual to combine gametes with is a critical determinant of individual fitness and likely to be under strong selection pressure (Andersson 1994. Sexual Selection. Princeton Univ. Press, Princeton, New Jersey). Mate choice is important for successful reproduction and females have been shown to discriminate between species, most commonly on the basis of difference in male vocalizations (Blair 1964. Q. Rev. Biol. 39:334–344). As is apparent from an examination of Figures 1 and 2, the morphological differences between the species are quite clear. Also, the calls of all three species can be readily distinguished, thus female selection is unlikely to have been the cause of these mismatches. Instead, the pairings are likely to have arisen from a male *L. cooloolensis* displaying indiscriminate amplexus, jumping on any frog nearby.

Amplexus confers substantial costs to the amplecting (McLister 2003. Can. J. Zool. 81:388–394) and amplected anuran (Bowcock et al. 2008. Anim. Behav. 75:1571–1579). Thus, it would be beneficial for females (and other males) to immediately terminate 'unwanted' amplexus (Bowcock et al. 2008, *op. cit.*; McLister 2003, *op. cit*). Furthermore, selection should act on males to terminate inappropriate amplexus by rapidly discriminating the sex and reproductive condition of the animal that they have seized (Bowcock et al. 2008, *op. cit.*).

The females may not have been receiving the correct chemical cues to proceed with breeding as neither was observed to commence with egg deposition. However some mechanisms for repelling unwanted suitors have been observed in other species. These include release vocalizations (Leary 2001. Anim. Behav. 61:431–438), inflating the body (Bruning et al. 2010, *op. cit.*), and laying fewer eggs when paired with heterospecific males (Hettyey 2009. Anim. Behav. 78:1365–1372).

KL has been surveying 16 Wallum Frog breeding sites over two years (approx. 500 survey hours) and has never observed a pair of *L. cooloolensis* or *L. olongburensis* in amplexus. This suggests that observations of such behavior might be rare, and might be quickly followed by egg deposition. The two observations discussed here lead to questions of hybridization between *L. cooloolensis* and *L. olongburensis,* as they share similar morphology, breeding habitat, breeding seasons, and calling perch sites. Further studies examining the viability of hybrid offspring and identifying the cause of matings between different species in hybrid populations would add to our understanding of hybridization and mate recognition in amphibians.

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***MEGOPHRYS KOBAYASHII* (Montane Horned Frog). ATYPICAL HABITAT AND MAXIMUM SIZE.** *Megophrys kobayashii* is endemic to the mountainous western Sabah, Bornean Malaysia between 1230–1675 m elev. (Inger and Stuebing 2005. A Field Guide to the Frogs of Borneo. 2nd ed. Natural History Publications [Borneo] Sdn. Bhd. Kota Kinabalu. 201 pp.; Frost 2010. Amphibian Species of the World: an Online Reference. Version 5.4 [8 April 2010]. Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia. Amer. Mus. Nat. Hist., New York. Accessed 1 February 2011), and is listed as Near Threatened in the 2010 IUCN Red List of Threatened Species (Inger et al. 2004. *In* IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>. Accessed 1 Feb 2011). The species has been reported to dwell in leaf litter of primary montane forests with small rocky-bottomed streams for breeding; maximum size reported to be SVL 109 mm (Inger and Stuebing 2005, *op. cit.*; Malkmus et al. 2002. Amphibians and Reptiles of Mount Kinabalu [North Borneo]. A.R.G. Gantner Verlag K.G. Ruggell. 424 pp.).

On 8 Dec 2010 at 1915 h, a gravid female *M. kobayashii* was found at the foot of a leaf-littered hill in the compound of Haleluyah Retreat Centre (6°N, 116.536°E; 1518 m elev.), Bundu Tuhan, Ranau District, West Coast Division, Sabah, Bornean Malaysia. Air temperature was 19.9°C, and relative humidity was 75.7%. The individual was found ca. 25 m from an artificial pond. However, the compound lacks a stream or brook thought to be necessary for breeding in *M. kobayashii* (Inger and Stuebing 2005, *op. cit.*; Malkmus et al. 2002, *op. cit.*). It is possible that an attempted escape from a predator might explain the presence of *M. kobayashii* in the compound although no predators were observed; additionally the species normally lives in permanent colonies (Malkmus et al. 2002, *op. cit.*). This observation suggests that *M. kobayashii* might utilize a wider variety of habitats than currently known.

This individual was 118 mm SVL and 151 g, and thus a new maximum size for *M. kobayashii*. Measurements were taken with a standard metric tape and an electronic balance. The individual was photographed *ex-situ* indoors and released on site the following day.

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***PLEURODEMA TUCUMANUM*. PREDATION.** Water bugs (Belostomatidae) are well known to prey on anuran larvae (Giaretta and Menin 2004. J. Nat. Hist. 38:1711–1722; Hinshaw and Sullivan 1990. J. Herpetol. 24:196–197; Kher and Schnack 1991. Alytes 9:61–69; Menin et al. 2005. Phyllomedusa 4(1):39–47) and adults (Bastos et al. 1994. Herpetol. Rev. 25:81; Haddad and Bastos 1997. Amphibia-Reptilia 18:295–298; Mijares-Urrutia et al. 1997. Herpetol. Rev. 28:84; Toledo 2003. Phyllomedusa 2[2]:105–108). Water bugs eat more frogs than invertebrates because anurans are better food items from an energetic viewpoint (Hidai and Hidaka 2002. Ecol. Res. 17:655–661); they use their piercing-sucking mouthparts to eat them (Lopez et al. 1998. Rev. Nica. Entomol. 46:1–5).

Herein we report predation of a juvenile *Pleurodema tucumanum* by the water bug *Belostoma discretum*. This observation took place during the night of 9 April 2009 in the vicinity of the Rio Claro (32.613°S, 66.139°W), near San Francisco, Ayacucho, San Luis 5570, Argentina, in a large pool enclosed by rocks at the river's edge. A juvenile *P. tucumanum* (19.6 mm SVL) was observed floating on the surface of the pool (no deeper than 0.2 m), with a *B. discretum* (24.8 mm long) attached to its abdomen. The water bug was holding the frog with its forelegs while piercing the frog's left hindlimb with its proboscis. At regular intervals the water bug swam with apparent difficulty carrying the frog to the bottom of the pool, where it rested for an instant before emerging for air and repeating these actions.

These individuals were photographed, collected, and preserved in 70% ethyl alcohol. The *B. discretum* was deposited in the UNSL Entomological Collection and the *P. tucumanum* (CH-UNSL 0429) in the Herpetological Collection of Universidad Nacional de San Luis. This is the first record of *B. discretum* preying on juvenile *P. tucumanum*.

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***POLYPEDATES LEUCOMYSTAX* (Java Whipping Frog). COMMUNAL NESTING.** Communal egg-laying is widespread in amphibians yet the exact reasons for it remain unclear (Doody et al. 2009. Quart. Rev. Biol. 84[3]:229–252). In nest building species, there appears to be plasticity within a population for nesting communally versus individually (Agostini et al. 2007. Herpetol. Rev. 38:441; Zina 2006. Amphibia-Reptilia 27:148–150), indicating that perhaps in certain contexts one method is more advantageous than another. Here we report communal nesting activity in *Polypedates leucomystax* at the Xishuangbanna Tropical Botanic Garden, Xishuangbanna Prefecture, Yunnan Province, China, during one of the driest rainy seasons on record (Qiu 2010. Nature 465[13]:142–143).

In weekly breeding site surveys, we recorded instances of communal nesting on 9 July and 12 Aug 2009. On 9 July, we encountered two large foam nests, the larger nest measuring ca. 59 cm × 48 cm, and the smaller one measuring 62 cm × 39 cm. In addition, at the same site but several meters away from the larger nest, we observed a single female actively mating with 4 males as has been recorded in this species before (Feng and Narins1991. Naturwissenschaften 78:362–364), however, when we approached the group, the males dispersed. On 12 Aug we recorded an additional large nest at the same site as the first two, and slightly smaller in size measuring 32 cm × 46 cm. On both dates we also observed multiple individual nests at the same site (see Fig. 1 for comparison of nest sizes). These communal nests are no doubt the product of multiple females ovipositing in the same location, but since we did not observe it, we do not know if oviposition happened simultaneously or separately.

FIG. 1. On left, the larger of two communal nests of *Polypedates leucomystax* observed on the night of 9 July 2009. On the right, an average-sized individual female nest. The 50 yuan note measures 15 cm x 7 cm.

In the three years of conducting breeding site surveys (2008–2010), these are the only instances of communal nesting we encountered for any species. Both dates that we recorded communal nesting were after major rain events (>50 mm rain) following significant dry spells (25–28 d) where no standing water accumulated. It is possible that since these populations rely heavily on ephemeral pools for reproduction there is high competition for the spots that retain water longest.

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***PRISTIMANTIS ACHATINUS* (Cachabi Robber Frog). PARENTAL CARE AND CLUTCH SIZE.** *Pristimantis* is the largest clade of frogs in the world with nearly 445 species, distributed mainly in northwestern South America (Amphibiaweb 2011.. [web application]. Berkeley, California. Available: http://amphibiaweb.org/; accessed 27 May 2011; Hedges et al. 2008. Zootaxa 1737:1–182). These frogs have terrestrial eggs and embryos undergo direct development (Hedges et al. 2008, *op. cit.*). To date, there are published data on clutch size, nest type, and parental care in 10 species of *Pristimantis*: *P. affinis*, *P. buccinator*, *P. caryophyllaceus*, *P. lymani*, *P. nicefori*, *P. percultus*, *P. racemus*, *P. simoterus*, *P. terraebolivaris,* and *P. verecundus* (Carrillo 2007. Herpetol. Rev. 38:183; Heatwole 1963. Carib. J. Sci. 3:17–23; Lynch and Duellman 1997. Univ. Kansas. Nat. Mus. Spec. Publ. 23:1–236; Lynch et al. 1996. Caldasia 18:329–342; Myers 1969. Am. Mus. Novit. 2396:1–52; Townsend 1996. *In* Powell and Henderson. Contributions to West Indian Herpetology, a Tribute to Albert Schwartz, pp. 229–239. SSAR Contrib. Herpetol. Vol. 12. Ithaca, New York; Vargas-S. and Castro-H. 1999. Rev. Acad. Colomb. Cienc. 23:407–410). Herein we provided the first data on nest site, clutch size, and parental care in *P. achatinus* from a premontane humid forest in the Central Andes of Colombia. This species occurs in Panama, Colombia, and Ecuador, at altitudes of 0–2330 m (Frost 2011. Amphibian Species of the World: an Online Reference. Version 5.5 [31 Jan 2011]. Electronic database accessible at http://research.amnh.org/vz/herpetology/amphibia/. American Museum of Natural History, New York; accessed 27 May 2011).

On 25 May 2011, we found an adult female *P. achatinus* (37.9 mm SVL) sitting on a clutch of 38 eggs (Fig. 1A) at Ecoparque Los Alcázares Arenillo, municipality of Manizales, Department of Caldas, Colombia (5.067°N, 75.533°W, 1730–1960 m elev.). Both the female and the egg mass were in a shallow depression (ca. 25 mm deep) on the ground beneath leaf litter, next to small shrubs. At the time of finding the nest, the female was completely covering the eggs with the body and head, so that the eggs were not visible, which could be evidence of parental care. However, minutes after being disturbed the frog moved, allowing us to see the eggs (Fig. 1A). The eggs were spherical with yellowish cream yolk and clustered in a grape bunch although not connected by a jelly or foam matrix (Fig. 1B). We examined 10 eggs that ranged from 4.1–4.6 mm diameter (mean 4.46 ± 0.17) and we estimated them to be approximately early stage 5 of development based on the limb buds elongate and attached to trunk, forelimbs round to ovoid, and hindlimbs round to ovoid-elongate, eyes prominent but unpigmented, and gill buds present (Townsend Stewart 1985. Copeia 1985:423–436).

Although there is a widespread lack of data on parental care *Pristimantis*, the available data and this report suggest that females attend nests. Based on the data summarized by Wells (2007. The Ecology and Behavior of Amphibians. University

FIG. 1. A) Egg attendance by female *Pristimantis achatinus* in the Ecoparque Los Alcázares Arenillo, Manizales, Colombia. B) *Pristimantis achatinus* egg clutch in a shallow depression in the soil.

of Chicago Press, Chicago, Illinois) and others (Rodríguez and Alonso 2009. Herpetol. Rev. 40:204; Ryan 2005. Herpetol. Rev. 36:234–236; Whitfield et al. 2008. Herpetol. Rev. 39:76), in *Craugastor* and *Strabomantis* the females performed parental care, whereas in *Diasporus* it is the male, and in *Eleutherodactylus* the behavior is accomplished by females, males, or either parent.

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***RANA BOYLII* (Foothill Yellow-legged Frog). REPRODUCTION.** *Rana boylii* is an obligate lotic breeding ranid ranging from southern California north into southwestern Oregon, USA. *Rana boylii* breeds in spring (March–June) as winter flows subside, exhibits high breeding-site fidelity, and oviposition typically occurs on cobbles and boulders along river and stream margins in microhabitats with less than ambient flows (Fellers 2005. *In* Lannoo et al. [eds.], Amphibian Declines: The Conservation Status of United States Species, pp. 534–536. Univ. California Press, Berkeley). This species is listed as Near Threatened by the IUCN (Santos-Barrera et al. 2004. *In* IUCN 2010. IUCN Red List of Threatened Species. www.iucnredlist.org; accessed 10 April 2011) and has been a California Species of Special Concern since 1994 (Jennings and Hayes 1994. Amphibian and Reptile Species of Special Concern in California. California Dept. of Fish and Game, Rancho Cordova. 254 pp.). Annual census of egg masses is an effective means for quantifying population trends in frog species that lay one clutch per year at conspicuous oviposition sites (Crouch and Patton 2000. Wildl. Soc. Bull. 28:895–901). However, historical data on annual reproductive output for *R. boylii* populations throughout the range are limited, making it difficult to adequately assess the severity of population declines. Here we report the highest known density of egg masses for this species.

On 31 May 2009 (1100–1630 h) we conducted a visual encounter survey along a 2.25 km segment of the Mad River, in Humboldt Co., California, USA (40.8292°N, 123.9423°W, elev. 45 m) to quantify *R. boylii* egg masses. The sampled river segment is a low gradient meandering channel, with abundant gravel and cobble substrates, and adjacent uplands principally comprised of third growth Coast Redwood (*Sequoia sempervirens*) timberlands. We timed this survey to coincide with the final descending limb of the hydrograph and to be at the apparent peak of the breeding season. The peak of the 2009 breeding season was determined based on two visits to a known breeding site located downstream (7 km) from the sample reach. The mean surface water discharge of the river was 258 cfs (U.S. Geological Survey, Surface Water data for California: USGS Surface-Water Daily Statistics. http://waterdata.usgs.gov/ca/nwis/ dvstat?. Accessed 10 April 2011). We counted a total of 728 *R. boylii* egg masses for a resulting density of 323.5 egg masses km^{-1}. Forty-one egg masses (5.6% of the total counted) we observed were stranded on the river bank and presumably desiccated prior to hatching. The density we report here is 183% the maximum reported elsewhere. The highest reported density for *R. boylii* egg masses among 27 other rivers or streams is 176.9 egg masses km^{-1}, however the average among these sites is 16 egg masses km^{-1} (Kupferberg et al., *in review*). We believe that our finding on the annual reproductive output for *R. boylii* is a useful baseline for describing the population-level reproductive potential for the species and for comparison with other populations in similar river systems.

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***RANA BOYLII* (Foothill Yellow-legged Frog) and *ANAXYRUS BOREAS* (Western Toad). INTERSPECIFIC AMPLEXUS.** On 14 June 2010, during egg mass surveys on the South Fork Trinity River, Humboldt Co., northwestern California, USA, a male *Rana boylii* was observed in amplexus with a female *Anaxyrus boreas* at 1455 h (Fig. 1). Yearly surveys for egg masses and egg strings have been conducted since 2004, with numerous encounters of intraspecific amplexus being seen every year. In previous reports for Western Toads in interspecific amplexus, Brodie (1968. Herpetologica 24:86) witnessed a male Cascades Frog (*Rana cascadae*) in amplexus with a female Western Toad and Brown (1977. J. Herpetol. 11:92–94) reported a male Western Toad in amplexus with a female Northern Red-legged Frog (*Rana aurora*). It has been reported that non-native American Bullfrogs (*Lithobates catesbeianus*) that enter amplexus with native anurans could create reproductive interference (D'Amore et al. 2009. Herpetol. Cons. Biol. 4[3]:325–330; Pearl et al. 2005. Amer. Midl. Nat. 154:126–134) and this would be a case of heterospecific mating attempt (Groning and Hochkirch 2008. Quart. Rev. Biol. 83:257–282). This is the first observation of amplexus between a native ranid and a native bufonid in California and of these species pairing.

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FIG. 1. Male *Rana boylii* in amplexus with female *Anaxyrus boreas* in the South Fork Trinity River, Humboldt Co., California.

***RANA YAVAPAIENSIS* (Lowland Leopard Frog). LARVAL CANNIBALISM.** *Rana yavapaiensis* is known to oviposit primarily in

late winter-spring, with a much smaller pulse of oviposition in early fall (Sartorius and Rosen 2000. Southwest. Nat. 45:267–273) and large tadpoles sometimes overwinter (Collins and Lewis 1979. Southwest. Nat. 24:371–373). This situation occurred during winter 2005–6 in my semi-natural, urban backyard pond (3 × 4 m, 0.4 m deep), which has had a self-sustaining frog population derived from three southeastern Arizona populations for several years. In monitoring the 4th of eight egg masses deposited in February–early March 2006, I briefly noted about 5–6 large tadpoles (5.5–7.5 cm LOA) from a single September 2005 clutch active around and under the egg mass, which had just begun to hatch, on 5 March. On 7 March closer inspection of the 5th egg mass, which was estimated to be at developmental stages 16–19 and predicted to be 50% hatched on 9 March, revealed about 12–18 large tadpoles (of an estimated 48+ present in the pond) active under, around, and on the egg mass. Tadpoles were swimming lazily, pushing into the mass with actively moving mouthparts, and, in at least one case observed to swallow a dislodged embryo. Water was 11 cm deep at the mass, which was about 8 cm diameter, and temperature was 17°C (range 13–20°C over 24 h). The mass originally contained an estimated 1100 eggs based on previous counts of hatchlings in other clutches of similar size; 30 h later there were only 18 developing ova remaining, the egg mass was reduced in size but not dissociating as expected post-hatching, and no hatchlings were observed near the egg mass site, as would normally be seen. Other egg masses appeared to be less affected in proportion to the depth of water column below them, with hatchlings seen around all of them, and there was less activity of large tadpoles near them. However, the 8th and deepest-water egg mass, which hatched last (15 March), attracted about 15 large tadpoles on the bottom where a cone of detaching hatchlings from it would likely fall. Five of these tadpoles transferred to a screened-in observation tray with 10 hatchlings apparently consumed four hatchlings in a 24-h period.

The frog and tadpole densities involved here are similar to the highest *R. yavapaiensis* abundances I have seen in Arizona and Sonora during 1983–2005, and the only other vertebrate in the pond is the Gila Topminnow (*Poeciliopsis occidentalis*). An accumulating literature on oophagy, larvivory, and cannibalism in tadpoles (Gunzberger and Travis 2005. J. Herpetol. 39:457–571), and their occurrence in species with generalized tadpoles such as in this species and the American Bullfrog (*R. catesbeiana*; Kiesecker and Blaustein 1997. Ecology 78:1752–1760), may support suggestions in McDiarmid and Altig (1999. Tadpoles: the Biology of Amphibian Larvae, pp. 218, 246. Univ. Chicago Press, Chicago, Illinois) that these may be widespread and ecologically important phenomena.

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***RHACOPHORUS MARGARITIFER* (Java Flying Frog). DEFENSIVE BEHAVIOR.** *Rhacophorus margaritifer* is endemic to the island of Java in Indonesia. This species has received little treatment in the literature and many aspects of its natural history remain unknown. A recent monograph examining the genus *Rhacophorus* (Harvey et al. 2002. Herpetol. Monog. 16:46–92) described morphological diversity in *R. margaritifer* and briefly mentioned an *in situ* Unken reflex exhibited by one of the specimens examined. The individual described herein (along with several other *R. margaritifer*) was collected at the Taman Safari Park, in Cisurua-Bogor, West Java (06.716667°S, 106.95000°E; WGS 84), 1300 m elev., on 13 May 1996 and is deposited in the vertebrate collection of the University of Texas at Arlington (UTA A-54009). This and another specimen (UTA A-54010) were found active on low bushes, 1.4–1.8 m above the edge of a rocky stream flowing through primary forest on a warm night, ca. 18°C and 1945 h. The photographs taken of this reflex (Fig. 1), enable us to describe the behavior in detail. The behavior was expressed the day after capture while trying to photograph the specimen. This behavior involved the *R. margaritifer* covering its eyes with its hands and slightly arching its back (Fig. 1; bottom). These actions are consistent with those reported to occur during the Unken reflex of several anuran species (Stebbins and Cohen 1995. A Natural History of Amphibians. Princeton Univ. Press Princeton, New Jersey. 315 pp.). Interestingly, a similar reflex was reported from *R. feae* (Duong et al. 2010 Herpetol. Rev. 41:342). The behavior is also known to occur in a closely related rhacophorid *Nyctixalus pictus* (Das et al. 2004. Herpetol. Rev. 35:363–374). As such, a thorough survey across rhacophorids might provide valuable insight into the prevalence and modes of defensive behavior in this group. Collection and exportation were conducted with Bogor Zoological Museum permits (14/SI/MZB/VI/1996).

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PHOTO BY E. N. SMITH

FIG. 1. *Rhacophorus margaritifer* (UTA A-54009) from Java, Indonesia defensive behavior prior to (top) and immediately following (bottom) probing.

***RHINELLA CRUCIFER* (Striped Toad) and *RHINELLA JIMI*. HETEROSPECIFIC AMPLEXUS.** Most members of the family Bufonidae are regarded as having an explosive breeding pattern (Wells 2007. The Ecology and Behavior of Amphibians, Univ. Chicago Press, Chicago, Illinois. 1148 pp.), where after the first heavy rains of the season males begin calling and actively searching for females. During this reproductive frenzy males may commit mistakes and try to amplex with male conspecifics, heterospecifics, other vertebrates, or even inanimate objects of adequate size (Marco and Lizana 2002. Ethol. Ecol. Evol. 14:1–8; Wells 2007, *op. cit.*).

On 25 Nov 2010, at Parque das Trilhas, municipality of Guaramiranga, State of Ceará, northeastern Brazil (4.266°S, 38.916°W; 865 m elev.), we observed males of *Rhinella crucifer* and *R. jimi* in amplexus with heterospecifics. These observations took place in an artificial water body at ca. 2000 h, when only these two species were heard calling (*R. crucifer*, N = 5; *R. jimi*, N > 50). One *R. crucifer* was found in amplexus with a female *R. jimi*. When first seen, the pair was already in an axillary amplexus position in which they remained for 10 min. Towards the end of this time period the female began to raise the rear part of her body and direct her snout towards the ground in an attempt to be released until it finally succeeded (the behavior was videotaped and is available from LB upon request). Fifteen minutes after this observation, a male *R. jimi* was found in amplexus with *Leptodactylus vastus* (sex undetermined), which made no apparent attempt to dislodge the male. When approached by LB, the *L. vastus* jumped into the deeper part of the lake taking with it the amplectant male.

Haddad et al. (1990. Rev. Bras. Biol. 50:739–744) reported a *R. crucifer* × *R. icterica* hybrid. Considering that *R. jimi* is closely related to *R. icterica* such mistakes might be relatively common in areas where these species occur in sympatry with *R. crucifer*. According to Sinovas (2009. Herpetol. Rev. 40:199) the cost of amplexing a reproductively inadequate specimen is probably outweighed by the benefits of being the first to encounter an appropriate partner, as this behavior has not been selected against. Machado and Bernarde (2011. Herpetol. Notes 4:167–169) reported heterospecific amplexus involving *Rhaebo guttatus* and *Rhinella marina* in the Amazon. Although most records of heterospecific amplexus have been made in temperate environments (Wells 2007, *op. cit.*), these recent observations from tropical areas suggest that such behavior is found in Bufonidae worldwide.

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***RHINELLA JIMI* (Cururu Toad). ECTOPARASITISM.** *Rhinella jimi* is a bufonid that occurs throughout northeastern Brazil where it inhabits forests along the Atlantic coast as well as open formations of Caatinga. It is the only species in the genus that inhabits the Fernando de Noranha archipelago (Stevaux 2002. Rev. Bras. Zool. 19[1]:235–242; Toledo and Ribeiro 2010. EcoHealth 6:351–357). Here we report parasitism of *R. jimi* by the tick *Amblyomma rotundatum* (Ixodidae).

On 19 Dec 2010 at 2114 h at the Unidade de Conservação Refúgio de Vida Silvestre Mata do Junco, municipality of Capela, State of Sergipe, Brazil (10.291037°S, 36.58370°W, 120 m elev. SAD 69), an adult R. jimi (167.5 mm SVL) was observed parasitized by five ticks of the species Amblyomma rotundatum (Fig. 1A). Three of the ticks were fixed on the posterior part of the toad's dorsum (Fig. 1B), and the other two ticks were located in the inguinal region between the folds of the rear legs. Amblyomma rotundatum, known as Toad Tick, has been reported to parasitize a variety of amphibians (Ahid et al. 2009. Rev. Bras. Zool. 11[2]:153–158; Guglielmone and Nava 2010. Zootaxa 2541:27–49; Rodrigues et al. 2010. Rev. Bras. Parasitol. 19[3]:174–178; Woehl 2002. Rev. Bras. Zool. 19[2]:329–333). Amblyomma rotundatum is native to Central and South America, but has been found in North America, where it was introduced via Rhinella marinus (Boffy and Santos 2010. Herpetol. Rev. 41:342–343; Rodrigues et. al. 2010, *op. cit.*).

The ticks are deposited in Coleção do Laboratório de Entomologia (ENTUFS 00001) and the toad in Coleção Herpetológica da Universidade Federal de Sergipe (CHUFS C 1248). This is the first report of parasitism of *R. jimi* by *A. rotundatum* and the first report of ticks parasitizing amphibians in the State of Sergipe.

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FIG. 1. A) Adult *Rhinella jimi* (167.5 mm SVL) parasitized by the tick, *Amblyomma rotundatum*. B) *Amblyomma rotundatum* attached to the dorsum of *R. jimi*.

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***RHINELLA MARINA* (Cane Toad). DIET.** Although the invasive Cane Toad's diet in Australia consists primarily of insects, vertebrates are occasionally ingested (Lever 2001. The Cane Toad. Westbury, Otley). Herein we report on predation by the Cane Toad on a nestling bird. As part of a larger study, LP collected a large female *Rhinella marina* (SUL 95 cm) on 1 Dec 2008, from the grounds of Walkabout Palms Caravan Park, Townsville, Queensland (19.3166°S, 146.8°E; WGS 84). Examination of the stomach contents from this specimen revealed one large beetle, and one nestling bird (Fig. 1). The bird was a House Sparrow, *Passer domesticus*, also an invasive species in Australia. These birds are cavity nesters, therefore it is likely the nestling somehow fell from the nest, or perhaps fledged prematurely. *Passer domesticus* nestlings fledge around 14 days of age (Lowther et al. 2006. The Birds of North America Online doi:10.2173/bna.12), and based on feather emergence the bird was approximately 11–12 days old. The nestling had a total body length (tip of bill to tail bud) of 50.7 mm, and was 15.6 mm at its widest point. *Passer domesticus* is commonly found in urban settings, and often uses cavities in buildings for nesting. To the best of our knowledge this is the first documentation of *R. marina* eating an invasive bird in Australia.

We thank the Australian Museum for assistance with the bird identification.

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FIG. 1. Female *Rhinella marina* with stomach contents of a nestling *Passer domesticus* and beetle.

