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

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

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

ANNUAL DUES AND SUBSCRIPTIONS: Annual membership dues for the year 2009 in the Society for the Study of Amphibians and Reptiles are as follows: **REGULAR** membership US$70 (Student $35)—includes *Journal of Herpetology* and *Herpetological Review*; **PLENARY** membership US$95 (Student $50)—includes *JH*, *HR*, and annual subscription to the *Catalogue of American Amphibians and Reptiles*; **INSTITUTIONAL SUBSCRIPTION (BASIC)** $140—includes *JH* and *HR*. **INSTITUTIONAL SUBSCRIPTION (COMPREHENSIVE)** $170—includes *JH*, *HR*, and *Catalogue*. Additional fee for airmail postage outside USA $35 for one year. Additional membership categories available on the SSAR webpage: http://www.ssarherps.org/pages/membership.html.

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 Allen Press website:

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Future Annual Meetings

2009 — Portland, Oregon, 22–27 July (with ASIH, HL)
2010 — Providence, Rhode Island, 7–12 July (with ASIH, HL)

About Our Cover: *Ranitomeya fantastica*

With brilliant colors and accompanying toxicity, fascinating parental behaviors, and convenient diurnal activity, dart-poison frogs in the family Dendrobatidae (*sensu lato*) have long attracted the attention of researchers. Arguably the most influential body of work resulted from the productive partnership of Charles Myers and John Daly (see p. 53 of this issue for a herpetological biography of Daly). For almost forty years, their collaboration yielded numerous new species, addressed taxonomic issues, and advanced the new field of anuran biochemical research. The work of Daly and his colleagues resulted in the discovery of over 800 chemical compounds isolated from dendrobatids, many novel and important in understanding broader physiological mechanisms beyond the herpetological realm.

More recent research has seen advances in our understanding of pattern polymorphisms, parental care, biogeography, and evolutionary theory. In 2006, Taran Grant and colleagues published a major systematic treatise (Grant et al. 2006. Bulletin of the American Museum of Natural History 299:1–262). New species continue to be described each year, with the total in late 2008 standing at over 260 (for the families Aromobatidae and Dendrobatidae combined; Frost 2008. Amphibian Species of the World: an Online Reference. Version 5.2 [15 July 2008]. Electronic database accessible at http://research.amnh.org/herpetology/amphibia/index.php. American Museum of Natural History, New York). An excellent source for additional information can be found at: www.dendrobates.org.

This issue's cover features *Ranitomeya fantastica*. Even for a veteran dendrobatid hunter, *R. fantastica* can be an extremely difficult frog to catch. They are very quick and have an amazing ability to completely disappear within leaf litter. This species is found in the Departments of San Martin and Loreto in central Peru and frequently is sympatric with *R. ventrimaculata* and *R. imitator*. *R. imitator* and *R. fantastica* are wildly polymorphic; our cover frog is representative of a population found adjacent to the city of Tarapoto, Peru. Recently, Brown et al. (2008. Zootaxa 1823:1–24) showed that *R. fantastica* consists of a complex of three species, two of which they described as new: *R. benedicta* and *R. summersi*. Our cover frog was photographed by **Tim Paine** in October 2006 using a Nikon D2x and a Nikkor 105mm macro lens (ISO 100, f/20). Lighting was accomplished using an SB800 flash (1/60 s) off-camera and Nikon's wireless R1C1 macro lighting set. Paine is a police officer with the San Francisco Police Department, and oftens travel to Latin America to photograph herpetofauna.

PHOTO BY BETH GOUDREAU

Kansas Herpetological Society Annual Meeting

The Kansas Herpetological Society held its 35th Annual Meeting at Friends University in Wichita, Kansas, on November 8–9, 2008. Over 100 participants attended scientific paper sessions presented by scientists and students from across the nation. Featured speaker was Ronald Bonett (University of Tulsa).

Ashley Inslee, student at Fort Hayes State University, received the 2008 Howard K. Gloyd/Edward H. Taylor Scholarship, honoring the memory of two great biologists with strong ties to Kansas. The 2008 Alan H. Kamb Grant for Research on Kansas Snakes was made to Page Klug, Kansas State University, Manhattan. Dustin J. Wilgers, University of Nebraska, Lincoln, was chosen as the eleventh recipient of "The Suzanne L. & Joseph T. Collins Award for Excellence in Kansas Herpetology." Steve D. Grant, West Texas A&M University, was presented with the George Toland Award for the best student paper given at the meeting. In 2009, the Society will meet at Overland Park, Kansas.

MEETINGS

Meetings Calendar

Meeting announcement information should be sent directly to the Editor (rwh13@csufresno.edu) well in advance of the event.

17–19 April 2009—Texas Herpetological Society Spring Field Meet, Rolling Plains Quail Research Ranch, near Roby, Texas, USA. Information: http://www.kingsnake.com/ths/2009_Spring%20Meet.htm.

19–23 April 2009—16th International Conference on Aquatic Invasive Species, Fairmont Queen Elizabeth Hotel, Montreal, Canada. A forum on Bullfrog Eradication and Control will be part of the program. Registration: http://www.icais.org/; information: www.bullfrogcontrol.com.

23–25 April 2009—56th Annual Meeting of the Southwestern Association of Naturalists, Monterrey, Mexico. Information: www.biosurvey.ou.edu/swan/annualm09.html.

6–7 June 2009—Southwestern PARC (Partners in Amphibian and Reptile Conservation) meeting and Herpetofauna Conservation Training (4–5 June), St. George, Utah, USA. Information: http://chelydra.unm.edu/swparc/.

17–20 June 2009—33rd International Herpetological Symposium, Monterrey, Mexico. Information: www.kingsnake.com/ihs.

18–20 July 2009—5th Meeting of the Snake Ecology Group, Donnelly, Idaho, USA. Registration and information: http://www.projectorianne.org/SEG_5.html.

22–27 July 2009—52nd Annual Meeting, Society for the Study of Amphibians and Reptiles; 89th Annual Meeting, Amercian Society

CURRENT RESEARCH

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

The current contents of various herpetological journals and other publications can be found at: http://www.herplit.com/contents.

Looking for Commonalities in Amphibian Declines

Amphibian species across the globe are suffering from population declines and extinctions, many of which are due to the *Batrachochytrium dendrobatidis* (Bd) pandemic. Focusing on anurans, the authors used existing phylogenetic data and data on amphibian declines to look for factors that make some taxa particularly susceptible to rapid population declines. They compiled a dataset consisting of ecological, life history, and environmental data for 553 species (spanning 32 of 33 families and six continents). Additionally, the taxa were coded for IUCN status (e.g., threatened, endangered), if they have experienced rapid declines (RD) and the suspected cause of the declines (based on information from the Global Amphibian Assessment), and if Bd infection has been found (Bd+ and Bd-, respectively). The cause of decline was divided into three categories: habitat loss, over-exploitation, and "enigmatic" (which includes Bd, as well as UV exposure, climate change, etc.). Tests were conducted to determine if RD species were different from other threatened species, if enigmatic RD species were different from species experiencing RD caused by other factors, if Bd+ species experiencing RD differ from Bd+ species not experiencing RD, and if Bd+ species suffering from RD differ from Bd- species experiencing RD. For these tests, the confounding effects of phylogeny were accounted for by using a Generalized Estimating Equation. An aquatic life-stage was found to be strongly correlated with RD, relative to other threatened species. Relative to threatened species, species suffering enigmatic RD are significantly associated with both habitats experiencing low annual temperature variation and an aquatic life-stage. Furthermore, for Bd+ species, those experiencing RD exhibit a strong association with small distributions and high elevation. Finally, no associations were found for Bd+ species experiencing RD relative to Bd- species experiencing RD. This study shows that the connections between Bd, RD, and threatened status are complicated, with different factors leading to different results in anuran species.

BIELBY, J., N. COOPER, A. A. CUNNINGHAM, T. W. J. GARNER, AND A. PURVIS. 2008. Predicting susceptibility to future declines in the world's frogs. Conservation Letters 1:82–90.

Correspondence to: Jon Bielby, Division of Biology, Imperial College London, Silwood Park Campus, Ascot, U.K., SL5 7PY; e-mail: jon.bielby04@imperial.ac.uk.

Quantifying the Nutrient Contributions of Salamanders to Terrestrial Ecosystems

As organisms that develop as larvae in aquatic ecosystems, then emerge and move as adults to terrestrial ecosystems, many amphibian species potentially contribute greatly to the transfer of nutrients between these two environments. While this has been examined extensively in other systems, few studies have explicitly addressed the roll of amphibians in these types of biomass transfers. The authors sought to quantify this transfer in three species of *Ambystoma* (*A. tigrinum*, *A. opacum*, and *A. maculatum*) occurring sympatrically in four ponds (two temporary and two permanent) in Illinois. Using *A. opacum*, food-specific assimilation efficiencies were determined for three prey types: zooplankton (cladocerans and copepods), larval midges (*Chironomus*), and hatchling *A. maculatum*. Larval diets of the three species were determined through gut content analysis of ethanol-preserved specimens; prey numbers and sizes were also quantified. Using these data and species-specific population density data, the volume of food consumed by the larval salamanders (prey production), the amount assimilated, and amount of biomass transferred by each species to the terrestrial environment (all in g AFDM [ash-free dry mass] $\times$ m^{-2} [pond area] $\times$ year^{-1}) were calculated. In different pond types, the various prey species were found to contribute differently to the biomass transported to terrestrial ecosystems via metamorphosed salamanders. Different prey species were also found to contribute differently to the biomass of the various salamander species. In the three ponds in which salamander cohorts survived to metamorphosis, between 0.3 and 0.85 g AFDM m^{-2} year^{-1} of biomass was delivered to terrestrial ecosystems by emerging salamanders, representing between 3.4% and 8.4% of prey production. This "emergence production" is considerably higher than has been found in most studies of similar systems, indicating that amphibians with both aquatic and terrestrial life-stages are very important contributors to the transfer of aquatic biomass to terrestrial ecosystems.

REGESTER, K. J., M. R. WHILES, AND K. R. LIPS. 2008. Variation in the trophic basis of production and energy flow associated with emergence of larval salamander assemblages from forest ponds. Freshwater Biology 53:1754–1767.

Correspondence to: Kurt Regester, Department of Biology, Clarion University, Clarion, Pennsylvania 16214, USA; e-mail: kregester@clarion.edu.

Comparative Biogeography Spanning the Strait of Gibraltar

The field of comparative phylogeography aims to understand the

effects of geography on biodiversity. One particularly interesting geographic feature, the Strait of Gibraltar, which separates the Iberian Peninsula from North Africa at the western terminus of the Mediterranean Sea, has long been of interest to evolutionary biologists. It currently is an effective barrier to dispersal to most terrestrial animals but was connected roughly 5.5 million years ago. Since that vicariant event, quantifiable morphological and/or molecular differentiation in taxon pairs occurring on either side of this feature may have accrued due to different selective pressures, founder's effects, or continued gene flow. To investigate this, the authors collected morphological and molecular data on eight taxon pairs divided by the Strait of Gibraltar spanning anurans, testudines, and squamates. The molecular data (mitochondrial DNA [mtDNA] and allozyme) is presumed to not be under selection and therefore give estimates of gene flow and degree of isolation between northern and southern populations. The morphological data is presumed to be under selection and therefore reflects the degree of differentiation due to selection attributable to the different environmental conditions existing in the two regions. Results suggest that the vicariant event led to different outcomes in the various taxon pairs. Three pairs (a hylid, a testudine, and a snake) exhibit low levels of genetic differentiation, suggesting continued gene flow between the two regions or recent colonization; however, discriminant analysis of the morphological variation revealed that the intercontinental morphological variation in the testudine was low while it was high in the anuran and the squamate. Two lacertid taxon pairs exhibited moderate to high morphological and mtDNA differentiation but low allozyme differentiation; this was attributed to limited gene flow during the formation of the isthmus via islands. Finally, the ranid, alytid, and, amphisbaenid taxon pairs exhibited moderate to high levels of morphological differentiation coupled with high levels of molecular differentiation, indicating the pairs diverged at, if not before, the formation of the isthmus and at least moderately different selective pressures are acting in the two regions.

BUSACK, S. D., AND R. LAWSON. 2008. Morphological, mitochondrial DNA and allozyme evolution in representative amphibians and reptiles inhabiting each side of the Strait of Gibraltar. Biological Journal of the Linnean Society 94:445–461.

Correspondence to: Stephen Busack, North Carolina State Museum of Natural Sciences, 11 West Jones Street, Raleigh, North Carolina 27601–1029, USA; e-mail: sbusack348@aol.com.

Potential Effects of Climate Change on an Arid Lands Lizard

With the threat of climate change on the horizon, understanding its effect on wild populations is imperative. While initially it may seem that the increased global temperatures and longer growing seasons predicted by most climate models might be beneficial, studies have shown that climate change frequently triggers unforeseen detrimental effects. The author investigated the effects of extended growing season and milder winter temperatures in a northern population of side-blotched lizards (*Uta stansburiana*), a taxon that could potentially benefit from such changes. Eggs from wild caught females were hatched in captivity and hatchlings were measured, uniquely toe clipped, and either returned to the source population or released into one of twelve 100 m^2 enclosures located 38 km north of the source population. The enclosures were designed to encompass suitable habitat, complete with overwintering sites and potential mates and predators. The enclosures were populated on four dates, with the later dates allowing the lizards less time to accumulate fat reserves, simulating a shorter growing season. Lizards were recaptured at the end of the growing season and again the following spring (source population only) to ascertain survivorship and to make measurements. Additional lizards were collected from the source population at the end of the growing season and maintained in the laboratory at either 2.0° C or 7.7° C to ascertain winter survivorship. Lizards provided with longer growing periods were larger than lizards experiencing truncated growing seasons, lizards maintained at higher temperatures during winter experienced increased rates of mortality, and winter survivorship was found to be correlated with body size. These results reveal that while the lizards exhibit increased fitness with an increased growing season, this is offset by the lower survivorship of milder winters, attributable to an increased metabolism during hibernation.

ZANI, P. A. 2008. Climate change trade-offs in the side-blotched lizard (*Uta stansburiana*): effects of growing-season length and mild temperatures on winter survival. Physiological and Biochemical Zoology 81:797–809.

Correspondence to: Peter Zani, Department of Biology, Lafayette College, Easton, Pennsylvania 18042; e-mail: zanip@lafayette.edu.

Chytrid Epidemic in Wild Population Traced to Captive Bred Frogs

For many anuran species, captive breeding programs represent the only remaining option for reestablishing wild populations. However, *Batrachochytrium dendrobatidis* (Bd) has surfaced in a number of captive populations, leading to the possibility of Bd being introduced into wild populations by captive bred frogs. The authors document an unintentional Bd introduction in a population of *Alytes muletensis*, a critically endangered alytid endemic to the Mediterranean island of Malorca. Known wild populations were assayed for Bd, as were frogs that had died in the captive breeding program over the last two decades. Data on captive die-offs and introduction attempts were also gathered. Four of 21 populations tested positive for Bd, as did several captive frogs that had died between 1991 and 1995. Multilocus genetic analyses revealed the Bd in both the captive specimens and the wild populations belonged to the same strain, one unrelated to Bd strains known from mainland Europe. Furthermore, records revealed that in 1991 a *Xenopus* was brought into the breeding center; it was also found to have been infected with the same strain of Bd and it was only shortly thereafter that a large die-off of captive *Alytes* occurred. This unfortunate inadvertent introduction of Bd into a wild population underscores the importance of adhering to the IUCN guidelines for captive breeding.

WALKER, S. F., J. BOSCH, T. Y. JAMES, A. P. LITVINSTEVA, J. A. O. VALLS, S. PIÑA, G. GARCÍA, G. A. ROSA, A. A. CUNNINGHAM, S. HOLE, R. GRIFFITHS, AND M. C. FISHER. 2008. Invasive pathogens threaten species recovery programs. Current Biology 18:R853–R854.

Correspondence to: Susan Walker, Imperial College Faculty of Medicine, Dept of Infectious Disease Epidemiology, St Mary's Campus, Norfolk Place, London, W2 1PG, UK; e-mail: susan.walker03@imperial.ac.uk.

Tracking the Evolution of Limb Reduction in Squamates

The growing number of well-supported phylogenies calibrated with a molecular clock has allowed researchers to answer questions regarding not only how many times a particular trait has originated within a clade, but also the timing of the change and how many different pathways have led to the derived state. Taking advantage of the recent availability of a robust, fossil-calibrated phylogeny for squamate reptiles, the authors investigated the evolution of a snake-like body form, which occurred no fewer than 26 times across the phylogeny. Data on eight morphological characters were collected for the 258 species included in the phylogeny on which regression analyses of independent contrasts were conducted to determine which traits were associated with limb reduction and to look for common patterns. Additionally, the terminal taxa in the phylogeny were coded for their forelimb and hind limb digit numbers and ancestral states were reconstructed across the phylogeny using a novel likelihood-based framework. Overall, forelimb and hind limb digit number were strongly correlated and reduction in limb lengths and digit numbers were strongly correlated with an increase in snout-vent length (SVL) and tail length (TL). Within some clades (Gymnophthalmidae and Scincidae), the correlation with TL dropped off; this was attributed to the discrepancy between the two different reduced-limb ecomorphs (long-tailed surface-dweller and the short-tailed burrower). Thresholds were found for limb lengths, SVL, and TL which when crossed a reduction in digit number invariably occurred. The median length of time between an ancestor with five digit limbs and a descendant missing at least one pair of limbs was found to be ~50 million years (My) and as short as ~16 My; lineages with extant members exhibiting morphologies intermediate between these two extremes have persisted for as long as ~63 My. Finally, instances of digit loss drastically outnumbered instances of digit gain and digit gain was found to occur more frequently in the forelimb than the hind limb.

M. C. Brandley, J. P. Huelsenbeck, and J. J. Wiens. 2008. Rates and patterns in the evolution of snake-like body form in squamate reptiles: evidence for repeated re-evolution of lost digits and long-term persistence of intermediate body forms. Evolution 62:2042–2064.

Correspondence to: Matthew Brandley, Museum of Vertebrate Zoology, University of California, Berkeley, California 94270, USA; e-mail: brandley@berkeley.edu.

Thamnophis Pupil Diameter Changes with Water Submersion

The eye's pupil allows for adjustment to light conditions by widening and shrinking under low and high light conditions, respectively. Previous studies have shown that despite a reduction in available light, *Thamnophis* (North American garter snakes) submerged underwater experience reductions in pupil diameter. Potential benefits conveyed by a reduced aperture size underwater include an increased depth of field and an adjustment to the altered refractive index encountered in the different medium. Therefore, pupil diameter controlled by aqueous submersion (as opposed to light level) may allow aquatic snakes to better take advantage of underwater resources and variation in influence in light versus submersion control may allow for niche partitioning among sympatric species. To investigate this, the author examined pupil size response to light and submersion in three species of *Thamnophis* that occur sympatrically in southern California and exhibit different ecologies: *T. sitralis* (terrestrial), *T. hammondii* (aquatic), and *T. atratus* (intermediate). Light was found to have no impact on pupil aperture size. Additionally, while all species exhibited a reduced pupil size when submerged, *T. sirtalis* showed the largest magnitude of change (which was contrary to the prediction that the more aquatic species should show the greatest response to submersion). An explanation for this phenomenon lies in the absolute pupil size (which is smallest in *T. hammondii*); perhaps the aquatic specialists have abandoned pupil size flexibility and adequate but suboptimal vision both terrestrially and underwater (as seen in *T. sirtalis*) for an eye optimized for underwater vision at the expense terrestrial vision. This finding supports the hypothesis of niche partitioning.

Fontenot, C. L., Jr. 2008. Variation in pupil diameter in North American gartersnakes (*Thamnophis*) is regulated by immersion in water, not by light intensity. Vision Research 48:1663–1669.

Correspondence to: Clifford Fontenot Jr., Department of Biological Sciences, Southeastern Louisiana University, Hammond, Louisiana 70402, USA; e-mail: cfontenot@selu.edu.

Sea Turtle Evolutionary Relationships Obscure Origin of Spongivory

Studies examining the evolutionary relationships among extant sea turtles have offered conflicting results. The placement of the Australasian flatback turtle (*Natator*) has been particularly problematic; previous analyses have placed it as the sister taxon to a clade containing hawksbill (*Eretmochelys*), loggerhead (*Caretta*) and ridley (*Lepidochelys*) turtles. This relationship would have the unique spongivorous diet of *Eretmochelys* arising from an ancestral carnivorous condition. To address this question, the authors generated sequence data for two mitochondrial and five nuclear loci for all the extant sea turtles, including Pacific and Atlantic green turtles (*Chelonia*). Their analyses found *Natator* forming a clade with *Chelonia*, which in turn was sister to a clade containing all remaining sea turtles with the exception of leatherbacks (*Dermochelys*). This obscures the origin of spongivory, making it equally likely that it, the herbivorous diet of *Chelonia*, and the jellyfish diet of *Dermochelys* are derived from either a carnivorous or an omnivorous ancestral diet.

Naro-Maciel, E., M. Le, N. N. FitzSimmons, and G. Amato. 2008. Evolutionary relationships of marine turtles: A molecular phylogeny based on nuclear and mitochondrial genes. Molecular Phylogenetics and Evolution 49:659–662.

Correspondence to: Eugenia Naro-Maciel, Sackler Institute for Comparative Genomics, American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024, USA; e-mail: enmaciel@amnh.org.

Recent Fossil Discovery Sheds Light on Amphibian Relationships

With a growing fossil record, it is clear that Amphibia is comprised of two clades, Temnospondyli and Lepospondyli. However, deciphering the origins of, and relationships among, the three extant amphibian lineages (Lissamphibia) has been problematic. Current hypotheses involve extant lineages forming a clade within Temnospondyli, forming a clade within Lepospondyli, or arising independently within Temnospondyli (Anura + Caudata) and Lepospondyli (Apoda). The authors describe a recent fossil from the early Permian and using morphological data, construct a phylogeny incorporating other known fossil amphibians. Their analysis reveals the new fossil is sister to the node-based clade defined by Anura and Caudata. Furthermore, Anura and Caudata are shown to be derived from within Temnospondyli while Apoda is derived from within Lepospondyli, rendering Lissamphibia paraphyletic. This phylogenetic reconstruction places the divergence between Temnospondyli and Lepospondyli within the Carboniferous, which is much more in line with molecular estimates than the monophyletic Lissamphibia hypotheses.

ANDERSON, J. S., R. R. REISZ, D. SCOTT, N. B. FRÖBISCH, AND S. S. SUMIDA. 2008. A stem batrachian from the Early Permian of Texas and the origin of frogs and salamanders. Nature 453:515–518.

Correspondence to: Jason Anderson, Department of Comparative Biology and Experimental Medicine, Faculty of Veterinary Medicine, University of Calgary, 3330 Hospital Drive, Calgary, Alberta T2N 4N1, Canada; e-mail: janders@ucalgary.ca.

Fossil Reveals Morphological Evolution and Ecology of Early Turtles

Previously, early testudinate material indicated a terrestrial origin for modern turtles (= Testudines). The recent discovery from China of the earliest testudinate calls this hypothesis into question. *Odontochelys semitestacea*, from the early Carnian (mid Triassic; ~220 million years ago), appears to have inhabited the terrestrial-marine interface and superficially resembles extant aquatic turtles. In collaboration with other unique osteological features, the presence of teeth on most bones defining the oral cavity firmly places this taxon as the most basal testudinate (*Proganochelys*, the next most basal testudinate, possess teeth on a subset of those bones; later testudinates are toothless). *Odontochelys* exhibits a fully developed plastron but a rudimentary carapace; this sequence of shell evolution mirrors shell development seen in embryonic Testudines. Further examination of the carapace reveals the presence of axial skeleton elements with no osteoderm contribution. Finally, the addition of *Odontochelys* into a phylogenetic analysis of reptiles finds increased support for the placement of Testudinata within Diapsida.

LI, C., X. C. WU, O. RIEPPEL, L. T. WANG, AND L. J. ZHAO. 2008. An ancestral turtle from the Late Triassic of southwestern China. Nature 456:597–501.

Correspondence to: Chun Li, Laboratory of Evolutionary Systematics of Vertebrates, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, PO Box 643, Beijing 100044, China; e-mail: lichun@ivpp.ac.cn.

OBITUARIES

Harlan D. Walley
November 7, 1932 – June 20, 2008

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Harlan Walley (Fig. 1) exhibited energy for life and love of natural history that began during his childhood in rural Sandwich, Illinois and continued throughout adulthood. He was a fixture in the Northern Illinois University Department of Biological Sciences, supervising the department's animal care facility from 1968 until his retirement in 1998 and curating its natural history museum until his death. Harlan's academic interests centered on herpetology, mammalogy, and Illinois natural history and he was a valuable, respected, and generous source of information to faculty, students, the community, and the state.

FIG. 1. Harlan D. Walley, ca. 2000.

Harlan's formal training in biology was cut short by the Korean War, during which he served as a Navy medic (1951–1959), and by health problems associated with psoriasis which began during his years in Korea. Harlan suffered with this disease and a range of ineffective and sometimes harmful treatments for more than a decade before he found hydrocortisone ointments that allowed him to manage his symptoms. Time-consuming treatments, often at facilities far from home, interrupted his course work so frequently that he abandoned formal education beyond undergraduate classes at Waubonsee Community College and Northern Illinois University.

A true curator, Harlan became obsessed with natural history books and papers at an early age and went on to build a personal

collection of more than 60,000 reprints and 3,000 bound volumes. He developed his museum skills through time spent as a technician in the Departments of Entomology and Herpetology at the Smithsonian Institution and through an informal association with the Illinois Natural History Survey. At the INHS, Harlan established a lifelong relationship with two eminent figures of North American herpetology, Philip W. Smith, who in 1961 authored *The Amphibians and Reptiles of Illinois*, and Hobart M. Smith, who has continued to contribute to the scientific literature into his 90s. It was with Phil Smith that in 1951 Harlan published his first scientific paper—a note documenting the occurrence of the Marbled Salamander, *Ambystoma opacum*, in Michigan (Copeia 1951:309). Harlan was 18 at the time! Harlan went on to publish over 100 professional papers, many focused on amphibian, reptile, and mammal natural history and distribution. More than 30 of these appeared in *Herpetological Review* alone. He also put his reprint collection to good use, regularly contributing entries to the *Catalogue of American Amphibians and Reptiles*. The literature cited sections of his entries are encyclopedic—a soon to be published entry on the Northern Watersnake includes over 1,000 references! Harlan was an avid reader and supported this habit and his penchant for book collecting by authoring more than 100 book reviews, many of which can be found in the *Bulletin of the Maryland Herpetological Society*, *Bulletin of the Chicago Herpetological Society*, and *Wilson Bulletin*. Though focused on amphibians and reptiles, included among Harlan's publications are papers on fish, birds, mammals, and even freshwater jellyfish. For complete publication list, email rbking@niu.edu.

Harlan contributed to natural history education and conservation in many ways. He was an officer in local and state chapters of the Audubon Society, served a term as index editor for the American Society of Ichthyologists and Herpetologists, was a member of the Illinois Endangered Species Protection Advisory Board, and served on the Indiana Bat Recovery Plan panel. Perhaps one of Harlan's greatest, if unrecognized, contributions was the informal mentorship he provided to NIU biology graduate students. Harlan was a resource, lunch companion, and field-trip guide to students with interests in any aspect of biology. He was generous with his reprint collection and often helped start students' publishing careers by urging submission of a life history or distributional observation or including them as coauthors on papers he initiated. He enriched all our lives in unfathomable ways and will be missed!

ZOO VIEW

Updating the Bookshelves Part III: Important Herpetological Books Appearing During the Last Two Decades

GENERAL— REGIONAL WORKS— SNAKES— LIZARDS

FOR HIM THAT STEALETH, OR BORROWETH AND RETURNETH NOT, THIS BOOK FROM ITS OWNER, LET IT CHANGE INTO A SERPENT IN HIS HAND AND REND HIM. LET HIM BE STRUCK WITH PALSY, AND ALL HIS MEMBERS BLASTED. LET HIM LANGUISH IN PAIN CRYING ALOUD FOR MERCY, AND LET THERE BE NO SURCEASE TO THIS AGONY TILL HE SING IN DISSOLUTION. LET BOOKWORMS GNAW HIS ENTRAILS . . . AND WHEN AT LAST HE GOETH TO HIS FINAL PUNISHMENT, LET THE FLAMES OF HELL CONSUME HIM FOREVER.

—*A Gentle Madness*, Nicholas A. Basbanes, 1995.

I have selected books, mostly from my library, which have been helpful as sources of information and, in my view, deserve a place in every zoo herpetologist's reference collection. Each entry includes title, author(s), call number or ISBN, place of publisher, name of publisher, and date of publication. Titles are listed alphabetically by author. Due to space limitations, I have decided not to include books covering a single genus, e.g., *Phelsuma*, *Rhacodactylus*, *Eublepharis*, which are geared toward the herpetoculturist. Books mentioned in Parts I and II are not listed here. Part IV will appear in the next issue.

GENERAL

Contributions to the History of Herpetology / / edited by Kraig Adler.
  QL26 .C76 1989
  Imprint: Oxford OH; Society for the Study of Amphibians and Reptiles, 1989.
Herpetology: Current Research on the Biology of Amphibians and Reptiles: Proceedings of the First World Congress of Herpetology / / edited by Kraig Adler; with a foreword by H.R.H. Prince Philip.
  World Congress of Herpetology (1st: 1989: Canterbury, England).
  QL640 .H56 1992
  Imprint: [England]: Society for the Study of Amphibians and Reptiles, 1992.
Contributions to the History of Herpetology. Vol. 2 / / edited by Kraig Adler.
  QL26 .C65 2007
  Imprint: St. Louis MO: Society for the Study of Amphibians and Reptiles, 2007.
Reptile and Amphibian Variants: Colors, Patterns, and Scales / / H. Bernard Bechtel.
  QL645.5 .B43 1995X
  Imprint: Malabar FL: Krieger Pub. Co., 1995.
The Phylogeny and Classification of the Tetrapods / / edited by M. J. Benton.
  QL607.5 .P49 1988X
  Imprint: Oxford [Oxfordshire]: Published for the Systematics Association by the Clarendon Press; New York: Oxford University Press, 1988.
Ecophysiology of Desert Reptiles / / S.D. Bradshaw.
  QL669.2 .B73 1986X
  Imprint: Sydney; Orlando: Academic Press, 1986.
Homeostasis in Desert Reptiles / / S. Donald Bradshaw.
  QL669.2 .B74 1997X
  Imprint: Berlin; New York: Springer Verlag, 1997.

Reptilian panorama from A. E. Brehm's *Les Merveilles de la Nature. Les Reptiles et les Batraciens* (Librairie J.-B. Baillière et Fils, Paris, 1883).

The Genesis of Animal Play: Testing the Limits / / Gordon M. Burghardt.
  QL763.5 .B87 2005
  Imprint: Cambridge MA: MIT Press, 2005.

Encyclopedia of Reptiles & Amphibians / / consultant editors, Harold G. Cogger & Richard G. Zweifel; illustrations by David Kirshner.
  q QL641 .E53 1998
  Imprint: San Diego CA: Academic Press, 1998.

Amphibians, Reptiles, and their Conservation / / Marty Crump.
  QL644.2 .C78 2002X
  Imprint: North Haven CN: Linnet Books, 2002.

Reptilian Incubation: Environment, Evolution and Behaviour / / edited by D.C. Deeming.
  QL665 .R46 2004
  Imprint: Nottingham: Nottingham University Press, 2004.

A Complete Guide to Scientific and Common Names of Reptiles and Amphibians of the World / / Norman Frank and Erica Ramus.
  QL645 .F82 1995
  Imprint: Pottsville PA: N G Pub. Inc., 1995.

Firefly Encyclopedia of Reptiles and Amphibians / / edited by Tim Halliday and Kraig Adler.
  q QL640.7 .F57 2002
  Imprint: Toronto; Buffalo NY: Firefly Books, 2002.

The New Encyclopedia of Reptiles and Amphibians / / edited by Tim Halliday and Kraig Adler.
  q QL640.7 .N49 2002
  Imprint: Oxford: Oxford University Press, 2002.

Molecular Systematics // edited by David M. Hillis, Craig Moritz, and Barbara K. Mable.
  QH83 .M665 1996
  Imprint: 2nd ed., Sunderland MA: Sinauer Associates, 1996.

The World's Most Spectacular Reptiles & Amphibians / / text by William W. Lamar; photographs by Pete Carmichael and Gail Shumway.
  q QL643 .L36 1997
  Imprint: Tampa FL: World Publications, 1997.

Island: Fact and Theory in Nature / / James Lazell.
  QH109.V55 L39 2005
  Imprint: Berkeley CA: University of California Press, 2005.

A Field Guide to Reptiles and the Law / / John P. Levell.
  KF5645.R4 L65 1995
  Imprint: Excelsior MN: Serpent's Tale Natural History Book Distributors, 1995.

Vertebrate Ecology and Systematics: A Tribute to Henry S. Fitch / / edited by Richard A. Seigel ... [et al.].
  QL640.5 .V48 1984
  Imprint: Lawrence KS: Museum of Natural History, University of Kansas, 1984.

The Manual of Lizards & Snakes / / Marc Staniszewski.
  SF459 .R4S78 1990
  Imprint: Morris Plains NJ: Tetra Press, 1990.

Life, Love, and Reptiles: An Autobiography of Sherman A. Minton, Jr., M.D. / / foreword by Kraig Adler.
  QL31.M625 A3 2001
  Imprint: Malabar FL: Krieger Pub. Co., 2001.

Society for the Study of Amphibians and Reptiles: A Fifty Year History, 1958 to 2007 / / John J. Moriarty and Breck Bartholomew.
  QL640 .M77 2007

Two vipers from *Histoire naturelle de Lacépède, comprenant les cétacés, les quadrupèdes ovipares, les serpents et les poissons* by Bernard Germain Etienne de La Ville sur Illon La Cépède (Count de Lacepède) in 1860.
  Imprint: Paris, Furne, 1860.
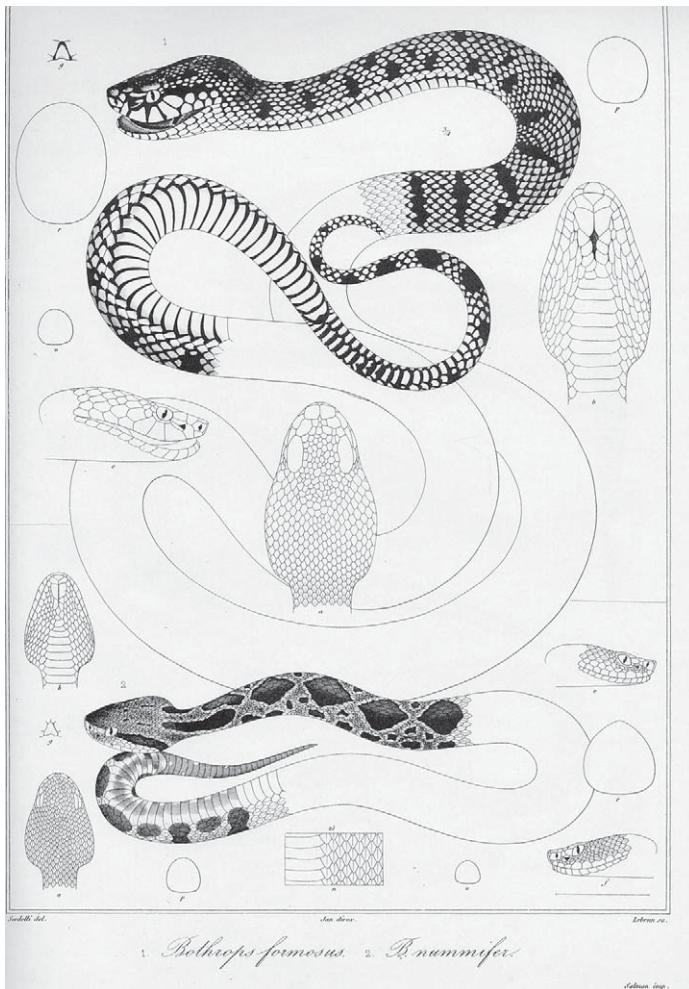
Imprint: Salt Lake City UT: Society for the Study of Amphibians and Reptiles, 2007.

Herpetology / / F. Harvey Pough ... [et al.].
QL641 .H47 1998X
Imprint: Upper Saddle River NJ: Prentice Hall, 1998.

Studies in Herpetology: Proceedings of the European Herpetological Meeting (3rd Ordinary General Meeting of the Societas Europaea Herpetologica), Prague, 1985 / / edited by Zbynek Roček.
QL640 .S62 1985X
Imprint: Prague: Published by Charles University, Prague for the Societas Europaea Herpetologica; Praha, Czechoslovakia: ARTIA, Foreign Trade Corp. [distributor], 1986.

Reptile Egg-Shells: SEM Atlas / / H. Hermann Schleich and Werner Kästle.
q QL665 .S34 1988X
Imprint: Stuttgart; New York: G. Fischer, 1988.

Temperature-Dependent Sex Determination in Vertebrates / / edited by Nicole Valenzuela and Valentine Lance.
QP278.5 .T46 2004
Imprint: Washington DC: Smithsonian Books, 2004.

Phylogenetic Analysis of Morphological Data / / edited by John J. Wiens.
QH351 .P58 2000X
Imprint: Washington DC: Smithsonian Institution Press, 2000.

Herpetology: An Introductory Biology of Amphibians and Reptiles / / George R. Zug, Laurie J. Vitt, Janalee P. Caldwell.
QL641 .Z84 2001X
Imprint: San Diego CA: Academic Press, 2001.

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Colored Atlas of the Reptiles of the North Eurasia / / Ananjeva, N. B., et al.
ISBN 5-98092-007-2
Imprint: Nature Conservation, Environment and Wildlife Health Committee under Administration of St. Petersburg [in Russian].

Reptiles and Amphibians of Europe / / E. N. Arnold.
ISBN 0-691-11413-7
Imprint: Princeton, Oxford: Princeton University Press, 2002.

Bill Branch's Field Guide to the Snakes and Other Reptiles of Southern Africa.
QL662 .A356B816 1988
Imprint: London: New Holland, 1988.

Amphibians and Reptiles: A Natural History of the British Herpetofauna / / Trevor J.C. Beebee & Richard A. Griffiths.
QL658.G7 B39 2000
Imprint: London: HarperCollins, 2000.

Amphibiens et reptiles du Maroc (Sahara Occidental compris): atlas biogéographique = Anfibios y reptiles de Marruecos (incluido Sáhara Occidental): atlas biogeográfico = Amphibians & Reptiles of Morocco (including Western Sahara): biogeographical atlas / / Jacques Bons et Philippe Geniez ; [editores, Albert Montori y Vicente Roca].
QL662.M8 B72a 1996
Imprint: Barcelona: Asociación Herpetológica Española, 1996.

Handbuch der Reptilien und Amphibien Europas / / hrsg. von Wolfgang Böhme unter mitarbeit von Natalija B. Ananjeva ... [et al.].
QL658.A1 B67
Imprint: Wiesbaden: Akademische Verlagsgesellschaft, 1981–

Reptiles and Amphibians of Australia / / Harold Cogger.
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Imprint: Chatswood, N.S.W. Australia: Reed; London: New Holland, 2000.

The Snakes of Thailand and Their Husbandry / / Merel J. Cox.
SF515.5 .S64C68 1991X
Imprint: Malabar FL: Krieger Pub. Co., 1991.

Biogeography of the Reptiles of South Asia / / Indraneil Das.
QL661.S64 D37 1996X
Imprint: Malabar FL: Krieger Pub., 1996.

The Serpent's Tongue: A Contribution to the Ethnoherpetology of India and Adjacent Countries / / Indraneil Das.
QL661.I4 D37 1998
Imprint: Frankfurt am Main: Ed. Chimaira, 1998.

An Introduction to the Amphibians and Reptiles of Tropical Asia / / Indraneil Das; photographs by the author.
QL661.S64 D375 2002
Imprint: Kota Kinabalu: Natural History Publications (Borneo), 2002.

Amphibians and Reptiles of the Hashemite Kingdom of Jordan: An Atlas and Field Guide / / Ahmad M. Disi ... [et al.].
QL661.J6 A47 2001
Imprint: Frankfurt am Main: Edition Chimaira, 2001.

A Fieldguide to the Amphibians and Reptiles of Madagascar / / Frank Glaw, Miguel Vences.
QL662 .M28G55 1994
Imprint: Köln, Germany: M. Vences & F. Glaw Verlags, 1994.

The Reptiles of Japan / / Richard C. Goris.
QL661 .J3G66
Imprint: Tokyo: Ikuei Technical College, 1966.

Biology of Australasian Frogs and Reptiles / / edited by Gordon Grigg, Richard Shine and Harry Ehmann.

This spectacular drawing is from the paper by Osbert Salvin (On the Reptiles of Guatemala) of a Yellow-blotched Palm Pit Viper (*Thamnocenchris aurifer*, now *Bothriechis aurifer*) feeding on Morelet's Leaf Frog (*Hyla holochlora*, now *Agalychnis moreletii*), published in the *Proceedings of the Zoological Society of London* in 1860.

q QL663 .A1B61 1985
Imprint: Chipping Norton, N.S.W., Australia: Surrey Beatty, in association with the Royal Zoological Society of New South Wales, 1985.

Amphibians and Reptiles of Madagascar and the Mascarene, Seychelles, and Comoro Islands / / Friedrich-Wilhelm Henkel and Wolfgang Schmidt, with the collaboration of Michael Knöthig, Klaus Liebel, and Roland Zobel; final translation and technical edit by Hinrich Kaiser.
QL662.M28 H4613 2000X
Imprint: Malabar FL: Krieger Publishing Co., 2000.

The Natural History of Amphibians and Reptiles in Sabah / / Robert F. Inger and Tan Fui Lian.
QL661.M4 I5 1996
Imprint: Kota Kinabalu: Natural History Publications (Borneo) Sdn. Bhd., 1996.

Herpetology in Australia: A Diverse Discipline / / edited by Daniel Lunney and Danielle Ayers.
q QL663.H56 1993
Imprint: Mosman, N. S. W., Australia: Royal Zoological Society of New South Wales; Chipping Norton, N. S. W., Australia: Distributed and sold by Surrey Beatty & Sons, 1993.

Amphibians & Reptiles of Mount Kinabalu (North Borneo) / / Rudolf Malkmus ... [et al.]; with 384 photographs by C. Brühl ... [et al.].
QL661.M4 A47 2002
Imprint: Ruggell [Liechtenstein]: Gantner Verlag; Königstein, Germany: Distributed by Koeltz Scientific, 2002.

Die Amphibien und Reptilien Portugals, Madeiras und der Azoren: Verbreitung, Ökologie, Schutz / / Rudolf Malkmus.
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Imprint: Magdeburg: Westarp Wissenschaften; Heidelberg: Spektrum Akademischer Verlag, 1995.

Amphibien & Reptilien Südostasiens / / Ulrich Manthey & Wolfgang Grossmann.
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Current Herpetology in East Asia: Proceedings of the Second Japan-China Herpetological Symposium, Kyoto, July 1988 / / edited by Masafumi Matsui, Tsutomu Hikida, Richard C. Goris. Japan-China Herpetological Symposium (2nd: 1988: Kyoto).
QL640 .J35 1988
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New Zealand Herpetology: Proceedings of a Symposium Held at the Victoria University of Wellington, 29–31 January 1980 / / edited by Donald G. Newman.
q QL663.5 .N56
Imprint: Wellington, New Zealand Wildlife Service, Dept. of Internal Affairs, 1982.

Contributions to the Herpetology of South-Asia (Nepal, India) / / Edited by H. H. Schleich & W. Kästle.
QL661.A1 C66 1998
Imprint: Wuppertal, Germany: Fuhlrott Museum, 1998.

Amphibians and Reptiles of Nepal: Biology, Systematics, Field Guide / / H. Hermann Schleich & Werner Kästle (eds.).
QL661.N35 A47 2002
Imprint: Ruggell [Liechtenstein]: A.R.G. Gantner; Koenigstein, Germany: Distributed by Koeltz Scientific Books, 2002.

Amphibians and Reptiles of North Africa: Biology, Systematics, Field Guide / / H. Hermann Schleich, Werner Kästle & Klaus Kabisch.
QL662.A355 S35 1996
Imprint: Koenigstein, Germany: Koeltz Scientific Books, 1996.

Reptiles of Australia / / Steve Wilson and Gerry Swan.
QL663 .W57 2003
Imprint: Princeton NJ: Princeton University Press, 2003.

Herpetology of China / / Er-mi Zhao and Kraig Adler.
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Imprint: Oxford OH: Society for the Study of Amphibians and Reptiles in cooperation with Chinese Society for the Study of Amphibians and Reptiles, 1993.

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Herpetology of the North American Deserts: Proceedings of a Symposium / / edited by Philip R. Brown, John W. Wright.
QL653.A165 H47 1994
Imprint: Van Nuys CA: Southwestern Herpetologists Society; Excelsior, MN: Trade distribution by Serpent's Tale Books, 1994.

The Venomous Reptiles of Latin America / / Jonathan A. Campbell and William W. Lamar.
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The Venomous Reptiles of the Western Hemisphere / / Jonathan A. Campbell, William W. Lamar, with contributions by Edmund D. Brodie III ... [et al.].
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Oklahoma Herpetology: An Annotated Bibliography / / Charles C. Carpenter and James J. Krupa.
Z7996 .R4C29 1989
Imprint: Norman OK: University of Oklahoma Press, 1989.

Reptiles del noroeste, nordeste y este de la Argentina: herpetofauna de las selvas subtropicales, Puna y Pampas / / José M. Cei.
QL657.A7 C39r 1993
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Amphibians and Reptiles in Kansas / / Joseph T. Collins; with photographs by Suzanne L. Collins.
QL653.K3 C64 1993
Imprint: Lawrence KS: University of Kansas, Museum of Natural History: Distributed by the University Press of Kansas, 1993.

A Field Guide to Reptiles & Amphibians: Eastern and Central North America / / Roger Conant and Joseph T. Collins; illustrated by Isabelle Hunt Conant and Tom R. Johnson.
QL651 .C65 1998X
Imprint: Boston MA: Houghton Mifflin, 1998.

Caribbean Amphibians and Reptiles / / edited by Brian I. Crother.
QL656.5.A1 C37 1999
Imprint: San Diego CA: Academic Press, 1999.

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Amphibians and Reptiles of New Mexico / / William G. Degenhardt, Charles W. Painter, Andrew H. Price; foreword by Roger Conant.
QL653.N6 D44 1996
Imprint: 1st ed. Albuquerque NM: University of New Mexico Press, 1996.

Amphibians and Reptiles of Texas: With Keys, Taxonomic Synopses, Bibliography, and Distribution Maps / / James R. Dixon.
QL653.T4 D59 2000
Imprint: College Station: Texas A&M University Press, 2000.

Cusco Amazónico: The Lives of Amphibians and Reptiles in an Amazonian Rainforest / / William E. Duellman.
QL657.P4 D84 2005
Imprint: Ithaca NY: Comstock Pub. Associates, 2005.

The Amphibians and Reptiles of Louisiana / / Harold A. Dundee, Douglas A. Rossman.
QL653 .L6D86 1989X
Imprint: Baton Rouge LA: Louisiana State University Press, 1989.

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Enge and C. Kenneth Dodd, Jr.

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Imprint: Tallahassee FL: Nongame Wildlife Program, Florida Game and Fresh Water Fish Commission, 1992.

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QL666 .O6E77 1992X

Imprint: Washington: Smithsonian Institution Press, 1992.

Guide to the Reptiles and Amphibians of the Savannah River Site / / J. Whitfield Gibbons, Raymond D. Semlitsch.

QL653.S6 G53 1991

Imprint: Athens GA: University of Georgia Press, 1991.

The Amphibians and Reptiles of New York State: Identification, Natural History, and Conservation / / James P. Gibbs ... [et al.].

QL653.N7 A47 2007

Imprint: Oxford; New York: Oxford University Press, 2007.

Amphibians and Reptiles of Baja California, Including its Pacific Islands, and the Islands in the Sea of Cortés / / L. Lee Grismer; with a foreword by Harry W. Greene.

QL655 .G75 2002

Imprint: Berkeley CA: University of California Press, 2002.

Amphibians and Reptiles in Colorado / / Geoffrey A. Hammerson.

QL653 .C6H35 1982x

Imprint: Denver CO: Colorado Division of Wildlife, 1982.

Amphibians and Reptiles of the Great Lakes Region / / James H. Harding.

QL653.G74 H37 1997X

Imprint: Ann Arbor MI: University of Michigan Press, 1997.

Islands and the Sea: Essays on Herpetological Exploration in the West Indies / / edited by Robert W. Henderson and Robert Powell.

QL656.5.A1 I85 2003

Imprint: Ithaca NY: Society for the Study of Amphibians and Reptiles, 2003.

Amphibians and Reptiles of Pennsylvania and the Northeast / / Arthur C. Hulse, C. J. McCoy, and Ellen Censky.

QL658.P4 H86 2001

Imprint: Ithaca NY: Cornell University Press, 2001.

The Amphibians and Reptiles of El Salvador / / Gunther Köhler, Milan Veselý, Eli Greenbaum.

QL656.S2 K64 2006

Imprint: Malabar FL: Krieger Publishing, 2006.

Amphibians, Reptiles, and Their Habitats at Sabino Canyon / / David W. Lazaroff, Philip C. Rosen, Charles H. Lowe, Jr.

QL653.A6 L39 2006

Imprint: Tucson AZ: University of Arizona Press, 2006.

The Amphibians and Reptiles of the Yucatán Peninsula / / Julian C. Lee; drawings by Julian C. Lee.

QL655 .L424 1996X

Imprint: Ithaca NY: Comstock, 1996.

A Field Guide to the Amphibians and Reptiles of the Maya World: The Lowlands of Mexico, Northern Guatemala, and Belize / / Julian C. Lee; drawings by Julian C. Lee.

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A Guide to Amphibians and Reptiles of Costa Rica / / Twan Leenders; preface by Adrian Forsyth.

QL656.C8 L44 2001

Imprint: Miami FL: Zona Tropical, 2001.

Field Guide to Amphibians and Reptiles of the San Diego Region / / Jeffrey M. Lemm.

QL653.C2 L46 2006

Imprint: Berkeley CA: University of California Press, 2006.

Scientific and Common Names for the Amphibians and Reptiles of Mexico in English and Spanish = Nombres científicos y comunes en ingles y español de los anfiibios[!] y los reptiles de México / / Ernest A. Lin-er; Spanish translation/traducción al español, José L. Camarillo R.

QL655 .L75 1994

Imprint: Society for the Study of Amphibians and Reptiles, 1994.

The Venomous Reptiles of Arizona / / Charles H. Lowe, Cecil R. Schwalbe, Terry B. Johnson.

QL666.O6 L79 1986

Imprint: Phoenix AZ: Arizona Game and Fish Dept., 1986.

Amphibians and Reptiles: Status and Conservation in Florida / / Walter E. Meshaka, Jr. and Kimberly J. Babbitt, editors.

QL653.F6 A47 2005

Imprint: Malabar FL: Krieger Pub. Co., 2005.

The Exotic Amphibians and Reptiles of Florida / / Walter E. Meshaka, Jr., Brian P. Butterfield, J. Brian Hauge.

QL653.F6 M37 2004

Imprint: Malabar FL: Krieger Pub. Co., 2004.

A Guide to the Frogs and Toads of Belize / / John R. Meyer & Carol Farneti Foster.

QL668.E2 M48 1996X

Imprint: Malabar FL: Krieger Pub. Co., 1996.

Amphibians & Reptiles of Indiana / / Sherman A. Minton, Jr.

QL653.I6 M5 2001

Imprint: Rev. 2nd ed., Indianapolis IN: Indiana Academy of Science, 2001.

Amphibians and Reptiles of Assateague and Chincoteague Islands / / Joseph C. Mitchell, John M. Anderson.

QL653.V6 M56 1994

Imprint: Martinsville VA: Virginia Museum of Natural History, 1994.

Amphibians and Reptiles of Trinidad and Tobago / / John C. Murphy.

QL656.5.T7 M87 1997X

Imprint: Melbourne FL: Krieger Pub. Co., 1997.

Amphibians & Reptiles Native to Minnesota / / Barney Oldfield and John J. Moriarty

QL653.M55 O45 1994

Imprint: Minneapolis MN: University of Minnesota Press, 1994.

Reptiles of North Carolina / / William M. Palmer and Alvin L. Braswell.

QL653.N8 P35 1995X

Imprint: Chapel Hill NC: University of North Carolina Press, 1995.

Catalogue of the Neotropical Squamata. / / James A. Peters.

QL666.L19 P48 1986

Imprint: Rev. ed. Washington DC: Smithsonian Institution Press, 1986.

Contributions to West Indian Herpetology: A Tribute to Albert Schwartz / / edited by Robert Powell and Robert W. Henderson; foreword by Thomas W. Schoener.

QL656.5.A1 C66 1996X

Imprint: Ithaca NY: Society for the Study of Amphibians and Reptiles, 1996.

Los anfibios y reptiles de Puerto Rico = The Amphibians and Reptiles of Puerto Rico / / Juan A. Rivero.

QL656.5.P8 R58 1998

Imprint: San Juan, P.R.: Editorial de la Universidad de Puerto Rico, 1998.

The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas / / Jay M. Savage; with photographs by Michael Fogden and Patricia Fogden.

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Imprint: Chicago IL: University of Chicago Press, 2002.

Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History / / Albert Schwartz, Robert W. Henderson.

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Imprint: Gainesville FL: University of Florida Press, 1991.

A Guide to the Reptiles of Belize / / Peter J. Stafford, John R. Meyer [and] The Natural History Museum, London.

QL656.B42 S73 2000

Sumatra Pit Viper (*Parias sumatranus*) and Jumping Pit Viper (*Atropoides nummifer*) from *Iconographie générale des ophidiens / par M. le professor Jan . . .[en collaboration avec Mr. F. Sordelli.] ...*
Imprint: Milan: chez l'auteur, [etc., etc.], 1860–1881.

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A Field Guide to Western Reptiles and Amphibians: Field Marks of All Species in Western North America, Including Baja California / / text and illustrations by Robert C. Stebbins; sponsored by the National Audubon Society and National Wildlife Federation.
QL651 .S783 1985X
Imprint: Boston MA: Houghton Mifflin, 1985.
The Amphibians and Reptiles of Arkansas / / Stanley E. Trauth, Henry W. Robison, and Michael V. Plummer.
QL653.A7 T73 2004
Imprint: Fayetteville: The University of Arkansas Press, 2004.
Proceedings of a Workshop on Neotropical Distribution Patterns, Held 12–16 January 1987 / / P.E. Vanzolini and W. Ronald Heyer, editors.
QH84.5 .P963 1987
Imprint: Rio de Janeiro: Academia Brasileira de Ciências, 1988.
Middle American Herpetology: A Bibliographic Checklist / / Jaime Villa, Larry David Wilson, and Jerry D. Johnson.
QL656.A1 V55 1988
Imprint: Columbia: University of Missouri Press, 1988.

MULTI-VOLUME CONTINUING SERIES

Grzimek's Animal Life Encyclopedia / / Bernhard Grzimek.
QL7.G7813 2003X
Imprint: Detroit MI: Gale, 2003.

Amphibian Biology / / edited by Harold Heatwole.
q QL667 .A52 1994
Imprint: Chipping Norton, NSW, Australia: Surrey Beatty & Sons, 1994-

In addition to the journal *Salamandra*, the book series Mertensiella is published by Deutsche Gesellschaft für Herpetologie und Terrarienkunde (German Society for Herpetology and Terrariums). Recent topics include biology of Nile Monitor, three books on varanid lizards, ecology of European Pond Turtle, mating biology of squamates, field techniques, history of herpetology and herpetoculture in German-speaking areas, and conservation and natural history of the Green Toad, European Viper, and Emerald Lizard.

In addition to its journal and news-journal, the Society for the Study of Amphibians and Reptiles (SSAR) has five continuing series: *Catalogue of American Amphibians and Reptiles*, *Herpetological Conservation*, *Contributions to Herpetology*, *Facsimile Reprints in Herpetology*, and *Herpetological Circulars*. A complete list of titles may be found at the back of any book published by SSAR.
The Herpetologists' League publishes *Herpetological Monographs* in addition to the journal *Herpetologica*.
The Center for North American Herpetology Facsimile Reprints Series was established in December 2005 and ten titles have been published:

The Herpetology of Hispaniola / / Doris Cochran (1941; ISBN 1-885209-00-2)
A Revision of the Kingsnakes: Genus *Lampropeltis* / / Frank N. Blanchard (1921; ISBN 1-885209-45-2).
The Poisonous Snakes of North America / / Leonhard Stejneger (1895; ISBN 1-885209-47-9).
Variations and Relationships in the Snakes of the Genus *Pituophis* / / Olive Griffith Stull (1940; ISBN 1-885209-46-0).
The Hellbenders / / Max Allen Nickerson and Charles Edwin Mays (1972; ISBN 1-885209-43-6).
Fossil Turtles of North America / / O. P. Hay (1908; ISBN 1-885209-44-4).
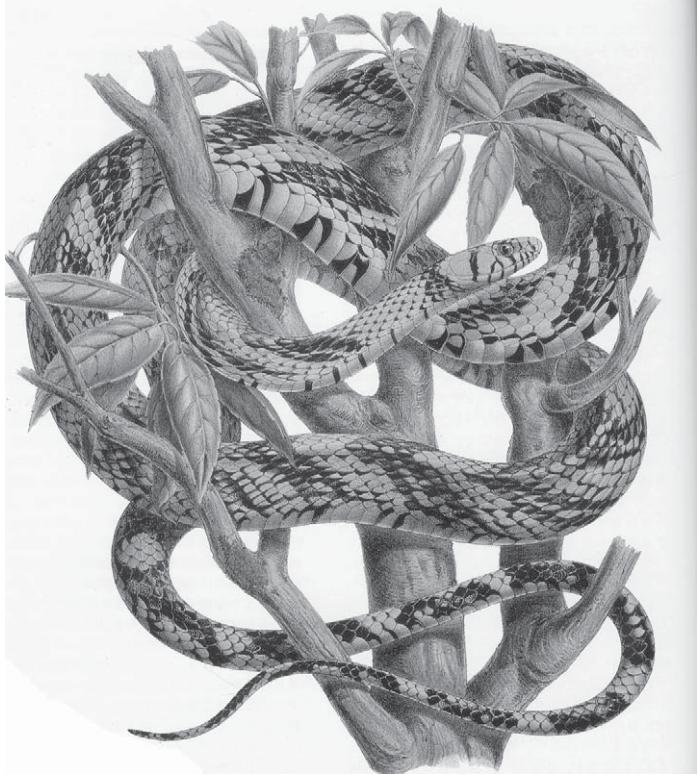
VIPERA NASICORNIS AND YOUNG ONE.
AFRICA.
Mother over five feet long, Viperling 9 inches.

Rhinoceros Viper (*Vipera nasicornis*, now *Bitis nasicornis*) in *Snakes: Curiosities and Wonders of Serpent Life*, by Catherine Cooper Hopley in 1882. This book was one of the most accurate books on snakes published at the time. In the last chapter entitled "Notes from the Zoological Gardens," she discussed some of the snakes at the London Zoo, including the King Cobra, Rhinoceros Viper, Cottonmouth, and Neotropical Rattlesnake.
Imprint: London, Griffith & Farran.

One of the most perfectly balanced and lovely snake drawings in the history of herpetological art was created by the artist R. Mintern and lithographer J. Green—Neotropical Rat Snake (*Spilotes salvini*, now *S. pullatus*) from Albert C. L.G. Günther's *Biologia Centrali-Americana. [vol. 7], Reptilia and Batrachia*, 1885–1902. The major reason why this image is so striking is this arboreal snake was shown entwined in branches in a naturalistic pose.

Imprint: London, Pub. for the editors by R. H. Porter.

The Herpetology of Michigan / / Alexander G. Ruthven, et al. (1928; ISBN 1-885209-49-5).

The Whip Snakes and Racers Genera *Masticophis* and *Coluber* / / Arthur Irving Ortenburger (1928; ISBN 1-885209-50-9).

Turtles of the Northeastern United States / / Harold L. Babcock (1919; ISBN 1-885209-51-7).

The Reptiles and Batrachians of North America / / Samuel Garman (1883; ISBN 1-885209-48-7).

SNAKES

Snakes of the World / / Manuel Aresté and Rafael Cebrian.
q QL666.O6 A7413 2003X
Imprint: New York: Sterling Pub. Co., 2003.

Snakes / / David Badger.
q QL666.O6 B15 1999X
Imprint: Stillwater MN: Voyageur Press, 1999.

Pythons of the World / / David G. Barker and Tracy M. Barker.
QL666.O63 B39 1994X
Imprint: Lakeside CA: Advanced Vivarium Systems, Inc., 1994-

Pythons of the World, Vol II. Ball pythons. The history, natural history, care and breeding. / / David G. Barker and Tracy M. Barker.
ISBN 0-9785411-0-3
Boerne TX: VPI Library, 2006.

Snakes: A Natural History / / edited by Roland Bauchot; translated from the French by Catherine Berthier.
QL666.O6 S392513 1994
Imprint: New York: Sterling Pub., 1994.

The Snakes of Trinidad and Tobago / / Hans E.A. Boos.
QL666.O6 B74 2001
Imprint: 1st ed. College Station TX: Texas A&M University Press, 2001.

Snakes of the World / / Peter Brazaitis and Myrna E. Watanabe.
QL666.O6 B827 1992
Imprint: New York; Avenel NJ: Crescent Books, 1992.

FitzSimons' Snakes of Southern Africa / / Donald G. Broadley; color illustrations by P.J. Smit.
QL662 .F56 1983
Imprint: Johannesburg: Delta Books, 1983.

A Check List of the Reptiles of Tanzania, With Synoptic Keys / / Donald G. Broadley and Kim M. Howell.
q QL662 .T35B76 1991
Imprint: Bulawayo, Zimbabwe: National Museums and Monuments of Zimbabwe (distributed by the Natural History Museum), 1991.

Snakes of Zambia / / Donald G. Broadley, Craig T. Doria, Jürgen Wigge.
QL666.O6 B867 2003
Imprint: Frankfurt am Main: Edition Chimaira; Lanesboro, MN: Zoo Book Sales [U.S. distributor], 2003.

Die Giftschlangen Europas: und die Gattung Vipera in Afrika und Asien / / Peter Brodmann.
q QL666 .O69B86 1987
Imprint: Bern: Kümmerly + Frey, 1987.

Biology of the Pitvipers / / editors, Jonathan A. Campbell and Edmund D. Brodie, Jr.
QL666 .O69B615 1992
Imprint: Tyler TX: Selva, 1992.

Les serpents de la Guyane française / / Jean-Philippe Chippaux.
QL666 .O6C54s 1986
Imprint: Paris: Institut française de recherche scientifique pour le développement en coopération, 1986.

The Atlas of Snakes of the World / / John Coborn.
QL666.O6 C65 1991
Imprint: Neptune City NJ: T.F.H. Publications, 1991.

The Venomous Sea Snakes: A Comprehensive Bibliography / / Wendy A. Culotta and George V. Pickwell.
Z7996 .S64C84 1993X
Imprint: Malabar FL: Krieger, 1993.

The Snakes of Sumatra: An Annotated Checklist and Key With Natural History Notes / / Patrick David and Gernot Vogel.
QL661.I5 D38 1996
Imprint: Frankfurt am Main: Edition Chimaira, 1996.

Snakes: Biology, Behavior and Relationship to Man / / Wolf-Eberhard Engelmann and Fritz Jürgen Obst.
QL666 .O6E57
Imprint: New York: Exeter Books: distributed by Bookthrift, 1982.

Snakes of Eastern North America / / Carl H. Ernst and Roger W. Barbour.
QL666 .O6E76 1989X
Imprint: Fairfax VA: George Mason University Press; Lanham, MD: Distributed by arrangement with University Pub. Associates, 1989.

Snakes of the United States and Canada / / Carl H. Ernst and Evelyn M. Ernst.
QL666.O6 E763 2003X
Imprint: Washington DC: Smithsonian Books, 2003.

Snake Life History in Kyoto / / Hajime Fukada.
QL666 .O6F96 1992
Imprint: Bunkyoku, Tokyo: Impact Shuppankai Co., 1992.

Fauna of Saudi Arabia, Vol. 9 [article by J. Gasperetti on snakes] / / editors, W. Wittmer and W. Büttiker.
QL334.S2 F26
Imprint: Basle: Pro Entomologia, Natural History Museum, 1988.

North American Watersnakes: A Natural History / / J. Whitfield Gibbons

and Michael E. Dorcas; foreword by Roger Conant.
QL666.O636 G53 2004
Imprint: Norman OK: University of Oklahoma, 2004.

Snakes of the *Agkistrodon* Complex: A Monographic Review / / Howard K. Gloyd and Roger Conant.
QL666 .O69G56s 1990
Imprint: St. Louis MO: Society for the Study of Amphibians and Reptiles, 1990.

Snakes: The Evolution of Mystery in Nature / / Harry W. Greene; with photographs by Michael and Patricia Fogden.
QL666.O6 G69 1997X
Imprint: Berkeley: University of California Press, c1997.

The Biology and Evolution of Australian Snakes / / Allen E. Greer.
q QL663 .G74 1997
Imprint: Chipping Norton, N. S. W., Australia: Surrey Beatty & Sons, 1997.

Asian Pitvipers / /Andreas Gumprecht ... [et al.].
QL666.O69 A85 2004
Imprint: Berlin: Geitje Books, 2004.

Sea Snakes / / Harold Heatwole.
QL666.O645 H43 1999X
Imprint: Malabar FL: Krieger Pub. Co., 1999.

Neotropical Treeboas: Natural History of the *Corallus hortulanus* Complex / / Robert W. Henderson.
QL666.O63 H46 2002X
Imprint: Malabar FL: Krieger Pub. Co., 2002.

Mating Strategies and Sperm Competition in the Adder (*Vipera berus*) / / by Mats Höggren.
QL666.O69 H64 1995
Imprint: Uppsala: Acta Universitatis Upsaliensis, 1995.

The Venomous Snakes of the Near and Middle East / / by Ulrich Joger.
QL666 .O6J637 1984X
Imprint: Wiesbaden: L. Reichert, 1984.

Phylogeny and Systematics of the Viperidae / / edited by Ulrich Joger. Heft 8.
QH1 .K212
Imprint: Kaupia. Darmstadt: Hessisches Landesmuseum Darmstadt, 1999.

Taking Up Serpents: Snake Handlers of Eastern Kentucky / / David L. Kimbrough.
BX7990.H6 K46 1995
Imprint: Chapel Hill: University of North Carolina Press, 1995.

Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind, 2 Vols. / / Laurence M. Klauber. 2nd ed. with a new foreword by Harry W. Greene.
QL666.O6 K56 1997
Imprint: Berkeley CA: Published for the Zoölogical Society of San Diego by the University of California Press, 1997.

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QL666 .O6L24s G1989
Imprint: Caracas, Venezuela: Verlag Armitano, 1989.

True Vipers: Natural History and Toxinology of Old World Vipers / / David Mallow, David Ludwig, and Göran Nilson.
QL666.O69 M34 2003
Imprint: Malabar, FL: Krieger, 2003.

Kingsnakes and Milk Snakes / / Ronald G. Markel.
q QL666 .O636M34 1990
Imprint: Neptune City NJ: T.F.H., 1990.

Rattler!: A Natural History of Rattlesnakes / / Chris Mattison.
QL666.O69 M37 1996X
Imprint: London: Blandford; New York: Distributed in the U.S. by Sterling Pub. Co., 1996.

The New Encyclopedia of Snakes / / Chris Mattison.

QL666.O6 E53 2007
Imprint: Princeton NJ: Princeton University Press, 2007.

Snake Species of the World: A Taxonomic and Geographic Reference / / Roy W. McDiarmid, Jonathan A. Campbell and T'Shaka A. Touré.
QL666.O6 M395 1999
Imprint: Washington, DC: Herpetologists' League, 1999-

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QL666 .O6M45 1987X
Imprint: New York: Sterling Pub. Co., 1987.

Snakes: Ecology and Conservation / / edited by S. J. Mullin and R.A. Seigel. Ithaca NY: Cornell University Press, *in press*.

Homalopsid Snakes: Evolution in the Mud / / John C. Murphy.
QL666.O636 M87 2007
Imprint: Malabar FL: Krieger Pub. Co., 2007.

Tales of Giant Snakes: A Historical Natural History of Anacondas and Pythons / / John C. Murphy and Robert W. Henderson.
QL666.O63 M87 1997X
Imprint: Malabar FL: Krieger Pub. Co., 1997.

The Meadow and Steppe Vipers of Europe and Asia — the *Vipera* (*Acridophaga*) *ursinii* Complex / / G. Nilson and C. Andrén.
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QL666.O6 O824 1996
Imprint: Port Moresby, Singapore: Independent Pub., 1996.

Venomous Snakes of the World / / Mark O'Shea.
QL666.O6 O844 2005
Imprint: Princeton NJ: Princeton University Press, 2005.

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QL666.O6 P47 1999
Imprint: Madrid: Comité Español del Programa MaB y de la Red IberoMaB de la UNESCO, 1999.

Problem Snake Management: The Habu and the Brown Treesnake / / editors, Gordon H. Rodda ... [et al.].
SF810.7.T79 P76 1999X
Imprint: Ithaca NY: Comstock Pub. Associates, 1999.

The Reproductive Husbandry of Pythons and Boas / / Richard A. Ross and Gerald Marzec.
SF515.5 .S64R66 1990X
Imprint: Stanford, Calif. (P.O. Box 2227, Stanford 94305): Institute for Herpetological Research, 1990.

The Garter Snakes: Evolution and Ecology / / Douglas A. Rossman, Neil B. Ford, and Richard A. Seigel.
QL666.O636 R67 1996
Imprint: Norman OK: University of Oklahoma Press, 1996.

Coral Snakes of the Americas: Biology, Identification, and Venoms / / Janis A. Roze.
QL666.O64 R69 1996X
Imprint: Malabar FL: Krieger Publ. Co., 1996.

Rattlesnake: Portrait of a Predator / / Manny Rubio.
QL666.O69 R835 1998X
Imprint: Washington DC: Smithsonian Institution Press, c1998.

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QP941.S6 R78 1983
Imprint: Great Neck NY: Scholium International, 1983.

Biology of the Vipers / / editors, Gordon W. Schuett ... [et al.].
QL666.O69 B62 2002
Imprint: Eagle Mountain UT: Eagle Mountain Pub., 2002.

A Monograph of the Colubrid Snakes of the Genus *Elaphe* Fitzinger / / Klaus-Dieter Schulz; with contributions by André Entzeroth.
q QL666.O636 S38 1996
Imprint: Czech Republic: Koeltz Scientific Books, 1996.

Snakes: Ecology and Evolutionary Biology / / editors, Richard A. Seigel,

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Imprint: Leipzig, Wien, Verlag des Bibliographischen Instituts.

Joseph T. Collins, Susan S. Novak.
QL666 .O6S66 1987c
Imprint: New York: McGraw-Hill, 1987.

Snakes: Ecology and Behavior / / edited by Richard A. Seigel, Joseph T. Collins.
QL666 .O6S65 1993X
Imprint: New York: McGraw-Hill, 1993.

Australian Snakes: A Natural History / / Richard Shine.
QL666.O6 S42 1995
Imprint: Ithaca NY: Cornell, 1995.

The Dangerous Snakes of Africa: Natural History, Species Directory, Venoms, and Snakebite / / Stephen Spawls and Bill Branch.
QL666.O6 S69 1995X
Imprint: Sanibel Island FL: Ralph Curtis-Books, 1995.

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QL666.O63 S725 1996X
Imprint: Malabar FL: Krieger Pub. Co.,1996.

Snakes of Western Australia / / G.M. Storr, L.A. Smith, and R.E. Johnstone.
QL666.O6 S88 2002
Imprint: Perth, W.A.: Western Australian Museum, 2002.

A Field Guide to the Snakes of Borneo // Robert B. Stuebing, and Robert F. Inger.
QL666.O6 S88 1999
Imprint: Kota Kinabalu: Natural History Publications (Borneo), 1999.

Snake / / Drake Stutesman.
QL666.O6 S78 2005
Imprint: London: Reaktion, 2005.

Venomous Creatures of Australia: A Field Guide With Notes on First Aid / / Struan K. Sutherland.
QL100 .S87 1994X
Imprint: Melbourne; New York: Oxford University Press, 1994.

Venomous Snakes: Ecology, Evolution, and Snakebite / / edited by R.S. Thorpe, W. Wüster, and Anita Malhotra.
QL666.O6 V44 1997
Imprint: Oxford: published for the Zoological Society of London by Clarendon Press; New York: Oxford University Press, 1997.

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QL666 .O63T65 1993
Imprint: Taunton: R & A; Excelsior, MN: Distributed in the Americas by Eric Thiss, 1993.

Texas Snakes: Identification, Distribution, and Natural History / / John E. Werler and James R. Dixon.
QL666.O6 W42 2000
Imprint: 1st ed., Austin TX: University of Texas Press, 2000.

Snakes of India: The Field Guide // Romulus Whitaker and Ashok Captain.
QL666.O6 W45 2004
Imprint: Chennai, India: Draco Books, 2004.
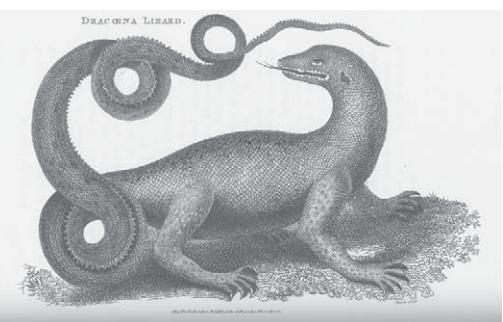
Snakes: Smithsonian Answer Book / / George R. Zug and Carl H. Ernst.
QL666.O6 E48 2004
Imprint: Washington, DC: Smithsonian Books, 2004.

LIZARDS

Iguanas: Biology and Conservation / / edited by Allison C. Alberts ... [et al.].

Three views of monitor lizards from the genus *Varanus*. The lizards pictured from left to right: Desert Monitor (*V. griseus*) from John Anderson's *Zoology of Egypt* in 1898; Water Monitor (*V. salvator*) from R. Lydekker's *The Royal Natural History* in 1896; and George Shaw's "Dracæna Lizard" in *General Zoology* may be the Bengal Monitor (*V. bengalensis*) in 1802.

QL666.L25 I368 2004
Imprint: Berkeley CA: University of California Press, 2004.

Lizards of Brazilian Amazonia (Reptilia: Squamata) / / T.C.S. Avila-Pires.
QL666.L2 A956 1995
Imprint: Leiden: Nationaal Natuurhistorisch Museum, 1995.

Biology of Gila Monsters and Beaded Lizards / / Daniel D. Beck; with contributions from Brent E. Martin and Charles H. Lowe; foreword by Harry Greene.
QL666.L247 B43 2005
Imprint: Berkeley CA: University of California Press, 2005.

Monitor Lizards: Natural History, Biology & Husbandry / / Daniel Bennett; edited by Thomas Wilms and Breck Bartholomew.
QL666.L29 B46 1998
Imprint: Frankfurt am Main: Edition Chimaira, 1998.

Bogert and Martín del Campo's The Gila Monster and its Allies / / with a new preface by Charles M. Bogert; and a retrospective essay by Daniel D. Beck.
QL666 .L247B67 1956a
Imprint: Oxford OH: Society for the Study of Amphibians and Reptiles, 1993.

Phylogenetic Relationships of the Lizard Families: Essays Commemorating Charles L. Camp / / edited by Richard Estes and Gregory Pregill.
QL666 .L2P5 1988X
Imprint: Stanford CA: Stanford University Press, 1988.

Lizard Social Behavior / / edited by Stanley F. Fox, J. Kelly McCoy, and Troy A. Baird.
QL666.L2 L59 2003X
Imprint: Baltimore MD: Johns Hopkins University Press, 2003.

The Biology and Evolution of Australian Lizards / / Allen E. Greer.
q QL666 .L2G816 1989
Imprint: Chipping Norton, Australia: Surrey Beatty & Sons, 1989.

Geckoes: Biology, Husbandry, and Reproduction / / Friedrich-Wilhelm Henkel, Wolfgang Schmidt; translated from the original German by John Hackworth.
SF515.5 .G43H4613 1995X
Imprint: Malabar FL: Krieger Publ. Co., 1995.

Biology, Husbandry, and Medicine of the Green Iguana / / edited by Elliott R. Jacobson; foreword by Thomas Huntington Boyer.
SF515.5.I38 B56 2003
Imprint: Malabar FL: Krieger Pub. Co., 2003.
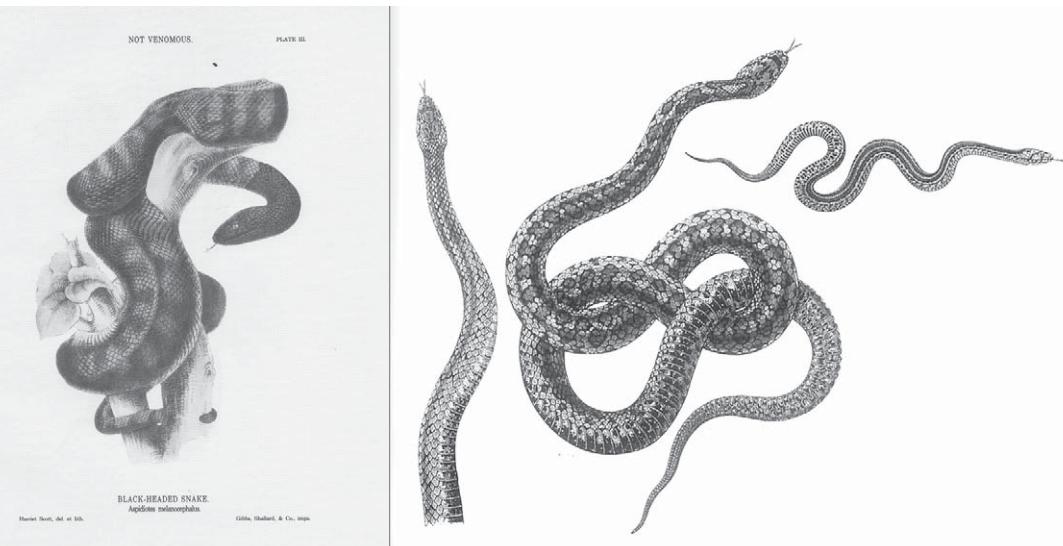
Monitors: The Biology of Varanid Lizards / / Dennis King and Brian Green.
QL666.L29 K56 1999
Imprint: 2nd ed., Malabar FL: Krieger Publ. Co., 1999.