TESTUDINES — TURTLES

***APALONE MUTICA* (Smooth Softshell). DIET.** Information on the diet of *Apalone mutica* in the Mississippi River is scanty. Routine fish surveys with trammel nets (Vogt 1983. Copeia 1980:368–371) in Cassville Slough, a side channel in Grant Co., Wisconsin, USA, resulted in the collection of 34 *A. mutica* during the period 2005–2011. We obtained gut contents from 17 adult females (carapace length: 239–301 mm, mean = 261 mm; mass: 0.97–2.22 kg, mean = 1.47 kg) that had died in the nets (living turtles were released), including at least one turtle from each year. Eight of the Cassville turtles were collected in late June, and the remaining nine in early August. Unpublished data were also available for a female (179 mm; 0.45 kg) collected in a fyke net in Devil's Run of the Fountain City Bay backwaters, Buffalo Co., Wisconsin (26 June 1975), and a male (182 mm; 0.40 kg) collected by seining in the Weaver Bottoms, Wabasha Co., Minnesota (24 August 1976) during a study of *A. spinifera* (Cochran and McConville 1983. J. Herptetol. 17:82–86).

Gut contents of *A. mutica* were dominated by aquatic insects. Sixteen of 17 turtles from Cassville Slough contained naiads of the large burrowing mayfly *Hexagenia*. Minimum counts in individual turtles, based on counts of head capsules or tusks, ranged from 10 to 151 (mean = 66.4). One of the Cassville turtles in August also contained remains of at least three adult *Hexagenia*. Two of the Cassville turtles each contained a caddisfly larval case, and one of these two also contained 17 pupae. One Cassville turtle contained a dragonfly naiad. The turtle from Devil's Run contained 7 *Hexagenia*, two dragonfly naiads, and 71 caddisfly larvae (many cases of sand grains or of leaf fragments had been swallowed whole), whereas the turtle from the Weaver Bottoms contained 23 caddisfly larvae, one dragonfly naiad, 15 chironomid larvae, and three unidentified insects.

One Cassville turtle contained a small crayfish (young-of-the-year), and ten contained the remains of small mollusks. One had eaten two helical snails (1–2 mm), six had eaten native mussels (< 1cm), and five had eaten Zebra Mussels (*Dreissena polymorpha*). Two turtles contained both native and zebra mussels. Most shells were unbroken, but shell fragments were present in five turtles.

Our results are consistent with some previous reports but provide new details. Although the importance of aquatic insects, including ephemeropterans, in the diet of *A. mutica* has been noted previously (e.g., Williams and Christiansen. 1981. J. Herptetol. 15:303–308), few studies have specifically mentioned *Hexagenia*. *Hexagenia* are abundant in many large aquatic habitats, including the upper Mississippi River (Fremling 1960. Iowa St. Univ. Agr. Home Econ. Exp. Sta. Res. Bull 482:842–852), where they are a major component of the diet of *A. spinifera* (Cochran and McConville, *op. cit.*). However, *Hexagenia* are also indicators of good water quality (Fremling 1964. Science 146:1164–1165); they declined in abundance historically in areas that were polluted or otherwise degraded and at least sometimes have reappeared when conditions ameliorated (Cochran and Kinziger 1997. Great Lakes Entomologist 30:89–92). Previous diet studies based on *A. mutica* collected in degraded habitats would not be expected to have found *Hexagenia* in great numbers.

Zebra Mussels have not been reported previously in the diet of *A. mutica*, but most studies pre-dated the colonization of the Mississippi River drainage by this exotic invasive species during the 1990s (McMahon and Bogan 2001. *In* J. H. Thorp and A. P. Covich [eds.], Ecology and Classification of North American Freshwater Invertebrates, 2nd ed., pp. 331–429. Academic Press, San Diego, California).

Unlike some previous surveys, we did not find terrestrial prey items in the diet of *A. mutica*. However, our samples were dominated by females caught in nets set in relatively deep, mid-channel habitat. Plummer and Farrar (1981. J. Herptetol. 15:175–179) noted that, unlike males, females foraged primarily in deep water and fed primarily on aquatic prey.

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***GOPHERUS AGASSIZII* (Desert Tortoise). BURROW COLLAPSE.** In the deserts of the southwestern U.S., burrows are utilized by the Desert Tortoise to escape environmental extremes (reviewed by Ernst and Lovich 2009. Turtles of the United States and Canada. 2nd ed. Johns Hopkins Univ. Press, Baltimore, Maryland. 827 pp.). However, the potential for mortality through burrow collapse and entrapment is poorly documented. Nicholson and Humphreys (1981. Proceedings of the Desert Tortoise Council, pp. 163–194) suggested that collapse due to livestock trampling may cause mortality. In addition, Lovich et al. (2011. Chelon. Cons. Biol. 10[1]:124–129) documented a Desert Tortoise that used a steel culvert as a burrow surrogate. The culvert filled completely with sediment following a significant rain event, entombing the animal and ultimately resulting in its death. We note that this mortality was associated with an anthropogenic structure; because tortoises are prodigious diggers, one might hypothesize that they have the ability to dig out of collapsed natural burrows in most situations. Circumstances described here presented us with an opportunity to test this hypothesis.

On 5 January 2011, we observed four occurrences of adult telemetered Desert Tortoises (one male and three females) hibernating in separate burrows that collapsed at our study site on a utility-scale renewable energy wind farm (33.95168ºN, 116.667295ºW; WGS84) in southern Riverside Co., California, USA. In mid December 2010, winter rainstorms in southern California caused the partial collapse of several burrows distributed throughout the study site (Fig. 1). Wet soil above the mouth of the burrows slumped into the openings blocking the entrance. The lengths of the collapsed segments were not measured relative to total burrow length but each completely occluded the burrow opening. The collapsed burrows were not located near any anthropogenic structures.

One Desert Tortoise, a female (CL = 25 cm, mass = 2950 g), was found (5 January) covered with dirt outside of a collapsed burrow from which she presumably extricated herself. By 5 May 2011, this individual had been relocated five times, producing two clutches of eggs, suggesting normal behavior unaffected by the temporary entombment. The second female (CL = 25 cm, mass = 3100 g) also successfully dug out of her collapsed burrow at some point in early February, and by 6 May 2011, had been relocated three times exhibiting normal behavior. The third female tortoise (CL = 23.3 cm, mass = 2750 g) began excavating her burrow, as observed by one of the authors while peering into a small opening in the dirt, but did not complete the process until early April 2011. By 5 May 2011 she has been relocated three times. By mid-April the last tortoise (male, CL = 32.8, mass = 6275 g) was still inside his collapsed burrow, on the right side of center of the original opening (from observer's perspective), apparently unable to extricate himself. A different female tortoise (separate from those above) began excavating into the left side of this male's burrow (from the outside) but did not complete the process. During the course of the spring the soil surrounding the male dried to an adobe-like consistency. On 14 April 2011, one of the authors used a shovel to remove soil from the top and left side of the male. Even with the body partially exposed, the tortoise was so firmly embedded in the soil that he could not be lifted out without digging away more soil on the right side of the body. The tortoise was completely encased in hard loamy soil with no space for moving the head, limbs, or body, exactly as the tortoise reported by Lovich et al. (*op. cit.*). It is our opinion that this animal would have remained entombed and would have died if not excavated.

PHOTO BY J. ENNEN

FIG. 1. A burrow of *Gopherus agassizii*, approximately 30 cm wide, caved in following winter rains in December 2010. The burrow depicted was the domicile of the third female to excavate herself (April 2011).

Because of the conditions under which the natural burrows collapsed, the survival of the three female tortoises contrasts with the impending mortality of the male observed in this study. This is likely due to the fact that the females were not entombed in burrows oriented so as to allow the sun to bake the collapsed soil. When entombed under these conditions it appears that some tortoises may be unable to free themselves. Given the digging prowess of Desert Tortoises we hypothesize that this is not a frequent cause of mortality. However, temporary entrapment may result in physiological stress or late egress that translates into a delayed or complete loss of opportunity for early spring feeding and reproduction.

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***GRAPTEMYS FLAVIMACULATA* (Yellow-blotched Map Turtle). UNIQUE AERIAL BASKING BEHAVIORS.** The genus *Graptemys* (Emydidae) is the most diverse genus of North American turtles, with most species occurring within river systems that drain into the Gulf of Mexico (Lindeman, *in press*. The Map Turtle and Sawback Atlas: Ecology, Evolution, Distribution, and Conservation of the Genus *Graptemys*). One of these species, *G. flavimaculata*, is

a small species endemic to the Pascagoula River system of southeastern Mississippi, USA (Selman and Qualls 2009. Herpetol. Cons. Biol. 4:171–184). This species is most commonly observed basking aerially, with high basking densities associated with river bends and associated emergent deadwood snags that provide basking platforms (Lindeman 1999. Biol. Cons. 88:33–42). I report on two unique basking behaviors observed in *G. flavimaculata* (Leaf River, Forrest Co., Mississippi): 1) extensive shuttling on/off basking structures, and 2) head dipping into the water. To the best of my knowledge, neither of these behaviors have been reported in this species, with the first rarely reported in other species and the second reported for only one other turtle species, *Trachemys scripta scripta* (Auth 1975. Bull. Florida State Mus., Biol. Sci. 20:1–45.).

On 20 June 2007, a female *G. flavimaculata* was observed shuttling on and off the same log eight times (1343–1511 h) for a total basking time of 74 minutes out of 88 total minutes (Table 1); unfortunately no data loggers were deployed at this time to collect temperature data. On 10 September 2007, a juvenile female shuttled eight times on and off different branches and tangles (0857 and 1400 h), for a total basking time of 163 minutes out of 303 total minutes. Lastly, a male individual was noted on 8 April 2008 to shuttle 9 times between a log and floating log (0939 and 1305 h), for a total time of 147 minutes out of 206 total minutes. Observations 2 and 3 had temperature data associated with behaviors (Table 1).

Basking turtles were also observed on multiple occasions head dipping in the water before submerging. This behavior was observed twice on 17 July 2007 with two different individuals (one male, one female). Before they returned to the water, both individuals dipped only their heads under the water surface. The male did this twice at 1020 h and then returned to the water following 141 minutes of basking; the female did this once for approximately 15–20 sec before submerging after basking for 138 minutes. During the week prior to these observations, the Leaf River basin received several inches of rain causing water levels to be abnormally high and water temperatures to be unseasonably cool for July. Another observation of this behavior was made on 7 May 2008 when a male *G. flavimaculata* submerged the anterior portion of his body while his hindlimbs were clinging to the basking structure. During the 1–1.5 minutes exhibiting this behavior, he raised his head out of the water twice and then submerged. Environmental temperatures for all three observations are described in Table 1.

Extensive shuttling behavior exhibited by *G. flavimaculata* has not been previously reported. Presumably this behavior allows basking individuals to thermoregulate on a fine scale, as the temperature data indicate that optimal body temperatures appear to fall within a relatively narrow window between the water [WT] and ambient air [AT]/log temperatures [LT]. During the two observations with associated temperature data, WT and AT were initially similar, but log temperature was higher than WT. By the end of the observations, both AT and LT increased considerably and were warmer than WT. A study with a similar species, *Graptemys geographica* (Bulté and Blouin-Demers 2010. Oecologia 162:313–322), found that individuals operated within a fairly narrow range of body temperatures throughout the day and individuals could raise their body temperatures well above water temperatures, thus playing a critical role in thermoregulation. Further, the three observations occurred across most of the active season of this species (April, June, September) and with different sizes/sexes, thus indicating that this behavior is not limited to a particular season and/or sex.

To the best of my knowledge, head dipping behavior has only been described in one study with *T. s. scripta* (Auth 1975, *op. cit.*) with little discussion of the behavior. From these observations, head dipping appears to be either 1) a thermal "test" of the water temperature prior to submergence, or 2) a method to gain olfactory cues of the nearby environment (i.e., detect conspecifics, predators, prey items). However, it is unclear if "water testing" is a better explanation than olfaction due to the inability to determine underwater conditions (i.e., presence of a predator). "Water testing" could be plausible as cooler WT relative AT or LT was documented, but one might expect this to occur more often due

TABLE 1. Description of extensive shuttling and head dipping behaviors with *Graptemys flavimaculata* (Yellow-blotched Sawback). Water (WT), ambient air (AT), and sunlit log (LT) temperatures describe the environmental conditions.

Date, sex of individual (shuttling [S], head-dipping [HD])	Initial emergence time	Initial final WT (°C)	Initial final AT (°C)	Initial final LT (°C)	Basking duration for each time individual emerged (in minutes)									Final submergence time
					1	2	3	4	5	6	7	8	9	
20 June 2007, female (S)	1343	n/a	n/a	n/a	17	13	10	8	5	7	8	6		1511
10 Sept 2007, juv female (S)	0857	26.9–29.4	26.6–32.2	28–33.6	80	9	52	19	8	8	29	31		1400
8 April 2008, male (S)	0939	20.1–24.4	19.0–26.2	22.5–32.4	3	2	17	9	39	2	1	2	72	1305
17 July 2007, male (HD)	n/a	24.7	28.3	31.4										n/a
17 July 2007, female (HD)	n/a	26.5	27.1	27.7										n/a
7 May 2008, male (HD)	n/a	24.7	27	30										n/a

to WT usually being cooler than AT/LT during the active months. Similarly, nesting female turtles have been observed "nuzzling" the ground (i.e., placing their head and chin on the soil surface) while on nesting forays, possibly to 1) gain olfactory cues to detect a better nest site, or 2) sense the texture, temperature, or moisture content of nesting substrate (Moore 2003. M.Sc. thesis, Southeastern Louisiana University, Hammond, Lousiana. 72 pp.; Morjan and Valenzuela 2001. J. Herpetol. 35:668–672). If head dipping and nuzzling are to test for water/soil temperatures, this could indicate that the head region of turtles might be acutely sensitive to temperatures and/or have a higher concentration of temperature receptors relative to the rest of the body; this would need to be verified in future studies. If head dipping was for olfaction, underwater cameras or a more controlled environment with addition of stimuli (i.e., conspecifics, predators) might elucidate the reason for this behavior.

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***PODOCNEMIS EXPANSA* (Giant South American River Turtle). NESTING RANGE EXPANSION.** *Podocnemis expansa* is gregarious during nesting; even today, beaches are found in the Brazilian Amazon where hundreds of females might lay their eggs in a single night. The high consumption of this turtle's meat and eggs, as well as the ease with which it is captured, especially during nesting periods, has contributed to the decline in populations throughout its entire range and to extirpation in some places. Despite conservation and enforcement efforts, the species has been classified by the IUCN SSC FTTG as Critically Endangered (October 2010) (www.iucnredlist.org). Areas with high concentrations are well known, but regions at the limits of its range, where there are few individuals, are not yet completely known, partly due to difficult access and the extensive area where the species occurs.

In the Lower Xingu River there are known nesting sites for *P. expansa*, most notably on Embaubal beach (2.6784°S, 52.0186°W), in Senador José Porfírio (Pará state), but information is still lacking on the species' occurrence throughout this hydrographic basin. Here we report the first occurrence of *P. expansa* in the Upper Xingu River, although regional studies have indicated that this area is a potential habitat for the species (Pritchard and Trebbau 1984. The Turtles of Venezuela. Society for the Study of Amphibians and Reptiles, Caracas. 403 pp.). In 2010 we recorded and monitored the temperature of two *P. expansa* nests in the Xingu Indigenous Park (11.9346°S, 53.5298°W). These were the only nests found on the sandy beaches that are formed during the river's dry season throughout a monitored area of 13 km where *Podocnemis unifilis* frequently nests, and *Phrynops geoffroanus* do so less often. Nesting of *P. unifilis* in this area has been monitored since 2006, but it was only in 2010 that *P. expansa* nests were seen. *Podocnemis expansa* nesting occurred when the water level reached its lowest point, which is standard for this species.

We used data loggers (Ibuttons Maxim DSG1921G) to monitor the temperature throughout incubation, at 60-minute intervals. For the two nests, incubation lasted 65 and 78 days and the thermo-sensitive-period temperature (in the second third of the incubation period) was 29.4 ± 0.86°C (range = 28–31°C) and 28.7 ± 1.01°C (range = 26.5–32°C), respectively. These incubation temperatures and durations are compatible with the production of males (Lubiana and Ferreira Júnior 2009. Zoologia 26:527–533). Hatching success was 57% in one nest with 101 eggs and 52% in the other nest with 73 eggs. No predation attempts were recorded for the nests.

On 29 October 2010, a female was captured by one of the Indians while fishing with a hook and line near the same beach where the two nests were found. This female had a straight carapace length of 33.6 cm, straight carapace width of 25.5 cm, plastron length of 28.1 cm, plastron width of 19.8 cm and weight of 3.38 kg. Tissue was collected from this individual for comparative genetic analysis with individuals from other regions in the future. The Indians confirmed that they do occasionally capture *P. expansa* when fishing. During the same incubation period in 2010 our group also saw *P. expansa* tracks on at least two other beaches in the area.

Reports from indigenous people suggest that *P. expansa* was introduced in the 1960s, when the Xingu Indigenous Park was created, by its founders and some indigenous people. These animals came from populations on the Ilha do Bananal, in the Araguaia River, in São Felix do Araguaia (Mato Grosso state). The animals were released at about 20 km upstream from the site where we observed the nests. Their introduction had been to provide an additional food source, mainly because the Indians of that region very much appreciate the meat and eggs of *P. unifilis*. In the 1980s a new release of young *P. expansa* took place in rivers in the Upper Xingu. This time the individuals were from Rio das Mortes (Mato Grosso) (Vera Lúcia Ferreira Luz, Environmental Analyst, Head of RAN/ICMBio, pers. comm.). On both occasions the translocation of animals was carried out without considering the species' ecological needs and without approval from the relevant environmental entities. There are various signs that the information about the introduction of the species may be reliable: the apparent rarity of *P. expansa* in the region; the lack of knowledge among the indigenous peoples of the nests and nesting sites; few reports of adult individuals being captured; scant knowledge of the capture techniques used for the species; the fact that this species is not part of the traditional indigenous diet (while *P. unifilis*, common in the area, is an important food item); and the absence of this species in local myths and rites.

Knowledge of all nesting sites is important for the establishment of the species' range, especially in regions that have been only lightly affected by agricultural inroads and intensive fishing. The report of *P. expansa* in the Xingu Indigenous Park is important because of the large changes foreseen with the damming of the Xingu River to generate energy. Hydroelectric plants are planned upstream and downstream of this recorded site, and it is vital that the feeding and nesting areas of the species are known, to study the possible effects on their ecology caused by the change in the river's hydric regime. The genetic diversity of these individuals should be compared with that of turtles from other areas (principally in populations from the Lower Xingu and Araguaia River Basin). This will lead to a better understanding of the evolutionary dynamic of the species in the reported site and of its diversity distribution within this area at the limit of its range.

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CROCODYLIA — CROCODILIANS

***ALLIGATOR MISSISSIPPIENSIS* (American Alligator). JUVENILE SITE FIDELITY.** *Alligator mississippiensis* is a highly adaptable, aquatic species, occupying a wide range of habitats in the southeastern United States (Elsey and Woodward 2010. *In* Manolis and Stevenson [eds.], Crocodiles. Status Survey and Conservation Action Plan. 3rd ed., pp. 1–4. Crocodile Specialist Group, Darwin). One prior telemetry study conducted on Rockefeller Wildlife Refuge in southwestern Louisiana found minimum home ranges of 12.0–616.5 ha (average 177.5 ha) for 15 immature female alligators, and minimum home ranges of 24.5–604.5 ha (average 228.6 ha) for 11 immature male alligators (McNease and Joanen 1974. Proc. SE Assoc. Game Fish Comm. Conf. 28:482–500). A recent large tag and recapture study found some juvenile alligators can disperse long distances (one moved >90 km), although many marked alligators stayed within the shallow marsh impoundments within which they were originally tagged (Lance et al. 2011. Southeast. Nat. [in press]).

Four recent major hurricanes impacted coastal marshes in Louisiana (Katrina and Rita in 2005, and Gustav and Ike in 2008, with massive storm surges in some cases pushing alligators previously tagged and marked for research studies northward (Elsey et al. 2008. Southeast. Nat. 7:737–743). Similar findings were noted after Hurricane Audrey with alligators being swept northward 4.8–16.1 km; it was also noted that alligator movement increases when marshes are flooded due to excessive rainfall or storm tides, with immature alligators responding more to flooding than adults (Chabreck 1965. Proc. SE Assoc. Game Fish Comm. 19:102–110). In one extreme case, a juvenile alligator from a local alligator farm was tagged and released to the wild in southwestern Louisiana six weeks before Hurricane Ike and was apparently swept away in the storm surge and recovered in extreme south Texas, some 489 km from its release site (Elsey and Aldrich 2009. Southeast. Nat. 8:746–749). In contrast, we herein report on four juvenile alligators from a group of eleven that were in a holding pen at Rockefeller Wildlife Refuge at the time of Hurricane Ike. All were presumably displaced by the storm surge (ca. 244 cm), yet have been recovered in close proximity to the original pen site, possibly demonstrating strong site fidelity.

As part of the alligator management program in Louisiana, a large scale tag and release program has been underway to monitor the survival of alligators released to the wild from farms. More recently we have considered the use of telemetry to evaluate survival and movement in the initial months after release to the wild. A pilot study was initiated in 2007 to evaluate transmitter attachment, retention, and detection capabilities under near field conditions (Wiebe 2008. Unpubl. report, Louisiana Department of Wildlife and Fisheries. 21 pp.). For these purposes, a 0.28 ha outdoor holding pen was constructed in early 2008 near the Rockefeller Wildlife Refuge headquarters in Grand Chenier, Louisiana to hold native wild and farm-raised juvenile alligators. The pen was initially stocked with 17 farm-raised alligators (obtained on 12 March 2008 from a commercial alligator farm) and 10 native wild alligators. The telemetry units were attached to the nuchal scutes (Wiebe, *op. cit.*) and the alligators were released to the outside pen over the next two days. The alligators appeared to easily adapt to the new environment, but by 29 March we observed one of the alligators basking on a feeding platform was missing the telemetry unit; the nuchal scutes were visibly torn. This was unexpected as similar attachment methods have been used successfully in other crocodilians (Brien et al. 2010. Herpetol. Rev. 41:305–308; Kay 2004. Herpetol. Rev. 35:354–357). However, those were larger animals with far more prominent nuchal scutes, and the relatively flat scutes in juvenile alligators likely being a contributing factor in unit loss. Despite the alligators readily accepting feed and exhibiting no evidence of intraspecific conflicts, loss of telemetry units continued to be a problem.

Over the next few months the pen was pumped dry and attempts were made to recover the animals and reattach telemetry units more securely (Wiebe 2008, *op. cit.*). On 20 May we replaced eleven of the alligators (previously farm-raised, mean total length 126 cm) back in the outside pen for further monitoring, each with one telemetry unit held in place by cables passing under the nuchal scutes and one attached to the tail.

Soon thereafter, Hurricane Ike impacted the region when it struck near Galveston Island, Texas on 13 September 2008, as previously detailed (Elsey and Aldrich, *op. cit.*). The storm surge at Rockefeller Refuge was estimated to be 244 cm and likely overtopped the fencing of the outside alligator enclosure, allowing alligators to escape or unwillingly be carried northward with the storm surge. We made a cursory inspection of the flooded pen area (accessible only by airboat) on 18 September, and could readily see loss of integrity to some areas of the fence, presumably allowing alligator escape. Refuge staff members were displaced from this site for several weeks due to localized flooding, lack of electricity, and general loss of infrastructure; thus we were unable to immediately monitor the fate of the eleven alligators that were in the pen at the time of Hurricane Ike's landfall.

On 15 October 2008, while doing landscape work in a pasture, an employee incidentally observed one of the alligators resting on a bank near a parked excavator. The alligator appeared well and was some 125 m from the enclosure (Fig. 1A). On a routine search for any remaining alligators that might still be within reception range, a second escaped/displaced alligator was recovered on 20 November 2008, using signals from the functioning telemetry unit(s) for guidance. This alligator was observed on floating vegetation, was then captured in good condition, and was determined to be ca. 135 m from the holding pen (Fig. 1B). With time, it became apparent many units were not functioning, possibly due to poor transmission in brackish water, loss of battery life, or damage due to saltwater corrosion after the

hurricane. Six months later, while catching wild alligators on 20 May 2009 for another research project, another of the 11 telemetered alligators was caught; it was recovered some 425 m (Fig. 1,C) from the outside holding pen site.

On 6 May 2011, an alligator was observed at ca. 1725 h basking near the refuge headquarters by one of us (RME) and the two missing tail notches were evident (suggesting it was an alligator released from a farm, Elsey et al. 2001. *In* Seebacher and Franklin [eds.], Crocodilian Biology and Evolution, pp. 426–441. Surrey Beatty and Sons, Chipping Norton, NSW). This prompted us to take some photographs for educational presentations and to possibly identify the year the alligator was released, due to the year-specific combination of tail notches used. One of us (WS) was able to identify the fifth and seventh tail scutes as having been removed (this "EG" tail notch identified it as a 2008 year release alligator). Upon closer observation, WS noted a telemetry unit was attached to the alligator's tail (Fig. 2). The site was some 475 m from the original holding pen (Fig. 1D), from where the alligator presumably escaped during Hurricane Ike, some 964 days earlier.

The following evening at ca. 1700 h, a similar-sized telemetered juvenile alligator with tail notches was again observed basking in nearly the same location. It was captured and appeared in excellent condition and both web tags in the feet were still present. The alligator was 167 cm in total length, compared to 127 cm when it was first measured on 12 March 2008. The alligator was released at the same site, and presumably the same alligator has been observed several times basking near the release site since (tail notches and telemetry unit on tail clearly seen).

Alligators have been shown to have a strong homing instinct (Chabreck, *op. cit.*; Rodda 1984. Behav. Ecol. Sociobiol. 14:241–246) as have other crocodilians (Read et al. 2007. PLoS ONE 9:1–5; Walsh and Whitehead 1993. Wildl. Res. 20:127–135; Webb et al. 1983. Aust. Wildl. Res. 10:403–406). It is unclear if the four juvenile alligators herein described were swept northward by the massive storm surge of Hurricane Ike and then returned, or if they were able to seek refuge in dens or burrows and avoid displacement. After the even more catastrophic Hurricane Rita in 2005, we documented (Elsey et al., *op. cit.*) a similar finding in 2007 of adult female alligators at nest sites within 20 m and 170 m of their prior nests sites (from seven years and three years earlier, respectively). Again it is unknown if this demonstrated a strong homing instinct if the alligators had been displaced, or if they remained on site despite the flooded conditions and high salinity environment post-hurricane.

The juvenile alligators in this study may have remained near the original pen site or returned to this area due to proximity to aquaculture fish ponds near the refuge headquarters, which provide permanent fresh water and seasonally available prey when ponds are stocked with fish fry or fingerlings. It is somewhat surprising however that the alligators remained in an area of relative high activity (despite being rural, all were located in very close proximity to the refuge headquarters, and were exposed to frequent vehicular traffic). Of note, staff had not (to our knowledge) observed marked alligators at the site where the most recently encountered alligator was seen, despite being immediately adjacent to a field work shop, perhaps suggesting the alligator recently returned to this site.

It also may be that alligators raised their entire life in a commercial farm setting are less likely to demonstrate a homing instinct, as reported in wild alligators after translocation (Chabreck, *op. cit.*). The alligators used in this study were obtained from a farm some 60 km west of the study pen site but to our knowledge made no attempts to return to that location. A short-term telemetry study likewise showed 75 of 78 farm-raised alligators and 43 of 44 native wild juvenile alligators dispersed less than 5 km from the release site or site of origin (Addison 1993. MS thesis, Louisiana State University, Baton Rouge, Louisiana. 79 pp.).

FIG. 1. Aerial map showing locations of four juvenile alligators relative to the original holding pen. Dates of recovery as noted in the text.

FIG. 2. The fourth alligator recovered, here seen basking on 6 May 2011. The telemetry unit is clearly visible on the tail.

It is of interest why some alligators seem to move extensively despite abundant, locally available quality habitat, while others remain within a relatively small area with little tendency to disperse. Individual behavior patterns of crocodilians may be an area for future studies.