Komodo Dragons: Biology and Conservation / / edited by James B. Murphy ... [et al.].
QL666.L29 K66 2002X

One definition of a dictionary is any alphabetically arranged list of words or articles related to a special subject. Here are two lovely plates of snakes ranging from A (*Aspidites*) to Z (*Zamenis*).

Left: Black-Headed Python (*Aspidites melanocephalus*) from *The Snakes of Australia; An Illustrated and Descriptive Catalogue of all the Known Species*, by Gerard Krefft.
Imprint: Sydney, T. Richards, Government Printer, 1869.

Right: European or Leopard Ratsnake (*Zamenis situla*, formerly *Coluber leopardinus*) from *Iconografia della fauna italica per le quattro classi degli animali vertebrati, principe Bonaparte, principe di Canino* by Charles Lucian Bonaparte. ,
Imprint: Roma, Tip. Salviucci, 1834.

Imprint: Washington DC: Smithsonian Institution Press, 2002.

Chameleons: Nature's Hidden Jewels / / Petr Nečas.
QL666.L23 N33 1999
Imprint: Frankfurt am Main: Edition Chimaira, 1999.

Lizards / / Mark O'Shea; consultant, Richard A. Griffiths.
QL666.L2 O84 2004
Imprint: New York: Lorenz, 2004.

Ecology and Natural History of Desert Lizards: Analyses of the Ecological Niche and Community Structure / / Eric R. Pianka.
QL666.L2 P53 1986
Imprint: Princeton NJ: Princeton University Press, 1986.

Varanoid Lizards of the World / / edited by Eric R. Pianka and Dennis R. King with Ruth Allen King.
QL666.L29 V27 2004
Imprint: Bloomington IN: Indiana University Press, 2004.

Lizards: Windows to the Evolution of Diversity / / Eric R. Pianka and Laurie J. Vitt; with a foreword by Harry W. Greene.
QL666.L2 P54 2003X
Imprint: Berkeley CA: University of California Press, 2003.

Lizard Ecology: The Evolutionary Consequences of Foraging Mode / / edited by Stephen M. Reilly, Lance D. McBrayer, and Donald B. Miles.
QL666.L2 L585 2007
Imprint: Cambridge; New York: Cambridge University Press, 2007.

Lizards, 2 Vols. / / Manfred Rogner; translated from the original German by John Hackworth.
SF459.L5 R6313 1997
Imprint: Malabar FL: Krieger Pub. Co., 1997.

Anolis Lizards of the Caribbean: Ecology, Evolution, and Plate Tectonics / / Jonathan (Joan) Roughgarden.
QL666 .L25R68 1995X
Imprint: New York: Oxford University Press, 1995.

The Iguanid Lizards of Cuba / / edited by Lourdes Rodríguez Schettino;

contributing editors, Alberto Coy Otero ... [et al.].

QL666.L25 I383 1999X

Imprint: Gainesville FL: University Press of Florida, 1999.

Chamaeleo calyptratus: the Yemen Chameleon / / Wolfgang Schmidt; translated from the original German by John Hackworth.

SF459.C45 S3413 2001

Imprint: Münster: Matthias Schmidt, 2001.

Introduction to Horned Lizards of North America / / Wade C. Sherbrooke.

QL666.L25 S48 2003

Imprint: Berkeley CA: University of California Press, 2003.

Giant Lizards / / Robert G. Sprackland.

SF515.5 .L58S65 1992X

Imprint: Neptune City NJ: T.F.H. Publications, 1992.

Lizards of Western Australia / / G.M. Storr, L.A. Smith, and R.E. Johnstone.

QL666.L2 S86 1999Y

Imprint: Perth: Western Australian Museum, 1999.

Lizard Ecology: Historical and Experimental Perspectives / / edited by Laurie J. Vitt and Eric R. Pianka.

QL666.L2 L57 1994X

Imprint: Princeton N.J: Princeton University Press, 1994.

Biology of Whiptail Lizards: Genus *Cnemidophorus* / / editors, John W. Wright and Laurie J. Vitt.

QL666 .L285B615 1993

Imprint: Norman OK: Oklahoma Museum of Natural History and University of Oklahoma, 1993.

The Lizards of Fiji: Natural History and Systematics / / George R. Zug.

QL666 .L2Z94 1991
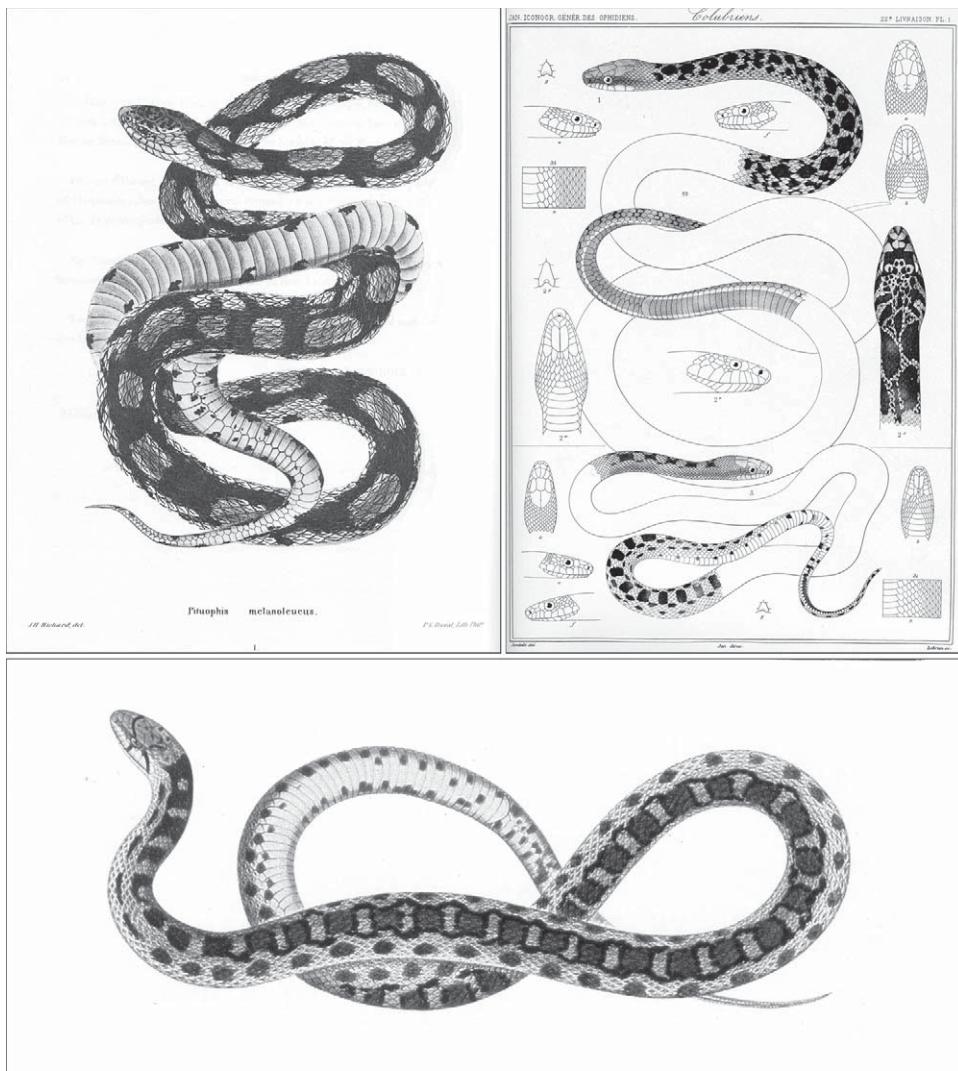
Imprint: Honolulu: Bishop Museum Press, 1991.

Herpetology from A to Z

Three views of the Pine or Bull Snake (*Pituophis melanoleucus* sensu lato) and varieties from the 19th century—*North American Herpetology; or, A Description of the Reptiles Inhabiting the United States*, by John Edwards Holbrook in 1842; *United States Exploring Expedition: during the years 1838, 1839, 1840, 1841, 1842, under the command of Charles Wilkes, U.S.N.; [v. 20]*, by Charles Girard, 1858; *Iconographie générale des ophidiens / par M. le professor Jan . . .[en collaboration avec Mr. F. Sordelli*]. . . , 1860–1881.

In 1964, James A. Peters wrote *Dictionary of Herpetology: A Brief and Meaningful Definition of Words and Terms Used in Herpetology*. Since my memory is not stellar, I used this book constantly until my copy was worn and tattered. Forty-four years later, my recall has certainly not improved but at least I can turn to a new source to refresh and refine my recollection of biological and herpetological terminology—*Dictionary of Herpetology* by Harvey B. Lillywhite (2008, Krieger Publ. Co., Malabar FL; Hardcover, 8.5 x 11, 384 pages; ISBN 1-57524-023-8). Lillywhite's book will be useful for decades: 11,358 readable definitions related to anatomy, physiology, systematics, evolution, and other disciplines in an alphabetical format.

Lillywhite's book contains over three times the number of entries found in the dictionary by Peters. One important element is the inclusion of recent terminology which updates the tools, methods and concepts from a variety of biological disciplines relevant to the study of amphibians and reptiles. Of particular value is the provision of a literature citation(s) accompanying many terms so the reader can go to the original source. For instance, the definition of the word species almost fills an entire page and identifies dozens of titles. In Peters, that word is not listed.

There are three tables: geologic time; International System of units, conversions, constant, and definitions; and metric prefixes and multipliers. This dictionary includes 41 figures to complement the text. Another feature is inclusion of the new taxonomic arrangements proposed in 2006 by Darrel Frost and 18 coauthors—The Amphibian Tree of Life (Bull. Amer. Mus. Nat. Hist. No. 297:1–370).

Some may complain that the list price of US $112.50 is pretty steep but that translates to around 1¢ a word in United States currency. That seems like a pretty good deal to me, especially since the value of the dollar is shrinking.

"TODAY, THE ONLY CHANCE ONE HAS TO SEE A RIM ROCK CROWNED SNAKE IS ON A PUBLIC OR PRIVATE WILDLIFE RESERVE. THE DAYS OF FINDING THIS SPECIES IN A SUBURBAN MIAMI BACKYARD OR UNDER A PIECE OF LIMESTONE AT THE SIDE OF A ROADWAY SPANNING A RURAL ZONE BETWEEN SOUTH FLORIDA TOWNS ARE GONE. ONE DAY SOON THIS WILL BE THE CASE FOR MOST OF THE SPECIES HIGHLIGHTED IN THESE PAGES."

—STEVEN B. REICHLING, 2008

Steven B. Reichling, Curator of Reptiles and Aquarium at the Memphis Zoo and adjunct professor of biology at the University of Mem-

TABLE 1. Chapters in *Biology of the Reptilia* series of particular importance to the zoo biologist. Publishers are Academic Press (AP), Wiley-Interscience (W-I), Alan R. Liss, Inc. (AL), University of Chicago Press (UCP), and Society for Study of Amphibians and Reptiles (SSAR).

Volume	Year	Publisher	Author(s)	Topic
1	1969	AP	Carroll	Origin of Reptiles
			Zangerl	Turtle Shell
2	1970	AP	Parsons	Nose, Jacobson's Organ
			Barrett	Pit Organs
			Gans & Parsons	Taxonomic Literature
3	1970	AP	Dessauer	Blood Chemistry
4	1973	AP	Walker	Locomotor Apparatus of Testudines
5	1976	AP	Gans & Dawson	Physiology
			McDonald	Study of Physiology
			Bennett & Dawson	Metabolism
			Bentley	Osmoregulation
			Dunson	Salt Glands
6	1977	AP	Fox	Urogenital System
7	1977	AP	Pianka	Species Diversity
			Schoener	Competition & the Niche
			Heatwole	Habitat Selection
			Turner	Dynamics of Populations
			Stamps	Social Behavior & Spacing Patterns
			Carpenter & Ferguson	Stereotyped Behavior
			Burghardt	Learning
8	1978	AP	Gans	Venoms
			Kochva	Oral Glands
			Latifi	Production of Anti-Snakebite Serum
9/10	1979	AP	Various Authors	Neurology
11	1981	AP	Various Authors	Musculo-Skeletal System
12	1982	AP	Gans & Pough	Physiological Ecology
			Pough & Gans	Vocabulary of Thermoregulation
			Huey	Temperature, Physiology, Ecology
			Avery	Field Studies of Body Temperatures & Thermoregulation
			Bartholomew	Physiological Control of Body Temperatures
			Firth & Turner	Sensory, Neural & Hormonal Aspects of Thermoregulation
			Tracy	Biophysical Modeling
			Various Authors	Water Relations
13	1982	AP	Seymour	Physiological Adaptations to Aquatic Life
			Gregory	Hibernation
			Bennett	Energetics of Activity
			Duvall et al.	Environmental Control of Reproductive Cycles
			Congdon et al.	Energy Budgets & Life History
			Andrews	Growth
14	1985	W-I	Billet et al.	Development
			Hubert	Origin & Development of Oocytes
			Ewert	Embryology of Turtles
			Miller	Embryology of Marine Turtles
			Ferguson	Reproductive Biology & Embryology of Crocodilians
			Moffet	Reproductive Biology & Embryology of Tuatara
			Maderson	Integument
			Cooper et al.	Immunity
15	1985	W-I	Hubert	Embryology of Squamates
			Darevsky et al.	Parthenogenesis
			Yaron	Placentation & Gestation
			Shine	Viviparity

Table 1. Continued.

Volume	Year	Publisher	Author(s)	Topic
16	1981	AL	Greene	Antipredator Mechanisms
			Pough	Mimicry
			Arnold	Caudal Autonomy
			Dunham et al.	Study of Populations
			Wilbur & Morin	Life History Evolution of Turtles
			Dunham et al.	Life History Patterns in Squamates
			Packard & Packard	Physiological Ecology of Eggs & Embryos
17	1992	UCP	Peterson	Retinal Structure
			Granda & Sisson	Retinal Function in Turtles
			Reperant et al.	Comparative Analysis of Primary Visual System of Reptiles
			Ulinski et al.	Optic Tectum
			Molenaar	Infrared Receptors
			Crowe	Muscle Spindles, Tendon Organs and Joint Receptors
			ten Donkelaar & Bangma	Cerebellum
			Reiner	Neuropeptides in Nervous System
18	1992	UCP	Whittier & Tokarz	Physiological Regulation of Sexual Behavior in Female Reptiles
			Moore & Lindzey	Physiological Regulation of Sexual Behavior in Male Reptiles
			Mason	Reptilian Pheromones
			Underwood	Endogenous Rhythms (circadian and circannual)
			Cooper, Jr. & Greenberg	Coloration of Reptiles
			Halpern	Nasal Chemical Senses in Reptiles: structure and function
19	1998	SSAR	Various Authors	Visceral Organs (pulmonary, cardiovascular, hepatic systems; spleen)

phis in Tennessee, has written a book on the herpetofauna found in the southeastern United States. The book is well written, clearly organized, and filled with excellent photographs but reading through this book was a bittersweet experience. I have traveled periodically to some of these places since I was a child and have watched many of them disappear before my eyes. When I saw the type locality (depicted in plate 7.3 in the book) for the Rim Rock Crowned Snake (*Tantilla oolitica*) strewn with trash and surrounded by buildings and a chain link fence in Miami, it was a reminder of how ravaged the land has become in southern Florida. But enough of this maudlin recollection—most herpetologists can say the same when thinking about changes to their favorite haunts.

Reichling's book—*Reptiles & Amphibians of the Southern Pine Woods* (2008, University Press of Florida, Gainesville, softbound, ISBN 978-0-8130-3250-4)—covers the pine woods from Texas to North Carolina, south to the Gulf of Mexico and north to the Appalachians. Twenty-six species or subspecies are highlighted and each account includes Description, Distribution Notes, Habitat, Ecology and Natural History, Conservation, and a Summary. Twenty-six distribution maps are included. Species are grouped by habitat types: pine woods generalists, flatwoods specialists, savanna specialists, ridge specialists, rockland specialists, and others. In the epilogue, Reichling passionately describes the daunting conservation task ahead: "What happens—or fails to happen—during the next four crucial decades will determine whether the species accounts and habitat descriptions in the preceding pages are still relevant and accurate, or have become an historical record of times and places lost to future generations."

He is well-qualified for writing this book as he has extensive experience with some of the prominent denizens of these forests: the endangered pine snakes of the Gulf Coast. His studies include reproduction in captive Black Pinesnakes, *Pituophis melanoleucus lodingi*; as well as reproductive biology, taxonomic status and its relevance to the evolutionary species concept, and current status of the endangered Louisiana Pinesnake, *P. ruthveni*. He has published the AZA's North American Regional Studbook for both of these taxa. Reichling has published other herpetological papers: dystocia in snakes, habits of the Mangrove Snake in captivity, reproduction in captive Dumeril's Boas, conservation status of the Lesser Antillean Iguana, and phenotypic consequences of incuba-

tion environment on cobra eggs in the African elapid genus *Aspidelaps*. He is also author of a book on tarantulas of Belize.

Biology of the Reptilia

The first volume of the series entitled *Biology of the Reptilia* was published in 1969. The general editor for the entire project was Dr. Carl Gans, now an adjunct professor at the University of Texas at Austin. His plan was to produce a timely and comprehensive series of books dealing with all aspects of reptilian biology; he solicited specialists to prepare chapters reflecting their areas of expertise. Gans invited co-editors versed in morphology, embryology and physiology, or ecology and behavior.

Twenty-one volumes have been published which represent the most complete coverage of these topics ever assembled. These books represent the highest scholarship and are essential for advanced zoo herpetologists who wish to go beyond current husbandry literature in an effort to understand the principles and dynamics of the processes which reflect the complexities of captive reptiles.

The final two text volumes (20, 21), published as a set, are available from SSAR and contain the following chapters: "The Skull of Lizards and Tuatara" by Susan E. Evans; "The Snake Skull" by David Cundall and Frances Irish; "The Appendicular Locomotor Apparatus of *Sphenodon* and Normal-limbed Squamates" by Anthony P. Russell and Aaron M. Bauer; "The Skull of Serpentes" by Samuel B. McDowell; "An Atlas of Amphisbaenian Skull Anatomy" by Carl Gans and Ricardo Montero.

—*James B. Murphy, Section Editor*

The Importance of Herpetological Survey Work in Conserving Malagasy Biodiversity: Are We Doing Enough?

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Madagascar is internationally recognized as being of high biodiversity conservation concern due to high levels of endemism, habitat destruction and predicted extinctions (Brooks et al. 2002; Myers 1988; Myers et al. 2000). The herpetofauna of Madagascar in particular is extremely species-rich and diverse with high levels of endemism (Glaw and Vences 2007).

Conservation strategies are in place to protect this unique biodiversity, including identification of priority areas in Madagascar for threatened or overall species diversity and their inclusion in protected nature reserves (Ganzhorn et al. 1997; ANGAP 2001). In theory these protected nature reserves are an effective means to protect tropical biodiversity (Bruner et al. 2001) and they can be successful at stopping land clearing, and to a lesser degree effective at mitigating logging, hunting, fire, and grazing (Bruner et al. 2001). However, in practice the identification and protection of priority areas globally is constrained by a lack of information regarding the distribution, abundance, and habitat requirements of threatened species and the size, condition, and threats to survival of forest remnants (Smith et al. 1997). This type of baseline information is needed to integrate information relevant to existing conservation and development programs and guide the course of future management strategies (Balmford and Gaston 1999; Kremen et al. 1994; Andreone et al. 2008; Kremen et al. 2008).

Furthermore, the regions in Madagascar where conservation management is most needed are also the regions where biological information is most limited (i.e., primary habitats located within non-protected areas [Andreone et al. 2003; D'Cruze et al. 2006; Kremen et al. 2008]). As a result, decisions affecting biodiversity often have to be taken without all the necessary information (data may be unavailable, incomplete, or unreliable [Funk and Richardson 2002]). This is partly because many surveys, in Madagascar and elsewhere, are conducted over a fairly short period of time, and often within sites that are already been designated as protected areas (e.g., Bildstein 1998; Gaston and Rodrigues 2003; Goodman 1999; Raxworthy and Nussbaum 1994). It is widely accepted that there are major financial, labor, and time-related constraints associated with conducting such work (Bildstein 1998).

Given the necessity for adequate baseline information to conserve this important region of biological endemism, we conducted a literature review of herpetological surveys published for Madagascar. We chose reptiles and amphibians as focal taxa because in Madagascar these vertebrate groups are highly endemic, species-rich, currently under threat, and often serve as excellent indicator species (Raxworthy 1988). We focused on papers published between 1994 and 2007 because prior to 1994 the knowledge of most Malagasy amphibians and reptiles was largely based on the studies of a few herpetologists who often provided comprehensive accounts and revisions (e.g., Blanc, Blommers-Schlosser, Brygoo and Domergue; Glaw and Vences 2007). Since 1994, a new research era has started in Madagascar, stimulated by the publication of a new field guide (Glaw and Vences 1994). Large-scale surveys and species inventories have subsequently been carried out by a new generation of more numerous researchers, operating in a much more collaborative manner, in many areas of Madagascar, including well-known sites and hitherto unexplored remote regions (Glaw and Vences 2007; Vences et al., *in press*).

We undertook this study to: 1) characterize the types of herpetological survey work conducted over the past two decades; 2) use this information to identify any biases in survey work conducted to date to guide future herpetological research initiatives; and 3) highlight any weaknesses so as to provide potential solutions to limiting factors which might be inhibiting such work.

METHODS

Literature Review.—We conducted a literature review of peer-reviewed scientific journals to compile a comprehensive list of herpetological survey-based published manuscripts. This type of information can be embedded in manuscripts focused on ultimate function (i.e., "why" something happens [Timbergen 1963]) making the data difficult to identify. Therefore, we specifically searched for manuscripts that included a detailed species inventory or list. However, any attempt to document survey/inventory-based manuscripts will have a degree of subjectivity involved (McCallum and McCallum 2006), and this study is no different. Still we made every effort to accurately portray what is and what is not a survey-based manuscript and to take the most inclusionary and liberal approach possible to classify manuscripts.

Following the completion of this review we subjected tabulated data to simple regression analysis using Systat statistical software (version 10.0, Systat Software Inc., San Jose, California, USA). We analyzed publications to reveal the number of papers published per year over the selected study period. We chose to ignore the duration of each survey as we were unable to determine the number of staff actively participating during fieldwork and ensure an unbiased comparison. In addition, we assembled a data set that included the protective status and dominant vegetation types of each survey site (we designated four categories for the purpose of this study: rainforest, dry deciduous forest, savanna, and spiny forest). We also tabulated various aspects of the survey methodology, including focal taxa, season, and capture methods used. Finally, when possible we recorded the primary funding source as listed in the acknowledgments section of each manuscript.

We found 37 herpetological survey-based published manuscripts (Table 1), based on surveys conducted in 31 different locations by 19 different primary authors. Five of these primary authors (26%) are Malagasy nationals. The remaining 14 (74%) are non-Malagasy nationals. Twelve (32%) of these 37 publications included Malagasy nationals as either a primary or co-author. Between 1994 and 2007 the number of survey-based manuscripts varied between 1 and 5 publications per year, with an average of 2.6. Linear trends analysis revealed that the number of survey-focused manuscripts published per year has remained relatively constant ($R^2 = 0.01$, P = 0.738) (Fig. 1).

Protected areas have been subject to more survey effort than unprotected areas (Table 1), as 22 surveys (59%) were conducted in areas currently awarded full protection (Strict Nature Reserve 3%, Special Reserve 8% and National Park 49%; Table 2). The remaining 15 sites (41%) are currently unprotected or have only been recently awarded Temporary Protected Status (Unprotected 38%, Temporary Protected Area 3%). However, it is important to note that despite this preference for protected areas only 17 of the 49 (35%) fully protected areas in Madagascar have been subject to published herpetological survey work.

The different vegetation types in Madagascar have also not been subject to equal survey effort (Table 1), as 26 (70%) of these 37 studies involved survey work in rainforest habitat, 13 (35%) involved survey work in dry deciduous habitat, 4 (11%) involved survey work in spiny forest habitat and one (3%) involved survey work in savanna habitat. With regards to focus taxa, we found that 32 publications (86%) focused on both reptiles and amphibians, three (8%) focused just on amphibians, and two (6%) focused solely on reptiles.

We also extracted information from our literature review regarding the seasonal aspect of each survey. We classified surveys as 1) dry season (May–October); 2) wet season (November–April); or 3) wet and dry (some field work conducted during both of the aforementioned periods). Seventeen (46%) of these 37 surveys involved field work conducted in the wet and dry season. Of the remaining surveys, 15 (41%) only involved field work conducted in the wet season, two (5%) only involved field work conducted in the dry season and three (8%) provided no information.

We also extracted information on the survey techniques used in each survey. Active searching was utilized in all of the surveys, while pitfall trapping was used in 29 (78%) to capture specimens. We were able to glean information regarding funding (from the acknowledgment sections) from 22 of the 37 manuscripts. All but three studies involved some form of research grant from a scientific or industrial benefactor, and five studies used volunteers in some capacity during field work.

DISCUSSION

Herpetological survey work trends in Madagascar.—A prior analysis of a list of almost 1400 publications focused on Malagasy amphibians and reptiles revealed a clear trend of increasing research intensity from the year 1838 until the present day with maximum levels reached for the periods of 1990–1999 and 2000–2009 (Vences et al., *in press*). In contrast, we found that the number of published manuscripts focused on herpetological survey work appear to have remained relatively constant during
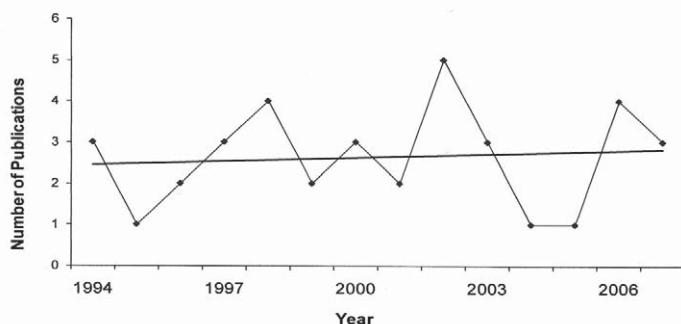

FIG. 1 Publication of herpetological survey-based manuscripts 1994–2007. Points are observed values and the line represents the trend.

the period 1994–2007. Initially, one might assume that a similar marked increase in this particular type of scientific research has not occurred as it is not required. For example, it may be that already there is sufficient information available in the existing literature (detailing the composition, geographical, ecological, and seasonal distribution of the herpetofauna in Madagascar) and that the majority of these surveys are monitoring efforts conducted to observe changes in population dynamics or community structure. However, unfortunately this is not the case and this is exemplified by the number of new species which continue to be described each year (Glaw and Vences 2007; Vences et al., *in press*) and by the fact that our study shows that the existing data currently available as a result of herpetological survey work is far from comprehensive. We estimate that it will take approximately another 20 years before even a preliminary herpetological species list is available for all of the current protected areas in Madagascar.

It is important to note that this observed trend might not be a direct reflection of the amount of field work that has actually being conducted over this time period. It is more than likely that researchers have been gathering these sorts of data without publishing their findings in a peer-reviewed format (Vences et al., *in press*). Either way, despite their recognized value (Greene and Losos 1988; Greene 1994, 2005), we suspect that the number of peer-reviewed survey-based studies published over this period might have been restricted because of the strong natural history component which is present in this type of manuscript (studies have indicated that the publication frequency of natural history studies has gradually declined over recent decades [Bury 2006; McCallum and McCallum 2006]). Explanations for these kinds of restrictions are complex but might be related to the fact that conservation and science are driven by different agendas (a lot of conservation science published in respectable journals will be of little use to practical conservation, while much good conservation practice would never get into a scientific journal). Peer-reviewed journal editorial strategies are driven by scientific agendas which are often subject to fads and fashions (R. Griffiths, pers. comm.). Therefore, factors affecting the publication trends of survey-based manuscripts will include less grant funding, editorial decisions, additional competition from other journals, and the rise of molecular and genetic studies (McCallum and McCallum 2006).

Unequal sampling effort.—In their prior analysis of a list of almost 1400 publications Vences et al. (*in press*) found that research on Malagasy amphibians has been less intensive as compared to reptiles. In contrast, we found that the majority of survey-based

TABLE 1. Details of the herpetological survey-based manuscripts found during this study. Habitat abbreviations: RF = rainforest, DF = dry decidu-ous forest, SP = spiny forest, SV = savanna.

Number	Authors	Publication Date	Survey Location	Protective Status	Survey Habitat Type
1	Andreone	1994	Ranomafana	National Park	RF
2	Raxworthy & Nussbaum	1994	Montagne d'Ambre	National Park	RF, DF
3	Raxworthy et al.	1994	Zombitse	National Park	DF
4	Emanueli & Jesu	1995	Tsingy de Bemaraha	National Park	DF
5	Bloxam et al.	1996	Kirindy Forest	National Park	DF
6	Raxworthy & Nussbaum	1996	Andringitra	National Park	RF
7	Andreone & Randriamahazo	1997	Andohahela	National Park	RF
8	Schimmenti & Jesu	1997	Tsingy de Bemaraha	National Park	DF
9	Langrand & Goodman	1997	Isoky-Vohimena	National Park	DF
10	Raxworthy et al.	1998	Anjanaharibe-Sud	Special Reserve	RF
11	Goodman et al.	1998	Ambositra	Unprotected Area	RF
12	Raselimanana	1998	Andranomay Anjozorobe	Unprotected Area	RF
13	Rasilamanana et al.	1998	Tampolo	Unprotected Area	RF
14	Nussbaum et al.	1999	Andohahela	National Park	RF, SP
15	Raselimanana	1999	Ivohibe/Andringitra	Special Reserve/National Park	RF
16	Andreone et al.	2000	Ambolokopatrika	Unprotected Area	RF
17	Raselimanana et al.	2000	Marojejy	National Park	RF
18	Vallan	2000	Ambohitantely	Special Reserve	RF
19	Andreone et al.	2001	Berara Forest	Unprotected Area	RF, DF
20	Rakatomalala et al.	2001	Ranomafana/Andringitra	National Park	RF
21	Rakotomalala	2002	Manongarivo	Special Reserve	RF
22	Ramanamanjato & Rabibisoa	2002	Ankarafantsika	National Park	DF
23	Vences et al.	2002	Ankaratra	Unprotected Area	RF
24	Ramanamanjato et al.	2002	Malahelo Forest	Unprotected Area	RF, SP
25	Goodman et al.	2002	Tsimanampetsotsa	National Park	SP
26	Andreone et al.	2003	Nosy Be	Strict Nature Reserve	RF
27	Glos	2003	Kirindy Forest	National Park	DF
28	Lehtinen et al.	2003	Mandena & Sainte Luce	Unprotected Area	RF
29	Vallan et al.	2004	An'Ala	Unprotected Area	RF
30	D'Cruze & Sabel	2005	Ranobe	Unprotected Area	SP
31	D'Cruze et al.	2006	Manondro	Unprotected Area	DF
32	Mori & Ikeuchi	2006	Ankarafantsika	National Park	DF
33	Rakotondravony	2006	Daraina	Unprotected Area	RF, DF
34	Lehtinen & Ramanamanjato	2006	Mandena & Sainte Luce	Unprotected Area	RF
35	Andreone et al.	2007	Antoetra	Unprotected Area	RF, SV
36	Bora et al.	2007	Befotaka-Midongy	National Park	RF
37	D'Cruze et al.	2007	Montagne des Francais	Temporary Protected Area	RF, DF

manuscripts published over the last 14 years (86%) provide infor-mation for both reptiles and amphibians. This is more than likely because traditional survey techniques used to target either reptiles or amphibians (e.g., visual encounter surveys [Campbell and Christman 1982] and pitfall trapping [Raxworthy and Nussbaum 1994]) typically result in the capture of species belonging to both of these vertebrate groups (Raxworthy 1988).

However, it appears that this survey work has not been so equally distributed throughout Madagascar with regards to the protective status of study areas. For example, we found that the majority of published survey work has been conducted in protected areas. This is understandable as only 35% of protected areas have been surveyed and this information is needed to manage them correctly. However, this means that the designation of future protected areas is greatly compromised. Furthermore, at least from a herpetologi-cal point of view, our study confirms prior claims that there have been lower conservation efforts in the dry deciduous forests, spiny forest and savanna areas of Madagascar when compared to those undertaken in Madagascar's evergreen rainforest (Ganzhorn et al. 2001). Explanations for this type of site bias are difficult to qualify;

TABLE 2. Details of the current ANGAP protected areas and related herpetological survey effort.

Province	Number of Surveys Conducted in non-ANGAP Protected Areas	Number of Surveys Conducted in ANGAP Protected Areas	Number of ANGAP Protected Areas	% ANGAP Protected Areas Surveyed
Toamasina	2	0	9	0
Mahajanga	0	4	12	17
Fianarantsoa	2	4	7	43
Antsiranana	5	5	10	50
Toliara	4	8	10	60
Antananarivo	2	1	1	100
Madagascar	15	22	49	35

however, this might be because these rainforest sites are more accessible, because more preliminary research has been conducted in this type of habitat or because the majority of protected areas are composed of rainforest habitat. Additionally this may be because of the perceived greater biological richness of this habitat type or because this type of habitat is not characterized by such pronounced seasonal variation (meaning that researchers do not have to worry about associated decreases in herpetological activity). Finally, it is also important to note that the relative area for each of the habitat types is different and might also be an influencing factor that is partly responsible for this observation.

Addressing the limitations of current survey work.—One important first step to address this situation would be to encourage and facilitate the further participation of Malagasy researchers. For a long time the participation of Malagasy researchers in the exploration work and publications of Madagascar's flora and fauna remained marginal, largely reflecting colonial history (Vences et al., *in press*). Although it has now been recognized Malagasy scientists can (and have in recent decades) strongly contribute to advancing the knowledge on Madagascar's biota (there is an increasing trend in the participation of Malagasy researchers in the process of publishing research results [Vences et al., *in press*]), we found that only 33% of the survey-based manuscripts published in the last 14 years included Malagasy researchers as either primary or co-author. In a similar study, researchers also found that more than 80% of all studies on Malagasy amphibians are published without the participation of Malagasy researchers (Vences et al., *in press*).

Another key step that could be made to address this situation would be to foster the participation of non-specialist, self-funded volunteer researchers (hereafter referred to as volunteers). Volunteers have been seen as a viable option by host countries with financial, labor, or training constraints (Mumby et al. 1995) which is apparent from their increasing contribution to conservation biology and wildlife management over the past 20 years (e.g., Bildstein 1998; Easa et al. 1997; Fore et al. 2001; Foster-Smith and Evans 2003; Gill 1994; Newman et al. 2003). However, our study indicates that over the last 14 years in Madagascar only four studies (Andreone et al. 2003; D'Cruze et al. 2005; D'Cruze et al. 2007; Raxworthy and Nussbaum 1994) utilized volunteers and only two of these (D'Cruze et al. 2005; D'Cruze et al. 2007) were solely reliant on them as a source of funding. We suggest that the under-utilization of volunteers in Madagascar is due to the fact that their use in scientific research is often criticized. A major problem

is that data that they generate are considered unreliable both because many volunteers lack a high level of biological knowledge and training, and due to inconsistencies through the use of many different observers (Bildstein 1998; Darwall and Dulvy 1996). Another worry relating to the use of volunteers is that they may be seen as a solution to the issue of under-funding, leading to further reductions in research funds.

In our opinion both of these groups should be viewed as key collaborators that have the potential to help in addressing the financial, labor, and time-related constraints associated with conducting modern survey work. We highly recommend that researchers should seek to increase collaboration and initiate capacity-building exercises to ensure the systematic collection of reliable and comparable data. This should include the collation of digital photos, morphological data, molecular tissue samples, call recordings, specimens, and associated ecological data.

Making survey data accessible.—The accessibility of data generated by modern survey work is also of fundamental importance. For example, it is possible that survey-based studies resulting in peer-reviewed manuscripts might have limited utility for practical conservation because a) many conservation practitioners do not have access to peer-reviewed manuscripts, and b) unpublished (i.e., "grey literature") reports might be more accessible to those who need to utilize these data (e.g., park management authorities). However, at the same time, because grey literature reports have typically not been subject to peer review their scientific and technical accuracy can be brought into question, and they are not always accessible to other external stakeholders (e.g., international NGOs).

A general change in the way that survey data are distributed might be required to ensure that data are made available to relevant stakeholders. To achieve this, several researchers (Rhee 2004; Vences et al., *in press*) have proposed to make data available through appropriate cyber structure and an electronically connected network of knowledge. Specifically, they propose that data should be published electronically and made instantly available on a seamless connection of community databases, public repositories, and journals. As a result, the data collected during herpetological survey work would no longer remain isolated in specialized papers and grey reports. The Réseau de la Biodiversité de Madagascar (REBIOMA) project (which aims to make validated, up-to-date biodiversity data available for conservation planning in Madagascar and to provide conservation tools and map products to facilitate identification of conservation priorities)

TABLE 3. Additional details of the herpetological survey-based manuscripts found during this study. Abbreviations: Focal Species A = amphibian, R = reptile; Survey Techniques AS = active searching, PT = pitfall trapping.