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SQUAMATA — LIZARDS

***AMEIVA AMEIVA* (Giant Ameiva). PREDATION.** *Ameiva ameiva*, a diurnal teiid lizard widely distributed across Central and South America, ranges from Panamá to Argentina (Vanzolini et al. 1980. Répteis das Caatingas, Acad. Bras. de Cienc., Rio de Janeiro; Vitt and Colli 1994. Can. J. Zool. 72:1986–2008; Sartorius et al. 1999. Biol. Cons. 90:91–101). Hawks, owls and snakes are well-known predators of *A. ameiva* (Santos and Germano 1996. Herpetol. Rev. 27:143; Tozetti et al. 2005. Herpetol. Rev. 36:443–444; Granzinolli et al. 2007. Herpetol. Rev. 38:449), but few published reports of predation by mammals exist. Rocha and Vrcibradic (1998. Cienc. e Cult. 50:364–368) reported predation by the Four-eyed Opossum (*Philander frenata*); no reports involve armadillos. Hence, we add to the predator set reported for *A. ameiva* with an observation of predation by the Nine-banded Armadillo (*Dasypus novemcinctus*).

At 2205 h on 23 October 2008, we observed a *D. novemcinctus* prey on an *A. ameiva* while traveling a dirt road near the city of Miranda, Mato Grosso do Sul, central-west Brazil (20.07833°S, 56.32444°W, datum: WGS84; elev. 177 m). The event occurred in vegetation best described as upland Pantanal savanna. As soon as we stopped the car, a *D. novemcinctus* that had just been observed crossing the road began to forage in leaf litter beneath shrubs about 5 m off the road. Within seconds, it attacked an adult male *A. ameiva* (101 mm SVL, 268 mm tail). The attack lasted less than a minute, with the armadillo killing its prey with its mouth and foreclaws. When we approached, the *D. novemcinctus* abandoned its prey and fled. Bite wounds had been inflicted to the left shoulder and the right thigh of the *A. ameiva*.

Armadillos are opportunistic, preying principally on invertebrates, but occasionally consume small vertebrates like amphibians and reptiles and other items such as plant material (Galbreath 1982. *In* J. A. Chapman and G. A. Feldhamer [eds.], Wild Mammals of North America, pp. 71–79. Johns Hopkins Univ. Press, Baltimore, Maryland). This is the first documented predation of *A. ameiva* by an armadillo.

FIG. 1. *Ameiva ameiva* being predated by nocturnally foraging Nine-banded Armadillo (*Dasypus novemcinctus*).

The *Ameiva ameiva* specimen was deposited at the Coleção Herpetológica do Museu de Zoologia da Universidade Federal da Bahia (MZUFBA–LAG1329). Jeff King and Ryan Watson provided helpful suggestions.

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***ANOLIS* SPECIES. FRUGIVORY.** Frugivory has been reported for more than 200 species of lizards (Valido and Olesen 2007. In A. J. Dennis, E. W. Schupp, R. A. Green, and D. A. Westcott [eds.], Seed Dispersal: Theory and its Application in a Changing World. CAB International), including 17 species of the genus Anolis (Herrel et al. 2004. Oecologia 140:160–168). In Puerto Rico, the consumption of fruits has been reported for two intermediate sized Anolis species, A. evermanni (Lister 1981. Ecology 62:1548–1560; Reagan 1996. In Reagan and Waide [eds.], The Food Web of a Tropical Rain Forest, pp. 321–345. Univ. of Chicago Press, Illinois) and A. monensis (Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies. University of Florida Press, Gainesville, Florida), and for the giant species A. cuvieri (Losos 1990. Carib. J. Sci. 26:65–66; Perez-Rivera 1985. Carib. J. Sci. 21:101–103). Aside from reports of seeds from stomach content analyses or fecal pellets of these three species, little is known about frugivory in Anolis from Puerto Rico. Here, we report incidental observations of frugivory for another three Anolis species of small to intermediate size.

On 5 May 1998, between 0900 and 0930 h, we observed an individual of *A. stratulus* picking and carrying away a single sweet and sticky fruit of the Wild Balsam Apple (*Momordica charantia*) in a shaded coffee plantation at the north-central part of the island. The fruits of the Wild Balsam Apple are dark yellow to orange when ripe and split open to reveal several seeds 12–16 mm long, covered with a red flesh (Acevedo-Rodríguez and Woodbury 1985. The Vines of Puerto Rico Vol. 1: 202). *Anolis stratulus* also has been reported consuming intra- and extra-floral nectar (Perry and Lazell 1997. Herpetol. Rev. 28:150–151; Ríos-López 2004. Herpetol. Rev. 35:386).

During the morning of 16 April 1999, we observed an individual *Anolis gundlachi* eating fruits of Red Palicourea (*Palicourea crocea*) at the Río Abajo State Forest in the northern kasrt region of Puerto Rico. These fruits are ovoid to globose, 4–6 mm in diameter and dark red, purple, or black (Liogier 1997. *In* Descriptive Flora of Puerto Rico and Adjacent Islands. Vol. 5. Editorial de la Universidad de Puerto Rico, San Juan, PR. 436 pp.). This same day we observed a male *A. krugi* consuming the white fruits of a stinging nettle (*Urera baccifera*). These fruits are white or pinkish, spongy, and watery (Little et al. 1974. *In* Trees of Puerto Rico and the Virgin Islands. Vol. 2. Agriculture Handbook 449. U.S. Department of Agriculture, Washington, DC. 1024 pp.). Both lizards picked the fruits and ingested them while perching in the respective plants. The report for *A. krugi* represents the first for a grass-bush anole eating fruits (Losos 2009. Lizards in an Evolutionary Tree: Ecology and Adaptive Radiation of Anoles. University of California Press, Berkeley. 507 pp.).

Body sizes, as well as ecological factors such as food limitation, low predation pressures, and high lizard densities, have been proposed to explain frugivory by lizards within insular ecosystems (see Valido and Olese, *op. cit.*; Herrel et al., *op. cit.*; Olesen and Valido 2003. Trends Rev. Ecol. Evol. 18:177–181). Our observations suggest that frugivory in small-sized lizards (size range 40–63 mm) might be of ecological importance in nature. Detailed studies are needed in order to better understand the factors that determine frugivory in *Anolis* lizards, as well as their potential role as seed dispersers. Given that *Anolis* lizards occur at high densities in Caribbean Islands, omnivory and seed dispersal by these lizards must be important in energy and mass flow as well as in the succession and regeneration of tropical forests.

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***ATLANTOLACERTA ANDREANSKYI* (Atlas Dwarf Lizard). ABNORMAL SCALATION.** In snakes and lizards, femoral glands produce secretions used for intraspecific communication. These secretions may reveal chemical information including self-recognition, conspecific discrimination, marking of territories, male dominance status, and reproductive condition (Houck 2009. Annu. Rev. Physiol. 71:161–76; Martin et al. 2007. Ecology 21:568–576). Although there have been several reports of supernumerary femoral pores in lacertid lizards (Kaliontzopoulou and Carretero 2006. Herpetol. Rev. 37:470–471), this is the first observation of total absence of femoral pores.

During an extensive survey, we studied the morphology of 142 individuals (males and females) from seven localities across the distribution of *Atlantolacerta andreanskyi*, a high-altitude endemic lacertid from the Atlas Mountains, Morocco. In this species adult males typically exhibit enlarged femoral pores when compared with other lacertids (e.g., *Podarcis*) and the two rows of femoral pores come into contact at the base of the ventral scales, while in females, as in most lacertids, they are significantly smaller (Arnold and Ovenden 2002. A Field Guide to the Reptiles and Amphibians of Britain and Europe. Ed. Collin, 288 pp.) and the two rows are not in contact (Fig. 1). Interestingly, of 70 female individuals studied, 16% had incomplete rows and 56% did not possess any femoral pores (Fig. 2), while all males surveyed exhibited a normal development of the femoral pores. This observation was common and present in all the populations. Busack (1987. Amphibia-Reptilia 8:231–236) estimated mean adult body size of this species at 41.9 mm SVL with females with oviductal eggs ranging 44–53 mm SVL (N = 8), indicating that all individuals analyzed in our study were adults. Interestingly, the median size of the females analyzed with no femoral pores (47.8 mm) was slightly larger than the females with femoral pores (44.8 mm) (Busack, *op. cit.*).

Kaliontzopoulou and Carretero (*op. cit.*) reported accessory femoral pores in one specimen of the lacertid, *Podarcis bocagei*. The authors suggested environmental stress as a cause of this abnormality because the animal was found in a cornfield where pesticides were commonly used. Because *A. andreanskyi* occurs only at altitudes above 2000 m, in widely isolated populations with limited distributions, environmental stress seems unlikely to be the cause. Instead, factors such as isolation and inbreeding might be involved, as suggested by Walker (1980. J. Herpetol 14:417–418). In Walker's (*op. cit.*) observations, the abnormalities were found in both sexes, while we found it present only in females. This fact might be due to selective pressures acting on males and related to sexual selection. Femoral pore secretions produced are directly related to the levels of circulating androgens (Houck, *op. cit.*) and they have been proposed to be the basis of female mate choice, being important in individual male recognition and dominance status, and related to a higher reproductive success (Houck, *op. cit.*).

FIG. 1. Female specimens of *Atlantolacerta andreanskyi* from Oukaimeden, Morocco (left and right). White arrows show the femoral pores.

FIG. 2. Female specimens of *Atlantolacerta andreanskyi* from Tamelt-elt (on the left) and Tizin-Tichka (on the right), High Atlas, Morocco. The black arrows show the place were the row of femoral pores should be.

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***CERCOSAURA ARGULUS* (Elegant Eyed Lizard). ARBOREAL BEHAVIOR.** *Cercosaura argulus* is a relatively uncommon inhabitant of the Amazonian forest (Avila-Pires 1995. Zoologische Verhandelingen Leiden 299:1–706). It is most commonly encountered in leaf litter (Vitt et al. 2003. Can. J. Zool. 81:302–312), but was documented up to 1.5 m on low vegetation by Vitt et al. (*op. cit.*) and up to 2.0 m by Duellman (2005. Cusco Amazonico. Comstock Publishing Associates, Ithaca, New York. 433 pp.).

On 20 March 2011, an adult specimen of *Cercosaura argulus* was captured at approximately 2145 h on the ground during a routine quadrat search at Sachavacayoc Centre, Tambopata

Province, Madre de Dios, Peru (12.86250°S, 69.36566°W; 94% relative humidity; 23.4°C ambient temperature). The animal was likely disturbed while sleeping and was caught while crawling through leaf litter. At approximately 2210 h the lizard was released near the base of a tree that measured ca. 43 cm DBH. The lizard walked briefly around the base and then started to climb directly up the trunk of the tree. Unlike most rainforest trees, this tree did not have buttresses, but had a straight trunk that was covered by foliose lichens, presumably making the surface texture easier to climb. We watched and video recorded the lizard for approximately 30 min., during which time the lizard slowly, steadily climbed straight up the trunk to over 10 m in height, stopping occasionally and then continuing to proceed. After the 10 m mark we lost sight of the lizard as it continued its upward climb. No previous records exist of a *C. argulus* climbing to such a height.

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***CROTAPHYTUS COLLARIS* (Eastern Collared Lizard). COMMUNAL BRUMATION.** *Crotaphytus collaris* can be found in appropriate habitat throughout central and western United States and northcentral Mexico. Southwestern Colorado and southeastern Utah represent the northwestern limits of the range of *C. collaris*. At 1545 h on 16 April 2011 with an air temperature of 16°C, three adult male *C. collaris* were observed in aggregation emerging from brumation from a hibernaculum opening on a south-facing rocky slope in extreme western La Plata Co., Colorado, USA, ca. 5.8 km W of Red Mesa, Colorado (1995 m elev.) (Fig. 1). The habitat at this site is pinyon-juniper woodland with expanses of agricultural land. Because weather prior to this observation had been unseasonably cold, it is very likely that 16 April was the first date of emergence for these lizards. The lizards spent considerable time basking at the burrow site, occasionally moving back and forth from the entrance. Occasional territorial posturing was observed, but for the most part they appeared uninterested in intraspecific interactions. The lizards were observed during a 1 h period.

The same site was revisited at 1150 h the next day (17 April) with an air temperature of 20°C. Three adult male *C. collaris* were seen again at the entrance and in close proximity to the same hibernaculum opening. It is presumed that, based on color pattern differences, these three males were the same as those observed the day prior. Again there was little activity over a 2 h observation period, although occasionally a single lizard would enter the burrow opening and re-emerge after several minutes. To our knowledge, observations of communal brumation for this lizard are unreported.

FIG. 1. Three adult male *Crotaphytus collaris* at the entrance of a communal hibernaclum during spring emergence at a rocky outcrop in western La Plata Co., Colorado, USA.

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***CTENOSAURA OEDIRHINA* (Roatan's Spiny-tailed Iguana). LIMB REGENERATION.** Limb regeneration has been observed in *Lacerta, Liolaemus,* and *Sceloporus* (Bellairs and Bryant 1985. *In* C. Gans and F. Billett [eds.], Biology of the Reptilia, Volume 15, Development B, pp. 387–392. John Wiley & Sons, New York). Here I report on the first case of this observation within Iguaninae.

On 20 October 2010, an individual *Ctenosaura oedirhina* was captured at Gumbalimba Park and Reserve on the western end of Roatan Island, Islas de la Bahia, Honduras (16.282883°N, 86.595083°W). The right hind limb of the individual appeared to be regenerated and looked much like that of a regenerated tail (Fig. 1). This individual was of normal size and did not seem to be disadvantaged by this deformity. Photos have been deposited under USNM Herp Image 2731, 2732.

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FIG. 1. *Ctenosaura oedirhina* with a regenerated hind limb, observed at Gumbalimba Park and Reserve, Roatan, Honduras.

***CTENOSAURA OEDIRHINA* (Roatan Spinytail Iguana). ENDOPARASITES.** *Ctenosaura oedirhina* is known only from Isla de Roatán, Isla de Santa Elena, Isla Barbaretta, and various small islets around Roatán, Honduras (Pasachnik et al. 2010. *In*: IUCN Red List of Threatened Species. Version 2010.4. www.iucnredlist.org; accessed 18 April 2011). There are, to our knowledge, no reports of endoparasites from this species. The purpose of this note is to establish the initial helminth list for *C. oedirhina*.

One adult male (roadkill) *C. oedirhina* was collected on 25 March 2011, near Oakridge on Isla de Roatán, (16.408617°N, 86.364883°W, datum WGS84; elev. 73 m), Departamento de Islas de la Bahía, Honduras. The individual weighed 540 g, had a SVL of 240 mm and a tail-length of 346 mm, although visibly stubby. The intestines were found to contain numerous nematodes,

which were preserved in 95% ethanol. A subsample was cleared in glycerol, mounted on a glass slide, coverslipped, examined under a compound microscope and identified as *Ozolaimus ctenosauri*. Voucher nematodes were deposited in the United States National Parasite Collection, Beltsville, Maryland, USA as USNPC (104699).

Ozolaimus ctenosauri was originally described from the caecum of *Ctenosaura acanthura* from Oaxaca, Mexico by Caballero (1938. Ann. Trop. Med. Parasitol. 32:225–229). It has been reported from other Mexican reptiles: *Ctenosaura pectinata* by Prado-Vera (1971. Estudio taxonómico de algunos nemátodos parásitos de reptiles de México. Tesis, Univ. Nac. Auton. México, 101 pp.), Moravec et al. (1996. J. Parasitol. 82:1011–1016), and Mayen-Pena and Salgado-Maldonado (1998. J. Helminthol. Soc. Washington 65:108–110); an unidentified iguana by Caballero and Cerecero (1943. An. Inst. Biol. Univ. Nac. Auton. México 14:527–539); and a rattlesnake, *Crotalus polystictus*, by Caballero (1939. An. Inst. Biol. Univ. Nac. Auton. México 10:73–82). It has also been reported in *Ctenosaura similis* from Costa Rica by Bravo-Hollis and Brenes (1960. An. Institut. Biol. Univ. Nac. Auton. México 30:209). *Ctenosaura oedirhina* represents a new host record for *Ozolaimus ctenosauri*; Isla de Roatán, Honduras is a new locality record.

Parasites were collected under permit DICTAMEN DVS-ICF-054-20120, granted by the Instituto Nacional de Conservacion y Desarrollo Forestral, Areas Protegidas y Vida Silvestre.

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***CTENOSAURA SIMILIS* (Black Spiny-tailed Iguana). DIET.** Iguanas in the genus *Ctenosaura* have been documented to eat a wide variety of items, including, but not limited to: arthropods (some potentially noxious), birds, bats, rodents, their own skin, juvenile lizards, fecal material, ctenosaur eggs, parts of conspecifics, and a variety of plants including at least one noxious species, *Croton suberosus* (Alvarez del Toro 1960. Los Reptiles de Chiapas. Inst. Zool. Estado Tuxtla Gutierrez, Chiapas; Blázquez and Rodriguez-Estrella 2007. Biotropica 39:496–501; Campbell 1998. Amphibians and Reptiles of Northern Guatemala, the Yucatán, and Belize. Univ. Oklahoma Press, Norman, Oklahoma; Coti and Ariano 2008. Iguana 15:142–149; Durtsche 2004. Physiol. Biochem. Zool. 77:459–470; Fitch et al. 1971. Southwest. Nat. 15:397; Fitch and Henderson 1978. Univ. Kansas Sci. Bull. 51:483–500; Henderson 1973. J. Herpetol. 7:27; Mora 1991. Bull. Chicago Herpetol. Soc. 26:197–198; Van Devender 1982. *In* Burghardt and Rand [eds.], Iguanas of the World: Their Behavior, Ecology, and Conservation, pp. 163–183. Noyes Publications, Park Ridge, New Jersey). We report on *Ctenosaura similis* consuming a post-mortem *Rhinella marina*.

Herbivory is the most common dietary strategy within the iguanine lizard clade (Iverson 1982. *In* Burghardt and Rand [eds.], *op. cit.*, pp. 60–76; Sites et al. 1996. Mol. Biol. Evol. 13:1087–1105; Torres-Carvajal 2007. J. Herpetol. 41:528–531). Non-herbivorous diets are rarely described within this clade, although limited carnivory in *Cyclura* (Auffenburg 1982. *In* Burghardt and Rand [eds.], *op. cit.*, pp. 84–116; Hayes et al. 2004. *In* Alberts et al. [eds], Iguanas, Biology and Conservation, pp. 232–257. Univ. California Press, Berkeley, California; Iverson 1979. Bull. Florida St. Mus. 24:175–358), *Ctenosaura* (Blázquez and Rodriguez-Estrella, *op. cit.*; Grant 1967. Copeia 1967:223–224; SAP, pers. obs.), *Dipsosaurus* (Norris 1953. Ecology 34:265–287), and *Iguana* (Loftin and Tyson 1965. Copeia 1965:515), and limited insectivory in *Ctenosaura* (Blázquez and Rodriguez-Estrella, *op. cit.*; Montanucci 1968. Herpetologica 24:305–315), *Cyclura* (Goodman 2007. Carib. J. Sci. 43:73–86), *Dipsosaurus* (Minnich and Shoemaker 1970. Am. Midl. Nat. 84:496–509; Norris, *op. cit.*) and *Iguana* (Campbell, *op. cit.*; Hirth 1963. Ecology 44:613–615) have been described. A less common dietary behavior in iguanine lizards is scavenging of vertebrate carcasses, with observations only from *Ctenosaura pectinata* (Grant, *op. cit.*) and *Iguana iguana* (Loftin and Tyson, *op. cit.*). In addition, *Ctenosaura similis*, *C. pectinata,* and *C. palearis* exhibit generalized insectivory as juveniles, making the ctenosaurs the only iguanine genus to demonstrate a predominant diet other than herbivory in any life stage (Coti and Ariano, *op. cit.*; Durtsche 2000. Oecologia 124:185–195, and 2004, *op. cit.*; Fitch and Hackforth-Jones 1983. *In* Janzen [ed.], Costa Rican Natural History, pp. 394–396. Univ. Chicago Press, Chicago, Illinois; Montanucci, *op. cit.*; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Chicago, Illinois).

Ctenosaura similis exhibits a further deviation from a fully herbivorous diet with an ontogenetic shift toward omnivory in adults (Savage, *op. cit.*; Torres-Carvajal, *op. cit.*), foraging on such things as vegetation, arthropods, birds, bats, ctenosaur eggs, conspecifics and other lizards (Campbell, *op. cit.*; Fitch et al., *op. cit.*; Fitch and Hackforth-Jones, *op. cit.*; Fitch and Henderson, *op. cit.*; Henderson *op. cit.*; Hotton 1955. Amer. Midl. Nat. 53:88–114; Mora, *op. cit.*; Traveset 1990. Amer. Midl. Nat. 123:402–404; Van Devender, *op. cit.*). Torres-Carvajal (*op. cit.*) has provided dental evidence correlated with a shift towards carnivory in adult *C. similis*, though it is not clear how large of a role carnivory plays, as field documentation of this sort is lacking.

One adult *C. similis* was observed feeding on and dragging away a dead adult Marine Toad (*Rhinella marina*) on 19 June 2008 in Esparza, Puntarenas, Costa Rica (9.989195°N, 84.711373°W). The iguana was first observed feeding on the toad at the edge of the road at approx. 1100 h. The iguana was thrashing its head violently, presumably to break the toad into pieces for consumption. When disturbed the iguana dropped the toad and fled from the road, but returned shortly and dragged the toad off of the

FIG. 1. Adult *Ctenosaura similis* consuming a post mortem Marine Toad, *Rhinella marina*.

road, and continued to dismember it. The iguana was clearly an adult based upon its size (Fig. 1). The entire observation lasted for approx. 20 min., and additional digital footage is available from the authors.

Though this is a single observation, it supports an ontogenetic shift to an omnivorous diet in *C. similis*, thus suggesting that carnivory in ctenosaurs may be more prevalent than previously thought. In addition this demonstrates that *C. similis* is one of few opportunistic scavengers of vertebrate carcasses in the iguanine lizard clade.

We thank numerous local volunteers who aided us in identifying areas where iguanas could be found, and John Iverson and Arthur Echternacht for their insight. Funding for this project was provided by the University of Tennessee, Knoxville. A permit for research in Costa Rica was obtained with the help of Francisco Campos Rivera and Organización para Estudios Tropicales and was provided by Ministerio del Ambiente y Energia Sistema Nacional de Áreas de Conservación. A photograph was deposited at the Milwaukee Public Museum as MPM Herp Photo P758. A digital recording of this observation is available from the authors.

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***ENYALIUS PERDITUS*. DEATH-FEIGNING.** *Enyalius perditus* is an Atlantic forest species of Brazil. It inhabits humid areas with lush vegetation and closed canopies (Jackson 1978. Arq. Zool. 30:1–79). This species is a semiarboreal forest-dweller that feeds exclusively on small invertebrates, and appears to be sensitive to forest structure and also sensitive to fragmentation, logging, and forest degradation (Dixo and Metzger 2009. Oryx 43:435–442). However, little is known about the natural history and ecology of *E. perditus*.

Death-feigning, also called tonic immobility or thanatosis, is an innate anti-predator behavior. In squamates, death-feigning is a widespread defensive tactic that is described from several different families, such as Anelytropsidae (Torres-Cervantes et al. 2004. Herpetol. Rev. 35:384), Leptotyphlopidae, Colubridae, Elapidae (Gehlbach 1970. Herpetologica 26:24–34), Crotaphytidae (Gluesing 1983. Copeia 1983:835–837), Scincidae (Langkilde et al. 2003. Herpetol. J. 13:141–148) and Tropiduridae (Bertoluci et al. 2006. Herpetol. Rev. 37:472–473; Machado et al. 2007. S. Am. J. Herpetol. 2:136–140). Herein we present data on death-feigning in *E. perditus* with a brief description of this behavior. The primary role of death feigning appears to be enhancing crypsis by ceasing movement.

FIG. 1. Death-feigning posture in a female *Enyalius perditus*.

We collected two *E. perditus* specimens during the inspection of drift fences with pitfall and funnel traps. On 12 October 2008, in the Reserva Biológica Municipal Santa Cândida (21.754917°S, 43.396833°W, WGS 84, 783 m elev.), in the municipality of Juiz de Fora, Minas Gerais State, Brazil, we collected a female (SVL 76.7 mm) and on 6 October 2008, in the Reserva Biológica Municipal Poço D'Anta (21.754278°S, 43.310889°W, WGS 84, 848 m elev.), we collected a male of *E. perditus* (SVL 71.4 mm) in the same municipality. Both lizards exhibited death-feigning behavior when they were removed from the traps and when manipulated in the laboratory to perform marking procedures and/or morphometric analysis. The lizards became immobile, lying belly-up, crossing the limbs over the stomach and closing the eyelids, although in some cases the eyes remained opened. Lizards remained motionless during manipulation with the legs and arms usually capable of being moved by the observer to any position with the lizard maintaining that position. The death-feigning posture persisted even after the animal was gently placed upside down. Lizards recovered after 15–30 min., subsequently fleeing.

Although we collected a total of 22 lizards, death-feigning behavior was observed only in these two specimens. However, we have previously observed death-feigning in many other individuals of *E. perditus* during the course of species inventories for study areas. Most specimens exhibited thanatosis when captured (Fig. 1). In all cases, the animals displayed a similar pattern of behavior and posture. We believe these observations to be the first records of death-feigning in *E. perditus*.

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***GALLOTIA CAESARIS* (Caesar's Lizard). NECTARIVORY.** Plant-lizard mutualistic interactions (pollination and seed dispersal) have been considered a phenomenon more frequently detected on islands due to the high densities commonly seen in insular lizards (Olesen and Valido 2003. Trends Ecol. Evol. 18:177–181). Lizards experience stronger intraspecific competition, favored by a lower predation risk and arthropod food supply compared to mainland taxa, expanding their diet to incorporate novel food resources (e.g., fruit pulp and floral rewards; Olesen and Valido, *op. cit.*). This appears to be the case observed in endemic Canarian lizards, *Gallotia* spp., which include a signicant amount of plant matter in their diets, whereas their closest continental relatives are mainly insectivorous (Carretero et al. 2006. Rev. Esp. Herpetol. 20:105–117; Martín et al. 2005. Zoology 108:121–130; Valido and Nogales 2003. Amphibia-Reptilia 24:331–344; Van Damme 1999. J. Herpetol. 33:663–674). The role of *Gallotia* spp. as seed dispersers of Canarian flora has been well established, with fleshy fruit as the most significant component of their

PHOTO BY PEDRO FELIPE

FIG. 1. *Gallotia caesaris* visiting *Echium hierrense* (Boraginaceae) inflorescences from El Hierro, Canary Islands. The tail seems to play an important role as a prehensile appendix as the lizard climbs to higher flowers.

diet year round (e.g., *G. galloti*; Valido and Nogales 1994. Oikos 70:403–411). However, their role as pollinators has received less attention despite nectar-feeding field observations on native and exotic flora (Font and Ferrer 1995. Herpetol. Rev. 26:35–36; Valido et al. 2002. Acta Oecol. 23:413–419; Valido et al. 2004. J. Biogeogr. 31:1945–1953). Most of these observations refer to the Canary Lizard (*G. galloti*) from Tenerife, with the unique exception of *G. caesaris* from El Hierro observed visiting *Euphorbia lamarckii* flowers (Speer 1994. Salamandra 30:48–54). Here, we report a new account of nectarivory and presumptive pollinating behavior by *G. c. caesaris* on flowers of *Echium hierrense* (Boraginaceae); both are endemic taxa from El Hierro (27.733333°N, 18.05°W), the smallest and the westernmost island of the Canarian archipelago. Observations were made in the south of the island, at a xeric scrubland area known as El Lajial (255 m elev.).

From 20 to 22 April 2007, we performed daily 2-h monitoring (approximately 1000–1200 h), during which we observed *G. caesaris* visiting flowers of *E. hierrense*. In each of these periods, one male individual climbed the same plant three to four times, visiting different flowers from the same inflorescence (Fig. 1). Occasionally, we also saw the aforementioned lizard accompanied by a conspecific crawling up other inflorescences of the same plant. In both cases, lizards visited flowers legitimately (i.e., the snout brushed against the anthers and stigma of the flowers as they clearly licked nectar from them). We never detected agonistic interactions between lizards, nor did we observe lizards trying to capture pollinating insects (mainly Hymenoptera) while in the inflorescences.