Number	Authors	Focal Species	Survey Season	Survey Technique	Funding Source
1	Andreone 1994	A & R	Wet & Dry	AS & PT	Research Grant
2	Raxworthy & Nussbaum 1994	A & R	Wet	AS & PT	Research Grant & Volunteers
3	Raxworthy et al. 1994	A & R	Wet	AS & PT	?
4	Emanueli & Jesu 1995	A & R	Wet	AS	?
5	Bloxam et al. 1996	R	Wet	AS	Research Grant
6	Raxworthy & Nussbaum 1996	A & R	Wet & Dry	AS & PT	Research Grant
7	Andreone & Randriamahazo 1997	A & R	Wet & Dry	AS & PT	Research Grant
8	Schimmenti & Jesu 1997	R	Wet	AS & PT	?
9	Langrand & Goodman 1997	A & R	Wet	AS & PT	?
10	Raxworthy et al. 1998	A & R	Wet & Dry	AS & PT	?
11	Goodman et al. 1998	A & R	Wet	AS & PT	?
12	Raselimanana 1998	A & R	Wet	AS & PT	?
13	Rasilamanana et al. 1998	A & R	Wet	AS & PT	?
14	Nussbaum et al. 1999	A & R	Wet & Dry	AS & PT	Research Grant
15	Raselimanana 1999	A & R	Wet	AS & PT	?
16	Andreone et al. 2000	A & R	Wet & Dry	AS & PT	Research Grant
17	Raselimanana et al. 2000	A & R	Wet & Dry	AS & PT	Research Grant
18	Vallan 2000	A	Wet	AS	Research Grant
19	Andreone et al. 2001	A & R	Wet	AS & PT	?
20	Rakatomalala et al. 2001	A & R	Wet & Dry	AS & PT	?
21	Rakotomalala 2002	A & R	Wet	AS & PT	?
22	Ramanamanjato & Rabibisoa 2002	A & R	?	AS & PT	?
23	Vences et al. 2002	A & R	?	AS	?
24	Ramanamanjato et al. 2002	A & R	Wet	AS & PT	Research Grant
25	Goodman et al. 2002	A & R	?	AS & PT	?
26	Andreone et al. 2003	A & R	Wet & Dry	AS & PT	Research Grant & Volunteers
27	Glos 2003	A	Wet & Dry	AS	Research Grant
28	Lehtinen et al. 2003	A & R	Wet & Dry	AS	Research Grant
29	"Vallan et al., 2004"	A	Wet	AS	Research Grant
30	D'Cruze & Sabel 2005	A & R	Wet & Dry	AS & PT	Volunteers
31	D'Cruze et al. 2006	A & R	Dry	AS & PT	Volunteers
32	Mori & Ikeuchi 2006	A & R	Wet & Dry	AS & PT	Research Grant
33	Rakotondravony 2006	A & R	Wet & Dry	AS	Research Grant
34	Lehtinen & Ramanamanjato 2006	A & R	Wet & Dry	AS & PT	Research Grant
35	Andreone et al. 2007	A & R	Wet & Dry	AS & PT	Research Grant
36	Bora et al. 2007	A & R	Dry	AS & PT	Research Grant
37	D'Cruze et al. 2007	A & R	Wet & Dry	AS & PT	Volunteers

could serve as the "embryo" for such an online resource. Progress towards this vision will require a high degree of collaborative effort. However, it appears that research on Malagasy amphibians is already a collaborative endeavor (exemplified by the increasing number of authors and nationalities involved in the publication of such papers [Vences et al., *in press*]) and therefore this is a feasible potential future strategy.

CONCLUSION

It appears that time, personnel, and financial resources have limited the amount of herpetologically-focused survey work con-ducted in Madagascar, which unlike other fields of herpetological biology, such as taxonomy, has remained relatively constant over the past two decades. The rapid and increasing rates of habitat loss make protective management and reserve selection in Madagascar an urgent task. Therefore, we recommend that more surveys should be conducted in Madagascar (both in protected and unprotected areas) and that researchers should look to work in habitat types that have been traditionally overlooked. Research programs should increase collaboration with Malagasy research-ers and self-funded volunteers, as both groups provide the means by which comprehensive data sets can be collected and both can

effectively contribute to long-term surveys. We also support the increasingly collaborative nature of research on Malagasy herpetofauna by utilizing approaches that speed up data availability via appropriate cyber infrastructure.

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Eyes Bigger than Stomach: Prey Caching and Retrieval in the Saltwater Crocodile, *Crocodylus porosus*

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Some animals store surplus food for later consumption (reviewed in Smith and Reichman, 1984; Vander Wall, 1990). For example, herbivores such as squirrels cache nuts for consumption during winter when food is less abundant (Smith and Follmer 1972). Long-term caching is possible for carnivores in cold climates, but predators can cache prey for several days in any climate. For example, leopards cache prey in trees to reduce competition from other scavengers (Kruuk 1972). Prey caching in carnivores is known for felids, hyenas, canids, bears, mustelids, shrews, birds of prey, and seals (Ingram 1942; Kim et al. 2005; Kruuk, 1972; McCord 1974; Michener 2000; Oksanen 1983; Phillips et al. 1990; Schaefer et al. 2007; Smith and Reichman 1984). The general explanation for this behavior is that a predator caches when its prey is too large to consume in one feeding bout (Smith and Reichman 1984), although surplus killing of smaller prey may also occur when predators are already satiated (Kruuk 1972; Oksanen et al. 1985).

Crocodilians are capable of killing prey much larger than their stomachs, and Webb and Manolis (1989) report that Saltwater Crocodiles (*Crocodylus porosus*) cache their recent kills underwater or in mangroves. *Crocodylus porosus* is a large crocodilian inhabiting rivers, estuaries, and swamps from northern Australia through to southeast Asia and eastern India (Webb and Manolis 1989). Like other crocodiles it is a generalist carnivore, feeding on a variety of invertebrates, fish, amphibians, reptiles, birds, and mammals (Taylor 1979; Webb and Manolis 1989; Webb et al. 1991). Larger individuals are known to capture medium to large terrestrial prey such as wallabies, cattle, and water buffalo (Doody et al. 2007; Pye 1976; Shield 1994; Webb and Manolis 1989).

Crocodylus porosus is relatively common in the Daly River, Northern Territory, Australia, where in recent years we have studied anti-predator behavior in Agile Wallabies, *Macropus agilis*, in response to the threat of crocodile predation (Doody et al. 2007; Steer 2007). During the dry seasons (May–October) of 2001–2007 my colleagues and I made a number of observations of prey caching by crocodiles in freshwater reaches between Oolloo Crossing (14.005ºS, 131.2402778°E) and Daly River Township (13.7747222°S, 130.7211111°E). We located crocodile kills via boat. Our evidence for kills was generally indirect or circumstantial (e.g., wallabies with missing heads or limbs, or with obvious crocodile bite marks). These kills were considered to be caches when there was evidence of manipulation by crocodiles (e.g., carcasses placed above water on snags, or on riverbanks

with associated crocodile tracks). Cache retrieval was documented opportunistically using remote camera systems. I used Trailmaster® camera systems, which consist of an infrared emitter box, a receiver with LED, and a 35mm camera. The system was employed such that a crocodile retrieving a carcass would break the infrared beam, triggering the camera mounted above. Herein, I summarize the findings and discuss a previously unpublished behavior in crocodiles—above-water prey caching. I also report a possible case of surplus killing in *C. porosus* associated with prey caching.

Thirty-eight prey caches of *C. porosus* were discovered during 2001–2007, including mammals, reptiles, a fish, and a bird (Table 1). The most common prey item cached was the Agile Wallaby (*Macropus agilis*), for which 28 carcasses were found. Individuals were usually found floating, either at the river's edge or lodged on woody snags, but in eight instances wallabies were dragged onto the riverbank (Fig. 1). For example, in 2001 an adult female wallaby carcass was found 5 m up a steep sand bank and footprints and marks in the sand revealed that the carcass had been dragged there by a large (~3 m) crocodile. I employed a camera system just below the carcass in an attempt to photograph the crocodile returning, but the carcass was dragged further up the slope by unknown predators, possibly dingos. However, in the same year, a camera system did reveal a ~3 m crocodile returning for a wallaby cache (Fig. 1). The carcass was found the previous day at the river's edge with puncture wounds to the neck and head, and I employed a camera trap that afternoon. The crocodile retrieved the carcass at 0440 h the following morning (Fig. 1).

Two days later I discovered the carcass of a Northern Quoll (*Dasyurus hallicatus*) on a nearby vegetated riverbank, 2 m from the river. Crocodile tracks in the sand suggested that a ~3 m crocodile had cached the quoll. I employed a camera system that afternoon, and a crocodile retrieved the carcass at 0537 h the next morning (Fig. 2). Interestingly, the quoll was found < 100 m from where the abovementioned wallaby had been killed, cached, and retrieved, suggesting that the same crocodile was responsible for both kills. This could explain why such a small prey item was cached rather than immediately consumed.

Other mammals found cached were Water Buffalo (*Bubalus bubalis*), one of which was found floating but lodged against a snag, with obvious 'towing' teeth marks at the base of the tail, and a feral pig, in which a front quarter was lodged on a snag just above water. Reptile caches found were snakes and turtles (Table 1). A Pig-nosed Turtle (*Carettochelys insculpta*) cache with crocodile teeth marks was located on a snag just above the water. A Black-headed Python (*Aspidites melanocephalus*) was cached on a riverbank next to tracks of a ~2.5 m crocodile (the carcass was gone the next day). A an adult Water Python (*Liasis fuscus*) carcass with crocodile teeth puncture marks was also found cached on a snag in water (Fig. 2; D. Steer, pers. comm.). The snake was gone the next day. A Freshwater Crocodile (*Crocodylus johnstoni*) was found cached on a snag in water. The carcass had clear crocodile bite marks on its body and was attended by a 2.5 m *C. porosus*. The next day the carcass was half its previous size, missing the head and two limbs. The single fish cache was a ~1 m long Bull Shark (*Carcharhinus leucas*) found on a riverbank in 2001. A 4.5 m crocodile was observed several times at this exact location, which was a flat, muddy area with abundant cover provided by a fallen tree. The single bird cache was a Great-billed Heron (*Ardea*

sumatrana) found on a riverbank and attended by a 4 m crocodile in 2006. The crocodile was sighted at the same location the next day, but the cache was gone.

Prey caching by carnivores often occurs when predators kill prey too large to consume in one feeding bout (McDonald 1976; Smith and Reichman 1984). For example, Bobcats (*Lynx rufus*) cache White-tailed Deer (*Odocoileus virginianus*) and return to the carcass for further feeding (Labisky and Boulay 1998; McCord 1974). Similarly, *C. porosus* apparently cached and recovered a wallaby and a quoll (Fig. 1). It is important to distinguish between caching a carcass vs. simply returning to a carcass to feed. Although in a few cases floating carcasses could have lodged themselves against snags, many were clearly placed above, or partly above water (Table 1; Fig. 1; Fig. 2). Thus, at least some *C. porosus* kills were manipulated, presumably to facilitate further feeding and reduce the probability of competition. It is likely that other crocodilian species cache their food, especially large species and those known to capture prey too large to consume in one feeding

TABLE 1. Prey caches of *Crocodylus porosus* discovered on the Daly River, Northern Territory, Australia, during the dry season.

Prey item	N	Location
Agile Wallaby (*Macropus agilis*)	28	water (20), riverbank (8)
Feral Water Buffalo (*Bubalus bubalis*)	2	against snag in water
Feral Pig (*Sus scrofa*)	1	snag just above water
Northern Quoll (*Dasyurus hallicatus*)	1	riverbank
Black-headed Python (*Aspidites melanocephalus*)	1	riverbank
Water Python (*Liasis fuscus*)	1	snag in water
Pig-nosed Turtle (*Carettochelys insculpta*)	1	snag just above water
Freshwater Crocodile (*Crocodylus johnstoni*)	1	snag in water
Bull Shark (*Carcharhinus leucas*)	1	riverbank
Great-billed Heron (*Ardea sumatrana*)	1	riverbank

bout. I could find no published reports of prey caching in crocodiles other than the report by Webb and Manolis (1989) that *C. porosus* will cache prey underwater or in mangroves. However, there have been a number of unpublished observations of individual *C. porosus* attending their kills. For example, in 2002 a *C. porosus* killed a tourist in a billabong in northern Australia, and authorities discovered the body later that night ~2 km from the attack site with the crocodile in attendance (C. Manolis, pers. comm.). In addition
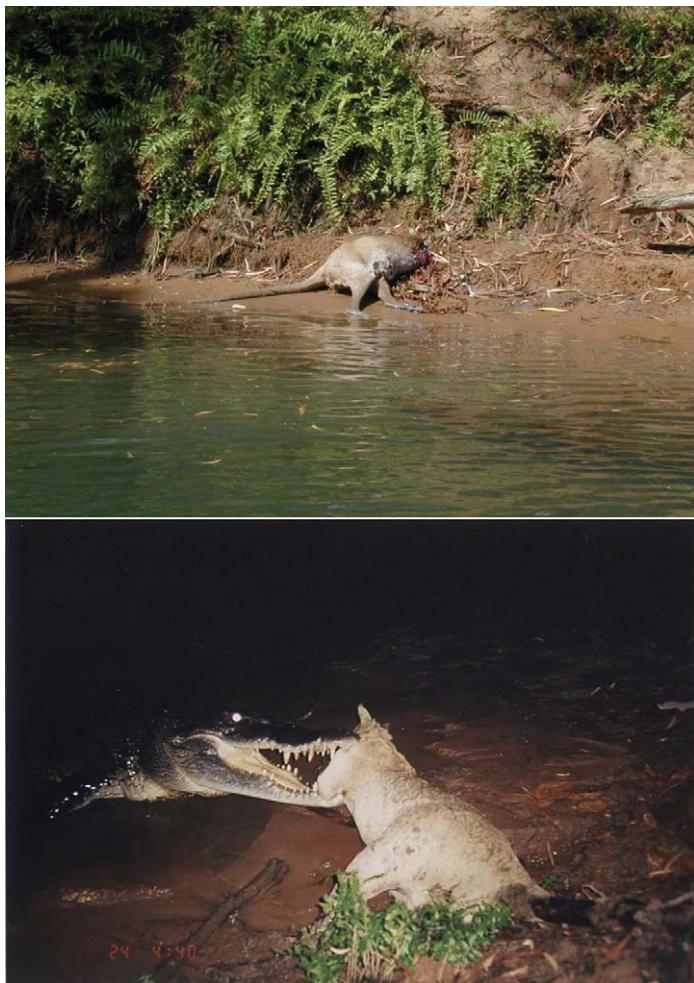
FIG. 1. Agile Wallabies (*Macropus agilis*) cached by Saltwater Crocodiles (*Crocodylus porosus*). Top: A headless wallaby carcass cached on the riverbank. Bottom: Wallaby cache retrieved by a crocodile.

FIG. 2. Top: A Northern Quoll (*Dasyurus hallicatus*) cached on a riverbank is retrieved by a crocodile. Bottom: A Water Python (*Liasis fuscus*) cached on a snag in water by a crocodile. Note the puncture marks inflicted by the crocodile.

to those reported in Table 1, numerous additional wallabies were found floating down the river, of which most showed signs of crocodile attacks, including missing heads, front limbs, or injuries to the head and neck (see also Doody et al. 2007). In an unrecorded number of instances the carcasses were attended by a crocodile. I could not accurately determine the proportion of caches with a crocodile in attendance because our approach via motorboat often caused the crocodiles to submerge before being sighted (pers. obs.). However, in three cases we observed crocodiles towing wallaby carcasses across the river, although these particular carcasses were not known to be cached. There is currently no evidence that crocodiles defend their caches against scavengers, but this occurs in other carnivores known to cache (Smith and Reichman 1984).

Prey caching is sometimes associated with 'surplus killing', whereby a satiated predator makes another kill (DelGuidice 1998; Kruuk, 1972; Oksanen et al. 1985). In this case prey size is not necessarily important, but recent feeding leads to 'killing on a full stomach'. This appears to be the case with my observations of the quoll cache. This kill was unlikely to be too large for the crocodile to consume (Fig. 1), but the crocodile had apparently taken a wallaby two nights before the cache was found (pers. obs.).

Above-water caching has not been reported for crocodiles, but 12 of the 38 caches I found were above water (Table 1). Why cache above water, when more effort would generally be required to cache there? Smith and Reichman (1984) contend that the defensibility of the cache should be the primary consideration in the decision of where to cache, and some carnivores are known to defend their caches (e.g., Kim et al. 2005). Crocodiles may have learned to cache above water to avoid losing carcasses that are stolen, eaten, or incidentally dislodged by scavengers. We frequently found wallaby carcasses floating down the river that were previously attached to snags, or floating but lodged against the riverbank. These carcasses were apparently dislodged by other scavengers—most wallaby carcasses we observed were accompanied by scavenging pig-nosed turtles (pers. obs.), and water levels do not fluctuate during the dry season. The smaller, freshwater crocodiles were also attracted to the carcass, as were other *C. porosus* (pers. obs.). However, above-water caches are also scavenged. I have observed scavenging of above-water caches by monitor lizards (*Varanus panoptes*), Sea Eagles (*Haliaeetus luecogaster*), Wedge-tailed Eagles (*Aquila audax*), Whistling Kites (*Haliastur sphenurus*), Black Kites (*Milvus migrans*), and Grey Goshawks (*Accipiter novaehollandiae*). The diverse suite of scavengers at a site may influence a crocodile's decision of whether to cache prey in, or above water.

It is not surprising that Agile Wallabies were the most common prey cached by crocodiles. The species is abundant in the area, and thrives in nearby paddocks and open savannah. During the dry season free water is restricted to the river and a few permanent billabongs, bringing wallabies into contact with predatory crocodiles (Doody et al. 2007). Drinking wallabies exhibit a number of anti-predator behaviors, including increased apprehension and the excavation of drinking holes in the sand just out of reach of crocodiles (Doody et al. 2007; Steer 2007). There are a few anecdotal reports of wallabies or kangaroos falling prey to *C. porosus* (Pye 1976; Shield 1994). Those findings, combined with the present observations, indicate that agile wallabies are a significant prey item for *C. porosus*, at least during the dry season

on the Daly River.

In summary, observations herein of crocodiles retrieving carcasses, combined with evidence that the prey were initially killed by crocodiles and manipulated thereafter, offer strong indirect evidence for prey caching in *C. porosus*. Although it is possible that these prey were killed by one crocodile and retrieved by another, in some instances the carcasses showed clear signs of being cached there by a crocodile. Caches are sometimes attended, but cache defense is unknown. I agree with Webb and Manolis (1989) that the commonly evoked idea that prey is cached because crocodiles prefer decomposed flesh over fresh kills is an unlikely explanation (see also Shield 1994). Indeed, predators may prefer fresh kills; some caching predators exhibit behaviors that may inhibit microbial action, such as burying, drying, and covering with 'antiseptic' sphagnum (Michener 2000; reviewed in Smith and Reichman 1984). It is more likely that large prey are cached due to constraints imposed by stomach size in the predator (about the size of a soccer ball in an adult *C. porosus*; Webb and Manolis 1989). However, evidence of latency to cache retrieval relative to decomposition rates is needed to determine why crocodiles cache their prey. Further research is also required on the potential defense of caches, their relative importance to energy uptake, and the relative costs to caching above water vs. in the water by *C. porosus*. Data from other crocodilians are also needed to evaluate the generality of the behavior in this group.

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Movement and Habitat Use of the Endangered Australian Frog *Nyctimystes dayi*

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The Australian Lacelid, *Nyctimystes dayi*, is an endangered, stream-breeding hylid frog endemic to rainforests in the wet tropics of northeastern Queensland, Australia. During the 1990s, populations of *N. dayi* declined dramatically, with the species disappearing from all upland (>300 m) areas, where they were once common (Richards et al. 1993; Northern Queensland Threatened Frogs Recovery Team 2001; Trenerry et al. 1994). The proximate cause of these population declines and disappearances was the amphibian disease chytridiomycosis (Berger et al. 1998). This disease had similar effects on several other species sympatric with *N. dayi* (Berger et al. 1998). Habitat modification and fragmentation are also potential stressors for *N. dayi* populations, since approximately 20% of the wet tropics region has been clear cut since 1880 (Winter et al. 1987), and smaller-scale clearing still occurs in non-protected areas (e.g., for pastures, human settlement and associated infrastructure; Department of Natural Resources and Water 2007).

In order to make informed management decisions aimed at species conservation, it is necessary to have species-specific information on movement and habitat use, information that is lacking for the vast majority of amphibians (Johnson et al. 2007; Semlitsch and Bodie 2003; Trenham and Shaffer 2005). This is especially true for stream-breeding species such as *N. dayi*.

The study of *N. dayi* in the field has been hampered by several factors. First, the species is cryptic in both appearance and behaviour, and inhabits complex, densely vegetated habitats. Only males calling along streams in the breeding season are readily detectable. Second, males weigh less than 4 g, making them too small to track remotely using either radio-telemetry or harmonic direction finding (see Rowley and Alford 2007a), and females are rarely encountered (Czechura 1987; Hodgkison and Hero 2002), with male *N. dayi* 24 times more common than females along stream transects (Czechura 1987). As a result, the only information available on the ecology and habitat use of *N. dayi* is on males, and is derived from nocturnal surveys along streams or in riparian vegetation within 10 m of the stream (Czechura 1987; Hodgkison and Hero 2002).

Our objective was to track to track *N. dayi* females in the field, obtaining information on their movement and habitat use. The study was conducted at Tully Falls Forest Reserve (145.68ºE, 17.80ºS; 70 m elev.), in northern Queensland, Australia. Individuals were initially captured along a low-gradient stream containing pools, riffles, and a number of waterfalls. The stream was surrounded by relatively undisturbed rainforest vegetation, except for a sealed, two-lane road, which crosses the stream via a bridge approximately 20 m above the stream bed.

The study was conducted during the warm/wet season from 22 February to 8 March 2005 and the cool/dry season from 25 August to 8 September 2005. Tracking methodology followed that of Rowley and Alford (2007b). Each frog was captured by hand, weighed, fitted with radio transmitters (model BD-2NT; Holohil Systems Ltd., Ontario, Canada; weighing ca. 0.67 g including silicone tubing harness) *in situ* and released at point of capture within five minutes. Frogs did not carry more than 6% of their total body weight (the recommended maximum relative weight for an attached tag is 10% of the body weight; Richards et al. 1994). We tracked each frog using a HABIT Research HR2500 Osprey VHF Receiver (HABIT Research, Victoria, B.C., Canada), fitted with a three-element folding Yagi antenna (A.F. Antronics, Urbana, Illinois, USA).

The location of each frog was determined during two surveys per 24-h period, once during the day (0700–1900 h) and once at night (1900–0700 h) over the duration of the study. We established a marked transect along the stream edge to serve as a reference for frog locations, and when we located a frog, we recorded its three-dimensional position in meters as its location along the transect, its horizontal distance from the stream, and approximate elevation above stream. Distances were measured using tape measures, range finders and transect markers. If the frog was more than 20 m from the stream, distance from the stream was recorded to the nearest 5 m. We also recorded the environmental substrate frogs were using: bare ground, dry rock, leaf litter, vegetation, wood, on wet rock in stream, and under rock in stream.

TABLE 1. Movement patterns and habitat use of female *Nyctimystes dayi*. Values represent medians (and ranges) of data obtained using individual frogs as replicates.

Individual ID	Season	Total number of relocations	Percent of observations individuals moved between surveys	Distance moved between surveys (m)	Elevation above stream (m)		Horizontal distance from stream (m)	
					Diurnal	Nocturnal	Diurnal	Nocturnal
Frog 1	Cool/dry	24	60.9	8 (0–91.3)	3 (0–12)	3 (0–10)	8 (0–50)	3 (0–50)
Frog 2	Cool/dry	28	33.3	0 (0–27.1)	13 (0–20)	13 (0–20)	0 (0–3)	0 (0–3)
Frog 3	Cool/dry	15	64.3	4.2 (0–91.3)	0 (0–3)	0.75 (0–3)	0 (0–4)	0 (0–4)
Frog 4	Warm/wet	28	55.6	0 (0–20.6)	5 (0–10)	6 (0–10)	5 (0–20)	2.5 (0–10)
Frog 5	Warm/wet	19	66.7	4.7 (0–17.1)	5 (0–12)	5 (0–12)	4 (0–5)	5 (0–5)

We used individuals as replicates and compared summary statistics calculated for each animal, in order to avoid pseudoreplication and biasing our results by including more data on frogs that were located more often (Rowley and Alford 2007b). Due to obvious differences between the diurnal and nocturnal behavior of *Nyctimystes dayi*, we examined diurnal and nocturnal data on habitat use separately.

Five female *N. dayi* were tracked during the study period, three in the cool/dry season and two in the warm/wet season (Table 1). Our sample size was limited by the low availability of females for initial capture. We successfully relocated all frogs on every attempt, resulting in between 15–28 relocations per frog, and a total of 117 relocations for the species.

Tracked frogs moved to a new position between 33.3–66.7% of surveys (Table 1). The median distance moved between surveys (over ca. 12 h) ranged from 0–8 m, however two individuals moved more than 90 m between surveys (Table 1). The elevation of frogs above the stream during surveys varied from 0–20 m and their horizontal distance from the stream ranged from 0–50 m (Table 1). Individual movement patterns were variable; one frog remained within 5 m of the stream in both elevation and horizontal distance, while others moved extended distances vertically and horizontally from the stream for several days at a time (Fig. 1). No frogs were observed to have moved during the day. Tracked *N. dayi* were always relocated in rainforest. A single individual, "Frog 1," traversed the sealed, two-laned road twice during the study period.

During both diurnal and nocturnal observations, tracked frogs

were most often located in vegetation (Table 2), typically in the canopy of large trees (>10 m height). When we were able to visually locate tracked frogs in the canopy, all were on the leaves of trees. During a single instance in which we opportunistically sighted a male *N. dayi* during the day, it was also located in vegetation, on leaves overhanging the stream. Frogs also spent up to several days at a time under rocks in the stream, and were occasionally observed during the night on wet rocks in the stream (Table 2). A single frog was observed on leaf litter during the study (Table 2).

We observed three of our tracked frogs in amplexus; two in the cool/dry season and one in the warm/wet season. "Frog 2" spent between 24–36 h in amplexus, on vegetation 1–2 m above the stream and 2 m in horizontal distance from the stream. "Frog 3" spent <12 h in amplexus on 3 m high vegetation, 4 m from the stream, and "Frog 5" was found in amplexus under a rock in the middle of the stream when we removed its transmitter at the end of the study.

Nyctimystes dayi females made relatively large (up to 50 m), extended journeys away from streams, spent a high proportion of their time in canopy vegetation, and were always observed in rainforest. Similar behavior has been recorded in females of the sympatric hylid *Litoria genimaculata* (Rowley and Alford 2007b). Although we did not track male *N. dayi*, due to their small size, we can make predictions about their behavior, based on the behavior of females. First, it is likely that the frequency and distance of movements in male *N. dayi* is lower than for females, as it is in many species, especially when males are smaller in size than females (Bartelt et al. 2004; Bellis 1965; Johnson et al.

TABLE 2. Substrate use of female *Nyctimystes dayi*. Values represent proportions of observations each frog was on each substrate type during diurnal and nocturnal surveys.

| Individual ID	Season	Nocturnal				Diurnal			
		Vegetation	Under rock in stream	Leaf litter	On wet rock in stream	Vegetation	Under rock in stream	Leaf litter	On wet rock in stream
Frog 1	Cool/dry	0.73	0.18	0.09	0	0.69	0.23	0	0.08
Frog 2	Cool/dry	0.77	0.23	0	0	0.8	0.13	0	0.07
Frog 3	Cool/dry	0.29	0.71	0	0	0.5	0.5	0	0
Frog 4	Warm/wet	0.85	0.15	0	0	0.87	0	0	0.13
Frog 5	Warm/wet	0.78	0.22	0	0	0.8	0.1	0	0.1
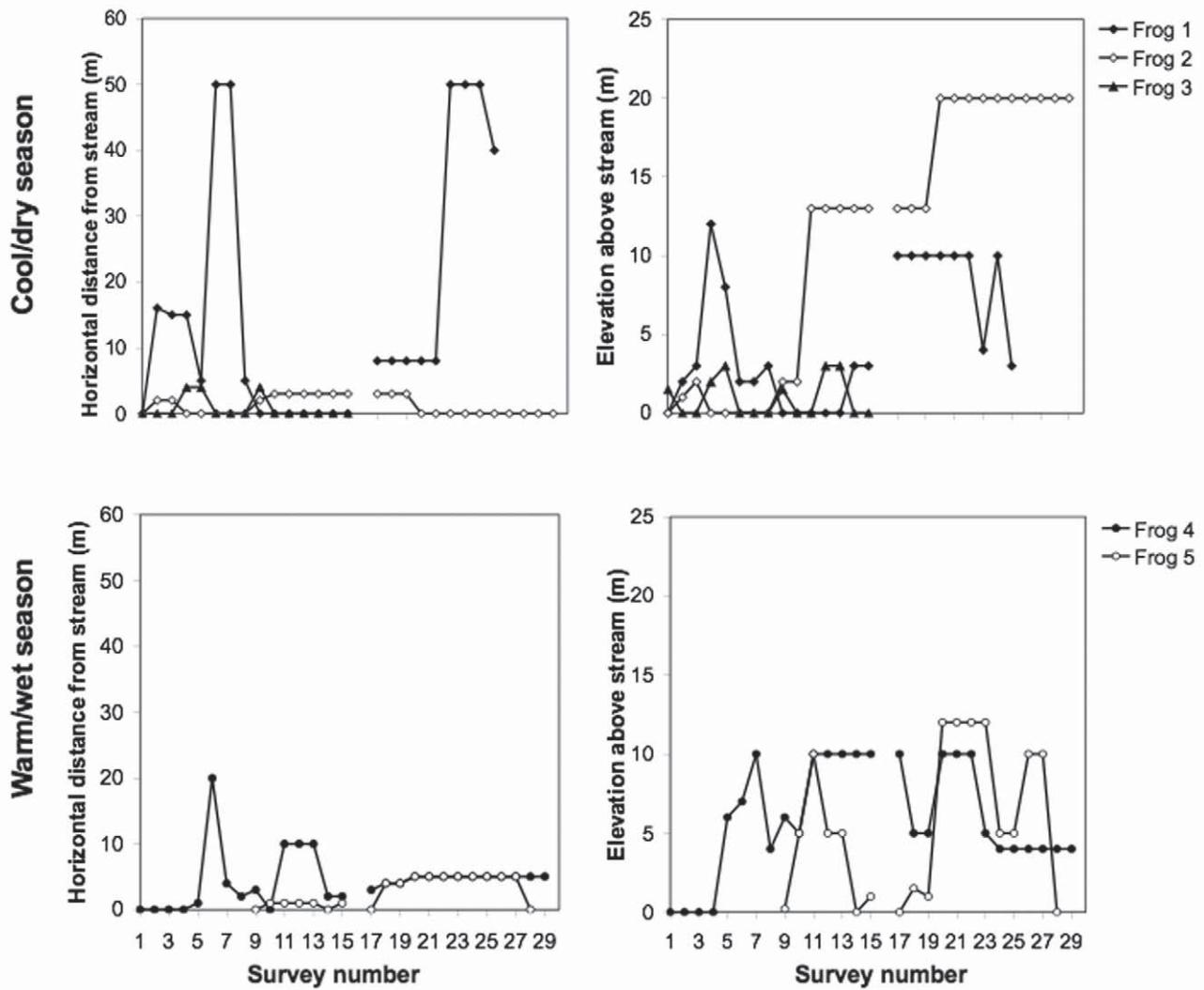
Fig. 1. Individual movement patterns of female *Nyctimystes dayi* during the cool/dry and warm/wet seasons. Values represent position of single frogs in terms of horizontal distance from stream (m) and elevation above stream (m) during successive surveys. Even numbered surveys represent diurnal surveys and odd numbered surveys represent nocturnal surveys.

2007; Miaud et al. 2000; Muths 2003; Ovaska 1992; Rowley and Alford 2007b). It is also likely that male *N. dayi* are more stream-restricted, especially considering their high relative abundance along streams, fidelity to calling-sites along streams (Hodgkison and Hero 2002; Rowley and Alford, unpubl. data), and inter-male aggression (Rowley 2007) during the breeding season.

Results of this study have important consequences for population censuses of *N. dayi* using techniques such as mark-recapture. The large movements of *N. dayi* both along and away from streams are likely to make it difficult to distinguish between mortality and emigration from fixed sites, an issue previously recognized for several other amphibian species (Rowley and Alford 2007b; Schmidt et al. 2007). In addition, it is likely that the high relative abundance of male *N. dayi* encountered during population surveys is simply a reflection of greater detectibility, with females spending large proportions of time farther away from the stream in terms of both horizontal distance and in elevation. This is probably exacerbated by the cryptic behavior of females. When they were adjacent to streams at night, they were often concealed from sight from the stream itself, and would have remained undetected had they not

been fitted with tracking devices.

As *N. dayi* were always observed in rainforest, and used habitat at relatively large distances from streams, management actions aimed at conserving the species should maintain terrestrial vegetation buffer zones along streams and habitat corridors between streams. Although a single *N. dayi* successfully traversed a sealed road during the study, we do not know how common these movements are, whether male *N. dayi* are capable of traversing such potential barriers, and how great the risk presented by such traversals is. Until further research is carried out, it should be assumed that roads and other habitat disturbances are barriers to movement for *N. dayi*.

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TECHNIQUES

Cross-Species Amplification of Emydid Microsatellite Loci in Three *Graptemys* Species and Their Utility as a Conservation Tool

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Microsatellites are a powerful set of highly variable molecular markers gaining widespread use in population genetics (Avise 2004) and increasingly in studies with a conservation focus (e.g., Beaumont and Bruford 1999; Jehle and Arntzen 2002). However, one drawback of microsatellites is that the development of these markers for use *de novo* typically involves the costly and time-consuming process of creating a genomic library, isolating microsatellite-containing clones, designing primers for the loci, and then optimizing the primers (Selkoe and Toonen 2006). Fortunately, the priming sites within the flanking sequences of microsatellite loci are sometimes conserved across species (e.g., Engel et al. 1996; Holman et al. 2005; Primmer et al. 1996; Primmer et al. 2005; Rico et al. 1996), including turtles (FitzSimmons et al. 1995). This allows the primers designed for one species (the focal species; Hutter et al. 1998) to successfully amplify loci in other species. In fact, many authors routinely test novel microsatellite loci on closely related species, usually within the same genus.

Turtles are considered one of the most endangered animal taxa, with 129 of the 205 species assessed by the World Conservation Union (IUCN) listed as critically endangered, endangered or vulnerable (http://www.iucnredlist.org/info/tables/table4a; accessed 27 May 2007). Genetic studies are playing an increasing role in the conservation of chelonians including the use of microsatellites, either alone (Pearse et al. 2006; Roberts et al. 2005; Schwartz and Karl 2005) or in combination with other genetic markers (Bowen et al. 2005; Sites et al. 1999). Interest in genetic studies of several species within the family Emydidae has been indicated by the recent publication of papers describing microsatellite loci for the Diamondback Terrapin (*Malaclemys*

terrapin; Hauswaldt and Glenn 2003), the Bog Turtle (*Glyptemys muhlenbergii*; King and Julian 2004) and the Blanding's Turtle (*Emydoidea blandingii*; Libants et al. 2004; Osentoski et al. 2002).

The imperiled nature of members of the genus *Graptemys* (family Emydidae) makes the use of genetic studies increasingly important. The genus *Graptemys* has a broad distribution across North America, but seven of twelve species in the genus are endemic to specific drainages east of the Mississippi River along the northern coast of the Gulf of Mexico (Ernst et al. 1994). Presumably this complex evolutionary history is the product of the fluctuating sea levels in the Gulf of Mexico during the Pleistocene (Lamb et al. 1994; Lovich and McCoy 1992; Wood 1977). Like many freshwater species, this genus appears to be extremely sensitive to human modifications and perturbations of the river and surrounding habitats (reviewed by Bulhmann and Gibbons 1997; Moll and Moll 2004).

The combination of such restricted distributions and apparent recent population declines has led to the listing of six species of *Graptemys* as either imperiled (G2) or vulnerable (G3) (NatureServe 2006). Two of the coastal species, *G. flavimaculata* and *G. oculifera*, have state endangered and federally threatened status (U.S. Fish and Wildlife Service 1988 and 1993). Furthermore, *G. barbouri*, *G. ernsti*, *G. nigrinoda nigrinoda*, *G. nigrinoda delticola*, and *G. pulchra* (all coastal species) are considered state protected in Alabama (Alabama Natural Heritage Program 2006). *Graptemys nigrinoda nigrinoda* is also considered state endangered in Mississippi (Mississippi Natural Heritage Program 2002). Developing effective management and recovery plans has been complicated by a general paucity of ecological information for *Graptemys* species (Bulhmann and Gibbons 1997), although there is a growing body of literature for *G. flavimaculata* (Horne et al. 2003; Jones 1996; Lindeman 1998; Shelby et al. 2000; Shelby and Mendonça 2001) and *G. oculifera* (Jones 2006; Jones and Hartfield 1995; U.S. Fish and Wildlife Service 1988). However, no published studies of genetic variation and population structure in the context of conservation issues exists for any of the *Graptemys* species. The goal of this project was to identify a suite of previously published microsatellite loci that would be useful for population and conservation genetic studies of *G. gibbonsi*, *G. flavimaculata*, and *G. oculifera*. Given the potential for cross-species amplification of microsatellite loci among related species, the loci we tested were selected from those developed for species within the family Emydidae. Loci found to be useful for the three *Graptemys* species in this study would also likely be useful for other members of the genus as well.

From April 2005 to November 2006 turtles were collected using basking traps or by hand during periods of low flow. *Graptemys gibbonsi* was collected from the Chickasawhay River (Pascagoula drainage) at Leakesville, Mississippi. *Graptemys flavimaculata* was collected from the Leaf River (Pascagoula drainage) north of Hattiesburg, Mississippi. *Graptemys oculifera* was collected from the Pearl River at Columbia, Mississippi. Approximately 1 mL of blood was drawn from the coccygeal vein using a heparinized 26.5-gauge needle and a 1 mL syringe. All individuals were released at the site of capture following sample collection. Samples were stored on ice for 4–6 h while in the field, centrifuged to separate plasma and blood cells and then stored at –20°C. All collections were made under permits from the Mississippi Department of Wildlife, Fisheries and Parks.

We selected a total of 21 loci for testing in *G. flavimaculata*, *G. oculifera* and *G. gibbonsi* (Table 1). All six loci for *Malaclemys terrapin* (Hauswaldt and Glenn 2003) were tested since each suc-

TABLE 1. Microsatellite loci tested in this study along with the repeat motif and optimal annealing temperature for each locus that was successfully amplified. Loci that were not successfully or reliably amplified are indicated by a –.

Locus and Focal Species	Repeat Motif	Species Tested & Annealing Temperature (°C)		
		G. gibbonsi	*G. flavimaculata*	*G. oculifera*
Malaclemys terrapin				
TerpSH1	$(AGAT)_{15}$	56	56	56
TerpSH2	$(AGAT)_{12}$	60	56	56
TerpSH3	$(CAAA)_{14}$	–	–	58
TerpSH5	$(CTAT)_{12}$	56	56	56
TerpSH7	$(AGAT)_{13}$	60	56	56
TerpSH8	$(GA)_{19}$	56	56	–
Glyptemys muhlenbergii				
GmuB08	$(TAC)_{10}$	–	56	56
GmuD28	$(ATCT)_{15}$	52	–	–
GmuD51	$(ATCT)_{52}$	60	56	–
GmuD70	$(ATCT)_{8}$	60	56	56
GmuD79	$(ATCT)_{10}$	56	56	56
GmuD87	$(ATCT)_{22}$	53	–	56
GmuD88	$(ATCT)_{18}$	60	56	56
GmuD90	$(ATCT)_{9}$	56	58	56
GmuD93	$(ATCT)_{18}$	56	56	56
GmuD114	$(ATCT)_{13}$	56	56	56
GmuD121	$(ATCT)_{8}$	56	56	53
Emydoidea blandingii				
Eb15	$(CA)_{18}$	–	56	–
Eb17	$(AAT)_{11}$	56	–	56
BTGA3	$(GA)_{11}$	–	–	–
BTCA7	$(CA)_{12}$	56	56	56

TABLE 2. Characteristics of the 21 microsatellite loci as reported for the focal species or as observed in the *Graptemys* species tested in this study: size range of alleles (in base pairs), the number of alleles (N_a) for each locus, and the observed and expected heterozygosity (H_O/H_E). NA means no amplification, and NR means not resolved. The number (N) of individuals tested for the focal species and each species of *Graptemys* is also reported.

Locus	Focal Species Size	N_a	H_O/H_E	*G. gibbonsi* (N = 34) Size	N_a	H_O/H_E	*G. flavimaculata* (N = 20) Size	N_a	H_O/H_E	*G. oculifera* (N = 20) Size	N_a	H_O/H_E
Malaclemys terrapin (N = 18–21)												
TerpSH1	254–302	12	0.571/0.913	239–255	5	0.655/0.589	266–276	5	0.545/0.550	269–295	6	0.833/0.736
TerpSH2	171–227	12	1.00/0.902	157–161	2	0.029/0.028	155–175	6	0.714/0.709	158–190	5	0.474/0.594
TerpSH3	283–311	8	0.857/0.803	NA	–	–	NR	–	–	265–273	3	0.444/0.568
TerpSH5	157–189	8	0.905/0.825	131–135	2	0.529/0.484	133–165	8	0.833/0.795	129–157	6	0.688/0.727
TerpSH7	97–137	10	0.722/0.872	97–125	7	0.765/0.780	102–126	7	0.667/0.784	102–134	7	0.800/0.764
TerpSH8	193–221	14	0.895/0.913	193–199	4	0.375/0.433	174–182	2	0.077/0.074	NA	–	–
Glyptemys muhlenbergii (N = 37)												
GmuB08	NA	–	–	221–224	2	0.406/0.359	218–224	3	0.625/0.588	219–223	2	0.389/0.461
GmuD28	208–236	6	0.917/0.789	197–221	4	0.300/0.345	NA	–	–	NA	–	–
GmuD51	307–359	10	0.545/0.843	320–380	13	0.875/0.878	201–273	9	0.889/0.819	NA	–	–
GmuD70	185–205	5	0.676/0.725	185–241	9	0.710/0.714	202–280	10	0.846/0.855	215–303	9	0.636/0.781
GmuD79	164–192	3	0.459/0.487	152–152	1	0.000/0.000	153–153	1	0.000/0.000	152–152	1	0.000/0.000
GmuD87	260–292	8	0.892/0.843	220–268	10	0.903/0.852	NR	–	–	220–240	6	0.947/0.684
GmuD88	154–178	17	0.730/0.753	115–135	6	0.600/0.627	113–157	9	1.000/0.838	119–147	8	0.833/0.813
GmuD90	122–134	3	0.568/0.520	115–119	2	0.514/0.431	121–121	1	0.000/0.000	119–119	1	0.000/0.000
GmuD93	185–389	10	0.730/0.843	183–191	3	0.059/0.058	185–185	1	0.000/0.000	161–189	2	0.111/0.105
GmuD114	92–128	6	0.757/0.738	87–87	1	0.000/0.000	97–101	2	0.167/0.153	99–99	1	0.000/0.000
GmuD121	138–154	5	0.703/0.678	126–142	4	0.629/0.504	127–147	2	0.053/0.051	130–142	2	0.211/0.266
Emydoidea blandingii (N = 100 & 12)												
Eb15	147–186	34	0.920/0.950	NA	–	–	166–166	1	0.000/0.000	NA	–	–
Eb17	94–109	5	0.690/0.690	87–87	1	0.000/0.000	NA	–	–	87–87	1	0.000/0.000
BTGA3	108–108	1	0.000/0.000	NA	–	–	NA	–	–	NA	–	–
BTCA7	154–158	2	0.333/0.290	158–164	2	0.324/0.271	86–88	2	0.389/0.313	165–165	1	0.000/0.000

cessfully amplified in *Chrysemys picta*. Two loci from each of the *Emydoidea blandingii* papers were also chosen based on their broad applicability in the species tested or the degree of polymorphism in *C. picta*. From Osentoski et al. (2002) we selected Eb15 and Eb17, and from Libants et al. (2004) we selected BTCA7 and BTGA3. Twenty–seven loci were reported for *Glyptemys muhlenbergii* (King and Julian 2004), and thirteen of these amplified in *Graptemys geographica*. We tested all but *Gmu*A18 and *Gmu*D89, since only a few alleles were reported in *G. geographica*.

Total genomic DNA was extracted with the DNeasy Tissue Kit (QIAGEN Inc.). Although heparin can sometimes have an inhibitory effect on the polymerase chain reaction (Beutler et al. 1990), this extraction method yielded good quality DNA that amplified well for most individuals. Amplifications were conducted in a total volume of either 12.5 µl or 25 µl using 50 mM KCl, 10 mM Tris-HCl (pH 8.3), 0.01% gelatin, 200 µM dNTPs, 2 mM MgCl$_2$ (4 mM for TerpSH3 & TerpSH7 and 1.5 mM for TerpSH8 in *G. oculifera*) 0.5 units of *Taq* polymerase (Promega Co.), 0.3 µM of the M13 tailed forward primer (Boutin-Ganache et al. 2001), 0.3 µM of the reverse primer, 0.1 µM of the labeled M13 primer (LICOR Co.), 20–150 ng of template DNA, and water to the final volume. PCR cycling conditions consisted of an initial denaturing step of 94°C for 2 min followed by 35 cycles of 30 sec at 94°C, 1 min at 52–60°C, and 1 min at 72°C. A final elongation step of 10 min at 72°C ended the cycle. Locus specific annealing temperatures are provided in Table 1. Microsatellite alleles were visualized on acrylamide gels using a LICOR 4200 DNA analyzer and scored using Gene Imag-IR v. 3.55 (LICOR Co.). We tested 20–34 individuals per species (Table 2). For polymorphic loci, summary statistics were generated using GENALEX 6 (Peakall and Smouse 2005). Tests for Hardy-Weinberg equilibrium and linkage disequilibrium were both conducted using randomization tests implemented in GENEPOP v 3.3 (Raymond and Rousset 1995). Statistical significance was adjusted using sequential Bonferroni procedures (Rice 1989) for all multiple tests. We performed statistical comparisons of several properties of each locus (number of alleles, expected heterozygosity levels, smallest allele size, and largest allele size) to determine if the values for our study species were different from those reported for the focal species, and whether there were differences among our study species. To do this, we used one-factor analyses of variance, and for tests that showed a significant difference among the four groups we also performed post–hoc comparisons (Tukey's HSD) to test for differences between each pair (SAS Institute 2002). All analyses were performed using JMP 5.0 software.

Eighteen loci were reliably amplified in *G. gibbonsi*, and 16 loci were amplified in both *G. flavimaculata* and *G. oculifera* (Table 2). Of these loci, 15 were polymorphic in *G. gibbonsi*, 12 were polymorphic in *G. flavimaculata* and 11 loci were polymorphic in *G. oculifera*, with 2–13 alleles per locus per species. Two other loci (TerpSH3 and *Gmu*D87) amplified inconsistently in *G. flavimaculata* but appeared to be polymorphic and may yet prove useful after further optimization. Observed heterozygosity values ranged widely across species with values of 0.029–1.0, however most loci exhibited observed heterozygosity values greater than 0.500 (Table 2). No loci exhibited significant departure from Hardy-Weinberg equilibrium expectations or demonstrated linkage disequilibrium after applying a Bonferroni correction.

A common observation in studies testing cross-species amplification of microsatellite loci is that alleles are typically longer and more numerous in the focal species (e.g., Ellegren et al. 1995; FitzSimmons et al. 1995). Hutter et al. (1998) tested two hypotheses for this observation by performing a reciprocal test of microsatellite loci designed for two species of *Drosophila*. They found no difference in mean PCR fragment length, but there was greater variation in the focal species as measured by the number of alleles and expected heterozygosity. The statistical tests of our data revealed the same pattern. We found no significant differences among groups in length of the largest (F = 0.877; df = 3,66; P = 0.458) and smallest (F = 0.274; df = 3,66; P = 0.844) alleles. Reduced genetic variability was observed compared to the focal species. The number of alleles differed significantly among the focal and study species (F = 6.73; df = 3,80; P = 0.0004), and post-hoc comparisons showed that this was due to significantly higher numbers of alleles in the focal species than in the three study species. Number of alleles did not differ among the three *Graptemys* species. Likewise, expected heterozygosity values differed significantly among the four groups (F = 4.65; df = 3,65; P = 0.005), and post-hoc comparisons showed that values for all three *Graptemys* species were significantly smaller than those reported in the focal species. Heterozygosity levels did not differ among the three study species. Differences in sample sizes and the geographical range of samples are unlikely to account for the higher genetic variability in the focal species. Only Libants et al. (2004) sampled a large number of individuals from a broad geographic range. Our samples sizes (Table 2) were comparable to, or larger than, all of the other studies.

We have identified a set of microsatellite loci designed for species in the Emydidae that amplify in *G. gibbonsi*, *G. flavimaculata*, and *G. oculifera*. Somewhat reduced levels of genetic variability compared to the focal species does not appear to affect their usefulness as a conservation genetic tool. We have already employed these loci to document genetic differentiation between *G. gibbonsi* populations from the Pearl and Pascagoula Rivers (unpublished data). Our lab is also using these loci to measure connectivity among populations of *G. flavimaculata* within the mainstem Pascagoula River and its tributaries. The loci identified here (Table 2) may likewise prove useful in population genetics studies of other *Graptemys* species or even other species within the Emydidae.

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The Use of Vehicle-Portable Scanners for Obtaining Morphological Data on Small- to Medium-sized Reptiles

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Rapidly and accurately recording morphological characters from live lizards and snakes can be difficult, especially for small and/or venomous species. Ventral scale numbers and belly color patterns can be particularly difficult to record from live specimens, despite their importance for determining vertebral numbers (Alexander and Gans 1966; Kerfoot 1970), sexual dimorphism trends (Shine 1993), environmental conditions (Castellano et al. 1994), and correlations with body size, growth rate, and survivorship (Lindell et al. 1993).

Body length is another important part of any study of reptiles and amphibians (Measey et al. 2003) and snout–vent length (SVL) is the most commonly reported measure of linear body size (Fitch 1987). However, measuring the SVL of a snake can be problematic, especially for venomous species (Bertram and Larsen 2004).

Fitch (1987) stated that stretching a conscious snake to its full length for a SVL measurement may set back growth by several weeks. We observed similar results during a previous study of *Sinonatrix* snakes (Mao, unpubl.). Measurements from stretched snakes have been demonstrated to be significantly longer than measurements obtained by other methods (Bertram and Larsen 2004). In addition, squeeze boxes must be turned upside-down or used following the methods of Bertram and Larsen (2004) in order to obtain ventral characteristics or tail lengths.

Animals can be anesthetized in order to reduce injury to both study animals (e.g., tail autonomy) and investigators and to increase measurement precision (Blouin-Demers 2003; Setser 2007). However, anesthesia can increase potential risk of mortality, can be time consuming, and may be impractical when processing large numbers of individuals at one time (Setser 2007). Anesthesia also requires experienced personnel and specialized equipment, and is subject to legal constraints in many countries (Beaupre et al. 2004, Bennett 1999). In addition, anesthetized snakes can stretch considerably and do not necessarily provide more accurate measurements (Blouin-Demers 2003).

Schuett (1997) used photocopiers for measuring snakes, following Quinn and Jones' methods, and other researchers have used digital images from cameras (Measey et al. 2003; Perera and Pérez-Mellado 2004). In 1999, we developed a technique that employs a modified flatbed scanner to gather morphological data on *Sinonatrix annularis* and *Sinonatrix percarinata suriki*. This approach provided high quality images of ventral characteristics and body length of small to medium sized reptiles in a safe and rapid manner. Unlike large photocopiers, the scanner method can be used in the field by using a notebook PC with a scanner, while drawing power from a vehicle or generator. Compared to images taken with digital cameras, which often suffer from spherical distortion, the scanner provides a standardized platform that eliminates problematic biases such as angle and distance from the subject.

Materials and methods.—We originally used Hewlett Packard (HP) Scan Jet 3300C and Epson Perfection 1650 scanners, with maximum image resolution of 600 and 1650 dpi (dots per inch) respectively. We later used a HP Scanjet 4670 scanner because of its faster scanning speed, higher image quality, compact design, and lighter weight. A squeeze labyrinth (L × W × H = 30.3 × 22.3 × 5 cm) was designed to keep the body of the animal being scanned extended (Fig. 1). To prevent the subjects from moving while being scanned, the labyrinth has a plastic cover, onto which six strips of sponge are glued (each sponge being L×W×H = 20 × 4.2 × 5.2 cm, respectively). Larger lizards like *Plestiodon elegans* can be placed in the labyrinth, while lizards such as geckoes or the brown anole (*Norops sagrei*), as well as very small snakes, can be scanned by manually restraining the animal under a white cloth on top of the scanner. Very small characters such as the enlarged post-cloacal scales of male *N. sagrei* can be scanned by selecting the area and scanning it at 200–300% with a resolution of 300–400 dpi. We saved all scanned images to both the computer's hard drive and to CD or DVD.

In addition to the two above *Sinonatrix* species, we tested the method on 16 additional snake species: *Amphiesma sauteri*, *A. stolatum*, *Bungarus m. multicinctus*, *Enhydris chinensis*, *E. plumbea*, *Elaphe c. carinata*, *Lycodon r. ruhstrati*, *Oligodon formosanus*, *Oreocryptophis porphyracea kawakamii*, *Pseudoxenodon s. stejnegeri*, *Ptyas korros*, *Rhabdophis tigrinus formosanus*, *Rhadinophis frenatum*, *Trimeresurus gracilis*, *Viridovipera stejnegeri stejnegeri*, and *Xenochrophis piscator*. The largest and smallest snakes tested were 1350 mm SVL (adult *E. c. carinata*) and 90 mm SVL (neonatal *E. plumbea*), respectively. We also tested the method on 12 lizard species: *Eutropis longicaudata*, *Gekko hokouensis*, *Hemidactylus bowringii*, *H. frenatus*, *H. stejnegeri*, *Japalura swinhonis*, *N. sagrei*, *P. elegans*, *Sphenomorphus indicus*, *Takydromus formosanus*, *T. kuehnei*, and *T. stejnegeri*. The largest

Fig. 1. The scanner platform module (the main figure) from left to right clockwise; the PC notebook, cover glued with six sponge strips, the white labyrinth with one transparent side for animal observations, and a HP-4670 scanner. The upper right insert is the ventral image of an *Enhydris chinensis* with a tag number, indicating the collection and measurement data.

and smallest lizards tested were 120 mm SVL (*E. longicaudata*) and 18.5 mm SVL (neonatal *T. formosanus*), respectively.

To examine the accuracy and precision of the proposed method, we accumulated the body axis measurements (e.g., SVL, and tail length) of a single adult male *X. piscator* by using the following methods: 1) conscious—stretching the snake and directly measuring it by tape ruler—repeated five times; 2) scanning the snake with the HP-3300C, at 150 and 200 dpi resolutions, and measuring those lengths with a digital map-reader on a full size printout and directly from the screen by using GIS software—repeated five times; 3) same as no. 2 but using the HP-4670 as scanner platform at 200 and 600 dpi resolutions; 4) anesthetizing the snake and measuring once with a tape ruler.

Results.—We compared the measurements from the anesthetized snake against the other nine treatments (Table 1; based on the precision study results of Blouin-Demers [2003] and Setser [2007] this measurement was considered the standard value). Both the standard value and measurements from the stretched conscious snake resulted in longer measurements for total length (TL; ca. 4.2% longer) and SVL (ca. 6.2% longer) when compared to measurements from scanned images, irrespective of being calculated by map-reader or GIS software. In addition, most measurements from images scanned at 150, 200, and 600 dpi resolutions, and measured with the map-reader, were significantly

smaller that the standard value of the snake length, especially for the images acquired with the HP-4670 scanner. Of the tail length measurements from different procedures, those acquired from scanner images were much closer to standard value than the ones from the stretched conscious snake. Although the TL measurements from stretched conscious snakes appeared to be very similar to that of the standard measurement, it resulted in a longer Tail-L and a relatively shorter SVL compared to the anesthetized snake (Table 1).

Most ventral characters can be easily counted from images on the computer screen. Unclear or small characters can be seen and counted after being magnified. Between 1999 and 2005 more than 400 different images have been recorded from *E. chinensis*, *E. plumbea*, *S. annularis*, *S. percarinata suriki,* and *X. piscator* for population monitoring. Ventral characters, including ventral scale number, gular region (Dowling 1951), subcaudals, chin-shield, and anal plate have been successfully scanned from every live snake, and we have successfully used ventral color patterns to identify individual snakes.

The scanned image also provides a record of the ventral markings and coloration. Ventral images of lizards scanned at a resolution of 300–600 dpi provides several additional characters in so far as the shape and number of the infra-labial scales, subdigital scales, posterior anal scales, tail-margin structure and, if present, groin
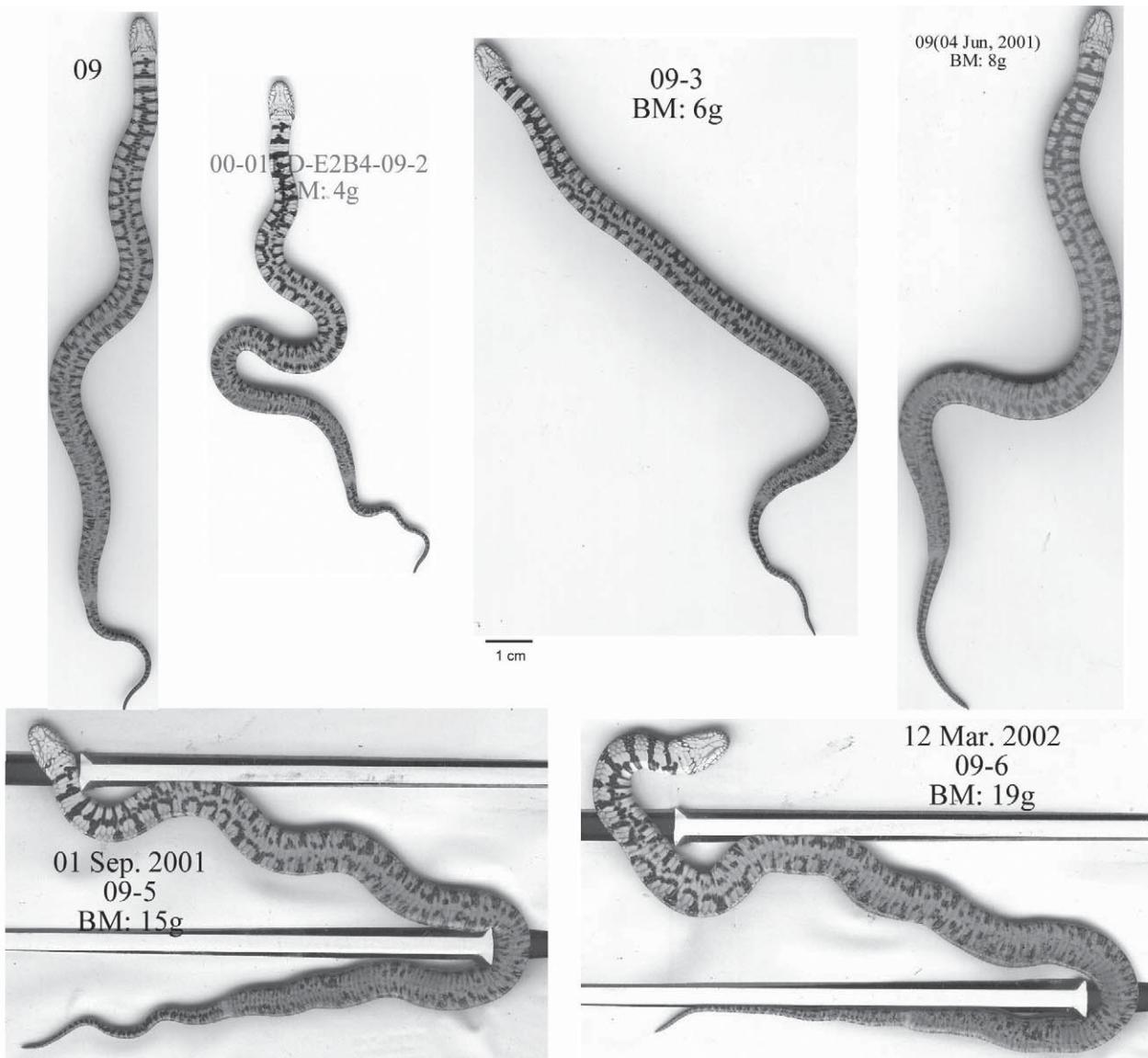
Fig. 2. The monitored ventral pattern and growth of a *Sinonatrix annularis* newborn over an 18 month period; (left to right, top to bottom) new born, 3 months old, 6 months old, 9 months old, 12 months old and 18 months old.

pores.

Our method has already been utilized to great effect in our field and laboratory studies. In 2000 the growth rate of a litter of newborn *S. annularis* was regularly recorded with this method in a field enclosure in a semi-aquatic Cape-lily (*Crinum* sp.) paddy, Yangminshan, Taipei (Mao 2003). For a period of nearly two years the seven neonatal *S. annularis* individuals were scanned every three months (Fig. 2).

Discussion.—Setser (2007) explained at length the problems associated with stretching snakes during measuring procedures, and although our proposed method does overcome this, it has some considerations that should be taken into account. The snake should be extended in the labyrinth, with as little kinking as possible, since these may result in slightly shorter measurements. In addition, the length measurements determined by GIS software were slightly closer to the standard value (anesthesia snake measurement), when compared to map-reader calculations, which may be due to multiple causes. First, the scanner models employed different image collection devices; for example the HP-

3300C acquired images by optical reflection while the HP-4670 uses CCD. The efficiency of these two devices will differ slightly, especially when the image is printed out on paper (HP technical support, Taipei, pers. comm.). Moreover, the length and distance on the image must be defined *a priori*, and some size rectification must be done by a length scale before GIS software measuring. This is not necessary with the printout measurements, but it must be taken into consideration that the snake's posture (coiled taut or loose) and anthropogenic operating biases may result in variation, especially when the map-reader must calculate the continually linear curves of a snake. However, a size rectification by verifying if the object size is 1:1 by checking certain length scales on the image (e.g., labyrinth trail width) can greatly reduce these problems, whether lengths are determined using software such as Image Tool (Measey et al. 2003), on the computer screen using GIS software (e.g., ArcView), or via a map-reader or proportional divider on a printout.

Natural markings were used in a Swedish *Natrix natrix* population (Carlström and Edelstam 1946) to identify individuals,

TABLE 1. Results of the length measurements taken from a male *Xenochrophis piscator* by four different methods and image resolutions. The asterisk indicates significant differences among the nine length measuring treatments compared to anesthesia of the snake (two tailed *t*-distribution test, P = 0.01, 4 df).

Input tool	Measuring method	TL in cm (mean ± SD)	t-value	SVL in cm (mean ± SD)	t-value	Tail-L in cm (mean ± SD)	t-value
	Anesthesia (N = 1)	63.6	—	43.9	—	19.7	—
	Conscious—stretching the snake (N = 5)	63.62 ± 0.42	-0.048	42.98 ± 0.30	3.033	20.64 ± 0.23	-0.483
HP-3300C (150 dpi)	Map-reader (N = 5)	60.37 ± 0.69	4.667*	40.62 ± 0.84	3.916	19.74 ± 0.22	-0.204
	GIS software (N = 5)	61.64 ± 1.02	1.934	41.53 ± 1.03	2.301	20.11 ± 0.12	-3.380
HP-3300C (200 dpi)	Map-reader (N = 5)	60.30 ± 0.78	4.265	40.63 ± 0.87	3.780	19.67 ± 0.13	0.250
	GIS software (N = 5)	61.89 ± 0.78	2.203	41.85 ± 0.72	2.830	20.04 ± 0.18	-1.871
HP-4670 (200 dpi)	Map-reader (N = 5)	60.38 ± 0.43	7.566*	40.80 ± 0.39	7.871*	19.58 ± 0.10	1.234
	GIS software (N = 5)	61.31 ± 0.50	4.576	41.50 ± 0.39	6.099*	19.81 ± 0.16	-0.691
HP-4670 (600 dpi)	Map-reader (N = 5)	60.57 ± 0.35	8.700*	41.02 ± 0.37	7.910*	19.55 ± 0.08	1.875
	GIS software (N = 5)	60.95 ± 0.78	3.404	41.19 ± 0.56	4.524	19.76 ± 0.22	-0.258

and this method was also proposed for studies involving some lizards and amphibians (Ferner 1979). However, it had only limited applications for some species because this method was based on color pattern permutation. A snake "fingerprinting" digital system was developed by Hailey and Davies in 1985, and was based on a combination of natural markings and ventral scale blotch patterns, recorded by photographing *Natrix maura*. Photo identification has also been shown to have good potential as a non-invasive identification technique for some amphibians such as *Eurycea bislineata wilderae* (Bailey 2004). Digital cameras can be used for recording characteristics of individuals and could aid in taking various measurements (Measey et al. 2003; Perera and Pérez-Mellado 2004). Bender (2001) proposed the use of natural markings to identify individual reptiles, especially for the registration of pets. In our opinion, images of the ventral views of lizards and snakes from digital cameras may be out-of-focus or exhibit insufficient image quality if using the technique proposed by Bender (2001). Measey et al. (2003) also stated that the digital cameras are prone to un-repairable error in the field. During previous observations it was found that photographs could not always reflect a clear ventral pattern image of the snake, especially, when the individual being photographed was small or under conditions of multiple light sources (Mao and Norval, pers. obs.). In addition, there was the problem of restraining the snake in an upside-down position. Mertens (1995) used xerographic copies to recognize individual juvenile *Natrix natrix*, but bulky xerographic equipment is difficult to transport and is costly to acquire and maintain. Furthermore, when a large number of fingerprinting files are required for resources management purposes, locating the correct fingerprinting pattern from the huge number of images in the database can be a time consuming process. Although some of the commercially available software does not fully satisfy our requirements of image database sorting and comparison, it is our opinion that by incorporating the proposed scanner method with some commercial digital camera software (e.g., Visual Similarity Duplicate Image Finder), the process can be greatly simplified, and could be an invaluable tool in dealing with herpetological fieldwork involving identification of individual animals. We believe our proposed method not only aids in measuring small reptiles, but can also

have broad application in population studies.

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A Novel Aquatic Thermal Mosaic for Assessing Preferred Body Temperature in Semi-Aquatic Snakes

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Reptiles maintain their body temperature (T_b) at or near a preferred level that is generally referred to as the thermoregulatory set-point range (T_{set}; Hertz et al. 1993). Knowledge of T_{set} is useful as an indicator of the T_b that an organism tries to achieve and maintain during thermoregulation (Angilletta and Werner 1998). Careful regulation of T_b increases the time spent at physiologically favorable temperatures (Huey et al. 1989). It is often assumed that T_{set} is the optimal temperature range since an animal would strive to maintain a T_b at which it performs and/or functions optimally (Bartholomew 1977).

Measuring T_{set} is significant in studies of ectotherms because it provides a yardstick against which field or operative temperatures (T_e) can be compared and the effects of environmental or physical conditions on thermal performances can be evaluated (Al-Johany and Al-Sadoon 1996; Van Damme et al. 1986). T_{set} is measured in the laboratory using thermal gradients or mosaics, which have been used in studies of thermal preferences in a wide variety of reptiles (e.g., see Al-Johany and Al-Sadoon 1996; Blouin-Demers et al. 2000; Firth and Belan 1998; Gvoždik and Castilla 2001; Patterson and Davies 1978; Stapley 2006; Tosini et al. 1995). While thermal gradients are useful in thermal studies on reptiles, thermal mosaics are preferable because they provide multiple thermal gradients and therefore create more choices for the reptile. Thermal gradients are generally constructed as a box with one end heated and the other end cooled creating a thermal gradient from one end to the other, which results in only one location for any particular temperature. In thermal mosaics, two opposite corners are heated and the other two corners are cooled, which establishes multiple gradients across the floor of the box. In a mosaic, the reptile is therefore able to choose among different areas that are the same temperature.

For semi-aquatic reptiles, the ability to regulate T_b within T_{set} may vary considerably between aquatic and terrestrial habitats. Water has a higher thermal inertia than air and is therefore more thermally stable than many terrestrial habitats. Although a terrestrial mosaic is useful in measuring T_{set} in a terrestrial environment, the thermoregulatory abilities and/or preferences of semi-aquatic reptiles in water may vary due to the different thermal properties of water. Owing to limitations with the design and construction of thermal mosaics, studies of thermal preference have been conducted primarily on terrestrial species.

Thermal preferences in fish are commonly measured using shuttleboxes. The shuttlebox usually consists of two chambers connected by a channel. The difference in the water temperature between the chambers is constant and the fish is able to move freely between the chambers. The temperature in the chambers is usually increased or decreased depending on whether the fish chooses the warmer or cooler chamber. The preferred temperature is measured as the actual chamber temperature (e.g., see Mortenson et al. 2007) or determined by the time spent in each chamber (e.g., see Larsson 2005). Thermal gradients are also used in some studies measuring thermal preferences in fish. These thermal gradients generally comprise a large box divided into zones or lanes with varying temperatures along the length of the box to create a temperature gradient (e.g., see Lafrance et al. 2005; Podrabsky et al. 2008). Tamplin (2006) successfully used an aquatic thermal gradient (similar to those used in fish studies) to investigate the thermal preferences of hatchling Wood Turtles (*Glyptemys insculpta*), but, to the best of our knowledge, there have been no studies of semi-aquatic or aquatic reptiles using an aquatic mosaic.

Here, we provide a description of a novel aquatic mosaic we successfully used in investigating thermal preferences in juvenile Yellow Anacondas (*Eunectes notaeus*; SVL 0.5–0.6 m, mass ca. 180 g; N = 8; McConnachie, Greene and Perrin, unpublished data) and Common Brown Water Snakes (*Lycodonomorphus rufulus*; SVL 0.4–0.6 m, mass ca. 60 g; N = 5; McConnachie and Perrin, unpubl. data).

The aquatic thermal mosaic (1.2 x 1.2 x 0.5 m) was constructed from 10 mm marine plywood with a transparent acrylic fitted lid. The plywood box was divided into 16 three dimensional (300 x 300 x 200 mm) compartments with 10 mm marine plywood partitions and the interior walls were coated with fiberglass. Each compartment contained an immersion heater (500 W – reconfigured to run at 250 W), earthing rod (for the safety of researcher and reptiles in case of a short circuit), temperature sensor and air stone (Fig. 1).

Fig. 1. Layout of the aquatic thermal mosaic. The immersion heater and temperature sensor were placed in opposite corners of compartments to ensure even heating of the water in each compartment.

Each immersion heater and corresponding temperature sensor was connected to a thermostat (-40–50ºC, resolution 0.1ºC) located in one of two control panels. Eight standard dual tube aquarium air pumps (Jumbo Jet 7800) powered the 16 air stones to circulate heated water. All wiring and tubing was glued and/or taped to the partitions or sides of the mosaic and each heater was enclosed in plastic mesh to avoid influencing or interfering with snake movement (Fig. 2). Each compartment was filled with water to within 5 mm of the top of the partitions and randomly assigned a temperature between 10ºC and 45ºC at 5ºC increments. We decided on a random placement of temperatures to create numerous gradients between the different compartments and to provide the snakes with as heterogeneous an environment as possible. The mosaic was set up in a constant environment (CE) room with T_a of 10ºC to maintain low temperatures and to encourage snakes to remain in the water. (Very little is known about Yellow Anacondas or Common Brown Water Snakes in the wild, but both occur in areas which experience environmental temperatures below freezing. A T_a of 10ºC is likely to be at the lower end of range of T_es usually available to both species in the wild.) The range of aquatic T_es available to the snakes (17-44ºC) was measured using 100 iButtons (Dallas Semiconductor, Texas) spread throughout the mosaic.

In order to avoid a build up of condensation on the acrylic lid of the aquatic mosaic, we raised each side of the lid to an angle of approximately 30º. A bracket was made for each side and the gap was covered in 30% shade cloth to allow moisture out, but keep snakes in. Although the modification resulted in some evaporative water loss, particularly from the warmer compartments, we were able to run a full trial (36 h; 12 h acclimation, 24 h recorded trial) without having to add water.

The design and construction of the aquatic thermal mosaic allowed us to establish the T_{set} for juvenile Yellow Anacondas (ca. 28ºC) and Common Brown Water Snakes (ca. 21ºC; calculated as the range of T_bs selected over the 24 h recorded trial; data from these experiments to be published elsewhere). Similar to a terrestrial thermal mosaic, the aquatic thermal mosaic provided multiple thermal gradients over a wide range of temperatures, which were easily adjusted. Because our mosaic allowed for such a wide range of temperatures, it should be suitable for determining T_{set} (and other thermal preference measurements) for species with different thermal requirements.

We encountered a variety of problems during construction and running of the aquatic mosaic. In the aquatic mosaic, snakes were observed resting on the partitions between compartments, with parts of their bodies in one or more compartments. Although completely aquatic species may spend all their time submerged in one compartment or another, semi-aquatic species can be expected to spend some time out of the water. Our compartments may have been too deep for the snakes to rest comfortably while submerged in the water. The snakes may also have preferred the support of the compartment wall because there were no resting points within the compartments. A stone or small branch submerged in each compartment would provide a shallower resting point within the compartment, which may encourage the snakes to remain in the compartment.

The immersion heaters we used initially were designed to heat water in coffee cups and often malfunctioned or burned out. While the immersion heaters were suitable for our study on juvenile Yellow Anacondas, they were replaced with 100 W aquarium heaters (Resun). The aquarium heaters were more stable and efficient and were used successfully for the study on Common Brown Water Snakes. The built-in temperature control mechanism was bypassed and each heater was controlled using the temperature sensors and controllers. The aquarium heaters proved superior to the immersion heaters, particularly because they can be more finely controlled. In addition, the original heaters in the middle four compartments could only be mounted in the centre of the mosaic. The aquarium heaters could be mounted identically in each compartment, which meant that each compartment was structured identically and was less likely to affect snakes' movements or preferences based on compartment structure. The original heaters also resulted in substantial amounts of evaporative water loss, particularly in the warmer compartments, and the snakes had a tendency to perch
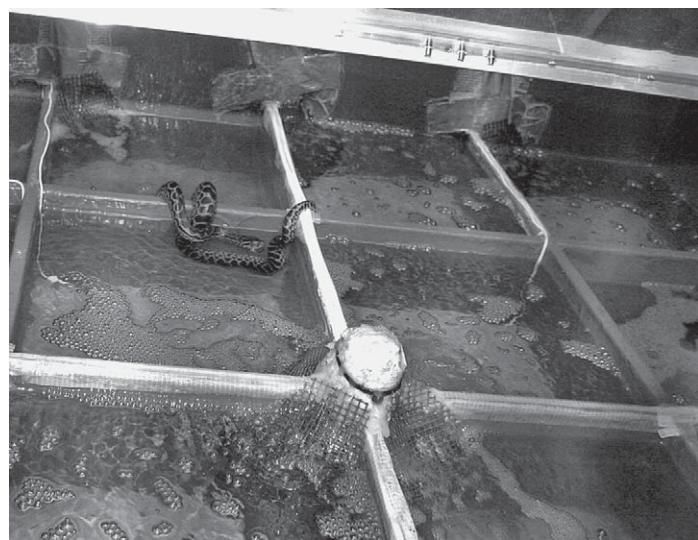

Fig. 2. Juvenile Yellow Anaconda (*Eunectes notaeus*) in the aquatic thermal mosaic. Wiring and tubing were glued and/or taped to the partitions or sides of the mosaic and each heater was enclosed in plastic mesh.

out of the water on the compartment partitions. Heating with the aquarium heaters resulted in less evaporative water loss, so the snakes tended to remain submerged instead of perching out of the water on the partitions.

Temperature in the aquatic thermal mosaic was easily adjusted using the temperature controllers. In addition, the temperature of the CE rooms where the mosaics were housed could also be adjusted. Adjusting both CE room and heater temperatures allow for a wide range of temperatures. Also, temperatures in individual compartments in the aquatic thermal mosaic could be individually controlled, so temperatures for compartments could be randomly or structurally organized. While we were able to maintain stable temperatures in most compartments, we were not able to maintain the lowest temperatures because warm compartments adjacent to coldest compartments often warmed them. There was no insulation between adjacent compartments other than the marine plywood partitions. Additional insulation may be necessary to maintain distinct temperature differences between compartments.

Overall, the aquatic thermal mosaic worked well for determining thermal preferences of juvenile Yellow Anacondas and Common Brown Water Snakes, and is suitable for use with other semi-aquatic reptile species. Despite the problems we experienced with the immersion heaters, they worked sufficiently to complete the Yellow Anaconda study, but the aquarium heaters used in the Common Brown Water Snake study are better suited. The ability to adjust the temperatures of both heating and cooling systems (directly through heaters or indirectly through changing T_a) suggests that the aquatic mosaic is suitable for use in studies on other aquatic and semi-aquatic snakes and potentially other aquatic and semi-aquatic ectotherms. Fine-tuning the mosaic for the requirements of each species will enhance the success of the apparatus while investigating thermoregulation in aquatic and semi-aquatic animals.

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A New View from a Novel Squeeze Box Design

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Obvious risks are associated with measuring venomous snakes. Herpetologists have employed several methods for restraining venomous snakes while taking measurements, including, but not limited to holding the snake behind the head by hand, anesthesia, tubing, and squeeze boxes (Fitch 1987; King and Duvall 1984; Quinn and Jones 1974). The squeeze box method may be considered among the safest options because it does not require direct contact with the animal. Squeeze boxes generally consist of a wooden box with a foam insert that fits snuggly inside the box and a Plexiglas® sheet that fits inside the box on top of the foam insert (Quinn and Jones 1974). The clear sheet permits general morphological measurements such as snout-vent length (SVL) and tail length (TL) (Quinn and Jones 1974). However, the traditional squeeze box design only allows a dorsal view of the snake. Here we present a new variation on the traditional squeeze box design that permits both a dorsal and ventral view of the study animal.