Lizards are not the only flower visitor of *E. hierrense*. In the Canary Islands, *Echium* species are considered to be mainly bee-pollinated (Dupont and Skov 2004. Int. J. Plant Sci. 165:377–386). However, the endemic *E. wildpretii*, distributed in the arid high-altitude sub-alpine vegetation zone, is also visited by *Gallotia* lizards (Valido et al. 2002, *op. cit.*). Our observations suggest the possibility of more *Gallotia-Echium* interactions in the Canarian archipelago. This raises the question of what intrinsic (e.g., floral rewards) and extrinsic (e.g., water scarcity) plant factors promote interactions and how these interactions impact *Echium* reproductive success.

The observations described here were made as part of 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 invaluable help in the field, as well as Alfredo Valido, Rubén Barone, and Kimberly Holbrook for reviewing an early draft of the manuscript.

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***GEHYRA AUSTRALIS* (Northern Dtella). PREDATION.** *Gehyra australis* is a variably patterned, ~81mm SVL, arboreal and rock-inhabiting gecko native to the northern reaches of the Northern Territory and Western Australia (Wilson and Swan 2010. A Complete Guide to Reptiles of Australia, 3rd ed. New Holland Publishers, Sydney). I am unaware of any reports of predation on *G. australis* by an arachnid. I report here an instance of predation on *G. australis* by the Grey Huntsman Spider (*Holconia immanis*).

On 2 May 2011, near the town of Wyndham in the eastern Kimberley region of Western Australia, I was performing daily checks of nest-boxes, specifically designed to be utilized by breeding Gouldian Finches (*Erythrura gouldiae*). These boxes consist of a natural log (ca. 20–40 cm long) attached to a 10 cm^2 plywood nesting box, which can be removed to investigate the contents. At 0746 h I came across a Grey Huntsman Spider in the process of subduing an adult *G. australis* in the anterior section of one of the aforementioned boxes (15.5704°S, 128.1892°E, 79 m elev.). The gecko was clearly still alive and was attempting to break free of the huntsman's grip. Upon removal of the box, the huntsman crawled out onto the box's exterior (Fig. 1), descended the tree in which the nest-box was situated, and withdrew into tall *Sorghum* grass with the gecko still in its grip. These two species are frequently observed cohabiting these boxes, but this was the first instance in which I, or any other members of the Save The Gouldian Fund, have encountered such a predation attempt.

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FIG. 1. *Holconia immanis* in the process of subduing an adult *Gehyra australis* near Wyndham, Western Australia.

***HEMIDACTYLUS FRENATUS* (Common House Gecko). PREDATION.** Many spiders feed on a variety of vertebrates such as small mammals, birds, and lizards (Corey 1988. J. Arachnol. 16:391–392; McCormick and Polis 1982. Biol. Rev. 57:29–58; Rubbo et al. 2001. Can. J. Zool. 79:1465–1471). On 20 August 2010, at 2015 h we encountered a predation event involving

FIG. 1. Predation of *Hemidactylus frenatus* by the spider *Heteropoda venatoria*.

Hemidactylus frenatus by the spider *Heteropoda venatoria* at Shahbajpur (24.7058°N, 92.1913°E) in Barlekha, Maulvibazar District, Bangladesh. The incident took place on the wall of a resident's house within a tea garden where the gecko was ambushed by the spider (Fig. 1). The struggle lasted for a period of ca. 20 min., after which the spider dropped the lizard and fled, most likely due to human interference.

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***IGUANA IGUANA* (Green Iguana). COPROPHAGY.** *Iguana iguana* occurs from Mexico to Brazil as well as some Caribbean islands (Burghardt and Rand 1982. Iguanas of the World: Their Behavior, Ecology, and Conservation. Noyes Publications, New Jersey. 472 pp.). It is a largely arboreal (Iverson 1982. *In* Burghardt and Rand, *op. cit.*, pp. 60–76) and herbivorous species, eating mostly leaves, flowers, and fruits from a wide range of shrubs, vines, and trees (Rand et al. 1990. J. Herpetol. 24:211–214). The Green Iguana is reported to occasionally scavenge on animal carcasses (Loftin and Tyson 1965. Copeia 1964:515), as well as eating insects (Hirth 1963. Ecology 44:613–615), or other invertebrates (Fitch 1973. Univ. Kansas Sci. Bull. 50:39–126; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. University of Chicago, Chicago, Illinois. 934 pp.). Consumption of bird eggs has also been reported (Schwartz and Henderson 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. Univ. Florida Press, Gainsville, Florida. xvi+720 pp.). In Florida, where the Green Iguana is a well-established exotic species, the examination of stomach contents revealed remains of snails in two individuals, including 12 snails in one juvenile (Townsend et al. 2005. Southeast. Nat. 4:361–354).

Coprophagy is generally rare in reptiles, and usually involves eating the feces of other taxa (Frye 1991. Reptiles: An Atlas of Diseases and Treatment. TFH, Neptune City, New Jersey. 637 pp.). The Green Iguana utilizes a microbial fermentation system in its elaborated hindgut to break down plant cell walls (Mackie et al 2004. Physiol. Biochem. Zool. 77:127–138). Hatchlings have been observed to actively associate with adults during the first weeks of life and to consume fresh fecal material from adult iguanas to obtain the complex microflora (Werner et. al 1987. Behav. Ecol. Sociobiol. 21:83–89). In Galapágos Archipelago, Land and Marine Iguanas (*Conolophus pallidus* and *Ampblyrhynchus cristatus,* respectively) have been observed eating feces of crabs and sea lions, and it has been speculated that this is done in order to acquire microorganisms, mostly bacteria, to properly digest various plant chemicals (Mackie et al., *op. cit.*). In a long term study on the endangered Grand Cayman Blue Iguana (*Cyclura lewisi*), Goodman (2007. Carib. J. Sci. 43:73–86) reported the consumption of Central American Agouti (*Dasyprocta punctata*) feces on one occasion. We have found no references in the literature regarding free-living juvenile or adult Green Iguanas feeding on the feces of other animals other than conspecifics. We report here on coprophagy of Green Iguana adults and hatchlings eating feces from Giant Otter (*Pteronura brasiliensis*) latrines.

Giant Otters live in social groups and use latrines to mark their territory (Leuchtenberger and Mourão 2009. Ethology 115:210–216). In December of 2010, during a Giant Otter research trip on the Vermelho River (56.7333°W, 19.6000°S, WGS84; elev. 60 m), in the southern Pantanal, camera traps were positioned at three Giant Otter latrines. These cameras were active in 24-h cycles during three days at latrines 1 and 2, and just one day at latrine 3, resulting in a total of 509 photos of Green Iguanas. All of these photos were during the diurnal period and revealed that both juveniles and adults lizards consumed feces of the otters. The eight photos taken from latrine 1 were consistently of the same adult female, while the five photos from latrine 3 indicated two adult females and one adult male. Detailed examination of the 495 photos taken from latrine 2 indicated that there were at least eight adult females, one adult male, and two juveniles visiting that locale. Often the iguanas visited the latrines soon after the otters left the area. For example, in one case one photo registered eight female iguanas eating feces together, just 15 min. after the otter group had left that latrine (Fig. 1).

Giant Otters feed mainly on fish, and their spraints are usually deposited in latrines that are used by the whole group (Duplaix 1980. Rev. Ecol. 34:496–620). Therefore, the spraints containing fish bones and scales probably provide a rich source of calcium for this herbivorous lizard species. Most individuals identified in the photo images were adult females or juveniles which would all have high calcium requirements; adult females due to the production of eggs and juveniles for growth. It may also be speculated that fecal samples provide the reptiles with special microorganisms and bacteria as hypothesized by Mackie et al. (*op. cit.*).

FIG. 1. *Iguana iguana* females feeding at a Giant Otter (*Pteronura brasiliensis*) latrine on the Vermelho River, Southern Pantanal, Brazil.

Another interesting aspect of this behavior is that lizards usually aggregated to the otter latrines. Aggregation of adult female iguanas has been described during the reproductive period where they exhibited a communal nesting strategy, which is often described as an antipredator tactic (Mora 1989. Herpetologica 45:293–298). Group behavior of hatchlings has also been reported as an antipredator strategy (Green et al. 1978. J. Herpetol. 12:169–176).

The importance of coprophagy in the dietary supplementation of *Iguana iguana* is difficult to evaluate. However, this behavior can certainly be precarious for the lizards. While on the ground, the arboreal iguanas are more susceptible to predators and coprophagy facilitates the transmission of parasites from the otters to the iguanas.

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***LAMPROLEPIS SMARAGDINA PHILIPPINICA* (Emerald Green Tree Skink). COLOR VARIATION.** *Lamprolepis smaragdina* is a widespread skink distributed throughout the Philippine Islands, eastern Indonesia, Papua New Guinea, and the islands of the West Pacific. This arboreal species is recognized to have a high degree of body color variation between populations (Mertens 1929. Zoologischer Anzeiger 84:209–220). One of three recognized subspecies, *L. s. philippinica* is endemic to the Philippine islands (Brown and Alcala 1980. Philippine Lizards of the Family Scincidae. Silliman University Press, Dumaguete City. 264 pp.; Mertens, *op. cit.*). Populations of *L. s. philippinica* range in color from green anteriorly and brown posteriorly, to mottled brown and black on a green ground color (Brown and Alcala, *op. cit.*). Outside of the Philippines, populations displaying a completely bright green body are known from the southern peninsulas of Sulawesi, Palau, the Solomon Islands, and the Marshall Islands (Buden 2007. Pacific Science, 61:415–428; Mertens, *op. cit.*). Here we report on the first records of green populations of Philippine *Lamprolepis*, discovered on the small, isolated islands of Caluya, in the west-central Philippines, and Siquijor, in the south-central Philippines.

In 1997, R. Brown and J. McGuire collected 12 specimens of a population of *L. s. philippinica* possessing bright green bodies with black rhomboid blotches on Siquijor Island in the south-central Philippines. Individuals were collected on 9 September 1997, on the trunks and small branches of trees, in two localities on Siquijor Island, Siquijor Province, Philippines (9.2°N, 123.5°E): (11 individuals) Barangay Kang-Adiang, Municipality of Siquijor; (one individual) Barangay Caitic, Municipality of La Arena. The specimens are deposited at the Texas Natural History Collections, University of Texas at Austin (TNHC 56434–65).

During recent fieldwork in the central Philippine islands, CDS collected five all green, adult *L. s. philippinica* (Fig. 1). The specimens were observed on 15 November 2004, in a mangrove swamp at sea level, on small branches of trees over water, in Barangay Tinogboc, Municipality of Caluya, Antique Province, Caluya Island, Philippines (11.93003°N, 121.54723°E, datum: WGS 84; elev. 0 m). The specimens are deposited at the herpetological collections of the Biodiversity Institute, University of Kansas (males: KU 302835–37; females: KU 302838, 302839).

FIG. 1 An adult female *Lamprolepis smaragdina philippinica* (KU 302839; total length = 232 mm; 14.0 g) from Caluya Island, Philippines.

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***LIOLAEMUS GOETSCHI*. PREDATION.** *Liolaemus goetschi* is an oviparous and insectivorous, medium-sized lizard (max. SVL = 73 mm) inhabiting the arid landscape of Monte Desert in northern Patagonia, Argentina. Its geographic distribution ranges through a narrow strip in northwestern Rio Negro Province along the boundary with Neuquén Province (Nori et al. 2010. Check List 6:3–4). To our knowledge, no studies are available on the biology of this species, including its natural predators. Here we report an observation of *Philodryas psammophidea* predation on *L. goetschi*. *Philodryas psammophidea* is an uncommon snake, with a large geographic distribution within Monte and Chacoan environments of Bolivia, Paraguay, and Argentina.

At 1930 h on 5 December 2010 during a collecting trip through northern Rio Negro Province we observed an adult female *L. goetschi* (SVL = 72.9 mm) basking in an open area between bushes outside National Road 151, 50 km S Catriel, General Roca Department (38.283861°S, 67.996278°W, WGS 84; 551 m elev.). As we approached, the lizard ran to seek refuge below branches of a *Larrea nitida* bush. When it reached the proximity

of the bush, a *Philodryas* (female; SVL 600 mm, TL 738 mm) appeared between the branches and chased the lizard for 3–4 m. It grabbed the lizard by its left forelimb and coiled around the lizard's body. We immediately grabbed the snake and forced it to release the lizard; it continued its grasp to the left forelimb with its mouth. After a minute of handling, the snake finally released the lizard. The *Liolaemus* was motionless after being released from the snake's grasp and did not appear to be alive. Two fang puncture wounds were evident in its leg and it likely died from envenomation. The specimens of *L. goetschi* (LJAMM-CNP 13731) and *Philodryas psammophidea* (LJAMM-CNP 13732) were deposited in the herpetological collection Luciano Javier Avila Mariana Morando of the Centro Nacional Patagónico – CONICET, Puerto Madryn, Argentina.

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***LIOLAEMUS QUILMES*. ULTRAVIOLET COLORATION**. *Liolaemus quilmes* is a liolaemid lizard from northwestern Argentina. It belongs to a genus of more than 223 species (Lobo et al. 2010. Zootaxa 2549:1–30) distributed throughout most of southern South America. Because *Liolaemus* species go from dull to bright coloration, they offer a model system for studies in visual communication (e.g., Font et al. 2010. Acta Zool. Lilloana 54:11–34; Fox et al. [eds.] 2003. Lizard Social Behavior. Johns Hopkins Univ. Press, Baltimore and London. 456 pp.). Some species of *Liolaemus* present blue-colored spots (e.g., those belonging to the *darwinii* complex of which *L. quilmes* is a member; Etheridge 1993. Bolletino Museo Regionale di Scienze Naturali, Torino 11:137–199), which in some lizards has been shown to be associated with ultraviolet coloration (UV, corresponding to wavelengths below 400 nm). This coloration and the ability to perceive it has been reported in more than 30 lizard species (Font et al. 2010, *op. cit.*) but it has not been studied in *Liolaemus*. Male *L. quilmes*, and females, to a lesser degree, exhibit blue spots, mostly on the lateral sides of their body (Etheridge 1993, *op. cit.*), which we hypothesized could indicate the presence of UV coloration.

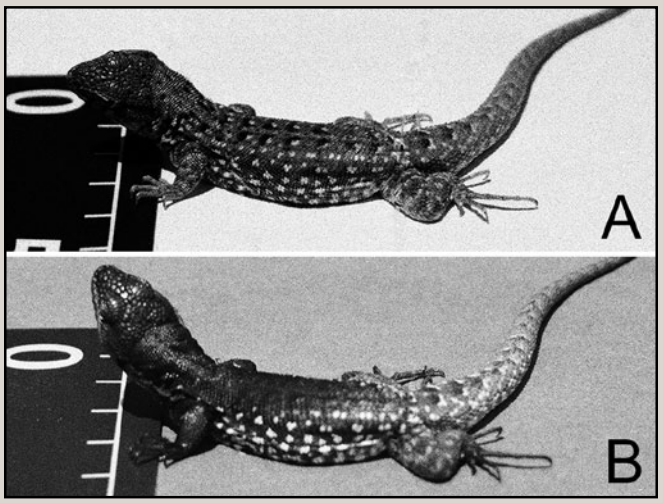

FIG. 1. Male *Liolaemus quilmes*: A) black and white picture taken without a UV filter (light white spots correspond to blue spots when seen by a human); B) black and white picture taken with a UV filter, showing brighter white spots where blue spots were, indicating UV reflectance.

We photographed live specimens of *L. quilmes* (2 males and 1 female) in their habitat, in Los Cardones, Tucumán, using a relatively simple method to confirm presence of UV coloration. Photographs were taken around noon, using natural sunlight. We first took a standard black and white photo with an analog camera (Canon EOS Rebel G), which was then compared to a second photo taken with the same camera and a filter B+W 403. This allowed only wavelenghts between 320 and 385 nm to pass through the filter, blocking the rest of the visible light spectrum.

We found that *L. quilmes* does reflect UV light corresponding to areas with light blue spots, this being the first report for a species in this genus (Fig. 1A, B). We then photographed live specimens of five congeners from Mendoza, Argentina, using the same method. These were *L. darwinii* (1 male), *L. grosseorum* (4 males), and *L. gracilis* (1 female), from El Nihuil, and *L. ruibali* (5 males and 1 female) and *L. bibroni* (1 male and 1 female) from Cruz de Paramillo. All of the individuals that were photographed reflected UV light except for those belonging to *L. gracilis* and *L. bibroni*. The latter two species are light to dark brown in coloration, explaining the lack of UV reflectance, whereas the other three species display blue spots, among other coloration. Our results open the opportunity for comparative research in the genus *Liolaemus* with respect to presence/absence of UV coloration and its communicative role within the behavioral ecology of each species (Fox et al. 2003, *op. cit.*; Font et al. 2010, *op. cit.*).

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***MESASPIS GADOVII* (Gadow's Alligator Lizard). REPRODUCTION.** *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. Univ. Nac. Auton. Mexico, D.F., México, 439 pp.). Ramírez-Pinilla et al. (2009. J. Herpetol. 43:409–420) reported a mean litter size of 7.3 ± 1.9 SD, range = 4–12 for 16 females of *M. gadovii* from Guerrero. The smallest reproductively active female (vitellogenic follicles) measured 76 mm SVL (Ramirez-Pinilla, *op. cit.*). The purpose of this note is to report a new minimum litter size and minimum size for female reproduction of *M. gadovii*.

One *M. gadovii* female (SVL = 73 mm) collected on December 1971 in the Sierra Madre del Sur, (17.5000°N, 100.0000°W, WGS 84; elev. ca. 1000 m), Guerrero, Mexico, and deposited in the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California as LACM 75504 was examined. A midventral slit was made and the reproductive system was examined. Two embryos were present. A litter size of two is a new minimum litter size, and the SVL of 73 mm is a new minimum body size for female reproductive activity in *M. gadovii*.

I thank Christine Thacker (LACM) for permission to examine *M. gadovii*.

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***OPHISAURUS VENTRALIS* (Eastern Glass Lizard). POSTMORTEM PREDATION.** Although several hawk species have been documented or implicated as predators of glass lizards (genus

PHOTO BY F. CLARKE

FIG. 1. Loggerhead Shrike (*Lanius ludovicianus*) with body segment of an Eastern Glass Lizard (*Ophisaurus ventralis*) held in its bill.

Ophisaurus; Fitch 1974. Condor 76:331–360; Fitch and Bare 1978. Trans. Kansas Acad. Sci. 81:1–13), we are aware of no other bird species reported to consume them. On 17 February 2010 at Skidaway Island, Chatham Co., Georgia, USA (31.95652°N, 81.02442°W), one of us (FOC) observed a Loggerhead Shrike (*Lanius ludovicianus*) fly down to a recently mowed berm along a weedy field, pick up a flexible and tubular item, fly back to its perch, and begin consuming this item. Photographs taken by FOC of this bird while back on its perch were shared with JBJ and JAC who positively identified the item as a body segment of an Eastern Glass Lizard (*Ophisaurus ventralis*) (Fig. 1). It is suspected that the glass lizard was killed (likely by the mowing activities) prior to its seizure by the shrike. The time it took for the shrike to fly from its perch and return with the motionless food item was estimated to be just 15–20 seconds. Although predation cannot be conclusively ruled out, the short duration of capture time, coupled with likelihood that a fully intact and live sub-adult or adult Eastern Glass Lizard would be too large for a shrike to attack, suggests it was seized postmortem. Although legged lizards have been reported in the diet of Loggerhead Shrikes (Yosef 1996. *In* Poole and Gill [eds.]. The Birds of North America, No. 231. Acad. Nat. Sci., Philadelphia, and Amer. Ornithologists' Union, Washington, D.C.), insofar as we can determine, this is the first reported observation of a Loggerhead Shrike consuming as carrion, or predating, any species of glass lizard.

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***PLESTIODON SUMICHRASTI* (Sumichrast's Skink). PREDATION.** There are many reports of large tropical spiders preying upon amphibians and reptiles (e.g., Antônio de Freitas et al. 2010. Herpetol. Rev. 41:202; Brito De-Carvalho et al. Herpetol. Rev. 2010. 41:336–337; Cicchi et al. 2010. Herpetol. Rev. 41:207; Hamidy et al. 2010. Herpetol. Rev. 41:66–67). Although many of these reports document predation on small frogs and lizards (< 4 cm SVL), larger prey items are occasionally taken or attempted (e.g., Silva Siqueira Nunes et al. 2010. Herpetol. Rev. 41:367–368). Here we report an instance of a relatively large lizard as a prey item for a tarantula from the highlands of southeastern Guatemala.

FIG. 1. Predation of *Plestiodon sumichrasti* (top) by *Brachypelma* sp. (bottom) in the Sierra Caral of Izabal, Guatemala.

On 2 October 2010 we were conducting a herpetofaunal survey in the Sierra Caral of Izabal, Guatemala. At approximately 1800 h while pulling apart a large fallen tree trunk, we discovered a cavity that contained a partially digested juvenile *Plestiodon sumichrasti* (ca. 6 cm SVL; Fig. 1 [top]). Further excavation immediately behind the partially digested lizard revealed a large male tarantula referable to the genus *Brachypelma* (Fig. 1 [bottom]). This observation occurred near Cerro Pozo de Agua at about 850 m (15.39367°N, 088.69183°W; WGS84 datum). The slightly dissolved skink was collected and deposited in the natural history collections of the Museo de Historia Natural of the Universidad de San Carlos in Guatemala City (USAC 2738; Field ID: CRVA 2162).

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***SAUROMALUS ATER* (Common Chuckwalla). ENTRAPMENT.** On 31 May 2008, we found an adult male *Sauromalus ater* dead in tortoise mitigation fencing along U.S. Highway 93, 1.0 km NW of Nothing, Mohave Co., Arizona, USA (34.48279°N, 113.35129°W, WGS84; elev. 965 m). The fence, originally intended to keep Desert Tortoises (*Gopherus agassizii*) off of the highway and direct them towards highway underpasses, is 60 cm in height, with galvanized mesh fabric (2.5 cm × 5 cm). The chuckwalla was caught between its rib cage and front legs at ground level probably as it tried to move through the fencing (Fig. 1). Use of fencing to modify animal movements away from roads should consider impacts to other small animals that may get stuck and die from starvation or exposure (Sherwood et al. 2002. Wildlife and Roads: The Ecological Impact. Imperial College Press, London. 316 pp.). One possible solution for this source of mortality would be to modify the fence mesh size at the bottom, however any modifications could change the level of hazard for other animals and affect the fence's effectiveness in preventing focal species from moving across the highway.

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FIG. 1. An adult male *Sauromalus ater* trapped in mitigation fencing for Desert Tortoises (*Gopherus agassizii*), resulting in its death.

***SCELOPORUS GRAMMICUS* (Mesquite Lizard). DIET.** Feeding is one of the most important aspects in the life history of amphibians and reptiles (Stearns 1977. Ann. Rev. Ecol. Syst. 8:145–171). It is well known that most reptile species are carnivores and omnivores. However; if they have the opportunity, many reptiles will feed on dead prey (carrion). Scavengery has been observed in lizards such as *Varanus panoptes* from Australia (Shine 1986. Herpetologica 42:346–360) and *Leiocephalus psammodromus* (Iverson and Smith 2006. Herpetol. Rev. 37:345–346). Within the genus *Sceloporus, S. grammicus* is particularly known for being insectivorous (Leyte-Manrique et al. 2006. Bol. Soc. Herpetol. Mex. 1:18–24) and Leyte-Manrique et al. (2005. Herpetol. Rev. 36: 454–455) reported cannibalism. However, to our knowledge, until now nothing has been reported on this species being a carrion-eater.

On 15 April 2008 at 1230 h, during a field trip to La Manzana, Zimapan (20.87056°N, 99.22417°W, WGS84; elev. 2531 m), Hidalgo, México, we observed an adult female *Sceloporus grammicus* (SVL = 52.6 mm, 6.0 g) in a crevice eating a female *S. minor* (SVL = 68.6 mm, 10.2 g). This observation suggests that *S. grammicus* could have opportunistic feeding habits. Moreover, a previous study reported that this *S. grammicus* eats neonates of its own species (Leyte-Manrique et al. 2005. Herpetol. Rev. 36:454–455) and skin of adult lizards (probably *S. spinosus;* Leyte-Manrique 2007. Bol. Soc. Herpetol. Mex. 15:23–24).

Both specimens (ZIMAPABR2-2008 and HAZIMAPSM-ABR1-2008) are deposited in the Laboratorio de Ecología de Poblaciones del Centro de Investigaciones Biológicas (CIB), de la Universidad Autónoma del Estado de Hidalgo.

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***SCELOPORUS MINOR* (Minor Spiny Lizard). HERBIVORY.** Herbivory in lizards has been well documented (Cooper et al. 1990. Herpetologica. 29:107–110). However, there are some species that display more than one feeding behavior, both insectivory and herbivory (omnivory) such as *Ctenosaura pectinata* (Durtsche. 2000. Oecología. 89:85–195) and *Tropidurus etheridgei* (Ávila et al. 2008. Herpetol. Rev. 39:430–433). Some species of the genus *Sceloporus* have been observed to feed on fruits, seeds and flowers, such as *S. torquatus* (Búrquez et al. 1986. J. Herpetol. 20:262–264). However, other species of this genus are thought to be completely insectivorous (Uribe-Peña et al. 1999. Anfibios y Reptiles de las Serranías del Distrito Federal, México. UNAM. 119 pp). The diets of many *Sceloporus* species remain poorly known in México. Herein, we provide information suggesting that one of these species, *S. minor,* has an omnivorous feeding behavior.

On 26 April 2008 at 1114 h at the locality of El Enzuelado, 7 km N of the Municipality of San Agustín Meztquititlán (20.57500°N, 98.62028°W, WGS84; elev. 1940 m), Hidalgo, México, we observed an adult male *S. minor* (SVL = 65.7 mm; 14.0 g) perching on a rock (26 cm high) within a xeric scrub community. We noticed that the lizard was eating the fruit of a cactus (163.1 mm^3; 0.0552 g; *Mammillaria* sp.); this fruit is locally known as *chilitos.* The fruit was eaten by the lizard within 15–20 seconds. After this feeding event, the lizard was captured and taken to the laboratory and later deposited in the Laboratorio de Ecología de Poblaciones del Centro de Investigaciones Biológicas (CIB), Universidad Autónoma del Estado de Hidalgo (SAM-ABR3-2008). This observation expands our knowledge about the diet of *S. minor,* possibly indicating this species is omnivorous and this opportunistic foraging provides evidence that *S. minor* may take advantage of chilitos as a food resource when available.

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***SCINCELLA REEVESII* (Reeves' Smooth Skink). REPRODUCTION.** *Scincella reevesii* is known from Vietnam, India, southern China, Korea, Thailand, and Malaysia (Van Sang et al. 2009. Herpetofauna of Vietnam. Edition Chimaira, Frankfurt am Main, Germany.768 pp.). *Scincella reevesii* is ovoviviparous with litters of 2–3 young born in late spring (Karsen et al. 1986. Hong Kong Amphibians and Reptiles. Published by the Urban Council, Hong Kong. 136 pp.). The purpose of this note is to report a new maximum litter size for *S. reevesii*.

One female *S. reevesii* (SVL = 48 mm) collected 12 June 1993 from Hong Kong, China (Port Shelter, Yim Tin Tsai (22.410278°N, 114.215556°E, datum WGS84; elev. 10 m) and deposited in the Museum of Comparative Zoology (MCZ) as MCZ R-177979 was examined. The posterior third of the body cavity was opened and four embryos were counted. Four is a new maximum litter size for *S. reevesi*.

I thank Jonathan Losos (MCZ) for permission to examine *S. reevesii* and Jose Rosado (MCZ) for facilitating the loan.