Traditionally, tongs are used to place snakes between the Plexiglas® top and foam rubber base, permitting a safe estimation of snout-vent length from a dorsal view (Quinn and Jones 1974). Little has changed in the squeeze box design, although modifications have been made with lightweight materials for field use (Cross 2000). Our squeeze box design maintains the general shape of the traditional box. Size during construction will vary according to the animals being investigated. The sides are constructed of wood with a foam pad placed inside. In addition to a Plexiglas® top, our squeeze box also has a Plexiglas® bottom secured to the sides with screws (Fig. 1). Holes are drilled through the center of the opposing sides of the box allowing a dowel to pass across the top piece of the Plexiglas®, which locks the removable Plexiglas® lid in place while viewing the animal's venter. Large boxes may require holes on each side of the box and two dowel rods to ensure a secure hold on the animal. Holes are drilled at varying levels to allow for variation in the robustness of different species. In order to view the venter, the animal is placed in the box on top of the Plexiglas® bottom, with the foam pad and Plexiglas® lid placed on top of the animal. Therefore, the snake can be safely viewed from above, like the traditional box, and from below.

Some snake measurements depend on ventral markers, such as the cloacal vent, ventral pattern and scale counts. Using a traditional squeeze box to estimate ventral markers from a dorsal view may lead to significant error in measurements (Bertram and Larsen 2004). To compare measurements, the SVL of 10 watersnakes (*Nerodia fasciata*) were traced from both the ventral and dorsal views. Each trace was measured three times with a flexible tape measure and the means of the ventral and dorsal measurements were compared using a one-tailed paired t-test. Bertram and Larsen
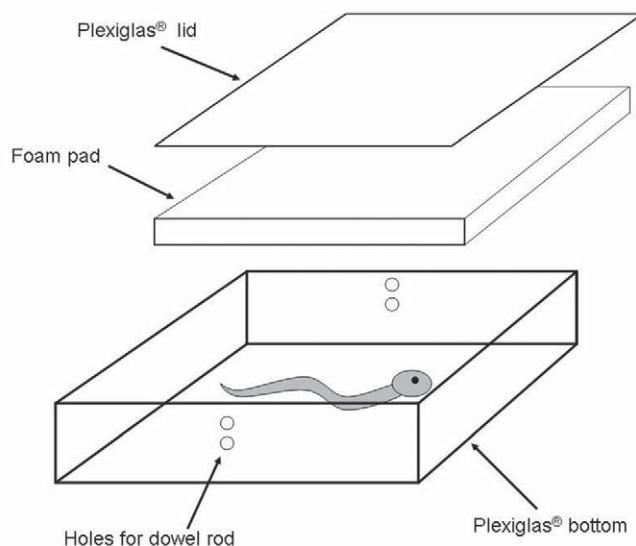

FIG. 1. Diagram showing the method for viewing the venter of snakes in the novel squeeze box.

(2004) found the accuracy of this measuring method equal to more rigorous methods and with less stress to the animal. From the dorsal view, SVL was significantly overestimated relative to the ventral view (mean$_{dorsal}$ = 45.45, mean$_{ventral}$ = 43.99; d.f. = 9, $P = 0.0038$), and the average standard deviation was less for the ventral view (SD$_{ventral}$ = 0.231, SD$_{dorsal}$ = 0.369).

With the use of the new squeeze box design, the dowel rod secures the lid at a chosen height, lightly squeezing the study snake between the Plexiglas® bottom and the foam insert. When turned over the snake remains in place, permitting confident measurements of SVL and TL. In addition to improved measurement accuracy, the new design allows a ventral view of the snake for photography or studies involving patterns or coloration. Further, with both dorsal and ventral views, scale counts can be taken safely on live individuals.

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AMPHIBIAN DISEASES

This section offers a timely outlet for streamlined presentation of research exploring the geographic distribution, host range, and impact of emerging amphibian pathogens, especially the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) and ranaviruses. *Bd* is an emerging pathogen linked to mass mortality and declines of amphibians worldwide, yet Bd has also been detected in amphibians without disease. Ranaviruses also cause mass mortality, but have not yet been linked to large-scale declines. We know relatively little about their global distribution, host range, or impacts on host populations. To improve our understanding of the scope of this issue, we encourage submission of studies that illuminate the geographic distribution, host ranges, and impact of these pathogens on amphibian populations, including research on individual species or groups of species, wild or captive animals, native or non-native species, live animals or museum specimens, environmental samples, and, provided there is sufficient sampling[1], reports of non-detections.

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

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

Batrachochytrium dendrobatidis in Arboreal and Lotic Water Sources in Panama

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Chytridiomycosis caused by the pathogenic fungus *Batrachochytrium dendrobatidis* (*Bd*) has been implicated as a cause for many widespread amphibian declines (Berger et al. 1998; Bosch et al. 2001; Briggs et al. 2005; Ron and Merino 2000; Skerratt et al. 2007). Amphibians of Central America have experienced substantial declines involving 30 genera and nine families (Young et al. 2001) and *Bd* has been implicated in a number of these declines (Lips et al. 2006). For example, about 50 percent of the amphibian species at Las Tablas, Costa Rica, have declined or disappeared apparently due to *Bd* infection (Lips et al. 2003). A more thorough understanding of the natural history and ecology of *Bd* is still needed, and knowledge of the geographic distribution of this fungal pathogen is important for biological conservation (Adams et al. 2007; Young et al. 2001). Recently described techniques allow for the rapid detection of *Bd* DNA from skin swabs (Boyle et al. 2004) and environmental water sources (Kirshtein et al. 2007; Walker et al. 2007). To gain insight into the spatial distribution of *Bd* within a neotropical cloud forest habitat we utilized water filtering and quantitative PCR techniques to: 1) determine the presence of *Bd* in lotic water sources at a site where historic die-offs were attributed to *Bd* mortalities; and 2) determine if *Bd* was present in water collected in arboreal, epiphytic bromeliads.

Methods.—Our study was conducted in the cloud forests of the Los Quetzales Preserve (8.876389°N, 82.547222°W, 2200 m elevation), a private land holding adjacent to Parque Nacional Volcan Barú, Chiriquí Province, Panamá. We used the US Geological Survey (USGS) Backcountry Chytrid-water Field Protocol (C. Anderson, pers. comm.), similar to that described by Kirshtein et al. (2007), to detect and quantify the presence of *Bd* zoospores in water between 4 and 7 January 2008. Using vinyl examination gloves, we processed one sterile water control, as well as samples from a headwater stream (N = 3) and bromeliads (N = 5). Zoospores in sampled water were trapped by using sterile 60 cc syringes with Leur-lok® ends to pump water through 0.22 μm Sterivex™-GP filters. The volume of pumped water necessary to nearly occlude each filter was recorded. Filters were rinsed with 50 ml of sterile buffered phosphate saline (Sigma-Aldrich P5368). Filters, with retained particulates, were preserved with 0.9 ml of cell lysis solution (Fisher Scientific FP2301320). Cell lysis accommodated sample storage under variable field temperatures until subsequent laboratory analysis (Kirshtein et al. 2007). Sterile Leur-lok® caps were used to seal filter inlets, while a hematocrit sealant was used for outlets of each Sterivex™ filter. All sample filters were labeled and sealed individually in plastic zippered bags.

Stream samples were obtained from a 1st-order tributary of Río Chiriquí Viejo. This permanent stream was ca. 1 m wide and maximum depth was approximately 0.1–0.3 m. Water clarity was high and the primary substrates were gravel and cobble, with small areas of sand and silt accumulation in low velocity pools and along stream edges. Stream temperature at the time of sampling was a mean of 13.1°C. There was little aquatic vegetation and only slight amounts of organic debris, with low levels of suspended and dissolved organic matter. During sample collection, the weather was overcast with a light drizzle and air temperature was 8.5°C. Water was collected from riffle zones near the stream margin at 25 m, 75 m and 125 m upstream from the river confluence. We filtered 4.0 L, 4.2 L and 4.0 L respectively (see Table 1). These quantities were roughly double the maximum filtered volumes from lentic waters reported by Kirshtein et al. (2007), owing to the lack of suspended material in the stream.

Bromeliads at heights of less than 1.75 m were sampled from the ground, while those located higher in the canopy (from 2 to 11 m) were accessed using both single and doubled rope techniques. Water was collected by pulling down exterior bromeliad leaves, re-

TABLE 1. Quantitative PCR analyses were used to detect the presence of the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) in water samples collected from a first-order stream and from arboreal sources (bromeliads) at Los Quetzales Reserve, Guadalupe, Panamá, in 2008. *Bd* zoospore equivalents per liter are reported for each of two replicate samples analyzed (rep) and their means. NA = Not applicable; ND = Not detected.

Water Source	Upstream from confluence (m)	Bromeliad Height and Number Sampled (N)	Water Volume Filtered (L)	*Bd* Zoospore Eq/L rep 1	*Bd* Zoospore Eq/L rep 2	Mean (SD) *Bd* Zoospore Eq/L
stream	25	—	4	6.3	4.2	5.3 (1.4)
stream	75	—	4.2	6.6	3.6	5.1 (2.1)
stream	125	—	4	9.0	6.0	7.5 (2.2)
bromeliads	-	0.9m (5), 1.2m (2), 1.5m (6), 1.8m (2)	0.066	ND	ND	NA
bromeliads	-	0.9m (3), 1.2m (3), 1.5m (2), 2.1m (5), 2.4m (2), 2.7m (2)	0.16	ND	ND	NA
bromeliads	-	0.m1 (1), 0.6m (2), 0.9m (1), 1.2m (2), 1.5m(1), 1.8m (3), 2.1m (1), 2.4m (2), 2.7m (1)	0.025	ND	ND	NA
bromeliads	-	1.2m (1)	0.035	6,840	6,720	6,780 (85)
bromeliads	-	11m (1)	0.084	3,580	3,920	3,750 (240)
field control	NA	NA	1.0	ND	ND	NA
lab control	NA	NA	0.15	ND	ND	NA

leasing stored water from leaf axils. As water was released it was captured in clean, 3.78-L plastic zippered bags. Underlying leaves on one side of the bromeliad (the lowest side if the bromeliad was growing at an angle) were successively bent down releasing additional water that dripped off the leaf tip. Individual bromeliads were sampled by this method until sufficient water had been obtained for a filter sample (~1 L). The amount of water from each bromeliad varied due to varying water holding capacities of the plants. Approximately 25–50 ml of water was obtained from each bromeliad. Three of the arboreal bromeliad water samples contained water from multiple bromeliads, ranging from 7 to 17 plants, and from heights of <1 to 6 m off the ground (Table 1). Two arboreal water samples were from a single bromeliad each, at heights of 1.75 m and 11 m. Bromeliad water ranged in temperature from 12.0 to 13.9°C. The five bromeliad samples had filtered water volumes ranging from 25 to 160 ml (Table 1). Because of the large amount of suspended organic material, we let each sample settle at ambient temperatures (< 17°C) for 2–7 h before extracting water for filtering. The high organic content of bromeliad water resulted in rapid clogging of the filters. All filters were labeled and placed in their own labeled plastic bag. Copies of data forms and bagged samples were shipped to the USGS laboratory in Virginia, USA, where they were analyzed using qPCR techniques (Boyle et al. 2004; Kirshtein et al. 2007).

Results.—Quantitative PCR analyses detected the presence of *Bd* in 5 of 9 water samples (Table 1). There were no *Bd* zoospores detected in the control sample. All three stream samples were positive for *Bd* zoospores, and two of the five bromeliad water samples tested positive for *Bd* zoospores (Table 1). The two positive bromeliad water samples were from plants that had the canopy-dwelling tree frog, *Isthmohyla picadoi* (Hylidae), in the plant or nearby (~1 m away).

Discussion.—These findings are significant because they confirm the presence of *Bd* at a site where declines of the local amphibian fauna have occurred (pers. observ.). Mortalities now believed to be caused by *Bd* were first observed in this area (Cerro Pando) in July 1994 (pers. obs.). Mortalities were directly observed in two species, *Atelopus chiriquiensis* and *Rana warszewitschii* (single dead individual of each species). Neither of these species was observed at our study site during three weeks of field research in January 2008. The apparent decade-long persistence of *Bd* has sobering implications for the prospects of repatriating susceptible amphibian species (Fellers et al. 2007).

In addition, while water filtering has been used to detect the presence of *Bd* zoospores in temperate, lentic waters (Kirshtein et al. 2007; Walker et al. 2007), to our knowledge this is the first published report of environmental testing using this technique in neotropical regions and lotic waters. The levels of *Bd* zoospore equivalents in our lotic samples were within the lower range of levels reported from temperate, lentic systems (Kirshtein et al. 2007; Walker et al. 2007; C. Anderson, pers. comm.). Tropical stream-dwelling amphibian species from moderate to high elevations in Central America have experienced inordinate levels of decline (Lips et al. 2003; Pounds et al. 2006), and Kriger and Hero (2007) found a greater prevalence of *Bd* infection among stream breeding amphibians in Australia. Consequently, the ability to detect the presence of *Bd* in lotic waters should prove vital to better understanding *Bd* ecology (Walker et al. 2007). The technique described herein is suitable even when low amphibian abundance prohibits skin swab sampling.

Although there are no known published accounts of *Bd* in arboreal water sources, a study by Longcore (2005) documented the presence of the fungal groups Chytridiomycota, Oomycota, and Hypochytridiomycota from canopy detritus samples obtained in New Zealand and Australia. Twelve of the species detected by Longcore (2005) were chytrids. We report the first published account of *Bd* in arboreal water sources. Our values are ~10x higher than any published samples acquired via these techniques. For example, Kirshtein et al. (2007) reported a range of 19–454 zoospore equivalents/L, and Walker et al. (2007) described ranges from 0.5 to 262 zoospore equivalents/L. Filtering water as soon as possible is advised, since Hyatt et al. (2007) reported declines in zoospore abundance in water samples that are allowed to settle for longer than 8 h. In addition, Hyatt et al. (2007) indicated that zoospores appear to attach to water containers. Consequently, an improved technique may include rinsing sample bags and filtering the rinsate. The presence and abundance of *Bd* in our arboreal samples suggest that arboreal sites may serve as additional environmental reservoirs,

facilitating the persistence of *Bd*.

Various hypotheses have been proposed to explain how *Bd* persists in the environment, including the presence of a saprophytic form (Johnson and Speare 2003; Longcore et al. 1999) although none has been described for *Bd*. Di Rosa et al. (2007) suggested that we still do not understand the entire life cycle of *Bd*, and they described a new growth form that may represent a persistent encysted-form. Non-vertebrate hosts have been proposed and Rowley et al. (2006) initially asserted that freshwater shrimp were *Bd* vectors, although subsequent studies failed to verify this hypothesis (Rowley et al. 2007). Regional persistence may be explained by reservoir species of amphibians that are not lethally infected (Briggs et al. 2005), and such species are known to occur in some areas (Daszak et al. 2004; Garner et al. 2006; Woodhams et al. 2007). While we have not yet identified a specific amphibian host, it is possible that infected individuals of two canopy-dwelling amphibian species occurring at this site are responsible for shedding *Bd* zoospores into bromeliad water. Work is currently under way to analyze skin swabs of *Isthmohyla picadoi* and *Bolitoglossa* sp. from this study site for the presence of *Bd*.

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Presence of *Batrachochytrium dendrobatidis* at the Headwaters of the Mississippi River, Itasca State Park, Minnesota, USA

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The disease caused by the pathogenic fungus *Batrachochytrium dendrobatidis* (*Bd*), chytridiomycosis, is one of several factors driving the global decline of amphibian populations (Blaustein and Kiesecker 2002; Lips et al. 2006; Muths et al. 2003). *Bd* has been found in amphibians at sites across North America including Minnesota, USA (Ouellet et al. 2005; Woodhams et al. 2008). The prevalence of *Bd* in wild anuran populations in Minnesota is unknown, and motivated the work described herein.

We investigated the occurrence of *Bd* at the University of Minnesota's Itasca Biological Station and Laboratories in Itasca State Park, site of the headwaters of the Mississippi River. Our research objectives were to: 1) verify if *Bd* is present in the park; 2) determine which anuran species are affected by the fungus; and 3) test if there are differences in infection rate among species.

Methods.—We collected frogs in Itasca State Park, Clearwater County, Minnesota in June and July 2008. We collected frogs by hand and with nets at night in breeding ponds and during the day near ponds and wetlands. We rinsed nets with 95% ethanol between outings and wore latex gloves in the field and the laboratory to prevent potential transfer of *Bd* among individuals. A subsample of frogs was toe-clipped and released in the field, but most were vouchered. Toe-clips were collected in individual plastic bags and we extracted genomic DNA immediately upon return to the laboratory. We kept frogs individually in plastic bags from time of capture until they were euthanised in the laboratory. Frogs were humanely euthanised with MS-222 (tricaine methanesulfonate) or topical application of benzocaine (Simmons 2002). MS-222 does not appear to inhibit growth or detection of *Bd* (Webb et al. 2005) and was the preferred method of euthanasia. We clipped one toe and a portion of adjacent webbing to obtain tissues. We stored tissues in 95% ethanol at 4°C until processing. All vouchers were deposited in the Bell Museum of Natural History, University of Minnesota (JFBM).

We extracted genomic DNA from tissues using the Qiagen extraction kit (Qiagen, Valencia, CA, USA) following the manufacturer's instructions. We used polymerase chain reaction (PCR) to amplify a 300-bp fragment consisting of part of internal transcribed spacer 1 (ITS1), ribosomal rRNA 5.8S, and part of internal transcribed spacer 2 (ITS2) using *B. dendrobatidis* specific primers (Bd1a and Bd2a; Annis et al. 2004). PCR was performed in 12.5 µl reaction volumes under the following conditions: an initial denaturation of 94°C for 5 min; 30 cycles of denaturation (94°C for 45 sec), annealing (50°C for 45 sec) and extension (72°C for 1 min); followed by a final extension of 72°C for 5 min. All PCR reactions contained a negative control. PCR products were run on a 1% agarose gel, stained with ethidium bromide and visualized under ultraviolet light. Presence of a strong, defined band approximately 300 bp was considered a positive result.

We sequenced two positive samples to ensure that we had amplified *Bd* rather than non-target DNA. We purified PCR products using Exonuclease I and Shrimp Alkaline Phosphatase (Hanke and Wink 1994). Sequencing was performed using Big Dye (Perkin Elmer, Boston, MA, USA) terminator cycle sequencing on an ABI 3730xl at the Advanced Genetic Analysis Center, University of Minnesota. We used BLAST (Altschul et al. 1990) to verify that sequences were *Bd*.

We tested whether infection rates of *Bd* were significantly different among sampled species and among sampled families of frogs using a Chi-square contingency test. All statistical analyses
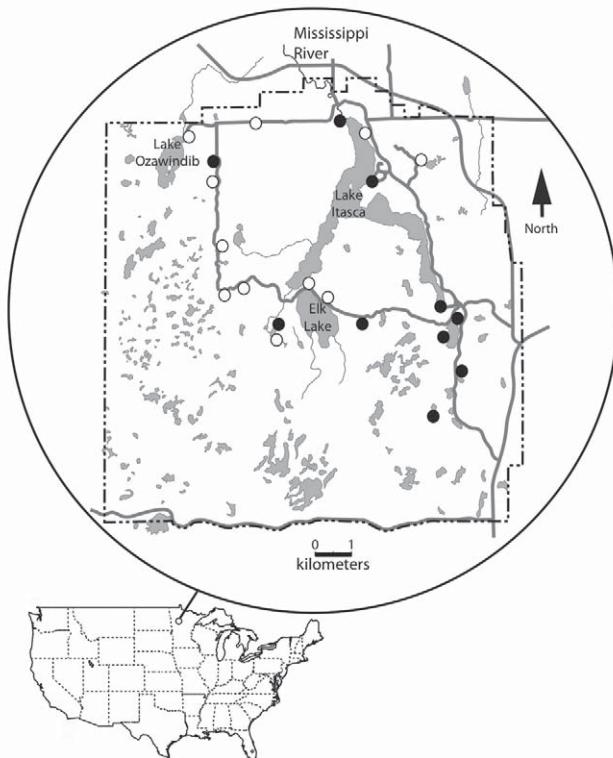

FIG. 1. Collecting locations (circles) of anurans examined for *Batrachochytrium dendrobatitis* (*Bd*) at Itasca State Park, Minnesota, USA. Localities with *Bd*-positive specimens indicated by filled cirlces, localities with no *Bd*-positive specimens indicated by open circles. Park boundaries shown by a dashed line. Light gray areas are water.

were conducted using JMP 7.0 (SAS 2007).

Results.—We collected tissues from 147 frogs and toads of three families from around Itasca State Park (Fig. 1), consisting of 133 vouchered specimens and 14 toe-clips of released frogs. Thirty-four of 147 (23%) individuals were *Bd*-positive. None of our negative controls produced bands on agarose gels. *Pseudacris maculata* had the highest percentage of positive individuals,

TABLE 1. Prevalence of *Batrachochytrium dendrobatidis* in seven frog species collected in Itasca State Park, Minnesota, USA, in 2008.

Species	Family	No. *Bd*-Negative Animals	No. *Bd*-Positive Animals	% Positive (95% C.I.)
Anaxyrus americanus	Bufonidae	20	1	4.8 (0–24.4)
Hyla versicolor	Hylidae	19	0	0 (0–19.8)
Pseudacris crucifer	Hylidae	2	0	0 (0–70.1)
Pseudacris maculata	Hylidae	1	1	50 (9.5–90.6)
Lithobates pipiens	Ranidae	14	7	33.3 (17.1–54.8)
Lithobates septentrionalis	Ranidae	13	3	18.8 (5.8–43.8)
Lithobates sylvaticus	Ranidae	78	22	22 (14.9–31.2)

50% (Table 1), although it is difficult to interpret this given the small number of individuals captured. *Lithobates pipiens* had the second highest infection rate with 33.3% of samples being *Bd*-positive. *Hyla versicolor* and *Pseudacris crucifer* had no positive samples. We collected one dead *Lithobates sylvaticus* (JFBM 15957) at the Mississippi River headwaters on the North end of Lake Itasca that tested positive for *Bd*. No other dead animals were found, and no animals were observed with symptoms of illness.

Rates of *Bd* infection differed among species (χ^2 = 16.505, P < 0.0113) and among families (χ^2 = 9.673, P < 0.0079). Frogs in the family Ranidae had a higher infection rate than Bufonidae and Hylidae (Table 1).

We confirmed that DNA fragments amplified using PCR were *Bd* by sequencing two of our positive PCR products. Both sequenced samples, one from *Lithobates sylvaticus* (JFBM 15884, Genbank accession number FJ229469) and the other from *Lithobates pipiens* (JFBM 15918, Genbank accession number FJ229470) had an identical sequence. We compared our sequences to *Bd* sequences on Genbank using BLAST, confirming our samples as *Bd*. Our samples had 100% identity with the following *Bd* sequences from Genbank: EU779867, EU779864, EU779863, EU779862, EU779860, EU779859. Our samples had a 98 % identity with *Bd* sequences AY997031 and EU779866.

Discussion.—Rates of *Bd* infection in Itasca State Park varied among species and families. This variance is similar to observations from other North American sites for the same species (Longcore et al. 2007; Ouellet et al. 2005). North American hylid frogs, for example, typically have had low *Bd* infection rates (Longcore et al. 2007; Ouellet et al. 2005; Pearl et al. 2007) and we found no evidence of *Bd* in the hylid species *Hyla versicolor* and *Pseudacris crucifer*. *Pseudacris maculata* and *Acris blanchardi* appear to be exceptions to this rule (Ouellet et al. 2005; Steiner and Lehtinen 2008) and we found one infected *P. maculata* in the Park. We found the highest rates of infection in the three ranid species examined, *L. sylvaticus*, *L. pipiens* and *L. septentrionalis*. Several hypotheses have been proposed to explain the species-specific variance in *Bd* infection rates. Because *Bd* can persist in aquatic environments (Johnson and Speare 2003), species that spend more time in the water are thought to be at greater risk of infection than species spending less time in the water (Hero et al. 2005; Lips et al. 2003). *Bd* is prevalent in species breeding in permanent wetlands and streams (Kriger and Hero 2007) and in species that overwinter in aquatic environments (Longcore et al. 2007). There is also, poten-

tially, a phylogenetic component to *Bd* (Corey and Waite 2008) with some amphibian lineages showing greater susceptibility to chytridiomycosis than others.

The presence of *Bd* in multiple frog species in Itasca State Park highlights the pathogen's pervasiveness in North America. North American amphibian populations have been exposed to *Bd* since the early 1960s and have been found across the continent (Ouellet et al. 2005). Presence of *Bd* does not always lead to mortality or population declines (Retallick and Miera 2007) but, given its potential as a pathogen, the presence of the fungus is cause for further monitoring of infected populations.

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Chytridiomycosis in Woodhouse's Toad (*Anaxyrus woodhousii)* in Colorado

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As scientists in the 1990s became aware that amphibian populations were experiencing population declines on a number of continents, the most perplexing mortalities were those observed in relatively pristine environments in which man-made habitat destruction, introduction of invasive species, or direct application of toxicants were not evident. Mass mortalities of amphibians in these relatively untouched environments, such as wilderness areas of the American West and tropical rainforests in Australia and Central America, shared a number of similarities that suggested a common proximate cause. These similarities were: 1) mass mortalities were observed principally in metamorphosed amphibians; 2) populations experienced severe declines in size, and, in some cases, total extinction; 3) only some of the amphibian species in a given locality experienced declines; and 4) population declines were more pronounced at higher elevations or in cooler regions than in lower/warmer areas (Lips 1998; Carey et al. 1999). Many of the mass mortalities sharing this pattern have now been attributed to a chytrid fungal pathogen, *Batrachochytrium dendrobatidis* (hereafter *Bd*; Berger et al. 1998; Skerratt et al. 2007). The observations that *Bd* is more likely associated with mass mortalities of amphibians at higher elevations in mountain ranges than in the adjacent lowlands have been replicated on several continents. For instance, numerous mass mortalities have been noted above approximately 400 m in Costa Rica and Panama (Lips 1998; Lips 1999; Young et al. 2001) but, even though *Bd* has been documented histologically on a number of species living at lower elevations in these countries, no mass mortalities have been observed (Puschendorf et al. 2006). Die-offs are most pronounced at elevations over 400 m in Australia (McDonald and Alford 1999 and above ca. 2000 m in Spain (Bosch et al. 2001; Bosch and Martinez-Solano 2006).

Woodhouse's Toads *(Anaxyrus woodhousii)* (formerly *Bufo woodhousii*; Crother 2008) are widely distributed in the US throughout the western central plains and Rocky Mountain states, from Montana and South Dakota south to Arizona and Louisiana. In Colorado, this species generally occurs at lower elevations up to ca. 2100 m. It is replaced at higher elevations by Western Toads (*Anaxyrus boreas*) (formerly *Bufo boreas*; Crother 2008) which range from about 2500–3550 m (Livo and Yackley 1997). Only one area of sympatric occurrence of the two species has been reported in Colorado (Hammerson 1999; Harris 1963). Western Toads are very susceptible to *Bd* (Carey et al. 2006). Beginning in the 1970s, Western Toad populations have experienced numerous mass mortalities that have extirpated breeding populations from about 85–90% of their historical habitats (Carey 1993; Corn et al. 1989). Some of these mass mortalities have been attributed to *Bd* (Carey et al. 1999; Muths et al. 2003). In a few instances, Woodhouse's Toad carcasses have been observed in the wild, but the deaths could not be attributed to *Bd*. Some carcasses were observed during one study in Arizona, but the carcasses were too decomposed to analyze for the presence or absence of *Bd* (Sredl 2000). Additionally, one of us (LL) found a dead Woodshouse's Toad in Canyonlands National Park, Utah (17 August 1992, ca. latitude 38.06814, longitude 109.76871) and two dead Woodhouse's Toads at Colorado National Monument, Colorado (24 June 1999, latitude 39.01993, longitude 108.64672). Toads at both of these locations were very decomposed and observed before a PCR test for *Bd* was developed. However, to our knowledge, no observations of mass mortalities of Woodhouse's Toads attributed to *Bd* have been recorded in the literature (see Sullivan 2005). Therefore, the goal of this study was to determine whether or not *Bd* is present on Woodhouse's Toads in Colorado.

A total of 86 Woodhouse's Toads were collected at a number of sites, the elevations of which ranged from 1096 to 2032 m (Table 1). Elevation for each sampling site was determined by plot-

ting the GPS coordinate as decimal degrees (WGS84 datum) with National Geographic TOPO! software (Version 3.4.3). When two or more individuals were sampled within a 10 km distance on the same date and the same drainage complex, the individual sites were combined into a single locality for which the mean elevation and latitude/longitude were calculated. We selected a 10 km distance because Woodhouse's Toads in our sampling areas would encounter fewer barriers to movement within a drainage complex than Western Toads in the mountains of Colorado. This latter species has been reported to move straight-line distances of at least 7–8 km between breeding sites (Lambert and Gaughan 2007), which, when following drainages rather than traversing intervening mountains, would result in movement estimates of more than 15 km.

Each animal was handled with a fresh pair of latex gloves. The ventral pelvic area and back legs were swabbed according to the method of Livo (2004). Swabs were placed in 2-ml vials with 70% ethanol and analyzed for *Bd* DNA by Pisces Molecular LLC, Boulder, Colorado.

Woodhouse's Toads tested positive for *Bd* at several sites in
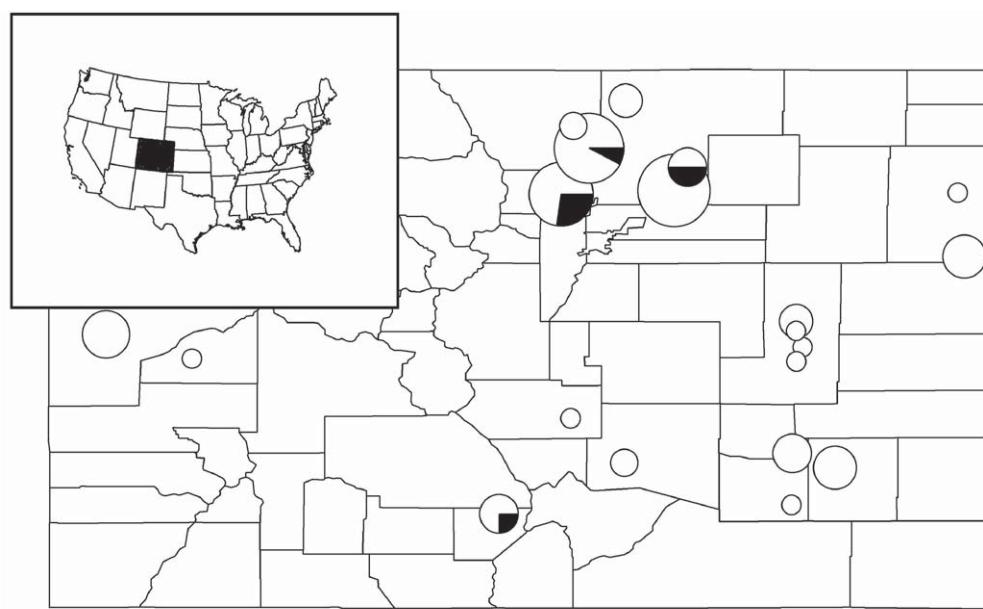
FIG. 1. *Anaxyrus woodhousii* sampling localities (circles) within counties in Colorado, USA. Within circles, open areas represent PCR-negative and black areas represent PCR-positive *Batrachochytrium dendrobatidis* samples. The relative size of each circle is proportional to the total sample size of Woodhouse's Toads. Circles are centered on the localities they represent. In one case, two circles are superimposed: samples were taken at the same location in two separate years.

Colorado (Table 1; Figure 1). Unfortunately, we have been unable to revisit the sites with sufficient frequency to determine whether population sizes are declining at the *Bd*-positive sites. At several localities at which one or more Woodhouse's Toads tested posi-

TABLE 1. *Anaxyrus (Bufo) woodhousii* that tested positive (P) and negative (N) for *Batrachochytrium dendrobatidis* (*Bd*) in Colorado, USA. *Bd*/Other Species indicates whether individuals of other amphibians sampled on the same date at the same locality were all *Bd* negative (N) or any were *Bd* positive (P). ANCO = *Anaxyrus cognatus*; PSTR = *Pseudacris triseriata*; LIBL = *Lithobates blairi*; LIPI/LIBL = *L. pipiens* x *blairi* hybrids; SPBO = *Spea bombifrons*; HYAR = *Hyla arenicolor*.

Date	Latitude	Longitude	Elev. (m)	County	Locality	No. *Bd*-N	No. *Bd*-P	*Bd*/Other Species
25 June 06	37.69439	105.69515	2302	Alamosa	GSDNPP	3	1	P (PSTR) N (ANCO)
9 Aug. 05	38.03862	103.18978	1187	Bent	Las Animas	5	0	N (SPBO)
2 July 04	40.08556	105.21889	1578	Boulder	Boulder Reservoir	2	1	
6 June 05	40.07306	105.23222	1578	Boulder	Boulder Reservoir	8	3	
30 Aug. 00	38.85037	107.98515	1714	Delta	Orchard City	1	0	
15 Aug. 01	38.40592	105.16198	1594	Fremont	Florence	1	0	
24 Aug. 01	40.58122	105.14067	1559	Larimer	Ft. Collins	2	0	N (PSTR)
15 May 05	40.41556	105.02389	1559	Larimer	Boyd Lake	12	1	
23 July 01	38.93520	103.43145	1533	Lincoln	Kinney	1	0	N (LIBL/LIPI)
12 May 03	39.12771	103.47991	1540	Lincoln	Hugo	3	0	P (PSTR)
27 May 03	38.82899	103.47807	1485	Lincoln	Rush Creek	1	0	
27 May 03	39.05677	103.47984	1589	Lincoln	Liberty	1	0	
1 Sept. 00	39.02957	108.62410	1511	Mesa	Echo Canyon	6	0	N (HYAR)
1 Sept. 01	37.76095	103.51485	1308	Otero	Vogel Canyon	1	0	P (LIBL)
10 June 05	38.14518	103.50906	1266	Otero	Cheraw	4	0	
16 Aug. 01	38.07464	104.76079	1601	Pueblo	St. Charles River	2	0	N (SPBO)
29 April 01	40.27450	104.28940	1380	Weld	Painter Road	2	2	P (PSTR)
22 Aug. 01	40.76870	104.75088	1612	Weld	Dover	3	0	
3 Aug. 05	40.10047	104.38910	1461	Weld	Prospect Valley	14	0	N (SPBO, LIPI)
30 July 01	40.08368	102.27472	1096	Yuma	Stalker Lake	1	0	N (LIBL)
12 April 03	39.60908	102.22553	1127	Yuma	Republican River	5	0	N (PSTR)

tive, other amphibian species also tested positive. In two cases (locations: Hugo, Lincoln County; Vogel Canyon, Otero County), another species tested positive but the Woodhouse's Toad samples were negative. While the presence of *Bd* on a single animal is sufficient to indicate that a locality is *Bd*-positive, small sample sizes at the localities at which all samples tested negative for *Bd* preclude judging whether or not *Bd* is actually present.

Some of the Woodhouse's Toads that were PCR positive for *Bd* were taken to our laboratory at the University of Colorado and subsequently died within 2–3 weeks after capture with many of the signs of chytridiomycosis (i.e., abnormal shedding patterns, lassitude, and decreased blood ionic concentrations; Carey and Livo, unpubl. data), although the presence of and severity of infection have not yet been histologically verified. Additionally, when newly captured Woodhouse's Toads have been experimentally exposed to *Bd* using standardized methods, they all died and were PCR positive for *Bd*. We tentatively conclude that Woodhouse's Toads are at least mildly susceptible to *Bd* infection and that the infection can prove lethal under laboratory conditions. However, whether or not *Bd* causes declines in Woodhouse's Toad populations in the wild deserves more research.

The effect of temperature on *Bd* growth may explain, in part, observations that amphibians living at lower elevations do not experience population declines due to *Bd* (cf. Puschendorf et al. 2006), whereas adjacent high elevation populations do. Exposure of an infected animal to 30°C can control or even kill *Bd* (Woodhams et al. 2003; Carey and Livo, unpubl. data). Amphibians living at higher elevations do not achieve such high temperatures for sufficiently long times to kill *Bd* (Carey 1978; Carey et al. unpubl. data) and, as a result, are unable to shed the fungus once they become infected.

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HERPETOLOGICAL HISTORY

Memories of John William Daly (1933–2008): A Biographical Sketch and Herpetological Bibliography

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John Daly—pioneering chemist, pharmacologist, and field herpetologist—died from sepsis associated with pancreatic cancer on March 5, 2008, in Rockville, Maryland. This brief history celebrates a career that fundamentally advanced basic and applied research in biology and medicine. We see frogs and birds and tiny creatures on the jungle floor in new light because of his enthusiastic study of things small and wonderful.

John was born on June 8, 1933 to John E. Daly and Hilda Daly in Portland, Oregon. He received degrees in Biochemistry (B.S., 1954) and Organic Chemistry (M.A., 1955) at Oregon State College, and a Ph.D. (1958) in Organic Chemistry at Stanford University. This was followed by a two-year postdoctoral appointment (1958–1960) at the National Institutes of Health (NIH), in what was then called the National Institute of Arthritis and Metabolic Diseases.

John's appointment was to Bernhard Witkop's Laboratory of Chemistry. Witkop allowed a degree of freedom to his postdoctoral chemists, and John spent time studying catecholamine neurotransmitters under the mentorship of Julius Axelrod, a section chief in a different NIH institute (Mental Health). Axelrod, who received a Nobel Prize for his work on catecholamines in 1970, later remembered (in 1998) that "John somehow drifted to our lab, and I was struck by his intense interest in research."

John was to spend all his professional life at the NIH institute that eventually became (in 1986, after two previous names) the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). He was appointed to the permanent staff as Research Chemist in Witkop's Laboratory in 1960, became Chief of the Section on Pharmacodynamics in 1969, and became founding Chief of his own Laboratory of Bioorganic Chemistry in 1981.

John became a NIH Scientist Emeritus in January 2003 and enthusiastically continued his research on frog toxins nearly to the week of his death. He is survived by his daughters, Kathryn Daly and Shannon Ostrander, his sister, Hildred Powers, four grandchildren, and his life partner Kathleen McKnight.

During five decades at NIH, John's research spanned several disciplines. The isolation, structural determination, and synthesis of novel natural products was only one interest. He also was especially keen on elucidating the pharmacodynamics of such products, with emphasis on receptors, ion channels, and second messenger formation in the nervous system. Some high points in his career included major discoveries and co-discoveries such as the "NIH Shift"—a surprising molecular mechanism that occurs during conversion of the amino acids phenylalanine and tryptophan to the crucial neurotransmitters dopamine, norepinephrine, and serotonin; the finding that forskolin, from the plant *Coleus*, directly activates adenylyl cyclase, an enzyme responsible for the formation of the intracellular messenger cyclic adenosine monophosphate (cyclic AMP) from ATP; the introduction of a prelabeling technique for investigation of cyclic AMP generation in intact cells; the introduction of a variety of selective agonists and antagonists as probes and radio ligands for adenosine receptors; discovering that the stimulant effects of caffeine in the central nervous system result from blockade of adenosine receptors; the finding that maitotoxin (the most potent marine toxin, produced by a dinoflagellate) stimulates breakdown of metabolically important phosphoinositide; that the anti-diarrhea drug loperamide is a unique modulator of a capacitative calcium influx pathway and that *N*-substituted dihydropyridines are selective blockers of such channels.

John's work on "frog alkaloids" ("dendrobatid alkaloids") led to a series of equally impressive discoveries after he and his associates worked their way through formidable analytical problems. Up to the 1960s, plants generally were considered to be the sole source of alkaloids (bioactive organic nitrogenous ring compounds). Typical plant alkaloids historically were obtained in quantity and structures determined through classic techniques of chemical degradation; alkaloids in frog skin, however, were to be measured in micrograms rather than milligrams. Thin-layer chromatography, electron-impact and chemical-ionization mass spectrometry combined with gas chromatography were used by the 1970s to separate and characterize small samples of "frog alkaloids." And, fortunately, some frogs occurred in exceedingly dense populations that could be harvested without harm to the species, yielding sufficient material for X-ray crystallography of key structures. Before the end of the century, increasingly sophisticated analytical techniques and improved instrumentation were allowing precise determination of many compounds even in a few mg of skin from a single frog.

Hundreds of previously unknown compounds were discovered and assigned to more than 20 structural classes of alkaloids. Many of the new alkaloids have remarkable pharmacological activity, and some of the new classes are characterized by chemical structures unprecedented in nature. Some of these have become widely used as research tools: batrachotoxin as a selective activator of sodium channels; histrionicotoxins as blockers of nicotinic channels; pumiliotoxins as sodium channel agents with biomedical potential as cardiotonic agents; and epibatidine as a nicotinic agonist with potent analgesic activity 200 times stronger than morphine. Many of these alkaloids became targets of synthetic research in laboratories around the world, and synthetic analogues of epibatidine are in clinical trials for treatment of chronic pain from neuropathies, cancer, and arthritis.

Considering his extraordinarily successful career in the laboratory, few of John's numerous collaborators could have been truly cognizant of his proficiency as a tropical field biologist. But, for over four decades, he was *extensively* involved in fieldwork leading to the discovery of over 800 different alkaloids in frog skin.

John himself identified two factors in the genesis of his tropical work. First, his lab chief Bernhard Witkop had studied curare arrow poisons as a student of Nobelist Heinrich Wieland in Germany and was intrigued by reports of a South American "arrow" (dart) poison derived from frogs. Witkop's curiosity led to an important initial

paper with Fritz Märki, a post-doctoral chemist who returned to Switzerland. John was then drawn into the project, eventually becoming lead scientist in the isolation and characterization of the batrachotoxin alkaloids. The second event was a letter from me, as mused by John in various articles and published interviews: e.g., "Our research at the NIH on further alkaloids from frog skins might have ended with batrachotoxin were it not for a news release [that] drew the attention of a herpetologist ..." (Daly 1998a: 165).

This all started in December 1963, when Witkop first sent the young chemist to Colombia to obtain additional skin extracts from a frog used for poisoning blowgun darts. John's involvement came to my attention in the July 16, 1965 issue of *Medical World News*, in a note titled "Deadly Frogs May Yield Therapeutic Agent." At the time, I was on leave from graduate school for a three-year assignment as Visiting Scientist at the old Gorgas Memorial Laboratory in Panama City (funded by an NIH grant with W. E. Duellman and myself as co-investigators). I had recently discovered a remarkable complex of small, brightly colored toxic frogs in the Bocas del Toro region of northwestern Panama, all or most of which seemed to represent a single species, *Dendrobates* (*Oophaga*) *pumilio*. Colors in different micropopulations collectively encompassed the visible spectrum from red to blue, except for one population of achromatic black-and-white frogs.

I mentioned this "exceedingly common" frog in a letter written on September 7, 1965; John responded on September 22 and made his first of many trips to Panama the following January, during a stop-over on his second excursion to Colombia. Our earliest fieldwork together was limited to a few areas accessible by four-wheel drive near Panama City, but we started collaborating immediately on the *pumilio* project. I sent my assistant with John to several of my collecting sites in Bocas del Toro; they obtained some frog-skin samples in methanol and I mailed additional samples a month later.

It was during our early Panama work that John and I initiated what was to become our field "taste test" for presence of pharmacologically active substances in frog skin. I had mentioned (in my 1965 letter) being puzzled as to why small, brightly colored toxic frogs should have no taste when put in one's mouth. We found that some poison frogs first had to be stressed before toxins are released from granular glands; foot-pinching or skin piercing (as by snake teeth) would do the trick. Touching a stressed frog to the tongue

Fig. 1. John Daly and one of our pack horses in the western Andes, on the 1970 Colombian expedition. This trip of 43 days was intended to close out a five-year survey of dendrobatid skin alkaloids. Instead, it stimulated further work by Daly that continued until his death in 2008.

(or frog–finger–tongue) provided a fairly accurate field bioassay for presence of alkaloids. Indeed, the human tongue sometimes seemed more sensitive than early analytical techniques then available at NIH. (Presence of "trace-trace" quantities of a powerful toxin in some specimens of Panamanian *Phyllobates lugubris* was suggested by taste when John's earliest lab tests were negative. Years later, it probably was fortunate that we did *not* taste the new, aptly named *Phyllobates terribilis*.)

A bond was established with my wife Joan and me in Panama, where John became a kind of visiting uncle to our young children, Charles and Tracy. When the time came in 1967 for us to drive back to the U.S., John flew down to travel (and collect) with us as far as San José, Costa Rica. Most of the southern part of the Pan American Highway was a rough, unpaved road in those days and we had scarcely entered Costa Rica when a gear broke in our four-wheel drive carryall. We found a mechanic who had an open-air, dirt-floor garage under a thatched roof. John and I spent anxious hours sitting on boxes, apprehensively watching our cheerfully confident mechanic figure out how to get into the transfer case and fabricating his own tool for one process. That done, he took a bus to the nearest Chevrolet dealership back in Panama and the next day smuggled the needed gear under his belt in order to circumvent Costa Rican customs.

While waiting for our mechanic's return, John and nine year-old Charles and I took a ride in a *cazadora* (a "hunter"), the name then applied to tiny country buses. We got off at a good section of forest

to look for poison frogs. We found two species along a stream that also harbored a surprisingly large population of fer-de-lance snakes. But most of our day was spent waiting for *cazadoras*, with no inkling that John and I were to do a lot of waiting together in coming years—waiting sometimes days at a stretch when bad weather kept planes or helicopters from reaching us at a backcountry landing strip or on some mountain top.

We published the results of our early Panama work in *Science* in 1967. The new alkaloids were mistakenly characterized as "steroidal," but never mind, John was to work on that amazing complex of frogs on-and-off for the next 40 years. But it was early days in 1967 and we were wondering about the extent of variation in skin alkaloids of dendrobatid frogs generally. After a field trip to Venezuela, we innocently decided that one trip to Colombia would allow us to wrap up the work started a few years earlier in Panama. The taxonomic diversity of poisonous frogs in Colombia would be sufficient for testing our hypothesis. The brightly colored species would all contain skin toxins that would be found to vary, but all the toxins probably would prove to be steroidal alkaloids—variations on a common theme. How wrong we were about the last part of that! Instead of finalizing the work, we caught the tail of the proverbial tiger and were unable to let go. Well, I might have let go, but John's enthusiasm could not be quelled.

Our first joint trip to Colombia lasted some 40 days in early 1970, during which time John and I covered thousands of kilometers by jeep, on foot, and by dugout canoe. We drove over much of highland and lowland northern and western Colombia and south nearly to Ecuador and into the Amazon basin. We drove to the end of an unpaved road in the western Andes, left our jeep and trekked a day-and-a-half with a few men and pack horses down to the Pacific lowlands, where we traveled by dugout to a collecting site (Fig. 1).

That was to have been our final trip, but back at NIH the field samples yielded dozens of new compounds in new classes of alkaloids. The tiger was running and over the next 30 years John

Fig. 3. John skinning *Phyllobates terribilis* for methanolic extraction of batrachotoxin alkaloids (1973); in addition to surgical gloves, he is wearing eye and respiratory protection. Batrachotoxin and homobatrachotoxin are among the most potent of all naturally occurring nonprotein toxins. These alkaloids are present in largest quantities (700–1900 μg) in skin of wild-caught *P. terribilis*—the world's most poisonous frog.


Fig. 2. John Daly at the front steps of a 1973 base camp, an Emberá Chocó house in the Pacific lowlands of western Colombia. This was the general type locality of the dangerously toxic new dart-poison frog that we later named *Phyllobates terribilis*.

and I worked together in eight tropical countries in the New World, with each of us also making independent trips to several of those countries. An annual field trip was not enough. Two or three trips a year were not uncommon in the 1970s and 80s, and the new alkaloids multiplied into the hundreds. It was an intensive program of discovery, with each new trip yielding treasures of new compounds and often new amphibians and reptiles as well, including a fearsomely toxic frog used by Emberá Chocó Indians as a source of poison for blowgun darts (Figs. 2, 3).

During the early work in Colombia we wondered aloud whether the "dendrobatid toxins" were synthesized by the frogs or sequestered from dietary sources. To test the last possibility, we extracted fresh stomach contents of a few common species of dendrobatids into methanol, but John was unable to detect alkaloids or potential precursors in those samples and we came to assume that the frogs themselves were inventive chemists. However, neither was he able to demonstrate biosynthetic pathways in a 1971 experiment with David Johnson; there was no incorporation of radioactive cholesterol, acetate, or mevalonate into the steroidal batrachotoxins of *Phyllobates* or the bicyclic or tricyclic alkaloids of *Dendrobates* (although cholesterol had been recently claimed as a precursor of

certain toad toxins and salamander alkaloids). And F_1 progeny of dart-poison frogs raised at the American Museum lacked detectable alkaloids, although they retained an altered sodium-channel that made them immune to their parents' toxins.

We continued to publish as though the frogs were making their own toxins, as seemed consistent with the absolute novelty of many of the alkaloids and the absence of toxicity in stomach contents. But it was a vexing problem in the back of John's mind, renewed by conversations with colleagues and by growing evidence that ants (a major food source) also were a source of interesting alkaloids. I recall John and the late A. Stanley Rand idly talking in Panama about how one might set about doing a "natural" feeding experiment using captive-raised frogs. That idea eventually bore fruit in 1994, when John and Stan and associates demonstrated uptake of alkaloids by froglets raised in outdoor screened enclosures provided with leaf litter from native habitats; some alkaloids also were obtained from a sampling of leaf-litter insects.

Also in 1994, John and colleagues demonstrated the presence of an efficient uptake system for sequestering dietary alkaloids in some (aposematic) dendrobatid frogs. These events suggested that the granular ("poison") glands may be primarily storage sites in some anurans rather than (or as well as) the chemical factories we had supposed. John doggedly pursued the sequestering evidence in a series of collaborative papers interspersed among publications on chemistry and pharmacology. The 1990s and first years of the 21st century saw a constant flow of discoveries emanating from what had become "the alkaloid program" in John's Laboratory of Bioorganic Chemistry. He depended greatly on chemists H. Martin Garraffo and Thomas F. Spande, the mainstays of the program who became involved in most aspects of John's later research.

Among John's numerous collaborators who figured importantly in the early frog studies, special mention should be made of Edson X. Albuquerque (School of Medicine, University of Maryland), who helped pioneer the pharmacology of anuran alkaloids; Isabella L. Karle (Naval Research Laboratory, Washington, D.C.), responsible for most of the X-ray crystallographic characterization of key structures; and Takashi Tokuyama (Department of Chemistry, Osaka City University), who continued collaborating for many years in the chemical studies. Many other talented chemists and pharmacologists became involved at various times, as shown by a reading of coauthors in the Bibliography.

I gradually withdrew from the dendrobatid work in the 1990s to give time to other long-term projects, but John tried to keep me abreast of the alkaloid program and joined me in several Venezuelan expeditions ending in 2000. Our young colleague Taran Grant expanded the systematic work and revised all dendrobatoid frogs in a masterful Ph.D. dissertation that, with John's assistance, made appropriate use of published and unpublished alkaloid data. (Grant's dissertation was published in 2006, with a number of honorary coauthors.)

My former postdoc Maureen A. Donnelly (Florida International University) and her student Ralph A. Saporito became associated with the alkaloid program at century's end. They collaborated with John's group on an important series of papers in 2002–2007 that determined major arthropod sources of dietary alkaloids in *Dendrobates* (*Oophaga*) *pumilio*—the Central American poison frog that John had started studying in 1963, on his first trip to Panama.

John's wondrously multifaceted and productive program at NIH serendipitously came to include birds as well as frogs and arthropods. Knowing that John thrived on the improbable, I called him in early April 1991, with news just received by phone from Jack Dumbacher (then a graduate student at the University of Chicago), who had evidence of toxicity in a bird. A few days later, Dumbacher wrote, "The same day that we spoke ... John Daly called and agreed to run some initial tests." The resulting collaboration between Dumbacher and Daly and their associates led to the extraordinary discovery of batrachotoxins on the feathers of some New Guinea birds; these highly toxic alkaloids theretofore had been known *only* from the Neotropical dart-poison frogs (*Phyllobates* s.s.). Two high-profile papers in 1992 and 2000 were followed in 2004 by the report that batrachotoxin had been found in *Choresine* beetles (Melyridae). Such beetles, known to be eaten by the birds, were also suggested as the putative source for batrachotoxin in frogs.

In the 1990s, John was on the road to convincing himself that *all* frog alkaloids must be sequestered. He sometimes would call me (always early morning) when there was new evidence of an arthropod origin for one class of alkaloids or another. I would tease that he could not yet rule out lack of biosynthesis for batrachotoxins, histrionicotoxins, or some other major class. But one morning he called with the news of early evidence that an Australian frog was manufacturing one of its own alkaloids. This was supported in print in 2002, with the added evidence that the frogs (*Pseudophryne*) were synthesizing one class of alkaloids (pseudophrynamines) while sequestering another (pumiliotoxins). Furthermore, biosynthesis of pseudophrynamines appeared reduced in the presence of high levels of dietary pumiliotoxins! As revealed by electron microscopy (Neuwirth et al. 1979), the granular secretory glands of amphibians are morphologically (and physiologically) complex structures, and generalized assertions about their evolution and function cannot yet be made with confidence.

Nonetheless, John and various associates collectively have shown that dietary sequestration, especially from mites and ants, is the principal source of what we originally termed the "dendrobatid alkaloids." The demonstration in 2007 that mites are a particularly major source of dietary *and other* alkaloids was a striking finding, particularly since the aposematic dendrobatids are generally regarded as ant-mite specialists (based on terrarium observations, they are physically unable to swallow prey as large as taken by many other frogs their size). However, one cannot yet justify stating categorically that all alkaloids in all genera and species of dendrobatid frogs are of dietary origin. A secondary dietary origin was shown for a few species, in which a precursor dietary alkaloid can be hydroxylated to a more potent compound in the frog.

The ultimate source of the myriad dietary alkaloids remains an open question. Some eventually may prove to be synthesized by the arthropods, but John fretted for years that symbiotic microorganisms may be involved (as in some marine occurrences of tetrodotoxin). The tropical forest floor has never been a simple place, but now I imagine it as a molecular jungle swarming with amazingly diverse alkaloids of astounding bioactivity—or, as envisioned by John in 1977, "a virtually untapped source of new pharmacologically active agents from the world's rain forests."

Fortunately, such complexity was not foreseen when we started our explorations. Given the state of analytical chemistry at the time, the thought of surveying alkaloids in microscopic mites would have been discouraging even to John. The frogs then seemed to be chal-

lenge enough, and in their pursuit we were enticed onto memorable journeys. Much of our travel involved wilderness expeditions by dugout or on foot with a few local packers and guides. John and I worked comfortably together in the forest and early on I quit worrying about him after realizing that he had a built-in compass and untapped stores of resourcefulness and common sense. He did not take his sense of direction for granted, however, and did carry a compass, being always appropriately cautious. After starting off collecting together, we commonly got separated in the forest, only to meet up again when it was time for a trail lunch. Neither of us fully understood how that worked.

Taran Grant coined the dendrobatid genus-group name *Adelphobates*, in honor of two "scientific brothers." However, Joan called us "The Odd Couple" after a popular TV series. But we seldom disagreed, although it happened one time during a trip from one place to another along the Colombian coast. We had hired a dugout with a small outboard motor, but it rode only a few inches above water once loaded. John loved boats and was unhappy when I insisted that for safety we travel up-coast through mangrove channels; John was an enthusiastic boatman and wanted us off coast, with the wind and salt spray in his face. Once the tide went out we were stranded for hours with some very poor folks, who were living off seafood easily gathered at a river mouth. Biting flies were so unimaginably bad that their daylight hours were mostly spent in close proximity to smoke pots. They kindly lent smoke pots for us to huddle over until the tide filled the mangrove channels, giving me time to contemplate my cautious stubbornness.

Over the years we were to spend much time living for a few days or a week or so with impoverished people in rural tropical America. We rented their porches for hanging our hammocks and some families came to expect our return in following years. I remember one isolated house at the edge of a jungle, where several fierce-looking men were sharing a single machete; there were tears of gratitude when John handed each a new machete. John enjoyed people and many came to adore him, except at one Indian settlement where small children ran screaming from us. They had been told that we were witches who would carry them away if they disobeyed their parents.

We conducted our back-country work with circumspection and little fanfare. Nonetheless, our interest in dart-poisons and other toxins did not go unnoticed at home or abroad. For example: John and I each received a few curiously probing calls from inquisitors with unconvincing cover; a pleasant, curious gentleman managed an assignment to the seat between us on a nearly empty flight that had vacant window and aisle seats in abundance (we pretended not to notice that he had been seated prior to boarding); colleagues in one foreign capital were questioned by officials about our poison work. Such interest was different from that of the occasional military patrol that sought out our camps in remote areas. We thought that it related to the global publicity and paranoia following disclosure that our Central Intelligence Agency had had a secret cache of exotic poisons (e.g., the paralytic shellfish poison saxitoxin) and methods of using them (e.g., suicide pills and the poison-dart pistol unwisely displayed to Congress in 1975). Not all bioweapon material had been destroyed as ordered by President Nixon in 1969; the CIA's supply of saxitoxin was transferred to NIH in the 1970s and ended up in John's lab.

John and I had separate but overlapping research objectives,
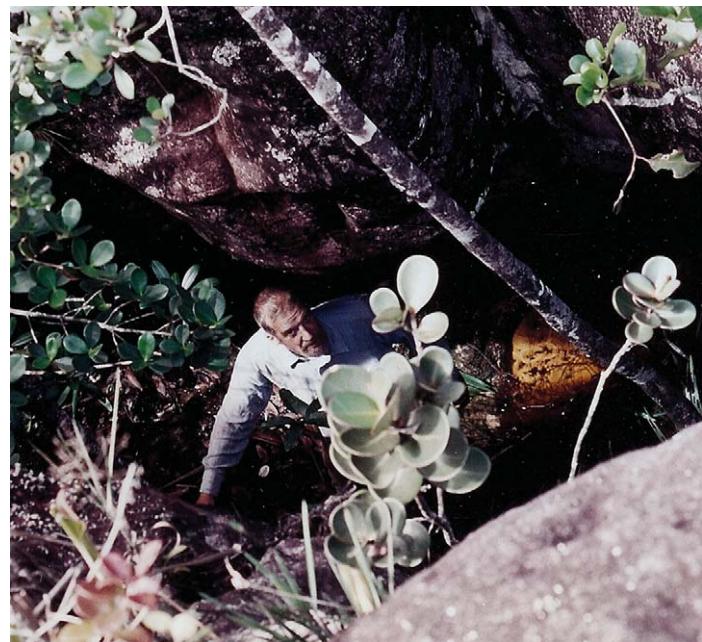
Fig. 4. John in 1994, exploring a sandstone crevasse on the summit of Auyantepui, one of Venezuela's "Lost Worlds."

both heavily dependent on fieldwork and general collecting. The discovery of new species of frogs and new alkaloids often coincided. But we collected amphibians and reptiles generally, often with great enthusiasm on his part. I have vivid memories of this world-renown scientist unceremoniously hurling himself at some small lizard or snake that was trying to scurry or slither into the leaf litter. However, he acceded to my early request that he not catch by hand any brightly-ringed snake. On one of our last trips, John called out that he was standing on a thrashing snake that he optimistically suggested was a coral-snake mimic, to which I soon replied, "It's not a mimic, but keep your foot on it until I decide which end is the head"—another rare specimen bagged thanks to John!

Fortunately for me and for the American Museum, John was interested from the start in sampling skin secretions of as many kinds of frogs as possible. Many amphibians and reptiles are nocturnal and nighttime collecting therefore is essential. With a powerful light strapped to his head, John joined the ranks of truly accomplished collectors. He was enthralled when the wet tropical forest came alive at night. In the early days I might rush to his side when hearing some exclamation of wonderment, only to find him exchanging stares with some gigantic insect and not the rare frog or snake for which I had hoped. After a day searching for diurnal poison frogs, we often were in the forest until after midnight, resulting in discovery of many previously unknown species of amphibians and reptiles.

John became a global collector, gathering frog-skin samples also in Africa, Thailand, and Australia—sometimes in conjunction with a symposium to which he had been invited. In later years John developed a major field program in Madagascar. But his heart was in the wild places in South America, and from 1989 to 2000 he participated when possible in the American Museum's helicopter-supported expeditions to the Venezuelan *tepuis* (the isolated sandstone mesas such as the one in Sir Arthur Conan Doyle's *The Lost World*). There was little of professional interest to John

Fig. 5. John (left) arriving at camp on a remote Venezuelan table mountain in 2000, for our last fieldwork together.

on these wild, uninhabited mountains, but he loved exploring and was easily persuaded to come lend a hand in the general collecting (Figs. 4, 5). He told me that he came only out of old friendship, but I noticed that his face seemed to light up and his "yes" would come quicker if I slyly mentioned that he might be able to fish in some virgin stream along the way. He usually carried at least a telescoping rod. Fishing in every kind of water was a passion and even the landing of a small piranha seemed fulfilling.

John's research touched many fields and attracted global attention. "During the 1980's [he] was among the 100 most-cited scientists worldwide as documented in *Current Contents*" (fide *NIH Record* August 25, 1998), and for the period 1993–2003, he was 41st among the 100 (of 2,081) most-cited scientists in Pharmacology & Toxicology. Recently, he was said to rank among the 10 most-cited government scientists (*The Pharmacologist* 50:118, June 2008). His work garnered many honors, including: the Hillebrand Award from the American Chemical Society in 1978; the Presidential Rank Meritorious Award, 1989; the Washington Academy of Sciences Award for Outstanding Achievement in the Biological Sciences, 1996; the Japanese Society Fellowship for the Promotion of Science, 1996; the Research Achievement Award from the American Society of Pharmacognosy, 1997; the Karl Wilhelm Scheele Award from the Swedish Academy of Pharmaceutical Sciences, 1999; and the American Chemical Society's Ernest Guenther Award in the Chemistry of Natural Products, 2002. John seemed especially proud of his appointment as Research Associate in Herpetology at the American Museum of Natural History in 1983, and his election to the National Academy of Sciences, USA, in 1997.

John Daly will be missed by the global scientific community. I miss him in ways unforeseen, and he continues to surprise me. Although always generous in his published comments, I was taken aback by his recent, last acknowledgment to me. I did not see it until after his death and for that reason it read like a final farewell. He expressed gratitude for "years of guidance from … his mentor both in the field of herpetology and on their many expeditions to Panama, Colombia, Ecuador, Peru, Venezuela, Suriname, Trinidad, and Brazil." That statement, from an experienced and accomplished field man, says much about John. As one close colleague said, "John was always very kind, even when he should not have been." He was a good friend, a great scientist, and one of the most unpretentious people I have ever known.

Memories and melancholy can be a potent mix. The years of traveling with John have left me with an ever-changing kaleidoscope of remembrances that sometimes come unannounced:

A certain light at the break of dawn reminds me of John just out of his hammock in back-country Suriname, grumbling at a small scorpion that had taken up overnight residence in the crotch of his trousers.

An exceptionally hard rain might recall the two of us alone in a Colombian cloud forest—in an area where annual rainfall is measured in meters—where we succeeded in having a fire and in keeping our jungle hammocks dry during 13 hours of drenching rain.

A howling gale in the night brings back the montane storm that pushed the side of our tent down across our faces and which would have blown away the tent itself had we not been in it.

Smoke wafting over trees can be reminiscent of the roadless frontier between Venezuela and Brazil, where we helplessly bore witness to a

small missionary plane that crashed and burned in the jungle far below our mountain-top camp.

Sound of a fast boat at night summons our exhilarating, frightening ride in a small speedboat caught after dark between Pebas and Iquitos, racing upriver without life jackets on a flooded Amazon, with logs and uprooted trees coming downstream. One boatman in back running the big outboard motor at full throttle, and one standing in front with a handheld search light spotting the on-coming obstacles and flinging an arm right or left, meaning turn! turn!

Sight of a Boy Scout pocket knife raises the memory of John being arrested during a police raid in a tough Colombian bar. He looked like a sailor and the Scout knife in his pocket a concealed weapon.

I seldom drink beer nowadays. When I do I sometimes remember beers shared with John at the ends of long dusty drives. And perhaps I see the Andean town where we had to hold tight our glasses and raise our legs so that fighting drunks could roll past our table, tumbling out the door and into the horses tied to the rail alongside our jeep.

Treasures of jewel-like frogs at the ends of tropical rainbows. And, along the way, wild towns at the ends of long roads, yes—and wild rivers—and wild places empty of people at the ends of long trails. All that and more did we share, but all trails come to an end. Goodbye old friend, our ways are severed and the jungle has never seemed so dark.

"Herpetological" Bibliography

John's "List of Publications" maintained by his lab contained 655 entries at the time of his death; some additional manuscripts (published, submitted, or in press) bring the minimal total to 666. By my count, at least 213 of these derive from his work on alkaloids and other compounds in the integument of frogs (especially) and other nonmarine animals. Herpetologists and other biologists have started mining data and ideas from some of these publications, but the interdisciplinary tangle and sheer bulk of the work do present a challenge. Many of his publications cannot easily be sorted into categories such as chemistry, pharmacology, biology, or systematics. Some papers span two or more of these disciplines.

This "herpetological" bibliography represents only about 32% of the total of John's published work. It is relevant primarily to amphibians, especially frogs, but some birds and arthropods also are represented, usually because of shared or similar alkaloids.

John's numbering system for the non-steroidal "dendrobatid alkaloids" needs to be understood. When it was realized that such alkaloids were too numerous (now > 800) for each to be given a name such as histrionicotoxin or pumiliotoxin, individual compounds were designated by nominal molecular weight (Myers and Daly 1976a), with identifying letters added to differentiate compounds with identical weights (Myers and Daly 1976b). The system was formalized a few years later (Daly et al. 1978) and the alkaloid designations were then set in boldface for emphasis and to avoid ambiguity when molecular weights are mentioned in discussion. This convention now is widely followed owing to the magnitude of John's work; it has not been used for the small number of steroidal batrachotoxins. For consistency in the bibliography, I have silently bolded molecular-weight/letter designations in a few titles where the practice was not followed.

Pharmacological papers are included in which specific "frog alkaloids" were used along with other molecular probes at one receptor or another. I doubtless have missed some papers in which such alkaloids are not singled out in the title. For practical purposes, such experimental studies may seem irrelevant to whole-animal biology. However, pharmacologic targets of the alkaloids must play a role in the evolutionary dance between prey and predators. John Daly pioneered discovery of an amazing new world of animal alkaloids, whose astonishingly diverse bioactivity is yet to be placed in broad ecological and evolutionary context. It is a new world awaiting further exploration.

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NATURAL HISTORY NOTES

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

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

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

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

CAUDATA — SALAMANDERS

AMBYSTOMA **SP. HABITAT USE.** On 17 May 2007, we observed an ambystomatid salamander inhabiting an unoccupied Gopher Tortoise (*Gopherus polyphemus*) burrow in Baker Co., Georgia, USA. The salamander was observed 3.5 m inside the burrow using a Sandpiper Technologies, Inc. (Manteca, CA) Peeper Video Probe System with a black and white monitor. The nearest potential breeding wetland, a cypress/tupelo swamp, was approximately 1100 m from the burrow. The individual was identified to genus using body size and type, however, species level identification could not be determined. Ambystomatid salamanders occurring in this region include *Ambystoma tigrinum*, *A. talpoideum*, *A. opacum*, and *A. bishopi* (Smith et al. 2006. Southeast. Nat. 5[4]:599–620). At least 60 vertebrate species inhabit gopher tortoise burrows for various reasons (Jackson and Milstrey 1989. Gopher Tort. Reloc. Sym. Proc. 86 pp). To our knowledge, however, ambystomatid salamanders have not previously been reported using Gopher Tortoise burrows. These salamanders spend much of their time underground in burrows they dig themselves or in small mammal burrows (Semlitsch 1983. Can. J. Zool. 61:616–620). We do not know if the salamander inhabited the burrow or was just passing through, although, the presence of leaf litter and the depth of the burrow suggest that the burrow would likely offer suitable shelter for ambystomatids.

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DESMOGNATHUS CONANTI (Spotted Dusky Salamander). **HABITAT.** *Desmognathus conanti* is one of the more widely distributed members of the genus, ranging across much of the Southeast and inhabiting a variety of moist environments from stream margins and seepages to muddy swamp edges and mesic forests associated with lowland streams (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington. 576 pp.). To this date, however, many aspects of the ecology and distribution of the salamander remain poorly understood. Here I provide a record for a new type of habitat utilized by *D. conanti* in the Appalachian Plateau region of northern Alabama.

On 15 Sept 2007, individuals of *D. conanti* were encountered on moist talus slopes below several sets of large sandstone bluffs near the Sipsey Fork, near the river's confluence with Borden Creek (34.29222°N, 87.39972°W; WGS84), Winston County, Alabama, USA. The bluffs were ca. 10 m high and ranged in distance from 50–75 m from the stream, situated very high above the water by thick stands of hardwood forest. The talus slopes were extensive beneath each set of bluffs, with available rock cover of varying sizes at each site, and were not directly associated with any type of lotic habitat or pools of standing water. No salamanders were encountered on the forest floor between the bluffs and Sipsey Fork. All individuals were adults and ranged between 47–51 mm SVL.

To my knowledge, this is the first record for this type of habitat use by *D. conanti;* nearly all other recorded habitats involve streamside environments or those directly contiguous to them. However, this species and a congener with similar microhabitat requirements have been found to inhabit crevices in wet cliff environments directly associated with mountain streams (Tilley 1980. Copeia 1980:806–821). It is important to note that individuals of *D. conanti* were also found in several small order tributaries of Sipsey Fork and Borden Creek at sites further upstream from these sandstone bluffs, and with the current drought in the region several other tributaries closer to the bluffs were found to be completely dry with no running water and dry substrate. It has been suggested that extreme drought or flood conditions may cause short-term migrations of *D. conanti* to areas of more suitable habitat. Given that these talus slopes remain shaded all day and were still relatively moist despite extreme drought conditions and dry streambeds nearby suggests that this migratory phenomenon may provide an explanation for our observations. However, a definitive explanation deserves further investigation.

Collected individuals were deposited in the University of Alabama Herpetological Collection (UAHC 15882 and 15883).

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GYRINOPHILUS PORPHYRITICUS PORPHYRITICUS
(Northern Spring Salamander). **REPRODUCTION**. Few accounts
of the nesting activity of *G. p. porphyriticus* exist. Green (1925.
Copeia 1925:32) observed a female in attendance of 15 eggs in a
spring in Pennsylvania on 8 August. Organ (1961. Herpetologica
17:53–56) observed two nests with females, one with 41 eggs on
14 July and the other with 66 eggs on 6 August in a small spring in
southwestern Virginia. Eggs were attached singly in a monolayer
to the underside of a rock at least partially submerged in both re-
ports. Bruce (1978. Herpetologica 34:53–64) and Bishop (1924.
New York St. Mus. Bull. 253:87–96) both observed similar nests
of the Blue Ridge Spring Salamander (*G. p. danielsi*) in North
Carolina. Because of the paucity of observed nests, most females
probably oviposit in deep underground recesses (Petranka 1998.
Salamanders of the United States and Canada. Smithsonian Insti-
tution Press. 587 pp.); however, nests have not been documented
from cave streams. Here, we report a nest of the Northern Spring
Salamander from a cave stream located in the Valley and Ridge
of east Tennessee.

We observed a female *G. p. porphyriticus* in attendance of a
nest on 30 Sept 2007 in Cruze Cave (Tennessee Cave Survey No.
TKN24) located in Knox County, Tennessee. The nest consisted
of at least 15 eggs attached in a monolayer to the underside of a
medium-sized (ca. 30 cm length) rock partially impeded in the
cave stream ca. 120 m from the cave entrance. Observable eggs
were in a late stage of development. The female was positioned
just underneath the nest. We did not have a camera during this
trip, and subsequently decided not to disturb the female and nest
further. MLN returned a week later on 07 Oct 2007, and only
eight eggs near hatching remained and two hatchlings with yolk
sacs were observed. The female was no longer in attendance and
could not be relocated. The remaining eggs were still attached to
the underside of the rock and were submerged in a 4.4 cm deep
depression. The hatchlings also were found in the depression and
measured 18 and 20 mm TL.

Our observation is consistent with the reports of others that *G.
p. porphyriticus* oviposits in summer followed by later summer
to autumn hatching (Green 1925, *op. cit*.; Organ 1961, *op. cit*.;
Petranka 1998. *op. cit*.). Nests in cave streams have not been
reported previously; however, adults and larvae are commonly
encountered in cave streams suggesting such habitat is utilized
for oviposition.

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RHYACOTRITON OLYMPICUS (Olympic Torrent Salaman-
der). **MAXIMUM LARVAL SIZE**. Data on larval size of torrent
salamanders (*Rhyacotriton*) are relatively few. Based on a sample
of well over 1000 torrent salamander larvae taken from two sites,
one of each of which now falls within the range of *R. variegatus*
and *R. cascadae*, Nussbaum and Tait (1977. Amer. Midl. Nat.

98:176–199) reported larval size ranges, respectively, of 13.5–38.6
mm, and 15.8–44.7 mm. Data on variation in larval size are lack-
ing for *R. olympicus*. Here we report an observation of a large *R.
olympicus* larva.

On 24 Sept 2007, JAT and KAD made these observations on up-
per Miller Creek, Mason County, Washington, USA (47.43531°N,
-123.15615°W, WGS84; elev. ca. 216 m). Upper Miller Creek
is a small (2–4 m wide), third-order perennial stream underlain
by Pleistocene glacial till containing interbedded sand, silt, and
gravel; however the basalt-based Crescent Formation upstream
also contributes large-clast material. Riparian overstory consisted
of Red Alder (*Alnus rubra*) and Vine Maple (*Acer circinatum*) with
a thin understory of Salmonberry (*Rubus spectabilis*) and Devil's
Club (*Oplopanax horridus*); adjacent uplands were second-growth
Douglas-fir (*Pseudotsuga menziesii*) managed for timber. At ca.
1000 h, JAT found a *R. olympicus* larva along the shallow (< 2 cm)
channel margin. The salamander measured 45.4 mm SVL, 36.8
mm tail length (SVL and tail measured to the anterior end of the
vent [*fide* Nussbaum and Tait 1977, *op. cit*.]), and weighed 2.5 g.
Though larval, as indicated by its fully developed gills, non-pro-
truding lidless eyes, and tail fins, this animal was probably male as
it displayed the distinctive square vent lobes that distinguish post-
metamorphic adult males (Good and Wake 1992. Univ. California
Publ. Zool. 126:1–91). In the course of sampling for *R. olympicus*
in this stream and 12 additional nearby streams over the last three
years, this represents the largest *R. olympicus* larva among over
500 animals measured. This animal was also just slightly larger
(by 0.7 mm) than the largest *Rhyacotriton* larva previously mea-
sured (Nussbaum and Tait 1977, *op. cit*.). After measurement, we
released the larva at the location of capture.

We deposited a photographic voucher of this *R. olympicus* at
the University of Washington Burke Museum (UWBM 2318).
Work was done under a programmatic Washington Department of
Fish and Wildlife handling permit provided to employees in the
course of their work; conditions of this permit require adherence
to the guidelines for use of live amphibians and reptiles in the field
(Beaupre et al. 2004. Guidelines for Use of Live Amphibians and
Reptiles in Field and Laboratory Research, 2nd ed. Herpetological
Animal Care and Use Committee, American Society of Ichthy-
ologists and Herpetologists). This is contribution No. 17 of the
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ANURA — FROGS

ANAXYRUS AMERICANUS (American Toad). **EGG CAN-
NIBALISM**. Cannibalism by tadpoles on conspecifics may be
advantageous when tadpoles occur at high densities in ephemeral
breeding sites (Crump 1983. Am. Nat. 121:281–287; Petranka and
Kennedy 1999. Oecologica 120:621–631; Dayton and Wapo 2002.
J. Herpetol. 36:531–532). Under these conditions, cannibalistic

oophagy may yield especially high payoffs, including not only reduced competition but also an easily accessed source of lipids, proteins, and calcium. Abundant nutrients can promote a decreased time to metamorphosis in an evaporating environment (Heinen and Abdella 2005. Am. Midl. Nat. 153:338–347), thereby increasing odds of survival.

While reports of cannibalistic oophagy are becoming more common for tropical, and especially arboreal anurans, few occurrences have been reported for *Anaxyrus* (reviewed in Petranka and Kennedy 1999. Oecologia 120:621–631; see also Babbitt 1995. Herpetol. Rev. 2:30). To my knowledge, there are no records for cannibalistic oophagy in *Anaxyrus americanus*. Heinen and Abdella (2005. Am. Midl. Nat. 153:338–347) found no evidence for active cannibalism by *A. americanus* tadpoles on conspecifics of same or smaller sizes, but suggested that such cannibalism may be facultative and occur under more stressful environmental conditions (e.g., higher tadpole densities and/or water temperatures) than were encountered by tadpoles in that study.

On 21 May 2006 at Big Creek trailhead (35.4198°N, 82.6755°W; WGS84) in Henderson Co., North Carolina, USA, I observed three pairs of amplexed *Anaxyrus americanus* in a shallow streamside pool at the confluence of Big and Fletcher creeks. Two of the females were laying eggs. All three pairs of adults were surrounded by a very high density of *A. americanus* tadpoles. Tadpoles were congregated on egg strings that were emerging from ovipositing females and many were actively feeding on the eggs (Fig. 1).

Although Petranka and Kennedy (1999, *op. cit.*) suggested diverse feeding strategies for generalized tadpoles, there is still a prevailing paradigm of pond tadpoles as obligate omnivorous suspension feeders. Oophagy on conspecifics greatly complicates current ecological theory and models by expanding the roles of tadpoles in temporary pond communities, the guild of predators faced by maturing conspecifics, and the strategic challenges faced by females selecting breeding sites.

I thank T. G. Forrest for photographs, J. W. Petranka for positive identification of the tadpoles, and R. B. Cocroft, T. G. Forrest, G. Hoebel, and J. W. Petranka for helpful comments.

Fig. 1. *Anaxyrus americanus* tadpoles feeding on egg masses from ovipositing female conspecifics in a shallow pool at the confluence of Big and Fletcher creeks (Henderson County, North Carolina, USA). Photo taken 21 May 2006 by T. G. Forrest.