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***SCINCELLA REEVESII* (Reeves' Smooth Skink). ENDOPARASITES.** *Scincella reevesii* is known from Vietnam, India, southern China, Korea, Thailand, and Malaysia (Van Sang et al. 2009. Herpetofauna of Vietnam, Edition Chimaira, Frankfurt am Main, Germany. 768 pp.). To our knowledge, there are no reports of helminths from *S. reevesii*. The purpose of this note is to establish the initial helminth list for *S. reevesii*.

Twenty *S. reevesii* from Hong Kong, China (mean SVL = 42.3 mm ± 5.5 SD, range = 30–52 mm) collected 1991–1994, 1996, were borrowed from the herpetology collection of the Museum of Comparative Zoology (MCZ): (MCZ) R-176657–17663, 176666–176669; 177083, 177977, 177979–177981, 179465, 17946, 179482, 182293.

The body cavity was opened and the digestive tract was removed, opened by a longitudinal incision, and examined under a dissecting microscope. Nematode larvae in cysts were found in the stomach wall and supportive mesenteries, which were cleared in lacto phenol solution, placed on a glass microscope slide, cover-slipped and identified as Acuariidae gen. sp. Prevalence (infected lizards/all lizards x100) was 20%; mean intensity (mean number helminths per lizard) was 2.0 ± 1.4 SD, range = 1–4. They were deposited in the invertebrate collection at MCZ as IZ-124533–124536.

Members of the Acuariidae are gizzard parasites of terrestrial birds; insects serve as intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission, 2nd ed. CABI Publishing, Wallingford, Oxfordshire, U.K. 650 pp.). Their occurrence in lizards likely results from ingesting infected insects; no further development occurs (Goldberg et al. 2002. Amer. Midl. Nat. 148:409–415). The occurrence of Acuariidae in amphibians and reptiles is summarized in Goldberg et al. (2007. Comp. Parasitol. 74:327–342). *Scincella reevesii* represents a new host record for larvae of the Acuariidae.

We thank Jonathan Losos (MCZ) for permission to examine *S. reevesii* and Jose Rosado (MCZ) for facilitating our loan.

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***TUPINAMBIS MERIANAE* (Black-and-White Tegu). NEST CONSTRUCTION BEHAVIOR.** *Tupinambis merianae* is one of the largest lizard species indigenous to the New World. There is little information published on the ecological aspects within natural environments for this genus. Daily and annual activity for *T. merianae* have been reported for an Atlantic Rainforest area in Southeastern Brazil (Van Sluys and Rocha. 1999. Herpetol. Rev. 30:42–43). Recently the hibernation and emergence behavior of a natural population in Southern Brazil were described (Winck and Cechin. 2008. J. Nat. Hist. 42:239–247). Oviposition inside burrows is known, including the importance of the presence of the female to the eggs during their development (Chani et al. 1994. Acta Zool. Lilloana 42:295–299). However, ecological aspects related to nest construction remains unknown in natural populations.

On 5 December 2005, during the study of ecological aspects of a population of *T. merianae*, we witnessed an adult female (366 mm SVL; 1.9 kg) preparing its burrow for oviposition in sandy soil. The observation was made at Taim Ecological Station (Estação Ecológica do Taim), municipality of Santa Vitória do Palmar, State of Rio Grande do Sul, Brazil (32.836944°S, 52.643889°W). By palpation, we confirmed the presence of eggs. About two days before laying the eggs, the female had started to collect vegetation material around the burrow. Positioned with her back to the burrow opening, her movements were recorded chronologically as follows: 1) the female moved plant matter towards her belly to the pelvic girdle with her forelimbs; 2), then pushed the vegetation with its hind limbs until the full extension of the limbs was reached; 3) the lizard then turned around and pushed the pile of plant matter with its forelimbs into the interior of the burrow. We were not able to see how the vegetation was arranged inside, as the lizard entered the burrow and we opted to avoid disturbance. On 19 December 2010, GRW observed a similar behavior displayed by an adult female of a similar body size of that from the Taim site, in the municipality of São João da Barra (Grussaí restinga habitat), State of Rio de Janeiro, Brazil (21.737778°S, 41.034722°W). The nest at Grussaí was also constructed on the ground in sandy soil. The vegetation is likely to assist in the manipulation of internal temperatures of the burrow. These localities are more than 1600 km apart, suggesting that this nest construction behavior may be related to the natural history of the species, rather than a behavioral adaptation to a particular environment.

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***UROSTROPHUS VAUTIERI* (Brazilian Steppe Iguana). DEFENSIVE BEHAVIOR AND COLOR CHANGE.** *Urostrophus vautieri* occurs in southeastern Brazil, from Paraná to Rio de Janeiro State. Basic behavioral information for the genus *Urostrophus* is limited to unpublished notes made on one captive animal by Rand (*In* Etheridge and Williams 1991. Bull. Mus. Comp. Zool. 152:317–361). Herein, we describe the first field observation of defensive behavior for this lizard species.

On 11 November 2010, at Serra do Japi Municipal Reserve, Jundiaí, São Paulo state (23.235°S, 46.935°W; WGS 1984; elev ca. 1092 m. At 0936 h). The lizard was observed during a behavioral study of a group of Black-fronted Titi Monkeys (*Callicebus nigrifrons*) conducted in a semi-deciduous secondary forest area. The lizard fell onto the leaf litter from its arboreal perch in front of CBC, just before being contacted by a group of *Callicebus nigrifrons* travelling towards it. It fell off a fructifying *Maytenus robusta* branch at a height of approximately 8 m. Immediately after reaching the ground, its color gradually changed from a grayish green to a reddish brown (Fig. 1). The color change clearly diminished the lizard's conspicuous form on the forest floor. The lizard remained immobile for at least five min, until CBC was no longer present.

This is the second report on behavioral ecology of *Urostrophus vautieri* and the first on color change. We provide a first context for color change in this species regarding potential predation avoidance. The specimen was not captured or manipulated for photographs, as collection inside of the Reserve is prohibited without permits.

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FIG. 1. Color change in *Urostrophus vautieri*. Image at left taken immediately after lizard fell onto leaf litter from an arboreal perch. Image at right taken approximately 2 min later, indicating rapid color change toward substrate matching.

SQUAMATA — SNAKES

***ARIZONA ELEGANS ELEGANS* (Kansas Glossy Snake). DIET.** Medium-sized diurnal lizards comprise a large proportion of the diet of *Arizona elegans* (Rodriguez-Robles et al. 1999. J. Herpetol. 33:87–92). Rodriguez-Robles et al. (*op. cit.*) suggest that diurnal lizards may be captured "when they are inactive by nocturnal wide-foraging glossy snakes." Here we document the first record of *A. e. elegans* feeding on *Sceloporus cautus*, a lizard that is distributed in Mexico from the northeastern section of the Mexican plateau, west from the western edge of the Sierra Madre Oriental, barely entering Tamaulipas, and south from southwestern Coahuila and central Nuevo Leon to the southern portion of San Luis Potosi and northern half of Zacatecas (Lemos-Espinal and Smith 2007. Amphibians and Reptiles of the State of Coahuila, Mexico. Universidad Nacional Autónoma de México and Comisión Nacional Para El Conocimento y Uso de La Biodiversidad. 550 pp.).

While conducting a survey of the herpetofauna of the municipality of Doctor Arroyo, Nuevo Leon, Mexico, driving on state road No. 61 (23.8094°N, 100.0853°W, datum NAD27; elev. 1791 m), on 12 September 2009, we found a road-killed juvenile *A. e. elegans* (female; SVL = 202 mm, total length = 233 mm; 4.19 g), that had in its stomach a juvenile *Sceloporus cautus* (female; SVL = 35 mm; total length = 60 mm; 1.57 g); the lizard represented 37.5% of the mass of the snake. As *A. elegans* is nocturnal and *S. cautus* is diurnal, the lizard was likely captured while inactive. Both specimens were deposited in the herpetological collection of the Universidad Autonoma de Nuevo Leon (*A. e. elegans* = UANL 7128a; *S. cautus* = UANL 7128b). Research and collecting were conducted under the authorization of SEMARNAT scientific research permits OFICIO/NUM/SGP/DGVS/ 02262 issued to DL.

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***ASTHENODIPSAS MALACCANUS* (Malayan Slug Snake). DIET.** *Asthenodipsas malaccanus* is a rare lowland forest snake from southern Thailand, the Malay Peninsula, Sumatra, and Borneo (David and Vogel 1996. The Snakes of Sumatra. An Annotated Checklist and Key with Natural History Notes. Chimaira, Frankfurt am Main. 260 pp.). Its diet has been reported to consist of snails and slugs (Inger and Stuebing 1999. A Field Guide to the Snakes of Borneo. Natural History Publications [Borneo] Sdn Bhd, Kota Kinabalu. 254 pp.), without specific information. At ca. 2130 h on 19 September 2010, an adult female *A. malaccanus* (SVL = 357 mm; Fig. 1) was found crossing a paved road within lowland forest (01.6061°N, 110.1955°E, datum: WGS84; elev. ca. 200 m), leading to the summit of Gunung Serapi (elev. 911 m), in Kubah National Park, Sarawak, East Malaysia. The snake was collected (Universiti Malaysia Sarawak Museum, UNIMAS 9379), and taken to the lab. Overnight, it voided an intact slug (RMNH MOL.127788), which was identified as *Valiguna flava* (Gastropoda: Soleolifera: Veronicellidae; Fig. 1), a nocturnal/crepuscular lowland (elev. < 1000 m) terrestrial slug, endemic to Sumatra and Borneo (Gomes et al. 2008. The Veliger 50:163–170; Schilthuizen and Liew 2008. Basteria 72:287–306).

We thank Sarawak Forest Department for permission to conduct fieldwork at Kubah National Park.

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COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

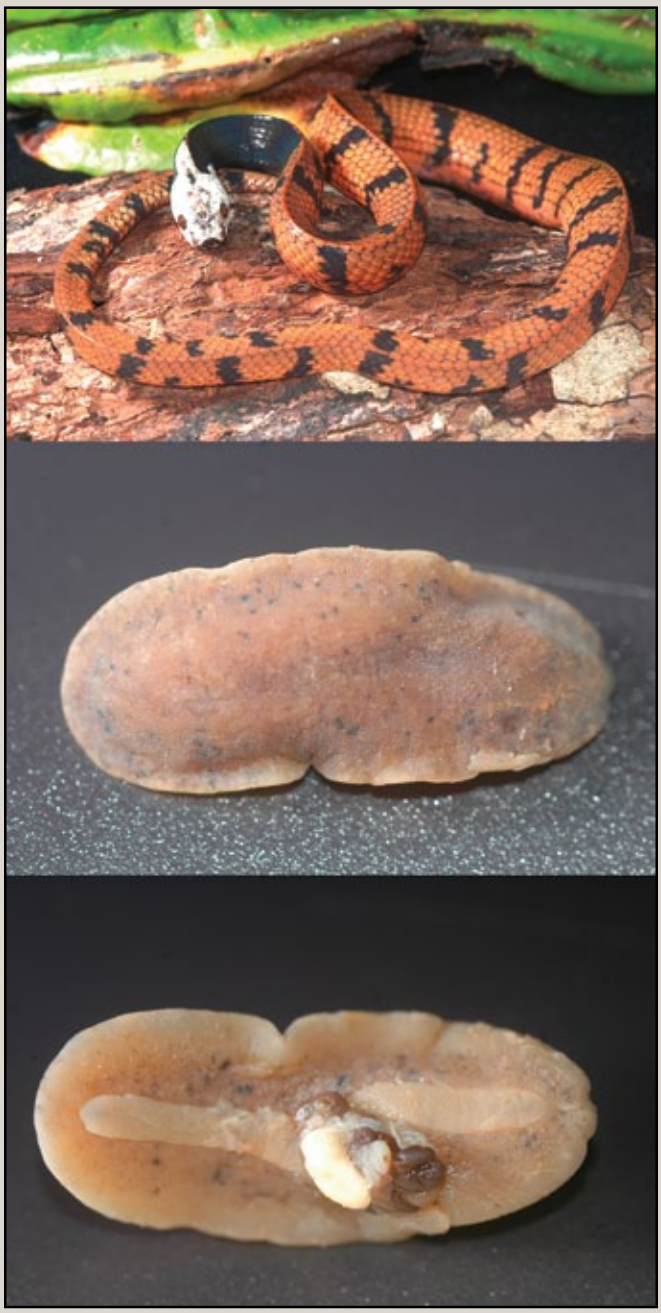

FIG. 1. Adult female *Asthenodipsas malaccanus* (top; UNIMAS 9379), with its prey, the slug *Valiguna flava* (bottom; dorsal and ventral views; RMNH MOL.127788).

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***BOTHROPS ASPER* (Terciopelo). ARBOREAL BEHAVIOR.** *Bothrops asper* is a common, large (up to 2.5 m total length), viperid snake ranging from southern Mexico to northern Venezuela and western Ecuador. Like many vipers, it is an ambush predator, remaining motionless in leaf litter for the majority of its activity budget and moving nocturnally to new ambush spots (Sasa et al. 2009. Toxicon 54:904–922). Although *B. asper* is typically regarded as a terrestrial snake (Henderson and Hoevers 1977. Copeia 1977:349–355), accounts of juveniles in low vegetation have been reported (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.; Guyer and Donnelly 2005. Amphibians and Reptiles of La Selva. Univ. California Press, Berkeley. 298 pp.) There are a few cases, however, of adults being observed in trees or other vegetation (Guyer and Donnelly, *op. cit.*). Here, we report a sighting of an adult *B. asper* in low-lying vegetation in central Panama.

FIG. 1. An adult *Bothrops asper* found in understory vegetation in El Copé, Panama.

At 1927 h, on 6 September 2010, we observed an adult (ca. 1.5 m total length) *B. asper* at a height of 2 m in a cluster of small understory trees (Fig. 1) at La MICA Biological Station, El Copé, Panama (8.374224°N, 80.345024°W, datum: WGS 84; elev. ca. 300 m). The *B. asper* attempted to cross a path by traversing a thin branch, but failed to do so. At 1955 h the snake left the vegetation and returned to the ground having moved a net horizontal distance of <2 m since the beginning of the observation. Because the snake was outstretched and moving, it seems that the purpose of ascending the vegetation was dispersal rather than ambush site selection. Sasa et al. (*op. cit.*) found that the majority of *B. asper* movements are short-range (<10 m), but that less frequently, longer-range movements (>50 m) related to foraging behavior also take place. This observation supports the idea that adult *B. asper* occasionally engage in arboreal behavior for various reasons.

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***CANDOIA ASPERA* (New Guinea Ground Boa). REPRODUCTION.** *Candoia aspera* is known from New Guinea and adjacent island archipelagos (McCoy 2006. Reptiles of the Solomon Islands. Pensoft, Sofia, Bulgaria. 147 pp.). In Papua New Guinea it occurs from 0–1300 m elevation (O'Shea 1996. A Guide to the Snakes of Papua New Guinea. Independent Publishing, Port Moresby. 239 pp.). Current information on *C. aspera* reproduction is reported by Harlow and Shine (1992. J. Herpetol. 26:60–66). The purpose of this note is to provide additional information on the reproductive cycle of *C. aspera*.

Eight male *C. aspera* (mean SVL = 451 mm ± 51.8 SD, range: 373–515 mm) and four females (mean SVL = 604 mm ± 148.7 SD) collected between1986–2007 from Papua New Guinea and deposited in the herpetology collection of the Bernice P. Bishop Museum (BPBM), Honolulu, Hawaii, were examined: BPBM 18932, 12174, 23168, 23436, 23437, 23439, 23440, 27338, 28282, 30797, 31321, 31323. The left testis was removed from males and the left ovary was removed from females for histological examination. Slides were stained with Harris hematoxylin followed by eosin counterstain. Slides of testes were examined to determine the stage of the spermatogenic cycle. Slides of ovaries were examined for the presence of yolk deposition and/or corpora lutea. Enlarged ovarian follicles (>10 mm) were counted. Histology slides were deposited in the BPBM.

Two stages were noted in the male cycle: 1) spermiogenesis (sperm production) in which the lumina of the seminiferous tubules are lined by sperm or clusters of metamorphosing spermatids; 2) regression in which the germinal epithelium is greatly reduced and contains primarily spermatogonia and interspersed Sertoli cells. Some residual sperm from the last period of spermiogenesis may remain. Monthly samples of males exhibited the following stages of the testicular cycle: February (N =1) regressed; May (N = 2) regressed, (N = 1) spermiogenesis; August (N = 2); September (N = 1); October (N = 1) all spermiogenesis. These data suggest there is seasonality in the testicular cycle of *C. aspera* as has also been reported for the congener *C. carinata* (Wynn and Zug 1985. The Snake 17:15–24.).

One female *C. aspera* each from February, May, and September contained quiescent ovaries with no yolk deposition. One female from August contained nine enlarged ovarian follicles (> 10 mm). The presence of three non-reproductive females may suggest seasonality in the ovarian cycle of *C. aspera* or that not all females reproduce annually as suggested by Harlow and Shine (*op. cit.*). Less than annual production of young by *C. aspesa* was also indicated in Parker (1982. The Snakes of Western Province. Widl. Papua New Guinea 82:1–78).

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COLUBER CONSTRICTOR **(Racer). FORAGING BEHAVIOR.** Foraging strategies of snakes have been linked to their morphology, physiology, and ecology (Mushinsky 1987. *In* Seigel et al. [eds], Snakes: Ecology and Evolution Biology, pp.302–334, McGraw-Hill, New York). Snakes considered ambush predators balance low energy expenditure with low food intake, while active foragers have greater energy expenditure, but high food intake (Secor and Nagy 1994. Ecology 75:1600–1614). *Coluber constrictor* is considered an active generalist forager that routinely takes both endothermic and ectothermic prey (Klimstra 1959. Copeia 1959:210–214; Shewchuk and Austin 2002. Herpetol. J. 11:151–155). It has been suggested the fundamental food niche of *C. constrictor* is that of an insect eater (primarily orthopteran), with vertebrate prey being taken opportunistically and more frequently in fragmented feeding grounds, which necessitate larger movements by the snake, and more chance encounters with vertebrate prey (Fleet 2009. Southwest. Nat. 8:31–40). Active foragers such as *C. constrictor* typically rely on sight to target and capture food (Mullin et al. 1998. Am. Midl. Nat. 140:397–401), and frequently prefer moving over non-moving prey (Herzog and Burghardt 1974. Herpetologica 30:285–289; Cooper et al. 2000. Amphibia-Reptilia 21:103–115).

In May of 2004 at Flat Rock Cedar Glade and Barrens, located east of Murfreesboro, Rutherford Co., Tennessee, USA, a radio-telemetered adult male *C. constrictor* (SVL = 87.3 cm) was observed three times within a 10 min period aerially attacking a swarm of small gnat-like insects. These observations took place on a partly cloudy, warm, afternoon (1215–1225 h) in an open cow pasture with grass approximately 30 cm high. This snake spent much of its time in the pasture and, as indicated by scat samples collected from *C. constrictor* observed in this mixed habitat area, foraged on the abundant orthopterans. The swarm of insects hovered directly above where the snake was observed and the behaviors all occurred within a 25 m^2 area. The *C. constrictor* raised the anterior portion of its body off of the ground in a typical foraging posture and, with its mouth open, made a series of short, controlled, lunges toward the swarm of insects. Since these observations were made from a distance (~15 m) using binoculars, it was unclear if the snake was successful in capturing any prey. Whether for food, or out of annoyance, the actions of the snake suggested that it was targeting the swarm.

To our knowledge this is the first report of *C. constrictor* making aerial attacks on small swarming insects. Although anecdotal, these observations support the idea that *C. constrictor* is an opportunistic, generalist forager and suggest that food items are selected based on availability, with foraging efficacy playing a lesser role in prey selection.

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COLUBER (= MASTICOPHIS) FLAGELLUM PICEUS **(Red Racer). ARBOREAL/NOCTURNAL BEHAVIOR.** Many species of snakes display arboreal behavior and are often found in vegetation many meters above ground. Mojave Desert snake species rarely get very far above the ground surface and are perhaps limited by predominantly low growing vegetation. *Coluber flagellum piceus* is considered strictly diurnal and although may ascend vegetation while active, is thought to retreat to subterranean refugia at night. Werler and Dixon (2000. Texas Snakes: Identification, Distribution, and Natural History. University of Texas Press, Austin. 437 pp.) stated "The western coachwhip is active above ground only during daylight hours. It almost invariably retires to depths of an animal burrow before sundown, where it spends the night." The normal morning activity period for *C. flagellum* appears to be from approximately 0700–1000 h from June through September (Jones and Whitford 1989. Southwest. Nat. 34:460–467). Secor and Nagy (1994. Ecology 75:1600–1614), and Secor (1995. Herpetol. Monogr. 9:169–186) determined that the average body temperature for active above ground activity of *C. flagellum* was (33.1°C ± 0.1°C, range of 24.0°C–40.8°C, N = 502), stating that coachwhip snakes were seldom active on the surface with body temperatures below 28°C. Here, I report a *C. f. piceus* that apparently spent the night draped in a Creosote Bush (*Larrea tridentata*).

On 24 June 1995 I observed an unusual behavior exhibited by a half grown *C. f. piceus* (SVL ca. 650 mm) basking in a moderate-sized creosote bush approximately 1 m above the ground at 0610 h in Piute Valley, Clark Co., Nevada, USA. I approached the snake slowly taking numerous photographs while the snake remained motionless in the shrub (Fig. 1). When I was within arm's length of the snake I reached out and captured it by hand to find that it

FIG. 1. *Coluber flagellum piceus* moments after sunrise (0610 h) in a Creosote Bush, Clark Co., Nevada.

appeared as cold as the ambient air temperature at waist height, which was 20°C at the time. All indications are that the snake had spent the night above ground draped in the Creosote Bush where I first observed it that morning. Numerous other desert reptiles are known to be nocturnal although nocturnal activity for *C. flagellum* is not commonly observed. Therefore, I assert that this snake likely placed itself in this precarious position sometime near dusk or possibly even at night and spent the night as depicted in Fig. 1.

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***DRYMOBIUS MARGARITIFERUS* (Speckled Racer). DEFENSIVE BEHAVIOR: THANATOSIS.** Thanatosis, also known as letisimulation or death feigning behavior, has been recorded in several families and species of snakes, but is most often associated with the genus *Heterodon* (Gehlbach 1970. Herpetologica 26:24–34). Although *Drymobius margaritiferus* is a common and widespread species throughout much of Middle America (Lee 1996. The Amphibians and Reptiles of the Yucatán Peninsula. Comstock Publ. Assoc., Ithaca, New York. 500 pp.), little is known about its ecology and behavior. To our knowledge, thanatosis has not been recorded in *D. margaritiferus*.

At 1112 h (CST) on 29 October 2003, a juvenile *D. margaritiferus* (total length ca. 50 cm) was found crossing State Highway 66 in the Sierra Tamalave in an area of tropical deciduous forest in the Municipality of Ocampo, Tamaulipas, Mexico (22.820833°N, 99.289167°W, datum: WGS84; elev. 389 m.; air temp. 28.3°C). It was detained for ca. 30 min to collect data and photographs. The animal, which appeared to be healthy and alert, was photographed on the side of a nearby dirt road. The snake was in perpetual motion in its effort to escape and it attempted to bite repeatedly while being photographed. After a period of approximately 15 min of struggling, it suddenly became very weak and appeared to have difficulty moving. The snake grew increasingly weak and after about 30–45 sec its body went completely limp and motionless except for the tail, which squirmed and twitched for the next two or three minutes. Unlike snakes of the genus *Heterodon*, this specimen did not exhibit gaping, extend its tongue, or attempt to right itself or to move itself from any given position. When held by the tail or at mid-body the snake dangled, completely limp, and when placed on the ground the snake remained limp and motionless in whatever position it was placed. Believing the snake was in fact dead, it was posed in a lifelike position and a few photographs were taken. After a minute or two, my attention (and eye contact) turned away from the snake and while changing film and putting lens away, the snake was observed on the ground nearby tongue flicking and raising its head. The snake was gently picked up and examined, and although it seemed slightly more subdued and ceased to bite, it appeared to be normal and soon resumed its efforts to escape. The snake was released near the point of capture where it quickly retreated and disappeared into dense foliage.

A second observation of this behavior was observed in the Municipality of Gonzalez, Tamaulipas, 29 km N of the town of Gonzalez (23.087222°N, 98.469444°W, datum: WGS84; elev. 360 m.; 28.3°C) on 20 September 2006, 1100 h. (CST). An adult *D. margaritiferus* (SVL = 83.8 cm) was collected in tropical deciduous forest in the southern foothills of the Sierra de Tamaulipas in a riparian area of the Arroyo el Cedral. As above, the specimen went limp and became motionless while being photographed. When the anterior half of the snake was raised off the ground the head and anterior body hung limp and when released the head of the snake came to rest upside down, with an elevated coil in the neck, and the posterior half of the body dorsal side up. When left in this position, the snake remained motionless. Unlike the first observation, this snake seemed to show slight signs of recovery as it was being photographed for ca. 5 min. A few times it started to orient its head right side up and made some feeble attempts to move its body forward, but it repeatedly relapsed. The second snake was also released at the location of its capture after being photographed.

Finally, 30 *D. margaritiferus*, 21 alive and 9 DOR, were recorded in field surveys of Tamaulipas conducted between 2003 and 2007. Seven of the live specimens were collected, handled, measured, photographed, and then released. Two of the seven (28.5%) individuals that were handled exhibited thanatosis. Photographs of the two specimens were deposited at University of Texas Arlington Digital Collection (UTADC 6808–6810). DOR specimens were salvaged and deposited at the Universidad Autónoma de Nuevo León.

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***ERYTHROLAMPRUS BIZONA* (Black-Ringed False Coralsnake). ARBOREALITY.** *Erythrolamprus bizona* is a moderately common snake that ranges between Costa Rica and Colombia. All accounts suggest that the snake is terrestrial (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. 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.). On 6 January 2011, at 1005 h, at La MICA Biological Station in

El Copé, Coclé Province, Republic of Panamá (08.66°N, 80.61°W; WGS84) we observed an adult *E. bizona* two meters high in a small tree. The snake moved to the end of the branch and then dropped to the ground and crawled away. *Erythrolamprus bizona* have not previously been reported to be arboreal. This observation expands the habitats that may be used by this species.

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***EUNECTES BENIENSIS* (Beni Anaconda). DIET: CANNIBALISM.** Cannibalism has been reported four times in the genus *Eunectes* (O'Shea 1994. Herpetol. Rev. 25:14; Rivas and Owens 2000. Herpetol. Rev. 31:45–46; Barros et al. 2011. Herpetol. Rev. 42:290–291). Two of these records were considered sexual cannibalism (Rivas and Owens, *op. cit.*), where a large female consumed a male of the same species during the breeding season. In this contribution we present the first report of cannibalism in the recently discovered *Eunectes beniensis*.

On 24 January 2010, as part of a comprehensive study of the spatial ecology and life history of *E. beniensis* in the Beni River basin, Beni Department, Bolivia, we captured a female *E. beniensis* (total length = 220 cm; 6 kg without prey) in a rice field (14.8°S, 64.467°W; WGS84). Following capture, the female regurgitated a conspecific male (total length = 192 cm; 2.5 kg; sex determined by presence of exposed hemipenes). Although the cephalic region of the regurgitated specimen was partially decomposed, it was possible to recognize the color pattern typical of *E. beniensis*. Because prior records of cannibalism in *E. murinus* occurred during or directly following the mating season (dry season), Rivas and Owens (*op. cit.*) believed that they were examples of sexual cannibalism. However, this report of cannibalism in *E. beniensis* occurred in the middle of the rainy season and thus was not likely to be associated with reproductive activities. The presence of cannibalism in three species of *Eunectes* in different locations suggests that it may be a relatively common strategy in the group.

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***HOLOGERRHUM PHILIPPINUM* (Philippine Stripe-lipped Snake). REPRODUCTION.** One of four snake genera endemic to the Philippines, the genus *Hologerrhum* contains only two species, known from fewer than 20 specimens worldwide (Brown et al. 2000. Asiatic Herpetol. Res. 9:1–13; Leviton 1963. Proc. California Acad. Sci. 31:369–416; Leviton 1965. Phil. J. Sci. 94:519–533). The apparent absence of adult males in collections previously led taxonomists to speculate that *H. philippinum* might be an all-female, parthenogenetic species (A. Leviton, pers. comm.). During recent fieldwork in the northern Philippines, we collected an adult male *H. philippinum* (total length = 302 mm; 4.8 g; Fig. 1). The specimen was observed on 28 December 2010, in mixed primary- and secondary-growth forest, under a rock in a dry river bed, in the Angat Dam Watershed Reserve, Sitio Langud, Barangay San Lorenzo, Municipality of Norzagaray, Bulacan Province, Luzon Island, Philippines (14.93231°N, 121.20562°E, WGS-84; elev. 194 m). This is the first known reproductively mature male specimen of *H. philippinum*; the only other male specimen is a juvenile with hemipenes retracted (USNM 498718; Brown et al., *op. cit.*). The specimen is deposited at the herpetological collections of the Biodiversity Institute, University of Kansas (RMB 13628).

FIG. 1 An adult male *Hologerrhum philippinum* from the Angat Dam Watershed Reserve, Luzon Island, Philippines.

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***IMANTODES CENCHOA* (Brown Blunt-Nosed Vinesnake). MAXIMUM SIZE.** *Imantodes cenchoa* is a relatively abundant neotropical arboreal snake that ranges from southern Mexico to Argentina. It is recognized by its long slender body and extremely thin neck. Savage (2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.) reported a maximum size of 1250 mm for female *I. cenchoa*. On 5 December 2006, at 2000 h, in Omar Torrijos National Park, Coclé Province, Republic of Panamá (08.66°N, 80.61°W, datum: WGS84), we found a female *I. cenchoa* that measured 1369 mm total length (SVL = 943 mm) and weighed 47.4 g. This snake was marked and released at the site of capture. On 8 March 2007, at 2236 h, in Omar Torrijos National Park we found a female *I. cenchoa* that measured 1439 mm total length (SVL = 986 mm) and weighed 36.0 g (without prey). This snake contained a *Dactyloa frenata* (19.1 g) and a large anole egg (1.3 g) prey items (Ray et al. 2011. Herpetol. Rev. 42:100). Photographs of this specimen were deposited at the Amphibian and Reptile Diversity Research Center, University of Texas at Arlington (UTADC 6526–27). The first record increased the maximum known total length of female *I. cenchoa* by 119 mm (8.6%) and the second by 189 mm (15.1%).

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***LAMPROPELTIS GETULA* (Common Kingsnake). DIET AND FORAGING.** The ability of a snake to successfully forage is a product of its morphology, physiology, and ecology (Mushinsky 1987. *In* Seigel et al. [eds], Snakes: Ecology and Evolution Biology, pp. 302–334, McGraw-Hill, New York). Consuming non-prey items by mistake could be detrimental to the snake and result in death. Thus, selection should favor behaviors that maximize a snake's ability to accurately discriminate between prey and non-prey items (Cooper et al. 1990. Chemoecology 1:86–91; Reiserer 2002. *In* Schuett et al. [eds], Biology of the Vipers, pp. 361–384, Eagle Mountain Publishing, Eagle Mountain, Utah).

Lampropeltis getula is an active forager that relies on both sight and chemoreception to locate and capture prey (Jackson et al. 2004. Zoology 107:191–200; Williams and Brisbin 1978. Herpetologica 34:79–83). This species, like others in the genus *Lampropeltis*, is known to routinely consume ectothermic (e.g., squamates) and endothermic (e.g., birds and mammals) prey, as well as squamate eggs (Clark 2009. Southwest. Nat. 54:352–353). Studies have investigated prey selection in snakes, including *Lampropelis* (Fitch 1978. Trans. Kansas Acad. Sci. 81:353; Greene and Rodriguez-Robles 2003. Copeia 2003:308–314), however, little is known about their ability to discriminate between certain qualitative traits of prey (e.g., color and texture).

In June of 2003 at Flat Rock Cedar Glade and Barrens, located east of Murfreesboro, Rutherford Co., Tennessee, USA, a *Coluber constrictor* nest was predated upon by an adult male *L. getula* (SVL = 71.6 cm). The snake consumed three *C. constrictor* eggs and an artificial egg, which had been constructed to record nest temperature, leaving behind two other *C. constrictor* eggs. Despite being of similar size, shape, and weight, the artificial egg was bright yellow in color (i.e., coated in Plasti Dip®), denser, and had a smoother texture than a *C. constrictor* egg. The oviposition site and artificial egg, which had only been there for approximately two weeks, were located in an ecotone between a cedar forest and a glade. The *L. getula* was located approximately 25 m away under a large rock, and the food items were palpated in order to retrieve the artificial egg. The snake was promptly release unharmed at the site of capture after recovering the artificial egg and recording basic measurements.

This observation indicates that *L. getua* will mistakenly consume non-prey items in the wild despite its visual and chemosensory capabilities. Similar observations have been made in other snakes (Ernst and Ernst 2003. Snakes of the United States and Canada, Smithsonian Institution Press, Washington, DC. 680 pp.; Souza et al. 2004. J. Herpetol. Med. Surg. 14:4–5) suggesting that despite some discriminatory abilities in prey selection, snakes may become confused when non-prey items that resemble prey are encountered while foraging. To our knowledge this is the first report of this type of behavior in *L. getula*.

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***LAMPROPELTIS GETULA HOLBROOKI* (Speckled Kingsnake). DIET.** *Lampropeltis getula holbrooki* is known to prey on reptiles and reptile eggs, amphibians, mammals, and several species of birds that construct open-cup nests (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Inst. Press, Washington DC. 680 pp.). One published account documents *L. g. holbrooki* depredating nestlings in open-cups: the Dickcissel (*Spiza americana*) and the Red-winged Blackbird (*Agelaius phoeniceus*; Facemire and Fretwell 1980. Wilson Bull. 92:249–250). These nests were located 15 cm and 70 cm above the ground, respectively. *Lampropeltis g. holbrooki* has also been documented to depredate nestling Indigo Buntings (*Passerina cyanea*) and Field Sparrows (*Spizella pusilla*), both species that construct open-cup nests within 1 m of the ground (Stake et al. 2005. J. Herpetol. 19:215–222). Although *L. g. holbrooki* has been observed depredating Eastern Bluebird (*Sialia sialis*) nest-boxes in Texas (Keith Kridler, pers. comm.), there is no published documentation of *L. g. holbrooki* climbing an artificial structure and consuming this species of cavity-nesting bird.

On 25 June 2010, at 1130 h, we discovered a *L. g. holbrooki* inside of a constructed Eastern Bluebird nest-box mounted 1.5 m above the ground. This nest box was mounted on a fence at the edge of a hay field off of state highway 51 in Payne Co., Oklahoma, USA (36.1152°N, 97.3007°W; datum WGS84). There were four 7-day-old bluebird nestlings inside the box being tended by both parents. The snake could only enter through the entry hole (3.81 cm in diameter). The snake was observed eating one nestling and constricting another. The observer opened a hinged door that was held shut with a nail and took photos, then closed the door without disturbing the snake. Only one nestling was consumed at this time and the rest remained alive. We monitored the box for the next two days and observed one nestling missing on each successive visit. Although we did not observe any other depredation events during our visits, we speculate these nestlings were preyed upon by the same snake. Similar return behavior to a nest was documented by Stake et al. (2005. J. Herpetol. 19:215–222). Only one nestling fledged from this box on 7 July 2010. To the best of our knowledge, this is the first documentation of *L. g. holbrooki* climbing and consuming nestlings inside of a secondary cavity.

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***LAMPROPELTIS ZONATA* (California Mountain Kingsnake). DIET.** *Lamproteltis zonata* is distributed from southern Washington state to northern Baja California and throughout the mountain ranges of California (Stebbins 2003. Peterson Field Guide: Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., New York. 366 pp.). The diet of this species has been examined in detail (Greene et al. 2003. Copeia 2003:308–314); it appears that the bulk of its diet consists of squamate reptiles

FIG. 1. *Lampropeltis zonata* constricting and beginning to consume a bat (*Myotis* sp.) headfirst.

and their eggs, but larger individuals may occasionally consume mammals and birds.

At 1350 h, on 20 October 2009, one of us (CW) observed a *L. zonata* constricting a bat of the genus *Myotis* along the Rogue River trail of southwestern Oregon just off BLM Rd. 34-8-1 (42.663661°N, 123.611255°W; datum WGS84) (Fig. 1). This section of the trail is adjacent to a talus slide. It is likely that the kingsnake found and captured the bat within the talus, and the two subsequently fell and rolled onto the trail. The two were not disturbed and actual consumption of the bat was not observed. This is the first record of *L. zonata* attempting predation upon a bat.

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***LEPTODEIRA PUNCTATA* (Western Cat-Eyed Snake). DIET.** Snakes in the genus *Letpodeira* prey primarily upon anurans and small lizards (Duellman 1958. Bull. Amer. Mus. Nat. Hist. 114:1–152), along with other reptiles and amphibians (Burchfield 1993. Bull. Chicago Herpetol. Soc. 28:266–267). Although species from the family Hylidae have been documented (Hardy and McDiarmid 1969. Univ. Kansas Publ. Mus. Nat. Hist. 18:39–252), *Smilisca fodiens* (=*Pternohyla fodiens*; Northern Casque-Headed Frog) has not been reported as prey of *Leptodeira punctata* (Duellman and Trueb 1966. Univ. Kansas Publ. Mus. Nat. Hist. 17:281–375). On 5 August 2008, at approximately 1930 h, we encountered an adult *L. punctata* with an adult *S. fodiens* in its grasp near the town of Concordia, Sinaloa, Mexico (23.2725°N, 106.03585°W; datum WGS84) (Fig. 1). The *S. fodiens* was inflated with air in an attempt to prevent the snake from consuming it. The *L. punctata* continuously chewed on the *S. fodiens* for approximately 45 min until the frog deflated and was consumed. This is the first documentation of a *L. punctata* preying upon a *S. fodiens*.

COLOR REPRODUCTION SUPPORTED BY THE THOMAS BEAUVAIS FUND

FIG. 1. *Leptodeira punctata* preying upon an adult *Smilisca fodiens* in Sinaloa, Mexico.

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***LIOPHIS DILEPIS* (Lema's Ground Snake) and *PHILODRYAS OLFERSII LATIROSTRIS* (Lichtenstein's Green Racer). BROMELIAD REFUGIA.** *Liophis dilepis* is colubrid species with a disjunct distribution, including Caatinga and Cerrado areas in northeastern and southern Brazil, and Chaco areas of Paraguay, northern Argentina, and southern Bolivia (Giraudo 2001. Serpientes de la Selva Paranaense y del Chaco Húmedo. L.O.L.A., Buenos Aires, Argentina. 328 pp.). In Argentina and southern Paraguay, the species inhabits savannas, xerophilous and semi-xerophilous forests in the Chaco biogeographic province (Giraudo, *op cit.*). *Philodryas olfersii* is a colubrid snake that is widely distributed in tropical and subtropical areas of cis-Andean South America from Guiana, Venezuela, and Colombia, to subtropical areas of Argentina and Uruguay (Thomas 1976. A Revision of the South American Colubrid Snake Genus *Philodryas* Wagler, 1983. Ph.D. dissertation, Texas A&M University, College Station. 338 pp.). In Argentina, *P. o. latirostris* is found in the humid Chaco phytogeographical region and other mesophytic vegetation and gallery forests along the Paraná River (Thomas, *op cit.*; Giraudo, *op cit.*).

We conducted periodic diurnal surveys to investigate the fauna associated with colonies of *Aechmea distichantha* (Bromeliaceae) at El Perichón, 10 km NE of Corrientes City, Argentina (27.4321111°S, 58.7466111°W, datum: WGS84). The area is included within the Chacoan Domain, Oriental Chaco District (Carnevali 1994. Fitogeografía de la Provincia de Corrientes. Gobierno de la provincia de Corrientes e INTA. 324 pp.), and is characterized by the presence of numerous temporary, semipermanent, and permanent water bodies. The original plant community at the study site was *Schinopsis balansae* "quebracho" forest, which is currently extremely degraded and largely replaced by sclerophyllous forest with prevalence of *Prosopis affinis*, *P. nigra*, *Acacia caven*, *Celtis* spp., and numerous colonies of *Aechmea distichantha* and *Bromelia* spp. (Carnevali, *op. cit.*). On 1 October 2007, at 1726 h, we found an adult *L. dilepis* inside

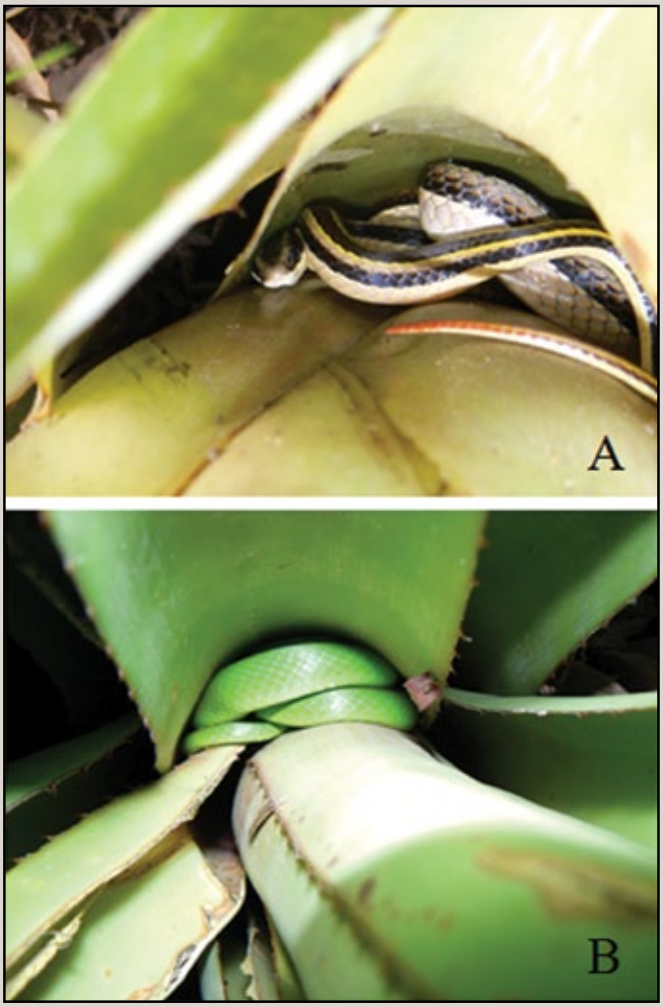

FIG. 1. A) *Liophis dilepis* and B) *Philodryas olfersii latirostris* hidden inside the axils of *Aechmea distichantha*.

an *A. distichantha* leaf axilla (Fig. 1A). Six days before, on 27 September 2007, at 1900 h, within another *A. disctichantha* colony, we discovered an adult *P. o. latirostris* hidden inside a bromeliad axil (Fig 1B). Considering that these snakes were found hidden in evening hours, it is possible that they use the axils of *Aechmea distichantha* as nocturnal shelter. It is also important to note that bromeliad axils have the capacity to store water for long periods and are used by several amphibian species. Thus, these plants may provide snakes abundant food in addition to shelter.

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***LIOPHIS EPINEPHELUS* (Night Ground Snake). DIET.** *Liophis epinephelus* is found in South America from Venezuela to Peru, at or above 2200 m in Ecuador and Peru (Dixon 1989. Smithson. Herpetol. Info. Serv. No. 79). *Liophis* are thought to feed primarily on anurans, but their diet is also known to include invertebrates, lizards, fishes, birds, small rodents (Esqueda et al. 2009. Acta Herpetol. 4:171–175), and squamates (Michaud and Dixon 1989. Herpetol. Rev. 20:39–41), including only a few records from the family Geckkonidae. In this note I report the first record of a *Liophis* feeding on gecko of the genus *Lepidobleparis*.

On 7 August 2010, a *Liophis epinephelus* (SVL = 140 mm) was captured in a disturbed-regenerating portion of Reserva Las Gralarias, a private 1064-acre reserve located in northwestern Ecuador, Pinchincha (elev. 1750–2350 m). Almost immediately upon being handled the snake regurgitated a *Lepidobleparis conolepis* (SVL = 38.5 mm). The gecko showed little evidence of digestion, indicating this was a very recent meal. The *L. conolepis* specimen was collected and deposited in the herpetological collection of Museo de Zoologia QCAZ, Pontifica Universidad Catolica del Ecuador and identification was verified by Omar Torres Carvajal.

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***MICRURUS MIPARTITUS* (Redtail Coralsnake). DIET.** New World coralsnakes are predators of elongate vertebrates, especially snakes, lizards, and amphisbaenians (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). They apparently do not eat amphibians very frequently (Wells 2007. The Ecology and Behavior of Amphibians. Univ. Chicago Press, Chicago, Illinois. 1148 pp.), although some species prey upon caecilians (Roze 1996. Coral Snakes of the Americas: Biology, Identification, and Venoms. Krieger Publ., Malabar, Florida. 328 pp.). Here we report *Micrurus miparitus* preying upon a caecilian, *Caecilia thompsoni*.

On 25 May 2010, at 1240 h, we observed a *M. mipartitus* (total length = 46.5 mm) struggling with a *C. thompsoni* (total length = 47.3 mm) for about 25 min at ICA (Instituto Colombiano Agropecuario) station in Tolima, Colombia (4.4388889°N, 75.2319444°W, datum WGS84; elev. 1150 m). We observed the coralsnake pursuing and biting the caecilian, primarily on the neck (Fig. 1A). Once the caecilian was immobile, it was ingested head-first (Fig. 1B). However, the caecilian, which was longer than the coralsnake, could not be totally consumed and was eventually regurgitated.

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FIG. 1. *Micrurus mipartitus* biting (A) and ingesting (B) a caecilian, *Caecilia thompsoni*.

***OPISTHOTROPIS KUATUNENSIS* (Striped Stream Snake). DIET.** *Opisthotropis kuatunensis* is a non-venomous aquatic snake with an average total length of 35–48 cm (Karsen et al. 1998. Hong Kong Amphibians and Reptiles. Provisional Urban Council, Hong Kong. 186 pp.). This snake is endemic to southern China and inhabits rocky hill streams in forests. It has been reported to feed on tadpoles and fishes in captivity (Karsen et al., *op. cit.*). Information concerning the diet of this species, or any other species of *Opisthotropis* in the wild, is very limited. *Opisthotropis lateralis* has been reported to feed on crabs in its natural environment (Karsen et al., *op. cit.*). Here I report the first documented observation of *O. kuatunensis* feeding on a crab in the wild.

At 2120 h on 3 October 2010, on Tai Mo Shan (22.40847°N, 114.12895°E, datum WGS84; elev. 769 m), New Territories, Hong Kong, while conducting an amphibian survey, I observed an *O. kuatunensis* (SVL = 52.5 cm; total length = 64.0 cm; sex unknown) swimming in the stream with a dead freshwater crab, *Cryptopotamon anacoluthon*, in its mouth. Upon capture, the snake released the carcass of the crab, which was collected and preserved in ethanol. The crab was presumably freshly molted, since its carapace was soft and deformed by bites from the snake. Except for two left legs, all chelae and other legs were missing from the carcass and may have been consumed by the snake (Fig. 1). This observation of a crab being eaten by *O. kuatunensis* is surprising because this species' small blunt teeth and relatively small gape size suggest that it preys on small or soft-bodied animals. In this observation, the dimensions of the crab's carapace were 2.0 cm (width) by 1.5 cm (length) while the head width and body width of the snake was approximately 1 cm. Despite its small gape size, the snake probably could have eaten the crab because it was freshly molted. It is unlikely that *O. kuatunensis* would be able to swallow the crab intact if it was hard-shelled.

FIG. 1. *Opisthotropis kuatunensis* (above) found feeding on a freshwater crab (*Cryptopotamon anacoluthon*; above and below) on Tai Mo Shan, Hong Kong.

It is possible that the snake may have been scavenging on a dead crab. Aquatic snakes may scavenge more frequently than other snakes since they tend to rely on chemical cues for prey detection underwater (DeVault and Krochmal 2002. Herpetologica 58:429–436). Although I did not observe the initial encounter of the *O. kuatunensis* with the crab, the relatively intact carapace of the dead crab suggested that the crab was not likely remains left by another predator. Potential crab predators in the area include Big-headed Turtles (*Platysternon megacephalum*) and Giant Spiny Frogs (*Paa spinosa*), both of which would have inflicted obvious damage to the crab or consumed the crab whole.

The aquatic snake *Gerarda prevostiana* preys on crabs much larger than its head (Jayne et al. 2002. Nature 418:143). This species circumvents the constraint of its gape limit by selectively preying on freshly molted crabs; it tears off and consumes the crab's legs first by a "loop-and-pull" action and then discards body parts that are too large to swallow (Jayne et al., *op. cit.*). The carcass of the freshly molted crab with missing legs suggests that *O. kuatunensis* may represent another species that engages in this unusual crab-eating behavior. Additionally, *O. kuatunensis* may selectively prey on or scavenge freshly molted crabs that are more easily ingested. Becasue crab molting can be temperature-triggered and thus highly seasonal (Yamaguchi and Takamatsu 1980. Kumamoto J. Sci. Biol. 15:1–27), crabs may be a seasonally important food source for *O. kuatunensis*.

I thank Kevin Wu for helping in field work, and Nancy Karraker and Kingsley Wong for valuable comments on the manuscript.

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***PITUOPHIS CATENIFER* (Gophersnake). DIET.** *Pituophis catenifer* feeds primarily on mammals, birds, lizards, eggs, and occasionally invertebrates (Diller and Johnson 1988. Herpetologica 44:228–233; Rodriquez-Robles 1998. Copeia 1998:463–466.; Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 668 pp.). On 20 May 2009, we collected an adult male *P. catenifer* (total length = 99 cm) from a south-facing limestone outcrop directly below a large, shallow cave in Snake Creek Canyon, Great Basin National Park, Nevada, USA (38.9169°N, 114.1731°W; datum NAD83). Upon palpation, the snake regurgitated two male *Tamius dorsalis* (Cliff Chipmunk) pups (BYU 5660; verified by Jack Sites and Eric Rickart). To the best of our knowledge, this is the first record of predation on *T. dorsalis* by *P. catenifer*.

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***PITUOPHIS CATENIFER DESERTICOLA* (Great Basin Gophersnake). PREDATION.** A variety of taxa have been observed to prey upon *Pituophis catenifer*, including mammals, birds-of-prey, and other snakes (Ernst and Ernst 2003. Snakes of the Unied States and Canada. Smithsonian Institution Press, Washington, D.C. 668 pp.). Here, we describe an unusual two-day observation of predation on a mature Great Basin Gophersnake by a Brown Trout (*Salmo trutta*).

The observation took place in Jones Canyon, Utah, USA, on the grounds of the Jones Hole National Fish Hatchery (JHNFH). Jones Creek emanates from springs at the head of Jones Canyon on hatchery grounds, and flows north to south 6.4 km to the Green River, approximately paralleling the Utah-Colorado border. The stream runs for ca. 0.3 km through a concrete channel across hatchery property before exiting into Dinosaur National Monument. The stream forms a pool at the end of the channel, which is cordoned off from public access by a 2 m high chain link fence. All insects and small wildlife species that fall into the channel are swept into this pool. The hatchery provides a plentiful supply of trout for the stream (primarily *S. trutta, Oncorhynchus mykiss,* and *O. clarki*) through escapes and planned releases. Numerous trout, many large, congregate in this pool, where they are protected from angling and are clearly visible. We have frequently observed snakes of various species basking atop the concrete walls of the channel. Through being startled or other accident, they may drop into the channel and are swept downstream to the pool. Partial bodies of snakes were observed on the bottom of the pool.

On 2 May 2006 the posterior portion of an adult *P. c. deserticola* was observed streaming from the mouth of a large (total length ca. 60 cm) *S. trutta,* the largest trout observed in the pool at the time. The visible length of the snake was approximately the same length as the fish carrying it and the diameter of the snake at the fish's mouth was ca. 2.5 cm. We estimate that the total length of the snake was ca. 90 cm. On the following day, the fish carrying the snake remained clearly visible throughout the day, with no readily apparent changes from the previous day. However, on 4 May 2006 there was no fish carrying a snake in the pool. We do not know if the snake was disgorged, swallowed, or if the fish vacated the pool. No whole or partial remnants of the snake were visible in the pool, only the portions of smaller snakes that were in the pool when observations began. To our knowledge, this is the first account of a Brown Trout consuming a mature *P. catenifer deserticola.*

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***PSEUDOBOA NIGRA* (Mussurana). DIET.** Two color morphs of *Pseudoboa nigra* exist in Brazil. The most common is plain black; the other is black with irregular white patches and might represent a different species (Orofino et al. 2010. Phyllomedusa 9:53–61). Although the diet of *P. nigra* consists primarily of lizards (Vanzolini et al. 1980. Répteis das Caatingas. Academia Brasileira de Ciências, Rio de Janeiro. 161 pp.), only two wild feeding events, both involving the black morph, have been reported (Avila and Ferreira 2006. Herpetol. Rev. 37:82; Rocha et al. 1999. Herpetol. Rev. 30:229). Here we report the first wild feeding observation of the black and white morph of *P. nigra* from Reserva Natural Vale, municipality of Linhares, Espírito Santo State, southeastern Brazil (19.1519444°S, 40.0708333°W; elev. 34 m). At ca. 0800 h, on 5 February 2008, we encountered an adult *P. nigra* (total length ca. 120 cm) in the process of swallowing a *Tropidurus torquatus* (total length ca. 25 cm; Fig. 1). At the time, the lizard was apparently dead and there were blood spots on posterior leg and feet. Despite our approach, the snake continued ingesting the lizard headfirst until it was consumed, approximately 1 h later.

We thank Francisco L. Franco (IBSP) for snake identification and Marco Aurélio de Sena and Miguel T.U. Rodrigues (IBUSP) for lizard identification.

FIG. 1. *Pseudoboa nigra* preying on *Tropidurus torquatus* (Linhares, Espírito Santo, Brazil).

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***SISTRURUS MILIARIUS BARBOURI* (Dusky Pygmy Rattlesnake). PREDATION.** Known predators of *Sistrurus miliarius* include carnivorous mammals, hawks (*Buteo* spp.), and snakes (Ernst and Ernst 2002. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 661 pp.). At 1852 h, on 13 November 2010, we observed a juvenile Yellow-crowned Night-Heron (*Nyctanassa violacea*) in the grass beside the road in Everglades National Park, Florida, USA

FIG. 1. Juvenile Yellow-crowned Night-Heron (*Nyctanassa violacea*) preying upon a *Sistrurus miliarius* in Everglades National Park, Florida.

(25.139098°N, 80.932128°W; datum WGS84). On closer inspection we ascertained the presence of an adult *S. miliarius* in the bird's beak (Fig. 1). We witnessed the heron thrash the snake approximately eight times in a 15-min span, with numerous tosses by the bird to adjust its grip on the snake, positioning its beak towards the head with each toss. The snake made several attempts to wriggle free but was apparently injured by the time we arrived and we assume the struggle commenced some time before our arrival. We watched until 1907 h when the heron ingested the entire *S. miliarius* and then flew off. The fact that we could see resistance from the snake as it writhed and tried to escape and the lack of any visible external injuries on the snake led us to believe the interaction was an act of predation and not scavenging of a road-killed animal by the *N. violacea*. Although wading birds are known to consume aquatic snakes (e.g., *Nerodia* spp.; Ernst and Ernst, *op. cit.*), to our knowledge, predation by wading birds on snakes of the genus *Sistrurus* has not been previously reported.

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***TANTILLA MELANOCEPHALA* (Black-headed Snake). DIET.** Little natural history data are available for the large genus *Tantilla*, with the exception of the North American *Tantilla gracilis* and *T. coronata* (e.g., Cobb 2004. Copeia 2004:397–402; Todd et al. 2008. Copeia 2008:388–394). The available information on the diet of the widespread *T. melanocephala* all pertains to southeastern Brazil and suggests an exclusively invertebrate diet consisting primarily of scolopendrid centipedes (Marques and Puorto 1998. Amphibia-Reptilia 19:311–318).

At 1430 h on 31 July 2010 an adult female *T. melanocephala* was found in a dry hole inside a steep-sided verge off a path in the Santa Lucía Cloud Forest Reserve, Pichincha, Ecuador (00.12917°N, 076.8048°W, datum WGS84; elev. ca. 1800 m). The specimen, which was in ecdysis, was found along with a number of eggs of the lizard *Riama oculata*. Upon capture one of the eggs was accidentally broken and the *T. melanocephala* subsequently started to 'lap up' the contents. It was unclear whether the specimen was intentionally in the area to feed upon the eggs. On closer examination, some of the eggs had hatched and others were complete but with two small holes in them, with no contents inside.

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***THAMNODYNASTES HYPOCONIA*. DIET.** Snakes of the genus *Thamnodynastes* are widely distributed in South America, but little information is available on their biology (Franco and Ferreira 2002. Phyllomedusa 1:57–74). *Thamnodynastes hypoconia* is a small (mean SVL = 300 mm), semiarboreal, nocturnal species that inhabits riparian areas, the borders of gallery forests, marshes, and temporary ponds (Sawaya et al. 2008. Biota Neotrop. 8:127–149).

On 12 January 2010, at 2114 h, in an area of Cerrado in the municipality of Borebi, São Paulo State, Brazil (22.8035°S 49.0044°W, datum WGS84; elev. 652 m) we encountered an adult *T. hypoconia* (SVL = 350 mm) near a pond. The animal was next to the fence of a pitfall trap. The snake was collected and placed in a plastic bag. After about 30 min we observed that the snake had regurgitated a frog, which we subsequently identified as *Chiasmocleis albopunctata* (SVL = 37 mm), a microhylid that occurs in open areas in the central region of South America (Caramaschi and Cruz 1997. Herpetologica 53:259–268). The animals were collected and deposited in the Scientific Collection Jorge Jim, located at Departamento de Zoologia, Instituto de Biociências, UNESP, Campus de Botucatu, São Paulo State, Brazil (CCJJ 7932, License IBAMA/ICMBio - SISBIO 16778-1). On the same night, about 40 calling male *C. albopunctata* were recorded. *Thamnodynastes hypoconia* seems to specialize on anurans; Sawaya et al. (2008, *op. cit.*) reported one of these snakes trying to eat an adult *Elachistocleis ovalis*. This is the first record of *T. hypoconia* preying upon *C. albopunctata*.

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***THAMNOPHIS BRACHYSTOMA* (Short-headed Gartersnake). REPRODUCTION: MAXIMUM LITTER SIZE.** Maximum litter size for *Thamnophis brachystoma* has been reported as 14 (Hulse et al. 2001. Amphibians and Reptiles in Pennsylvania and the Northeast. Cornell Univ. Press, Ithaca, New York. xii + 419 pp.; Swanson 1952. Am. Midl. Nat. 47:161–182). Here I report two litters exceeding this number. On 22 July 2005, I found a gravid female *T. brachystoma* at a site 6 km SE of Wattsburg, Erie Co., Pennsylvania, USA, that I maintained in captivity until parturition. She produced 16 young on 8 August 2005, of which 15 were live and one was stillborn. The mean mass of these 16 offspring (mean ± SD, [range]) was 0.95 ± 0.069 g (0.85–1.07 g). An additional stillborn individual (not measured) was produced on 10 or 11 August, for a total litter size of 17. Mass of the adult female on 6 August was 46.05 g, and was 23.10 g on 8 August, after parturition. The female and her living young were released at the point of capture. On 22 July 2007, I captured another gravid female (SVL = 396.8 mm, total length = 511.3 mm) at the same site. This individual gave birth to 16 live young in captivity on 2 August. Mean SVL (mean ± SD [range]) was 112.6 ± 2.13 mm (109.0–116.8 mm), and mean total length (mean ± SD, [range]) was 146.3 ± 4.25 mm (139.6–152.8 mm). There were 7 females and 9 males. The female (TREC R- 00028) and her litter (TREC R- 00029) were deposited in the collection of the Natural History Museum at the Tom Ridge Environmental Center.

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***THAMNOPHIS ELEGANS* (Terrestrial Gartersnake). PREDATION.** At approximately 0715 h on 25 November 2009, 16 km N of Cabin City, Sanders Co., Montana, USA (47.474°N, 115.236°W, NAD83; elev. 1573 m) we observed a minimally digested *Tham-*

nophis elegans in the scat of a Gray Wolf (*Canis lupis*). The scat was fresh as it was still warm on top of melting snow at an air temperature of approximately -8°C. Snow depth was approximately 25 cm. We found tracks from at least five wolves in the area. The snake was intact and after cleaning it in the snow was clearly identifiable to species based on coloration. It is unknown whether the wolf found the snake active or removed the snake from its hibernaculum. In Montana, *T. elegans* are found at elevations up to 2499 m (Maxell et al. 2003. Herpetology in Montana. Northwest Fauna 5. Society for Northwestern Vertebrate Biology, Olympia, Washington. 135 pp.). Small animals including reptiles make up only a minor portion of a wolf's diet (Mech and Boitani 2003. Wolves: Behavior, Ecology and Conservation. University of Chicago Press, Chicago, Illinois, 428 pp.). However, this snake was not digested despite the gray wolf's efficient digestive tract (Mech and Boitani, *op. cit.*).

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***THAMNOPHIS SAURITUS SEPTENTRIONALIS* (Northern Ribbonsnake). REPRODUCTION: LITTER SIZE.** Litter size in *Thamnophis sauritus* is known to vary geographically (Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. Univ. Oklahoma Press, Norman, Oklahoma. 332 pp.). The largest recorded litter was 26 from a specimen of *T. sauritus sackenii* collected in Florida (Telford 1952. Quart. J. Florida Acad. Sci. 15:175–185). Hulse (2001. Amphibians and Reptiles in Pennsylvania and the Northeast. Cornell Univ. Press, Ithaca, New York. xii + 419 pp.) reported a mean litter size of 11.3 (range 8–13) in a sample of 8 litters from Pennsylvania, but did not indicate which of the two subspecies native to the state were involved. Litter sizes reported for specimens from within the range of *T. s. septentrionalis* include 9 (Bishop 1927. Amphibians and Reptiles of Allegany State Park. New York State Museum. 141 pp.); 6, 9, and 10 (Gilhen 1984. Amphibians and Reptiles of Nova Scotia. Nova Scotia Museum. 162 pp.); and 7 and 9 (Langlois 1924, cited in Ruthven et al. 1928. The Herpetology of Michigan. Univ. Michigan. 229 pp.). Ruthven et al. (*op. cit.*) stated that they counted embryos in "a few specimens and they seem to average about a dozen." Carpenter (1952. Ecol. Monog. 22:235–258) reported an average litter size of 10 from 5 specimens in Michigan. Here, I report an unusually large litter of this subspecies from Erie Co., Pennsylvania, USA.

On 8 July 2007, I captured a gravid female *T. s. septentrionalis* (SVL = 565 mm; total length = 817 mm) in Pennsylvania State Game Land 109. I maintained her in captivity until parturition on 2 August 2007, when she produced 24 live young. There were 14 males and 10 females. Mean SVL of neonates (mean ± SD, [range]) was 156.7 ± 3.98 mm (147.8–163.5), mean total length was 225.9 ± 6.06 mm (214.3–239). The total mass of the litter was 39 g and the female's mass after parturition was 61 g, yielding a relative litter mass of 0.639. Photo vouchers of the female (TREC R-00086) and litter (TREC R-00087) were deposited in the collection of the Natural History Museum at the Tom Ridge Environmental Center. All snakes were released at the point of capture. I thank Brian Gray for useful input on the manuscript.

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***TROPIDONOPHIS DORIAE* (Barred Keelback). REPRODUCTION: MAXIMUM CLUTCH SIZE.** *Tropoidonophis doriae* is known from Indonesia (Irian Jaya, Aru Islands) and Papua New Guinea (Malnate and Underwood 1988. Proc. Acad. Nat. Sci. Philadelphia 140:59–201). Malnate and Underwood (*op. cit.*) reported seven clutches of *T. doriae* from New Guinea (mean 5.4 ± 2.0 SD; range: 3–8). The purpose of this note is to report a new maximum clutch size for *T. doriae*.

One female *T. doriae* (SVL = 904 mm) collected 27 January 2004 at Laronu, Central Province, Papua New Guinea (9.44387°S, 147.98383°E, datum WGS84; elev = 880 m), and deposited in the Bishop Museum herpetology collection (BPBM), Honolulu, Hawaii (BPBM 19486) was examined. A ventral incision was made in the lower body wall to expose the reproductive tract. Eleven oviductal eggs were counted which is a new maximum clutch size for *T. doriae*.

I thank Pumehana Imada (BPBM) for facilitating my examination of *T. doriae*.

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***TROPIDONOPHIS STATISTICUS*. REPRODUCTION: MINIMUM REPRODUCTIVE SIZE.** *Trophidonophis statisticus* occurs from southeastern Irian Jaya, eastward through the central massif of New Guinea (Malnate and Underwood 1988. Proc. Acad. Nat. Sci. Philadelphia 140:59–201). Malnate and Underwood (*op. cit.*) reported 18 *T. statisticus* females contained 3–9 eggs, of which the smallest female measured 483 mm SVL. The purpose of this note is to report a new minimum reproductive size for *T. statisticus* females.

One female *T. statisticus* (SVL = 415 mm) collected February 2003 at Siyomu Village, Milne Bay Province, Papua New Guinea (10.0171°S, 149.5970°E, datum WGS84; elev. 1300 m) and deposited in the Bishop Museum herpetology collection (BPBM), Honolulu, Hawaii as BPBM 17297 was examined. A rear ventral incision was made to expose the reproductive tract revealing three enlarged eggs > 6 mm length. Four-hundred fifteen mm is a new minimum size for reproductive activity in female *T. statisticus*.

I thank Pumehana Imada (BPBM) for facilitating my examination of *T. statisticus*.

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BOOK REVIEWS

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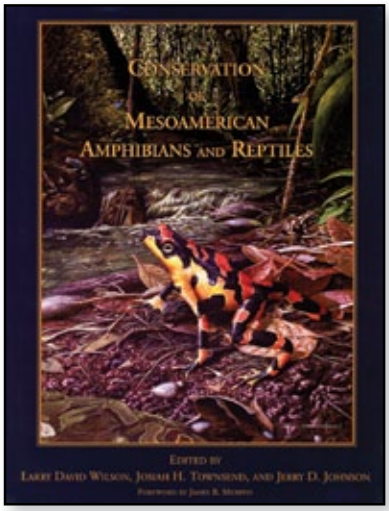

Mesoamerica is a region of megadiversity, with amphibians and reptiles especially well represented. Given the relative size of the region, diversity is extraordinary, yet despite decades of intense fieldwork the fauna is still not fully known. Sadly, this fauna is at great risk of extinction. Human population growth has been extraordinary. Costa Rica, with fewer than 900,000 people in 1950, is projected to have in excess of 5,900,000 in 2025. Mexico, which had fewer than 28,000,000 people in 1950, is projected to have about 130,000,000 people in 2025 (World Resources Institute 2011). These increases, roughly a factor of 5, are characteristic of the region. These dramatic increases in numbers of people are accompanied by rampant habitat modification that is taking a terrible toll. I made my first visit to Costa Rica in 1961, when a trip to Finca La Selva was still an adventure. Finca La Selva was a small, cleared area in a magnificent forest; today The La Selva Biological Field Station *is*, effectively, the forest.

Given the relatively small size of Mesoamerica compared to the great continents, its hepetological diversity is amazing. My favorite organisms, plethodontid salamanders, are especially well-represented. It is surprising enough that nearly 45% of all salamanders are the Neotropical plethodontids, but even more surprising is that 90% of these occur in Mesoamerica. One would like to think that we have a good understanding of amphibian diversity in the region. The message from salamanders is that we should not be so sure. In 1926 Dunn reported 30 species of tropical salamanders (Bolitoglossini). By 1976 the number had increased to 132 (Wake and Lynch 1976). Today 268 are recognized of which 241 occur in Mesoamerica (AmphibiaWeb 2011). This book lists 215, an indication of the rate of discovery and description of new species from Mesoamerica (and I know of more than 25 awaiting description). These are nearly all morphologically identifiable taxa; we are only beginning to appreciate how many cryptic species are yet to be described (Crawford et al. 2010). While distinctive new clades are still being discovered (McCranie et al. 2008), nonetheless it seems likely that we are largely at the stage of filling in details; the main dimensions of the herpetofauna are now known. Frankly, there is too little habitat remaining that has not been at least superficially surveyed for many more major discoveries to be made. Thus, the appearance of this book represents a benchmark in our understanding of the herpetofauna of Mesoamerica and the threats to it.

Following a Foreword by Jim Murphy and a somewhat longer Preface by the editors, the book is arranged in six major sections. Appropriately the first of these, entitled The Global Amphibian Assessment, is a chapter by Simon Stuart, Janice Chanson, Neil Cox, and Bruce Young. The Preface makes clear that this chapter was the first one completed for the book and that some time has passed since it was produced, due to delays in publication. The chapter is based on the 2004 assessment. Nevertheless, it is a nicely produced chapter that remains both useful and relevant.

The second section, by the editors, is a short, workman-like account of recent taxonomic changes. They recognize that this is a moving target. Unfortunately, by listing "previous names" and "present names" they inadvertently validate names that are currently in dispute. For example, debates continue over the content of such taxa as *Bufo*, *Rana*, and even less well-known taxa (e.g., *Hylobates*), and I do not think the authors are sufficiently clear that many such changes are matters of taste rather than rule, and are optional.

The largest and most ambitious section of the book is entitled "Distributional patterns of the herpetofauna of Mesoamerica, a biodiversity hotspot," by Wilson and Johnson. The chapter is more than 200 pages long. Following a well-constructed introduction to the natural setting of Middle America, the authors frame their analysis by recognizing 21 physiographic regions and 15 vegetation zones. They then proceed to categorize 731 species of amphibians and 1,148 species of reptiles with respect to these regions and zones. A key element of their analysis is calculation of a Coefficient of Biogeographic resemblance. They conclude that endemnicity of amphibians is very high, but reptiles, too, show strong endemism, with more than a half of the species endemic to specific countries. It is not surprising that Mexico has the highest levels of endemicity, given its relative size and topographic and historical geological heterogeneity. They also calculate a Coefficient of Habitat

Resemblence, which enables them to argue that Subalpine Moist Forest is most unlike other vegetation zones. This is not surprising to me, because salamander endemics, for example, are highly concentrated in cloud forests. This chapter is filled with tables, but also with words, and it is an impressive accomplishment. The data are up-to-date to the end of 2008. In an addendum they discuss 21 new studies (well into 2010) and discuss how these change their results. This is clearly a moving target and I think it was not worth the effort for such a short term update, given the rate at which publications on this region are appearing.

The remainder of the book is dominated by "country assessments," starting with Baja California, then proceeding from northern Mexico, central highlands of Mexico, southeastern Mexico, Belize, Guatemala, Salvadoran protected areas, Honduras, Nicaragua, Costa Rica, and finally to Panama. In addition to the three editors, authors include 26 people, mostly residents of the countries analyzed. The chapters contain lists of species, current conservation status (CITES, IUCN, and country-specific, where appropriate), environmental vulnerability scores, and occurrence in protected areas, but while there is general uniformity, each chapter has its own unique features. Overall the information content is valuable and the authors have made scattered information generally accessible.

Special conservation topics are covered in six chapters, mostly focused on particular taxa, but one, by Townsend and Wilson, deals with a vegetation type in a particular region (subhumid forest of Honduras). The book concludes with a section labeled "Looking Ahead," a ca. 50 page account by Wilson and Townsend summarizing the contents of the book and presenting a general discussion. A final appendix lists the conservation scores for the entire Mesoamerican herpetofauna. Their prognosis for the future of the unique herpetofauna of Mesoamerica is not very rosy.

Mesoamerica has an enormous herpetofauna, given its relatively small area, and levels of endemism are extraordinary. The book nicely balances analyses of political entities and those of physiographic regions and vegetation types. It was an audacious undertaking, and yet I think the results are substantive and illuminating. Probably most taxa are sufficiently well known (salamanders may be an exception) that the many tables and calculations will prove to be relatively robust.

The book is beautifully produced and it has a highly professional appearance. The individual chapters resemble journal articles in format, each with both English and Spanish abstracts and separate Literature Cited sections. The layout is attractive, the illustrations and photographs (although not numerous) are high quality and uniform in production, and the book is solidly bound with an attractive dustcover. However, the downside is that the book weighs 3.2 kg!

I congratulate the editors and authors for making a permanent contribution to our knowledge of the herpetofauna of Mesoamerica. Every student of the region will want to own this book.

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Snakebit: Confessions of a Herpetologist

By Leslie Anthony. 2008. Greystone Books (http://www.dmpibooks.com/greystone-books). 292 pp. Hardcover. US $27.95. ISBN 978-1-55365-236-6 (also available in paperback and e-book editions).

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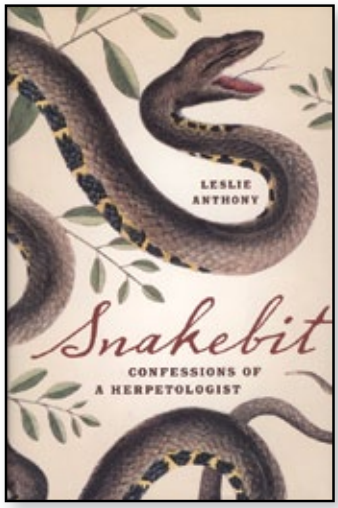

Reviewing books can sometimes be a tedious, dreary task for a scientist, foisted upon us by friendly (or pushy) editors-in-need. Hesitation to take on a book review is usually not so much based on disinterest in the matter presented in the book, but on the fact that there really isn't much "bang for the buck" in writing a book review: who really reads them anyway? Furthermore, considering the time commitment required for making a book review passably entertaining, we might rather spend our valuable time studying a real data set.

The request to review Leslie Anthony's *Snakebit* was different for two reasons, which gave the task an irresistible allure. Firstly, we know this ink slinger and most of his cabal well and, secondly, we are both immortalized in Chapter 8, entertainingly and ominously titled "Another Messy Freak Show." Playing a sufficiently prominent part in someone else's life to end up in "their book" is special, and led to instant agreement on our part to compose this review when approached. Little did we know how this freak show would play out, and we ask the reader's

forbearance if we respond to the author's literary kindness with our own sprinklings of humor.

To place *Snakebit* and its author into a proper context one must first deal with a nomenclatural issue. In professional herpetological circles, popular writer Leslie Anthony is none other than Leslie A. Lowcock, infamous and heretofore thickly mustachioed and otherwise hairy salamander geneticist, winner of the prestigious 1989 American Society of Ichthyologists and Herpetologists' Stoye Award. A search for publications under that name will reveal some fine research that lends Les lasting, indubitable scientific credibility. However, this path essentially terminates with the switch from Lowcock to Anthony, and it appears the herpetologist author of *Snakebit* morphed from passionate scientist to something much more tame and lame, a herp advocate. In fact, Les states that herpetology is his "distant past" (p. 7), one that he "released" (p. 8) some time ago. Despite this temporal break and the unjustified emendation of his name, and with forgiving admiration, his contributions to herpetology are still significant enough for us to accept that the moniker "herpetologist" still applies to Les. We simply marvel at Les's more recent fixation with a wide range of more popular prose, such as detailing adventures in places as divergent as the ski slopes of Scandinavia or the hunting grounds of Anticosti Island, through magazines such as *Powder*, *Skier*, or *Bike* (to name but a few), via an exposé of adventure skiing (and of skiing as an adventure) in his book *White Planet*, or in the interesting short film *Missing*.

Snakebit travels the classic arc of autobiography, from the protagonist's youth to his dotage, prefaced by a chilling experience in Finland that led to the writing of the book. The chapters provide appropriate thematic divisions to Les's story, and each chapter not only gives insights into the man we knew, but cleverly picks up one or more relevant scientific threads. Les masterfully integrates the science with his story and creates an intellectually appealing and entertaining narrative that will be attractive to the scientist and the interested amateur alike. A warning to those considering having their young children read the book, which, for its entertainment value, may be a draw: reality-based, but contextually gratuitous, f-bombs exist.

The trajectory of Les's life begins with a chapter describing the development for his initial interest in herps in suburban Toronto and at Camp Mil-da-ta-ca ("Into the Swamp"). A chapter introducing readers to some key herpetological influences for Les, which also serves as a well-timed introduction to herpetology as a science, follows ("Creepy Critters and Animals, Too"). Chapter 3 ("A Salamander Under a Log") showcases the on-goings in the lab of James Bogart at Guelph University (of particular interest to HK and TFS, since Jim is academic grandfather to us both). "Bulletin from the Pacific" is the story of a Fijian herp adventure with a solid exposé of hybridization, which completes a four-chapter set of what we classify as Les"s pre-professional life.

In the following five chapters, the author tells the story of Les Lowcock, the professional scientist. While this was the time in Les's career that included his greatest scientific contributions ("Slime Buckets"), it was also the time of fairly inane extracurricular activities ("Rommy, Can You Hear Me?"), noteworthy field trips ("A Day in Hell," "Boneheads") with über-scientists like the two Bobs (Murphy from the Royal Ontario Museum and Carroll from the Redpath Museum), and a postdoctoral fellowship ("Another Messy Freak Show"). The first of these chapters might best be summarized (with apologies to *The Producers*) as "Springtime for Leslie and Canada" as Les mud-wrestles hordes of "ambitious amphibian immigrants" (p. 95), salamanders in particular, as they emerge from the Canadian winter and need to be checked for their hybrid status. The chapter also includes a lot of valuable information on amphibian natural history and ancestry, as well as salamander genetics. In the Rommy chapter, Les follows on with a discourse on museum collections made lively by an introduction to his contemporaries at the Royal Ontario Museum. Having traveled widely ourselves, we are not convinced that Baja California is deserving of the chapter title "A Day in Hell," but we appreciated Les's perspective on deserts ("If the continents are the Earth's skin, then deserts are a patch of eczema on its butt." p. 132). We also applaud his insightful comments on biogeography, lizards, and the ancestry of birds. These are continued in "Boneheads" with well-placed paragraphs on fossils and the origin of snakes. The style of popular writing displayed in these chapters is probably why Les does so well outside the world of scientific journals. It is informative and captivating.

We separate out the chapter titled "Another Messy Freak Show" here since this is where Les includes us in his story. Doubtless, some interesting things did happen two decades ago, but memories can be deceiving. It is therefore with keen interest and satisfaction that we note the "Oprah Clause" on the book's dedication page, stating that in this book "anything to do with people is as close to true as the subjectivity of experience and the unconscious temptation to exaggerate will permit." We believe it likely that, as a result of an already addled brain, the "subjectivity of experience" failed Les. Characterizing TFS by a purported penchant for "hockey, hash, beer, and women" (p. 152) and HK as "Der Kaiser, [...] a cartoon character passing steam through his ears" (p. 159) could, in some circles, be considered unflattering. In the spirit of literary freedom, we understand these humorous depiction as more fiction than fact. We are convinced that neither the computer smash-up (HK was an early Apple adopter and used Macintosh computers even then, and there were definitely no old Mac parts anywhere in the PC-besotted museum) nor the frog-in-pee-snowglobe (even before getting a PhD, HK could tell "his" new species, a dendrobatid, from the eleutherodactylids of his research focus despite the purported tagging shenanigans) ever happened. We are happy to report that TFS repaid the soggy chair cushion in kind nearly two decades later at his office in Germany (TFS is the "former colleague" on p. 81). HK is still looking for a suitable snowglobe to fill and mail. Oprah Clause, indeed.

The remaining five chapters mostly form the Leslie Anthony component, or what may be considered the post-professional time of the story arc. Key episodes include additional fieldwork, in Vietnam ("Saving the World One Jungle at a Time"), Armenia ("Saving the World Redux"), the snake pits of Manitoba ("Ode to a Gartersnake"), and the Okanagan of British Columbia ("Riesling and Rattlesnakes"). "Geeks Like Us" introduces the reader to the discourse at scientific meetings, with particular mention of the early discussions about amphibian declines, with which Lowcock the Professional was intimately familiar in the Canadian context. Overall, the combination of science and storytelling is quite compelling and beautifully executed. Having now outlined the book in its entirety, let us be forthright and thank the two Finnish *kyy käärme* (*Vipera berus*) for leading Les onto the path of this autobiographical enterprise.

Of course, there are a few quibbles. In the first place, regarding the book's title it is unclear to us what Les is "confessing"—unless he is seeking absolution for occasional pranks that may not have been enjoyed equally by the prankees. We were also wondering why the snakebit poet-herpetologist would choose

cover art that, while doubtlessly meritorious, does not accurately depict its serpentine subject (we note with pleasure that this has been nicely remedied in the paperback). We found exactly two typos (p. 170: "Caldwell, Sharbel, Carroll, and me" instead of "and I"; p. 276: "Brughuel" should be "Brueghel") and want to note that the Grateful Dead did not play their unforgettable concert in Berkeley but in the Shoreline Amphitheatre in Mountain View (p. 237), where we were all enlightened by some serious second-hand smoke. Taxonomic quibbles are only minor (*Vipera* vs. *Pelias*, *Laudakia* vs. *Agama*, *Dolichophis* vs. *Hierophis*). We also take exception to the statement that "[animals were] waiting in the fridge for a governor's reprieve" (p. 61), since Canadian provinces are governed by Premiers and, at last accounting, Ontario was still a Canadian province. Furthermore, Cuban treefrogs, coquís, and Amazon forest frogs would have died in Jim Bogart's fridge and must have made their last home somewhere else. Lastly, it is incorrect to state (p. 102) that frogs of the genus *Eleutherodactylus* are the only vertebrate genus with a member in amber, as such specimens are also known for Hispaniolan *Anolis*, European lacertids, and geckos from three continents. All of this means that whereas the post-Lowcock Anthony *is* capable of scientific accuracy in listing by Latin binomials 13 species of salamanders, 20 frogs, 16 lizards, 10 turtles, 3 crocodilians, and 56 snakes, he nevertheless *is* a post-Lowcock Anthony.

The foregoing notwithstanding, nothing can detract from the genius of Les's writing. To use herpetological hyperbole, if David Dennis is the Robert Bateman of herpetology, then Leslie Anthony may be its Bard. How else does one explain flowing alliterations like "bevy of bewildered wildlife" (p. 12), "susurration of something sliding through grass" (p. 14), "dalliance of the decadent and deadly" (p. 250), or "As I wandered, waded, and wallowed, my nostrils flared daily with the pungent miasma of ... the Chthonic Domain" (p. 54). Who else could come up with "[The snake] brushes me with flickering tongue as a lover might" (p. 27), "[herpetology, a] lascivious vixen, with [a] dangerous embrace and many whispered secrets" (p. 167), or "the Trans-Canada Highway, [...] with the thawing carcasses of a zoo's worth of winter roadkill, draped on the shoulder like toys kids had shaken the stuffing out of and tossed from the car" (p. 218). Where else have herpetologists been exposed to new word creations like "the snake waterfalls between my hands like a slinky" (p. 27)? Since when is "waterfall" a verb? "Inculcated" (p. 133) or "mountebank," anyone? And then there are the plentiful, simply elegant expressions that convey in few words a fabulous image, such as "46 chromosomes ... lounging around in the nucleus in a great, unconcerned tangle" (p. 67), "Baja's deconstructionist landscape" (p. 137), "a bag of snakes can be a powerful carnet" (p. 139), and "Yerewan slid by like an unfinished basement" (p. 273). Given the magic of the writing, the book really ends too abruptly. Maybe we just wish for a reflective chapter so that the poetic journey through Scrabble didn't have to end so soon.

In approaching this review, we were initially mildly put out because of our own portrayal. However, we are content to allow Les his little bit of Oprah Clause-protected fiction in view of the undisputed service *Snakebit* does to bring some higher-level prose to herpetology. Just as *The Economist* magazine is capable of the twofer of excellence in news and writing, so Les is able to weave an appealing tale of solid scientific substance and choice composition (witness our feeble attempt at alliteration). Buy the paperback, because it has a real snake on the cover, and enjoy the read.

Herpetological Review, 2011, 42(4), 625–626.

Anfibios y Reptiles del Estado de Querétaro, México / Amphibians and Reptiles of the State of Querétaro, México

By James R. Dixon and Julio A. Lemos Espinal. 2010. Texas A&M University, Universidad Nacional Autónoma de México, and Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México, D.F. Available from Bibliomania (www.herplitsales.com). xvi + 428 pp. Hardcover. US $85.00. ISBN 978-607-7607-22-9.

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There is no denying the fact that México has become a world leader in assessing and conserving its herpetofauna. This is certainly due to remarkable growth in the number of professionally trained native herpetologists, along with the continued interest by international researchers, especially from the United States and Europe. Furthermore, several national and state organizations (e.g., Sociedad Herpetológica Mexicana, ECOSFERA, CONABIO, among others), including academic institutions, have been actively supporting and funding herpetological research projects on a state, regional, and national scale. *Amphibians and Reptiles of the State of Querétaro, México*, is one of the latest state oriented books, coauthored by two prominent herpetologists who have been investigating Mexican amphibians and reptiles for many years. James R. Dixon, now Professor Emeritus at Texas A&M University, along with many of his students, began visiting México around 1957 and was one of the first to begin assessing in detail the herpetofauna of Querétaro, the results of which formed a good portion of the baseline data used in the present volume. Julio A. Lemos Espinal is a Research Professor in the Laboratorio de Ecología of the Unidad de Biología, Technología y Prototipos de la Facultad de Estudios Superiores Iztacala UNAM. He has been studying the herpetofauna of northern and central Mexico and is well known for coauthoring, along with Hobart Smith, volumes on the amphibians and reptiles of Chihuahua, Coahuila, and Sonora. No two herpetologists were better suited for producing a book on the herpetofauna of Querétaro.

Amphibians and Reptiles of the State of Querétaro, México, is hardbound with a dust jacket and reasonably constructed for durability. It is bilingual in Spanish and English, most of which is divided by language in separate sections of the text. The introduction includes sections on historical herpetological perspectives, a description of the climate, geography, vegetation, an explanation of sections within species accounts, and a list of the current amphibians and reptiles known from the state. The bibliography,

maps (districts, topography, vegetation, and climate), photos of physiographic features and species (Appendix 1), gazetteer with mapped localities (Appendix 2), distribution maps (Appendix 3), and locality of collection (Appendix 4) are located near the end of the volume after species accounts. Accounts for the 117 listed species (29 amphibians, 88 reptiles) known from Querétaro are prefaced by descriptions of class, order, and family, and species accounts include sections on explaining title information ("title" here referring to scientific name, original author and date of original publication, and allocation to genus), common name, identification, morphology, coloration, distribution, habitat, behavior, diet, taxonomy, etymology, protected status, and references that are separate from the bibliography section located after the species accounts. The protection status section is based mostly on the classifications published in 2002 by Secretaria del Medio Ambiente y Recursos Naturales (SEMARNAT). Needless to say, the volume contains tremendous amounts of information not only gleaned from the literature, but most obviously from personal experiences by the authors. This is an essential book for anyone, including professional and amateur herpetologists, interested in the herpetofauna of Querétaro in particular and México in general.

The layout for the volume is good, although it would have been easier to use if the municipality, topography, vegetation, and climatic maps were placed closer to the section where they are discussed, but I suspect the placement was a publisher decision. There are a few minor typographical errors in the text, but none cause confusion. A very useful aspect of the species accounts are the dichotomous keys preceding each group, with depictions of valuable indentifying characters and figures of some species placed at appropriate positions within the keys.

The species accounts also include the "most important references" pertaining to each species, although it would have been helpful to the reader if a taxonomic cut-off date would have been designated in the introduction section to clear up any confusion of what literature sources were available for citation. That particular point leads to a related issue prevalent in not only the volume reviewed here, but in many recent comparable publications conveying significant taxonomic information. The issue is the lack of taxonomic synonymies being identified by literature sources, which if present would have aided readers unfamiliar with nomenclatural history. This is especially important today because of the large number of recent phylogenetic studies that have changed long established family and genus names (see Johnson et al., 2010 for a list of changes). In the case of the present volume, the following are pertinent (present names first followed by older names in brackets): *Anaxyrus*, *Incilius*, and *Rhinella* or *Chaunus* [*Bufo*]; *Craugastor* [*Eleutherodactylus*]; *Eleutherodactylus* [*Syrrhophus*]; *Ecnomiohyla* and *Scinax* [*Hyla*]; *Lithobates* [*Rana*]; *Spea* [*Scaphiopus*]; Scaphiopodidae [Pelobatidae]; Dibamidae [Anelytropsidae]; Corytophanidae, Phrynosomatidae, Polychrotidae [Iguanidae, in part]; *Plestiodon* [*Eumeces*]; *Aspidoscelis* [*Cnemidophorus*]; *Pantherophis*, *Pseudelaphe*, and *Senticolis* [*Elaphe*]; and *Rena* and *Epictia* [*Leptotyphlops*, Adalsteinsson et al., 2009]. The primary taxonomic rank of all accounts is noted as being at the species level, although the authors do comment on subpecies in several instances, a practice that in my opinion is outdated in modern phylogenetic systematics. In general, the taxonomic status of most species is up-to-date, although the authors chose to use a few names, without comment, that are contentious: *Norops* vs *Anolis* (Poe 2004) and *Coluber* vs *Masticophis* and *Rhinella* vs *Chaunus* (both discussed in Wilson and Johnson 2010).

A few major references are cited in different sections of the species accounts, although a small number were inadvertently left out of the reference section and were also not listed in the bibliography (e.g., Jameson, 1950 – *Craugastor augusti*; Roth, 1972 – *Hyla arenicolor*; Iverson and Berry, 1979 – *Kinosternon integrum*; Smith et al., 2008 – *Plestiodon tetragrammus*; Slevin 1942 – *Ninia diademata*; Goldberg, 1998 – *Oxybelis aeneus*; Anderson, 1960 – *Storeria storeroides*).

The range maps (Appendix 3) use dots to identify species locations listed in the locality of collection section (Appendix 4), but in at least one instance (*Chiropterotriton magnipes*), the distribution description in the species account does not match the mapped localities (Map 13) or collecting sites (Appendix 4).

There are 227 color photographs of varying quality for listed species (several with multiple photographs); there are no pictures for 17 forms. Several photographs were of individuals found as far away as Arizona, Texas, Chihuahua, Durango, Sonora, and in one case, from an exotic individual from Peru (*Hemidactylus frenatus*). It would have been more supportive if at least one photograph of species not pictured, even from a distant locality, were included in place of one from a species depicted multiple times. Many of the 17 species are not necessarily rare throughout their ranges, so a photograph of some of those may have been available from an outside source. Of course, the best photographic scenario would have depicted individuals from Querétaro, because geographic variation within wide-ranging species creates the possibility of showing an individual not typical of those found within the state. It would also have been better if all photographs would have identified both the sex and locality of portrayed individuals instead of listing them for some, but not for others.

In summary, the few weaknesses in the book do not overly influence its value to those interested in an information source with taxonomic keys and photographs of the amphibian and reptiles of Querétaro, México. The $85.00 price tag, which might seem high to some, is comparable to other hard-bound books on related herpetological subjects. I highly recommend *Amphibians and Reptiles of the State of Querétaro, México*, to professional and interested amateur herpetologists or to any wildlife enthusiast who wants to learn about the herpetofauna and natural landscape of a fascinating region of México.

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The Snakes of Honduras — Systematics, Distribution, and Conservation

By James R. McCranie. 2011. Society for the Study of Amphibians and Reptiles (www.ssarherps.org). 724 pp. Hardcover. US $95.00. ISBN 978-0-916984-81-6.

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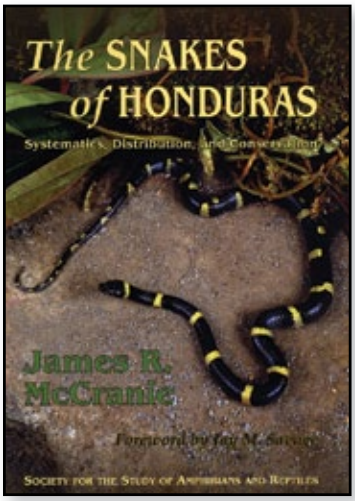

Given the astonishing species richness of tropical herpetofaunas, even the baseline exploration and documentation of their diversity is a laborious and time-consuming task. This holds equally true for the best-studied fraction of the neotropical realm, Central America. Notwithstanding the comparably small surface area of its nations, more than two centuries have passed since the first descriptions of amphibian and reptile species until, only during the last decade, the first truly detailed treatments (i.e., works that address various aspects of each species' biology and extend well beyond the scope of mere identification guides) of herpetofaunal groups at the country level could be compiled.

One such milestone summarizing all available information for a higher taxon within one country was *The Amphibians of Honduras* by Wilson and McCranie (SSAR Contributions to Herpetology Vol. 19, 2002), which has set a high standard in many ways. Now Randy McCranie has released its worthy successor, *The Snakes of Honduras*. This opus follows the format and concept of the amphibian book and constitutes a comprehensive scientific account of all 136 snake species known to occur within the country. The book is slightly more voluminous than its predecessor and, with 724 7x10-inch pages, is too bulky to carry around in the field. But that is not the purpose of this reference work.

Following a foreword by Jay M. Savage and a preface by the author, the Materials and Methods section introduces the structure of the species accounts and coherently explains how the data were obtained, processed, and presented. Readers will be pleased to learn that all content is updated to July 2010. They will be awestruck by the firm footing of the morphological and biogeographical data; as many as 6160 specimens were examined by the author, who has personal field experience with 90% of the species!

The introductory chapter on the Honduran environment is a revised update of its analogue in the amphibian book, detailing general information as well as the country's complex physiographic and climatic setting. The author places special emphasis on the nine general forest formations, including their respective distribution, climate, typical vegetational characteristics and important subtypes, snake diversity and conservation status. The maps in this chapter introduce the reader to the uncomplicated, concise map format employed consistently throughout the book.

After a brief history of reptile research in Honduras, the reader is introduced to the composition of the Honduran snake fauna, and provided with a key to the nine families known to occur in the country. Dichotomous keys to the 67 genera and 136 species are placed preceding the respective taxa. Each key is accompanied by an exact Spanish translation, allowing for the determination of any Honduran snake at hand to species level by anyone. The elaborate keys are perfectly practicable owing not only to the characteristics employed, but especially to their illustration; every distinctive feature is excellently clarified by accompanying drawings or photos and their truly informative legends.

The 136 species accounts themselves and the interspersed keys comprise almost 500 pages, leaving virtually nothing to be desired. After references to the original description and type specimens, synonyms applied to Honduran material are listed. The overall distribution as well as that within Honduras are given along with a map of actual collection localities. The in-depth descriptions of external morphology, hemipenes, as well as coloration in life and in preservative are almost exclusively based on explicitly listed specimens from Honduras, complemented with and compared to data from other countries where sensible. A short diagnosis leaves almost no possibility to confuse the respective species with similar ones occurring in Honduras. One highly appreciated feature is the illustration list, which is not limited to mere references, but actually specifies the content of the itemized figures. The obligatory remarks paragraph is succeeded by comments on natural history that include data from outside Honduras. After a brief explanation of the scientific name's etymology, the author concludes each species account by listing the specimens he has examined personally, as well as other reliable records plotted on the respective distribution map. The book's core section ends with a quick mention of four species reasonably expected to occur in the country.

The following biogeographical analysis scrutinizes the distribution of the Honduran snake fauna among political, physiographical, ecological, and historical units, revealing broad patterns as well as examples of endemism and distributional end points. Subsequently, the conservation status of all native species is assessed by analyzing population trends and known occurrences within protected areas, and the calculation of Environmental Vulnerability Scores and IUCN categories. Against the country's sociocultural and economic background, this thorough assessment necessarily draws a rather pessimistic picture of Honduras' environmental future as a whole—reason enough for the author to call for more biodiversity research coupled with actual enforcement of the existing environmental legislation by the hitherto rather passive authorities in charge. Yet, McCranie kindly offers his reader a little comfort by providing a very personal epilogue that is guaranteed to raise a smile on the face of anyone who has spent field time in the Neotropics.

Approximately 180 well-labelled color photographs exemplify major snake habitats and depict 132 of the species discussed, overwhelmingly showing specimens from Honduras.

Close to its end, yet another treasure of its own within this work is the gazetteer detailing not only the localities mentioned in the species accounts, but every single herpetological collection site known to the author within Honduras—most valuable

for anyone who works on Honduran biogeography. A glossary defining the terminology and abbreviations used throughout the text, references, and indices to both scientific and authors' names complete this work.

Probably the only drawback of this magnificent book is the photographs, many of which should have been further processed to appear a little clearer in print. Beyond that, one can hardly find anything to animadvert in this opus. Like its predecessor, *The Snakes of Honduras* is a meticulous, encyclopedic study of a complex and species-rich herpetofaunal group at the country level. Owing to over 30 years of research by the author and his companions, the book is bursting with clearly structured, reliable information resulting in a final product that is unparalleled within the realm of Latin American herpetology.

Taking into consideration the numerous publications by the author and his colleagues, one is bound to agree with McCranie's preface statement that they "have come close to achieving the goal of documenting the distribution and content of the Honduran herpetofauna." Indeed, Honduras will be the first country in Central America having its herpetofauna described in such detail once the equivalent treatment of the remaining reptile groups, which is already in preparation, is published. This final book will be much anticipated by members of the herpetological community who appreciate, work with, and rely on *The Amphibians* and now *The Snakes*.

Herpetological Review, 2011, 42(4), 628–630.

Chameleons of Africa. An Atlas including the Chameleons of Europe, the Middle East and Asia

By Colin Tilbury. 2010. Edition Chimaira, Frankfurt am Main (www.chimaira.de). Hardcover. 831 pp. EUR 98.00 (approx. US $140.00). ISBN 978-3-89973-451-5 (in the US available at Zoo Book Sales, www.zoobooksales.com).

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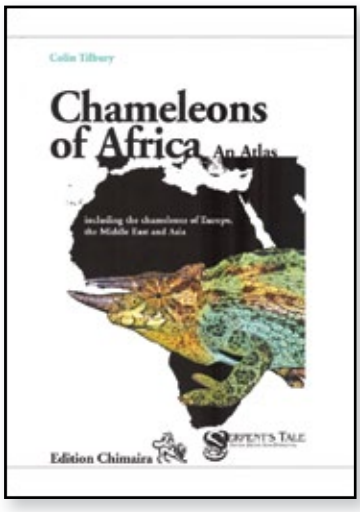

This voluminous book by Colin Tilbury in the Chimaira "white series" is a remarkable summary of knowledge about chameleons. However, despite the thickness of the volume only the species occurring in mainland Africa, southern Europe and Asia are included (the distinction between the Middle East and Asia in the title is, of course, unnecessary because the Middle East *is* part of Asia). If the author would have also included the species of Madagascar and the Indian Ocean islands, then this would indeed have much exceeded the possible number of pages for such a project, and a second volume would have been necessary. However, it is with the African continent that Colin Tilbury is most familiar and it is there that he carried out numerous excursions in order to take his own photographs in the field of as many species as possible. Generally, this geographic delimitation makes sense because Africa (including southern Europe, the Near East and southern Asia) and Madagascar harbor distinct evolutionary lines (genera in the taxonomic sense) of these most bizarre lizards. Only very recently, after the publication of this book, has it been revealed that the Seychelles might have better been treated with mainland Africa. The endemic Seychellean chameleon, now placed in the resurrected genus *Archaius* (Townsend et al. 2010) and formerly thought to be part of the Madagascan genus *Calumma*, is in fact sister to the East African dwarf chameleons of the genus *Rieppeleon*.

This example demonstrates how fast the current knowledge about chameleon species diversity is growing. Tilbury's book lists 102 currently recognized species from the non-Madagascan realm, whereas the checklist by Klaver and Böhme (1997) listed only 57 species for the area covered by the present book. This is nearly a doubling of the species number in just 13 years! Tilbury's count would have even been a bit higher if he had followed another species concept concerning the *Chamaeleo dilepis* complex within which, for example, the taxa *quilensis* and *roperi* are often considered to be good species by other authors (myself included). Although his species count includes a good number of recently elevated subspecies (e.g., in *Bradypodion* or in the *fischeri* group of *Kinyongia*), it is out of date due to the continuing discovery and recognition of new species. In some instances the increase of species is of course due to (1) the elevation of former subspecies as mentioned above, or (2) to the resurrection of synonyms, but (3) formerly unknown, truly new species are among this number as well. An example of the first case is *Trioceros perreti*, *T. serratus* exemplifies the second, and *Nadzikambia baylissi* as well as *Trioceros hanangensis* (Krause and Böhme 2009; Barej et al. 2010; Branch and Tolley 2010) are novelties.

It must be noted, that with respect to taxonomy, Tilbury has not restricted himself to compiling the systematic literature on chameleons, rather he has contributed significantly to the discovery and description of many new species, e.g., *Rhampholeon acuminatus*, *R. beraduccii*, *R. chapmanorum*, and *R. viridis* and the spectacular tree chameleons *Trioceros balebicornutus*, *T. conirostratus*, and *T. marsabitensis*.

What makes this book more exceptional are its illustrations. Colin Tilbury, who was already well-known for his brilliant photography, travelled through many parts of Africa in order to get his own photographs of common as well as rare species, and the result of this great effort is the impressive visual impact of this atlas of Africa's chameleons. It is, of course, also expected that an atlas will contain distribution maps, and this book does not disappoint: point distributions plotted on colored relief maps not only show the records where a species has been found but also provide information on whether this is a mountain or lowland, savanna or forest species, etc. Biogeographic patterns can be deduced from the maps: widespread vs. relictual, confined to the Rift Valley or the Cameroon highlands, etc.

On the other hand, this book exceeds the requirements of a distributional atlas because it provides also much general information, not only on the individual species, but also on this lizard family as a whole, starting with locomotion, vision, color

change, and many other general aspects, including some very interesting, but so far largely unstudied issues such as the strange buzzing behavior as an aposematic strategy and/or means of intraspecific communication; or the foul-smelling oral glands as a repellent and/or chemical bait which, if confirmed, would be unique in squamates.

Each species chapter, after giving the scientific, English and (if known) local name as well as the relevant synonyms and chresonyms, provides an exhaustive description also covering lungs, hemipenes, and karyotypes (these three character sets have previously been used for systematic purposes), sexual dimorphism, and colour pattern, followed by a listing of key distinguishing characters. These key characters are often accompanied by line drawings, most of which have also been prepared by the author himself. This is followed by a paragraph on distribution, linked to the relevant map, and finally ecology is dealt with by accounts treating habitats, natural history, reproduction, and conservation. A list of specific references concludes each species chapter.

It is not surprising that this enormous amount of information contains some errors, some of which could have easily been detected during proof-reading. For instance (p. 214) the head drawing of *Rieppeleon brevicaudatus* is still assigned to "*Rhampholeon*" *brevicaudatus*. The dot map for the genus *Chamaeleo* as a whole places a few dots where no populations of *Chamaeleo* (nor any other chamaeleonid) exist, e.g., in Albania or the Canary Islands (in the latter case only translocated single individuals are known and these were not even mentioned by Pleguezuelos et al. 2002; see also p. 475). But if accidental introductions of single individuals seem worth mentioning to Tilbury, he might also have cited the records published from the Caucasus area in western Georgia (Chkhikwadze and Bakradze 1993). On the other hand, Mauritania is devoid of mapped records although these are mentioned in the text (see Fig. 563 and map on p. 537). Figure legends 495 and 496 (*Chamaeleo chamaeleon*) read *C.* "*chamɛleon chamɛleon*" and *C.* "*chamaleon chameleon*" which is a bit more problematic than a simple misprint because it involuntarily creates a new "in error" synonym of the taxon. In the reference section, some citations are duplicated, e.g., Hofer et al. on chameleons in Cameroon; in other cases multi-authored papers precede citations of the first author alone (e.g., Klaver). But such faults are really rare in proportion to the total of 831 pages!

In two cases, new taxa discovered after the appearance of this book are already figured under other names: *Kinyongia uthmoelleri artytor* (figs. 439, 440–443) from the South Pare Mts. (Lutzmann et al. 2010) as a typical *K. uthmoelleri,* and *Trioceros hanangensis* from Mt. Hanang (Krause & Böhme), as *T. sternfeldi* (figs. 769, 770). A further taxonomic comment has to be made in respect to the restriction of formerly vague type locality designations, as done in this book with *Bradypodion gutturale* and *B. ventrale*. This procedure is not covered by the Code of Zoological Nomenclature (ICZN 1999), since such restrictions or redesignations of type localities may be only made together with designations of neotypic specimens individually bearing such new and precise locality data.

Some aspects can also provoke stimulating discussions: In the etymology section of the systematic paragraphs, here for the genus name *Chamaeleo* (formerly also *Chamaeleon*, p. 467), one finds a repetition of the old interpretation of Greek "chamaí" (on the soil) and "león" (lion), in the present book "earthlion," which—except for *C. namaquensis* and the likewise ground-dwelling dwarf chameleons of the genera *Rhampholeon* and *Rieppeleon*, all of which are unlikely to have been known to Aristotle and the ancient Greeks—does not really not make sense for these highly arboreal creatures! More plausible to me is the alternative, but largely overlooked or even forgotten interpretation given already by Keller (1913) who derived the name of these creatures (which actually can form a hump with their dorsal line when resting) from the Hebrew word for camel, viz. gamal, with the Arabian diminutive ending "-ún" which reads gamalún, i.e., a little camel. Tilbury's book contains many photographs showing chameleons in this position, e.g., figs. 467, 473, 474, 479, 482, 490, 505 (all from the *C. chamaeleon* group).

An unfortunate bit of information must be added for one of the rarest species: the recently discovered *Kinyongia vanheygeni* was known from the single holotype and one additional living male specimen which was not collected (Neças 2009). The catalogue number for the holotype (ZFMK 88383), cited in this book, had to be provided to the author, due to time pressures with manuscript submission, before the specimen physically reached the collection. When it was finally sent it was lost in transit and never reached the Museum Koenig in Bonn (P. Neças, pers. comm.). As if Colin Tilbury would have foreseen this misfortune, he fortuitously figured the unique living male of *K. vanheygeni*, photographed by E. van Heygen, no less than four times.

In summary, Tilbury's "Atlas" is a true handbook with lots of useful general and specific information on the African and Asian representatives of this fascinating Old World lizard family. It is even more impressive when one takes into account that its author was never paid for his herpetological work. As a medical doctor by profession, he is an illustrious example for what a herpetological "amateur" is capable of contributing to our science.

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Herpetological Review, 2011, 42(4), 630–631.

Frogs: The Animal Answer Guide

By Mike Dorcas and Whit Gibbons. 2011. The Johns Hopkins University Press (http://press.jhu.edu). Softcover. xiii + 160 pp., 16 pp. pls. US $24.95. ISBN 978-0-8018-9936-2.

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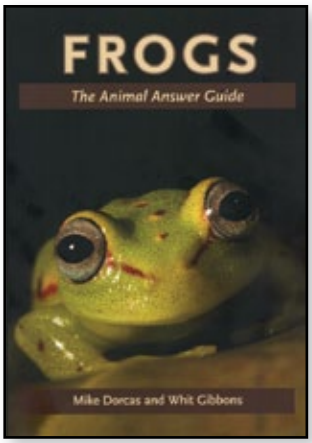

The Johns Hopkins University Press "Animal Answer Guide" series includes recent books on fishes (Helfman and Collette 2011), rabbits (Lumpkin and Seidensticker 2011), and small wild cats (Sanderson and Watson 2011). This excellent volume, covering frogs worldwide, is second in the series to be co-authored by Gibbons, following the similarly-arranged *Turtles: The Animal Answer Guide* with Judy Greene (2009).

Structured as a series of questions and answers grouped by topic, this book begins with "Introducing Frogs" ("What are frogs?" "When did frogs evolve?" "What other types of amphibians are there?") and moves through chapters on coloration, ecology, reproduction and development, and so on. Three chapters cover human-frog interactions, including "Frog Problems" from a human viewpoint. Anurans get the last word with the chapter "Human Problems," which clearly highlights the decline of these animals, touching on pollution, habitat destruction, chytrid infection, climate change, and the synergistic effects of these threats combined. The final chapter covers the how and why of "Frogology," offering an inside look into the world of herpetological research.

Answers are in-depth enough to satisfy curiosity and perhaps spark further investigation by the intrigued reader. Additionally, primary research is occasionally cited throughout, serving as a welcome introduction to how scientists know what they know.

Over 120 questions are answered in manageable sections of one to several paragraphs in length. While the question-answer format can sometimes be repetitive if reading the book straight through, the overall result is that most answers are complete and self-contained. The book thus lends itself to being a handy reference for the intended lay audience.

Sentences are generally short, clear, and easily read and understood, expanding the book's appropriateness to younger audiences. There is no glossary, however, and the authors have sometimes elected to use a more difficult term when a simpler one might have sufficed (ingested instead of eaten, etc.). Further, technical terms such as aestivation, "sex recognition" and "simple Mendelian inheritance" are sometimes mentioned without explanation and are not always included in the index for cross-reference. Key terms are italicized, somewhat inconsistently, and would have been the natural starting list for forming a glossary.

There is a geographic emphasis on frogs in the United States, but the authors often mention European counterparts of common species and also discuss the more intriguing and unusual anurans of Africa, Australia, South America, and Asia. Despite including a chapter devoted to "Frogs in Stories and Literature," the discussion of traditional or cultural use of frogs is fairly limited apart from the consumption of frogs' legs and the use of poison dart frog skin secretions. Frog lore is largely concerned with western cultures, including modern pop culture references and the re-telling of several frog short stories and jokes.

Many fine photographs are included, liberally placed through the book in black and white. Additionally, sixteen pages of color plates showcase a variety of anurans, both familiar and lesser-known. The color portraits are aesthetically pleasing but fall short of their potential informativeness. The plates are not numbered and are not referred to in the text, even when they could have served to illustrate a concept discussed. Unlike those of the black and white images, the color figure captions do not even briefly mention concepts or behaviors illustrated, such as amplexus. There remains plenty of white space on the color plate pages where such information might have been provided. Additionally, a few of the color portraits might have been moved to the black and white pages in exchange for images that would have benefited from inclusion in the color plates. For example, the visual impact of a leucistic frog sitting on moss is reduced when the entire image is rendered in shades of gray.

Unlike other books in the series, no maps or illustrations are included where a few may have been educational. For example, an illustration of select Gosner stages (Gosner 1960) might have been appropriate for "How fast do frogs grow?" or perhaps a cutaway view of how a frog uses its eyes to assist in swallowing food in the discussion of "Do frogs chew their food?"

Given the target audience, discussion of taxonomy is left deliberately simple. Scientific names follow traditional taxonomy. An appendix references common species to their equivalents as indexed by the Amphibian Species of the World Database (Frost 2009). Another appendix lists internet resources, scientific and conservation societies, magazines and journals, and zoos with a focus on frogs and toads, all useful stepping stones for the lay person looking for more information.

It is easy to imagine this volume resting comfortably in the library of a high school biology teacher or on the shelf of a student who shows a budding interest in herpetology. It would likewise serve as a handy reference for the dedicated herpetologist who fields questions from non-specialists, for it is easy to direct inquiring minds to this book for succinct and accurate answers to common questions, up to and including a judicious response to the inevitable inquiry about toad-licking. Most importantly, this informative book deserves to be in the hands of the interested public, the non-scientists who stand to learn the most about the intriguing biology of anurans as well as their plight in a world increasingly modified by humans.

A hardcover edition of *Frogs: The Animal Answer Guide* (ISBN 978-0-8018-9935-5) is available for US $45.00. A version for the Kindle electronic reader is available from www.amazon.com for US $14.97.

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