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BUFO BOREAS BOREAS (Boreal Toad). **PREDATION**. Olson (1989. Copeia 1989:391–397) reported Raven (*Corvus corax*) predation on adult *Bufo boreas* at three breeding aggregations in the central Cascade Mountains of Oregon (USA). However, carcass condition prevented Olson (1989, *op. cit.*) from identifying the gender of predated animals. Here, we provide additional observations of *B. boreas* predation attributable to *C. corax* from another population in the Oregon Cascades. In these, we were able to distinguish the gender of predated toads, providing novel insight into this phenomenon.

MPH and RFP made these observations at Horse Lake, Douglas County, Oregon (43.1266°N, 122.1533°W; datum WGS84, elev. 1586 m) in 2007. However, MPH had also collected observations at this site over four additional years since 1997. The latter observations were always made over a 2–3 day period during snowmelt (May) when *B. boreas* breeding was at its peak. Horse Lake is a small (1.5 ha) lake underlain by a pumice-dominated volcanic lithology and surrounded by mature Lodgepole Pine (*Pinus contorta*) with a thin understory. It has two subequal lobes positioned northwest–southeast that are connected at high water; though maximum depth is ~1.5 m, 80% of the lake is <1 m deep.

During an extensive visual encounter survey of Horse Lake and vicinity between 1145 and 1540 h on 11 May 2007, we found the remains of 8 *B. boreas*, 7 at Horse Lake and an 8th individual in a small (0.1 ha) sedge-filled pond ca. 150 m south of Horse Lake. In each case, remains included a near-complete skin. Based on the sizes of 39 live adult toads measured at Horse Lake (males: N = 37, mean = 96.9 mm SVL, SD = 6.2; females: N = 2, mean = 113 mm SVL, SD = 6.2), all belonged to adults ca. 90–110 mm SVL. These skins were remarkable in that except for one in which a forearm bone and a little flesh remained, all had been pulled inside out, often down to the digits, and were thoroughly cleaned of flesh and bone. All skins seemed fresh; they were moist, pliable, and displayed coloration we could not distinguish in quality from that of living adult toads. Each skin was also notable in that the severed margin was always on the ventral side; the skin across the entire back and sides (including the parotoid glands) was always intact, making it easy to observe the toad's original dorsal color pattern by laying the skin flat. We found 6 of the 8 skins on downed Lodgepole Pine logs bordering Horse Lake; the remaining two were in water. In addition to the skins, fragments of toad ovaries were found within 1 m of five of the six skins. Notably, we saw no well-developed eggs in any discarded ovaries. As individual toad skins were scattered (all were >5 m apart), discarded ovaries helped determine gender. However, presence (or absence) of nuptial pads on toad skins (easily viewed on fresh skins by inverting the skin of the digits on an anterior limb) was the definitive criterion for gender determination. In every case, at least one anterior limb had some intact digits. Male Western Toads at Oregon Cascade sites where we have collected data develop nuptial pads on the dorsolateral surface of digits 1, 2, and 3 on the anterior limbs (MPH, unpubl. data), so only one of these digits needed to be intact for gender determination. Color pattern of the dorsal skin also helped confirm

gender since females tend to have a more complex or blotched pattern than the more uniformly colored males (Blair 1963. Evolution 17:1–16; Schueler 1982. Can. Field Nat. 96:329–332).

During our 2007 survey, we also found toad egg strings that we estimated as representing the complement of at least 29 egg masses (i.e., we counted at least 58 separate egg strings; each female deposits one pair of separate strings: see Kagarise Sherman 1980. Ph.D. dissert., University of Michigan, Ann Arbor, Michigan. 394 pp.), and observed 15 additional adult toads that were not measured. Because each female is assumed to lay eggs once per breeding season (Kagarise Sherman 1980, *op. cit*.) and the two living females we found appeared gravid, we observed evidence of at least 91 adult toads during our survey, 9% (N = 8) of which were dead. This would overestimate mortality if live adults contributing to this aggregation were missed, or underestimate it if we missed dead adults; both are possible.

We attributed the dead toads to *C. corax* predation because we observed a Raven fly away from the *B. boreas* breeding aggregation as we approached it, and the pattern of predation was nearly identical to that which Olson (1989, *op. cit*.) described. However, we cannot unequivocally exclude other predators. We observed at least two pairs of Gray Jays (*Perisoreus canadensis*) during our 2007 survey, and MPH has recorded Clark's Nutcrackers (*Nucifraga columbiana*), a known toad predator (Mulder et al. 1978. Condor 80:449–451; Kagarise Sherman and Morton 1993. J. Herpetol. 27:186–198), on previous visits. However, in five years of visits to this breeding aggregation, this is the first time we recorded predation on adult toads. Two further aspects merit comment. Given the high visibility of nearly constantly moving male *B. boreas* in the breeding aggregation, we were surprised to find that most dead adults we encountered were female. This is especially true given our general experience that female toads are far less conspicuous (to the human eye) in breeding aggregations, a pattern consistent with other observations (Olson et al. 1986. Oecologia 70:351–356; Kagarise Sherman 1980. *op. cit*.). Lack of developed eggs in discarded ovaries also raises questions regarding the female toads that were prey. These could represent either post-breeding or non-gravid females, but given apparent female-biased predation, such females may exhibit unrecognized vulnerability to predators.

Work was done under an Oregon Department of Fish and Wildlife scientific handling permit 031-07 to C. Rombough, under which MPH was a permitee; conditions of this permit require adherence to the guidelines for use of live amphibians and reptiles in the field (Beaupre et al. 2004. Guidelines for use of live amphibians and reptiles in field and laboratory research, Second edition. Herpetological Animal Care and Use Committee of the American Society of Ichthyologists and Herpetologists). We thank C. Rombough and D. Olson for valuable comments. This is contribution No. 15 of the Forests and Fish Section of the Washington Department of Fish and Wildlife Habitat Program Science Division.

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BUFO BUFO (Commond Toad). **PARASITISM**. The distribution of *Bufo bufo* covers the whole of Europe, northeastern Africa, and western Asia (Nöllert and Nöllert 1992. Los Anfibios de Europa. Omega Editions. 399 pp.). It breeds mainly in permanent water (Lizana 1997. *In* Pleguezuelos (ed.), Distribución y Biogeografía de los Anfibios y Reptiles de España, pp. 152–154. Asociación Herpetológica Española, Universidad de Granada, Granada), where it may be parasitized by different species of leech (Hoffmann 1960. Notules Hirundinologiques. Archieves de la Section des Sciences Naturalles, Physiques et Mathematiques de L´Intitut Grand-Ducla de Luxembourg [new series] 27:285–291; Fontaneto et al. 1998. *In* Miaud and Guyétant [eds.], Current Studies in Herpetology, pp. 121–124. Societas Europaea Herpetologica, Le bourget du lac, France). Parasitism of adult *Bufo bufo* by the leech *Hirudo medicinalis* has been reported in previous studies (Hoffmann 1960, *op. cit*.; Fontaneto et al. 1998, *op. cit*.), although its attack on other *B. bufo* developmental stages has not been described.

On 30 July 2007, a larval *B. bufo* (total length = 26 mm; Gosner Stage 37) (Gosner 1960. Herpetologica 16:183–190.) was found being parasitized by *H. medicinalis* in a permanent cistern located in Sierra Espuña Regional Park (Province of Murcia, southeastern Iberian Peninsula, 37.86873°N, 1.52032°W; European 1950 datum; 772 m elev.). The leech was attached to the back of the larva, which was forced to swim in a supine position (Fig. 1). Because both larva and the leech were preserved immediately after capture, the consequences of this parasitism on natural history traits, such as locomotion, feeding, and survival of the affected larva, could not be assessed.

We thank the Consejería de Desarrollo Sostenible y Ordenación del Territorio de la Región de Murcia for providing the corresponding permits.
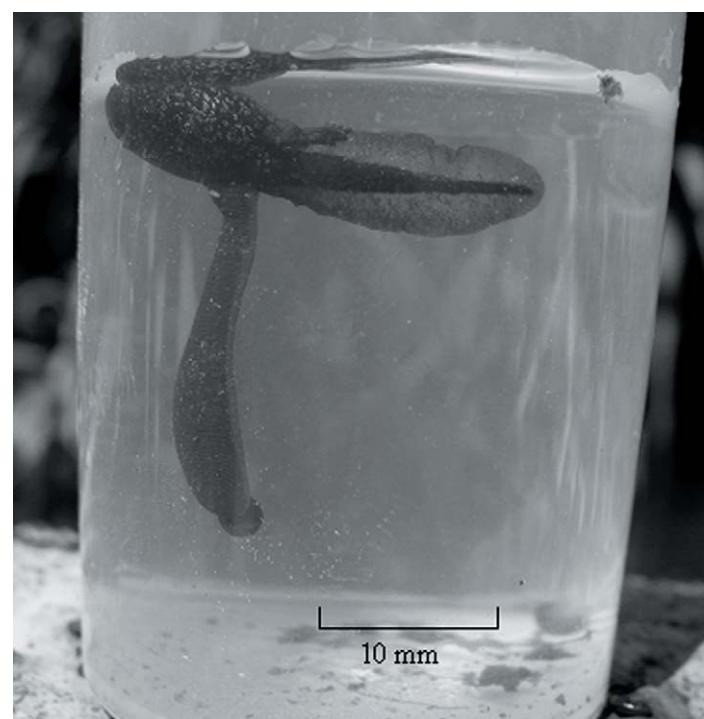

Fig. 1. Lateral photo of *Bufo bufo* larvae, showing *Hirudo medicinalis* on its back.

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BUFO MELANOSTICTUS (Spectacled Toad). **ARBOREAL BEHAVIOR**. *Bufo melanostictus* is a typical ground dwelling toad; based on its relatively short hind limbs. This species naturally occurs in the Himalayas, India, Indochina, Indo-Australian Archipelago, Malaysia, Myanmar, southern China (Nutphund 2001. Amphibians of Thailand. Amarin Printing and Publishing, Thailand.192 pp. [in Thai]) and Taiwan, including Orchid Island and Green Island (Lue et al. 2002. The Transition World—Guidebook of Amphibians and Reptiles of Taiwan. SWAN, Taipei. 350 pp. [in Chinese]; Yang 1998. A Field Guide to the Frogs and Toads of Taiwan. Taipei. Nature and Ecology Photographer's Society. 144 pp.).

At 0954 h on 03 Aug 2007, a sub-adult male *Bufo melanostictus* (47 mm SVL) was found 1.6 m above ground, on the trunk of a *Macaranga tanarius* that was growing at a 45° angle out of an embankment in a secondary forest in Santzepu, Sheishan District, Chiayi County (23.42666°N, 120.48583°E; WGS84; elev. 90 m). The habitat consisted of *Tetrastigma formosanum*, *Alocasia macrorrhiza*, *Alpinia zerumbet*, *Brachiaria mutica*, *Christella acuminata*, *Cinnamomum camphora*, *Clerodendrum paniculatum*, *Costus speciosus*, *Dimocarpus longans*, *Ichnanthus vicinus*, *Lantana camara*, *Lygodium japonicum*, *Macaranga denticulata*, *Machilus thunbergii*, *Maesa perlaria* var. *formosana*, *Mangifera indica*, *Mikania micrantha*, *Miscanthus sinensis*, *Morus australis*, *Passiflora foetida* var. *hispida*, *Smilax ocreata*, and *Stephania japonica*. The canopy cover, created by the crowns of *C. camphora* and *M. denticulata*, was 80%.

No possible prey or refuge was observed on the trunk, so it is not clear why the *B. melanostictus*, which is a nocturnal terrestrial species, was in an arboreal location during the day. We believe the arboreal behavior of the toad could relate to its thermal requirements. The highest air temperature (36.3ºC) for Chiayi County for 2007 was recorded on the same day, and was 8.4ºC higher than the mean air temperature (27.9ºC) of August (Central Weather Bureau. 2007. Monthly Report on Climate System. Ministry of Transportation and Communications, Taipei. [in Chinese]). Arboreal relocation probably offered better air circulation and reduced thermal stress for the toad. This appears to be the first description of arboreal behavior in *B. melanostictus* from Taiwan.

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CRAUGASTOR BRANSFORDII (Bransford's Rain Frog). **REPRODUCTION AND NEST SITE.** The genus *Craugastor* contains 111 currently recognized species of Neotropical direct-developing brachycephalid frogs (Frost 2007. Amphibian Species of the World. Vers. 5.1. http://research.amnh.org/herpetology/amphibia/index.php). While all species in this genus are presumed to exhibit direct development of eggs and many species exhibit parental care, few reports of reproduction have been documented within the genus (Townsend 1996. *In* Powell and Henderson [eds.], Contributions to West Indian Herpetology, a Tribute to Albert Schwartz, pp. 229–239. SSAR Conrib. Herpetol. Vol. 12. Ithaca, New York). We are aware of no documentation of reproduction for *C. bransfordii*, nor for any other member of the *bransfordii* species group. Herein, we report the first description of reproduction in *C. bransfordii* from primary forest within La Selva Biological Station (10.42°N, 84.00°W; WGS84, ca. 60 m elev), Heredia Province, northeastern Costa Rica.

On 23 Aug 2007, we encountered a female *C. bransfordii* (22.4 mm SUL) perched on top of a clutch of eggs at ca 1300 h. The nest site was on bare soil from which leaf litter had been removed, between the stilt roots at the base of a small (10 cm diam) palm. We observed the female rotating the longitudinal axis of her body over the clutch, keeping her mid-venter positioned directly over the center of the clutch as her head and legs rotated around the periphery of the nest cavity. She was observed performing this unusual behavior intermittently for approximately one hour. We returned at ca 1900 h on the same day to conduct a closer inspection of the nest site. The female was still present in the same location, but was perched on bare soil, and no eggs were visible at that time. We removed the female and located the clutch under ca 5 mm of soil. The egg mass measured ca 15 × 14 × 12 mm, and consisted of ten eggs. Four individual eggs from the clutch measured 3.7, 3.9, 4.1, and 4.4 mm in diameter, but the other six eggs were not measured. Using a staging table developed for another species of brachycephalid frog (Townsend and Stewart. Copeia 1985:423–436), we estimated the developmental stage of these eggs to be stage 1—the yolks were featureless and cream-colored and were surrounded by a thin clear covering. While the staging table we used is species-specific and was developed for *Pristimantis coqui*, *Pristimantis* and *Craugastor* are presumed to share a common evolutionary origin of direct-development, and Townsend and Stewart (1985, *op. cit*.) provide the only staging table for direct-developing embryos of which we are aware. We returned to the nest site on 24 Aug 2007 at ca 1130 h, and on several occasions thereafter, but did not detect the female within a 3 m radius of the nest site despite a careful examination of the surrounding area. We checked the status of the nest on 3 Sept 2007 by carefully removing the soil covering the nest, and the clutch appeared intact. We returned to the nest site once again on 20 Sept 2007. At this time, there were no eggs present in the nest site, nor was there any evidence of disturbance surrounding the nest cavity.

Within the genus *Craugastor*, nests are often constructed in shallow depressions excavated by the parent, but we are not aware of burial of eggs by any species in this genus. We presume that the unusual rotating behavior we observed was a behavior of the female to draw soil from the edges of the nest depression to cover the eggs. While many species of *Craugastor* are characterized by parental care by either the male or female parent (Townsend, *op. cit*.), we detected nest attendance by the female only for a short time after the eggs were presumably laid. However, because we disturbed the female parent, we cannot objectively evaluate whether further

parental behaviors would have occurred. Finally, we are also unable to determine whether the nest in the field failed or hatched, or whether our disturbance of the nest played any significant role in its fate.

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ELEUTHERODACTYLUS* cf. *PARVUS (Girard's Robber Frog). **PREDATION.** Predation on anuran amphibians by spiders has been reported many times in the literature and appears to be a common phenomenon in the neotropics (Menin et al. 2005. Phyllomedusa 4:39–47; Costa et al. 2006. Herpetol. Rev. 37:337–338; Pazin 2006. Herpetol. Rev. 37:336). Herein, we present another case of predation of an anuran by a spider, adding another neotropical frog species to the list of amphibians known to be preyed upon by spiders.

On 18 Aug 2005, at the Reserva Ecológica de Rio das Pedras (22.98333°S, 44.1°W; 370 m elev, SAD 69), municipality of Mangaratiba, State of Rio de Janeiro, Brazil, one of us (JALP) captured a spider, *Oligoctenus medius* (Ctenidae) with a live frog, *Eleutherodactylus* cf. *parvus*, being held between its chelicerae. The spider and its prey were found on the leaf litter at 1910 h. The frog, which was being held by the abdominal region in the spider's chelicerae, was released when the spider was picked up by the observer, and remained alive for about 15 h afterwards, until being euthanized. The spider (female; body length = 31 mm; mass = 2.7 g) was later deposited at the arachnological collection of the Museu Nacional, Rio de Janeiro (MNRJ 03085), whereas the frog (unsexed; SVL = 15.4 mm; mass = 0.37 g) was deposited in the herpetological collection (MNRJ 40177).

Members of the families Ctenidae, Pisauridae, Sparassidae, Lycosidae, and Theraphosidae (especially the first two) appear to be the most common arachnid predators of neotropical anurans (Brescovit et al. 2004. *In* Marques and Duleba [eds.], Estação Ecológica Juréia-Itatins. Ambiente Físico, Flora e Fauna, pp. 198–221. Holos Editora, Ribeirão Preto; Menin et al. 2005, *op. cit.*; Costa et al. 2006, *op. cit.*), and the present report agrees with this trend. Menin et al. 2005. (*op. cit.*) observed a trend for spiders preying on frogs in the neotropics to be about the same size or slightly smaller than its prey, but our report does not concur with the apparent trend, as the spider was considerably larger than its anuran prey. Since the frog remained alive and apparently in good health after being released by the spider, it is possible that the spider had not yet injected it with venom by the time it was captured, as the venom of ctenid spiders is frequently quite potent and can cause paralysis and death in small vertebrates within a short time (Massary 1999. Herpetol. Rev. 30:167; Teixeira et al. 2003. Herpetol. Rev. 34:368–369; Menin et al. 2005, *op. cit.*).

We thank C. A. G. da Cruz and J. P. Pombal Jr. for identifying the frog and E. Winskonski for identifying the spider. Fieldwork at the Reserva Ecológica de Rio das Pedras was financed by the Critical Ecosystems Partnership Fund (CEPF).

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HYLA ARBOREA (Tree Frog). **BLOWFLY PARASITISM**. *Lucilia*-fly parasitism on *Bufo bufo* in Europe is well documented and most often concerns the blowfly *Lucilia bufonivora* which seems to favor *B. bufo*. Incidentally, infections by maggots in the nostrils of other amphibians, including *B. calamita*, *B. viridis*, *Alytes obstetricans*, *Pelobates fuscus*, *Rana arvalis*, *R. esculenta*, *R. temporaria*, and *Salamandra salamandra* are reported (Koskela et al. 1974. Ann. Zool. Fennici. 11:105–106; Garanin and Shaldybin 1976. Parazitologiia 10:286–288; Krous 2007. J. Nat. Hist. 41:1863–1874). There is one report on the presence of *Lucilia* eggs on *Hyla arborea* in Switzerland (Meisterhans and Heusser 1970. Mt. Schweiz. ent. Ges. 43:41–44). This frog was kept in captivity to study the development of the *Lucilia* infection. After Day 3 the eggs were gone, and on Day 10 the *H. arborea* was healthy with no sign of *Lucilia* maggots in the nostrils or other forms of myiasis. The authors suggested the eggs were less strongly attached to the frogs' skin, as compared to earlier observations on bufonids.

On 13 August 2007, an infected *H. arborea* (Fig. 1) was found in De Doort, middle part of Limburg, The Netherlands. This is the first documented report of a *Lucilia* infection on *H. arborea*. The frog or maggots were not collected and thus the species of *Lucilia* remains uncertain.

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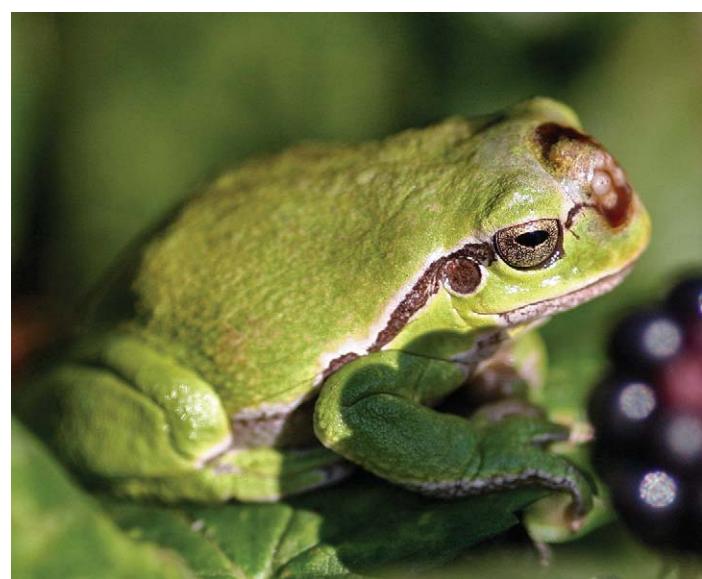
FIG. 1. *Hyla arborea* infected by *Lucilia* blowfly; maggots are visible in the nostrils. Photograph by Jan Vandewall.

LEPTOBRACHIUM SMITHII (Smith's Litter Frog). **DEFENSE AND PIGMENTATION**. The megophrid frog, *Leptobrachium smithi* has been described from Thailand (Matsui et al. 1999. Japan J. Herpetol. 18:19–29), Myanmar (Das and Chanda 2004. Asiatic Herpetol. Res. 10:245–246), India (Sengupta et al. 2001. J. Bombay Nat. Hist. Soc. 98[2]:289–291), and Laos (Stuart 2005. Herpetol. Rev. 36:473–479). Chuaynkern et al. 2007 (Herpetol. Rev. 38:323–324) noted its distribution in Bangladesh, citing Asmat et al. 2003. (Univ. J. Zool. 22:141–143); however, Asmat et al. 2003, *op. cit.*) did not actually report its occurrence in Bangladesh.
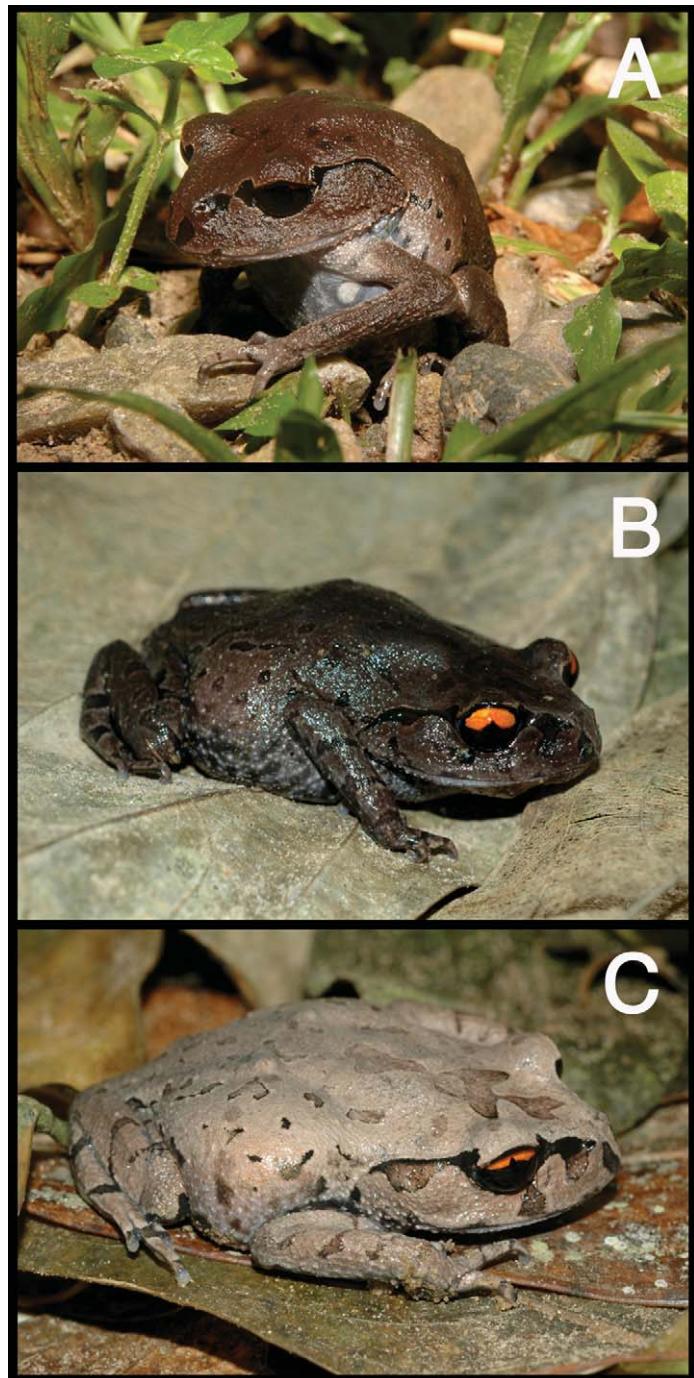
FIG. 1. A) *Leptobrachium smithi*, with its head arched (ca. 90°) towards the vent. B) Adult *L. smithi* with the true color and distinct red-eye before being manipulated. C) The same *L. smithi* completely loses its color after being held in a plastic jar for 30 min.

Defensive behavior has been described in *L. smithi* but defending its body by arching its head towards the vent and by changing its color has not been previously reported.

On 27 June 2007, an adult *L. smithi* (Jahangirnagar University; JU 0058) was found stalking prey at about 2230 h on a rail-way line in the middle of a hilly evergreen forest of Lawachara National Park (24.316°N, 91.783°E; WGS84, 144–150 m elev.), Moulvibazar District of northeastern Bangladesh. When approached and disturbed with a strong camera flash, the frog arched its head towards the vent (ca. 90°) while pushing its body into the rocky ground and remaining motionless (Fig. 1A). Similar behavior has been described in *L. smithi* but with a head arched ca. 90° elevated in opposite direction (Chuaynkern et al. 2007, *op. cit.*) which reveals the capability of the species to bend its head both ways up to 180°. While carrying the frog in a plastic jar for less than an hour, its body color changed completely into a light-ash color (Fig. 1C) from its original dark color with contrasting orange and black eye (Fig. 1B). When the ash-colored frog was taken out of the jar, it remained motionless for several minutes and then tried to escape by moving backwards.

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PROCERATOPHRYS **SP.** (NCN). **PREDATION.** The Cerrado species of the genus *Proceratophrys* belong to the *cristiceps* group, and are found in open grasslands and gallery forests (Reuber Brandão, pers. comm.). On 12 March 2002, four adult White-eared Puffbirds (*Nystalus chacuru*, Bucconidae) were captured in mist nets in a "campo cerrado" area at Fazenda Água Limpa, Distrito

FIG. 1. White-eared Puffbird captured in a mist net carrying a *Proceratophrys* sp.

Federal, Brazil. One was holding a *Proceratophrys* sp. in its beak (Fig. 1). The White-eared Puffbird digs in the ground or in banks to construct a gallery as an entrance for the nest chamber, and could have captured the frog in its diurnal retreat on the soil. It is a common Cerrado bird that is mostly insectivorous, although other food items including lizards and vegetable matter have been reported (Del Hoyo et al. 2002. Handbook of the Birds of the World. Cotingas to Pipits and Wagtails. Lynx Edicions, Barcelona). This is the first record of a White-eared Puffbird predating a frog.

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SCAPHIOPUS COUCHII (Couch's Spadefoot). **PREDATION**. Predation upon larval *Scaphiopus couchii* by vertebrate and invertebrate predators has been well documented (Duellman and Trueb 1986. Biology of Amphibians. McGraw–Hill, New York. 670 pp.). Predation upon adults is likely common as well, especially during active periods such as the breeding season. However, there are few comprehensive studies detailing predation upon adult *S. couchii*. On 3 Aug 2006 at ca. 2400 h during a trip through Bottomless Lake State Park (Chaves Co., Roswell, New Mexico, USA: 33.31583°N, 104.32307°W; WGS84) we found a single adult male *S. couchii* on a road being consumed by an adult Common Barn Owl (*Tyto alba*). The owl had pinned down the toad with one talon piercing the midsection and had already created a large wound on the toad's back using its beak. The owl immediately flew away when our vehicle headlights illuminated the area from ca. 10 m away. The toad was still alive when collected, but expired shortly thereafter. The specimen was deposited in the University of Texas at Arlington Amphibian and Reptile Diversity Research Center (UTA–A57962).

To our knowledge, this is the first documented instance of predation upon *Scaphiopus couchii* by an avian predator. Common Barn Owls prey heavily upon small mammals, but have been known to eat other prey, including frogs (del Hoyo et al. 1999. Handbook of Birds of the World: Volume 5: Barn-owls to Hummingbirds. Lynx Edicions, Barcelona). This observation suggests that Common Barn Owls living in arid regions may utilize *S. couchii*, or desert breeding anurans in general, as a seasonally abundant food resource. *Scaphiopus couchii* adults may be attractive prey items during the breeding season owing to their large numbers, increased activity, and conspicuous advertisement calls.

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SCINAX FUSCOMARGINATUS (NCN). **PREDATION**. Batracophagy between adult anurans is not frequently documented. Cardoso and Sazima (1977 Ciência e Cultura 29:1130–1132) reported predation of *Chaunus granulosus* by *Leptodactylus labyrinthicus* in Parque Nacional de Sete Cidades, in state of Piauí, Brazil. Can-

Fɪɢ. 1. An adult *Scinax fuscomarginatus*, captured by a adult *Leptodactylus furnarius*.

nibalism of nests and tadpoles of other species has been reported by *Leptodactylus labyrinthicus* tadpoles (Silva et. al. 2005. J. Nat. Hist. 39:555–566). On 13 Dec 2006, at 1000 h (air temp. 21°C; water temp. 24°C) we observed an adult *Scinax fuscomarginatus* (20.5 mm SVL), being captured by a adult *Leptodactylus furnarius* (30.7 mm SVL). This observation occurred beside a pond, located in Botucatu (22.923°S, 48.458°W, 800 m elev, WGS84), State of São Paulo, Brazil. The pond was filled with water, the soil around the pond was sandy, and there were small grasses along the shoreline. The *S. fuscomarginatus* was captured by its posterior left leg as it walked close to the *L. furnarius* (Fig. 1). Both individuals were collected and deposited at the Departamento de Zoologia, Instituto de Biociências da UNESP-Botucatu (*S. fuscomarginatus* CCJJ 7816; *L. furnarius* CCJJ 7817).

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TESTUDINES — TURTLES

CHELYDRA SERPENTINA SERPENTINA (Common Snapping Turtle). **NESTING BEHAVIOR AND SITE SELECTION.** On 31 May 2008, we observed a ca. 36 cm CL C*helydra serpentina serpentina* in unexpected nesting circumstances. Observations were made from 0908 to 1027 h on clear day with ambient temp ca 24°C. The nest site near Longmont, Colorado, USA (40.1599528°N, 105.1259861°W; WGS84) was 4.3 m from a seasonal ditch running north-south to connect two lakes, one on either side of a busy road. The intriguing aspect of the nest location was that it was immediately adjacent to a heavily traveled concrete sidewalk that bordered a road with a high volume of traffic. The frequent foot traffic on the sidewalk and virtually constant vehicle traffic on the adjacent road did not deter the turtle from the particular nest loca-

tion, even though virtually identical soils, gradients, and directional aspects were available equidistant from the ditch, but away from constant human activity. In fact, aside from the potential for nesting disruption, the particular nest location might hold incubation advantages. The position adjacent to the sidewalk might yield thermal advantages from radiant heat from the sidewalk, both above and below ground. The depth of the nest was ca. 15 cm, similar to the thickness of the sidewalk, and probably allowing the entire depth of the nest to be warmed by heat stored in the concrete. The nest was also on a west-facing side of the ditch, allowing it to receive maximal effect of solar radiation during the summer. Altitude is a limiting factor in Colorado for the range of *C. s. serpentina*, with the species only distributed below 1680 m elev. (Hammerson 1999. Amphibians and Reptiles in Colorado. 2nd ed. University Press of Colorado, Niwot). At 1518 m, the elevation of the nest site might be high enough such that any thermal advantages could be important.

Assuming the turtle lives in the pond on the same (south) side of the road as the nest, and can only use the ditch, which connects the ponds on the north and south sides of the road on a seasonal basis (spring only), then there are ca. 3–4 ha of open area for nest building. Unlike turtles that live in city parks where the body of water is often surrounded by sidewalks or bike paths, this turtle had >99% chance to choose a less traveled location to lay her eggs. Using the ditch to gain access to her nesting site provided many opportunities to exit the ditch anywhere along its ca 30 m length to lay her eggs in a non-traveled and secluded area. The ditch embankments are such that they would not inhibit her ability to climb out of the ditch at any location along the way.

At the time observations were initiated, ca. 20 eggs appeared to have already been deposited in the nest. Egg laying was completed at 0932 h. During the 24 min from initiation of observations, 15 additional eggs were added to the clutch already in the nest (average inter-egg interval: 1 min. 36 sec). By 1025 h (53 min after final egg was laid), the turtle had completed covering the nest to the extent it could not be distinguished from the neighboring ground. By 1027 h the turtle had re-entered the ditch.

Unfortunately, this nest was destroyed by a Raccoon (*Procyon lotor*) on 30 August 2008 (predator identification based on tracks and scat), so we were unable to determine if the nest would have produced viable hatchlings. The adjacent ditch, which is often dry by late summer, had been filled during an unusual heavy rain event, so it seems possible that hatchlings might have successfully dispersed if the nest had not been predated.

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CLEMMYS GUTTATA (Spotted Turtle). **DISPLACEMENT.** *Clemmys guttata* utilizes a wide variety of shallow wetland habitats including streams, marshlands, and swamps (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, DC. 578 pp.). Juveniles of this species (≤ 6 cm carapace length) tend to be secretive and are observed less often than adults (Ernst 1976. J. Herpetol. 10:5–33). On 16 May 2008, I observed a juvenile *C. guttata* (carapace length 5 cm, with 3–4 annuli) swimming westward across the Patuxent River (38.7839222°N, 76.7093278°W) in Maryland. The river at this location is ca. 110–120 m wide, with a depth of 3 m. On the east side of the river, a 400-m wide freshwater tidal marshland dominated by Spatterdock (*Nuphar advena*) separates the main channel from the adjacent floodplain, where adult *C. guttata* are commonly sighted. The juvenile was captured while swimming close to the water's surface and was photographed for verification.

This unusual occurrence might be explained by a major flood that took place on 14 May 2008. A late northeastern storm caused the river's channel to expand significantly, with strong currents that deposited large amounts of debris along the banks. This turtle might have been displaced by the effects of the storm, and was possibly attempting to return to its place of origin. Other species of semi-aquatic and terrestrial turtles were also sighted adjacent to or swimming across the Patuxent River following the storm, suggesting that the displacement of turtles as a result of major weather events is not uncommon. Previous investigators have found that strong current velocity associated with floods might displace turtles from their home ranges (MacCulloch and Secoy 1983. J. Herpetol. 17:283–285; Moll and Legler 1971. Bull. Los Angeles Co. Mus. Nat. Hist. 11:1–102). Moll and Moll (2004. The Ecology, Exploitation, and Conservation of River Turtles. Oxford University Press, pp. 23–24) suggest that displacement as a result of flooding is more likely to affect juvenile age class individuals of semi-aquatic turtle species. Ernst (1968. Herpetologica 24:77–78) reported that of 25 adult *C. guttata* relocated a distance of 310 m from the original capture point, 14 were later recaptured within 27 m of their capture point, suggesting that this species might have some homing ability.

This observation was made while conducting research at the Jug Bay Wetlands Sanctuary in Lothian, Maryland. Chris Swarth, Sanctuary Director, assisted in identifying and measuring *C. guttata*, and provided additional local observational records of the species.

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GLYPTEMYS INSCULPTA (Wood Turtle). **DIET.** North American Wood Turtles are omnivores that feed on a variety of sources, including green leaves, fruits, algae, moss, fungi, insects, slugs, snails, and earthworms (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington D.C. 578 pp.; Harding 1997. Amphibians and Reptiles of the Great Lakes Region. University of Michigan Press, Ann Arbor, Michigan. 378 pp.). Wood Turtles feed opportunistically, as the abundance and availability of food items changes seasonally, and are known to scavenge animal carcasses, including fish (Harding 1997, *op. cit.*; Farrell and Graham 1991. J. Herpetol. 25:1–9). As part of a population genetics study, we collected morphometric data and DNA samples from 47 *Graptemys insculpta* in Berkeley County, West Virginia during May 2008 and noted feeding events and food items when possible. Wood Turtle food sources in Berkeley County (listed in order of frequency of observation) included grasses,

green leaves, berries, moss, and a dried Scarlet Oak leaf (*Quercus coccinea*). On 21 May 2008, we noted evidence of ophiophagy in two adult female Wood Turtles from Berkeley County. At 1335 h, an adult female Wood Turtle (mass = 1050.0 g; carapace length = 189.59 mm) defecated a 27.2 x 19.7 mm section of intact, previously shed snake skin. The skin section was undigested, clearly a shed specimen, and appeared to be from a gartersnake (*Thamnophis* sp.). At 1501 h, another adult female (mass = 986.0 g; carapace length = 181.75 mm) defecated a 62.4 x 11.1 mm section of partially digested Ring-necked Snake (*Diadophis punctatus*) while cloacal temperature was being recorded. This specimen had intact skin and muscle, and several vertebrae and ribs emerging from one end. Snake material, including exuviae, has not been reported as a food item for *G. insculpta*.

Thamnophis and *Diadophis punctatus* are both abundant in Berkeley County, although all *D. punctatus* we observed were found well hidden under rocks and logs during daylight hours, when Wood Turtles typically forage. *Diadophis punctatus* is nocturnal, but may be active diurnally during the breeding season (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington D.C. 668 pp.). We have no evidence to suggest whether the *D. punctatus* specimen was taken as carrion or predated. The worm-like appearance of *D. punctatus* might have elicited predation by *G. inscuplta*, or the snake might have been taken as carrion, possibly as the remnant of another predator's meal. Although a wide variety of vertebrates have been reported to prey on *D. punctatus*, the only reptile predators recorded are squamates (Ernst and Ernst 2003, *op. cit.*).

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GOPHERUS AGASSIZII (Desert Tortoise). **BURROW ASSOCIATE**. Desert Tortoises are semi-fossorial and construct burrows that are a unique environment that provides shelter from the extreme heat and are generally more humid, both features which aid in reducing water loss (Bulova 2002. J.Therm. Biol. 27:175–789; Zimmerman et al. 1994. Herpetol. Monogr. 8:45–59). It would be expected that numerous other species would make use of this structure; however, in a review of burrow associates, Luckenbach (1982. *In* Bury [ed.], North American Tortoises: Conservation and Ecology, pp. 1–38. Wildl. Res. Report 12, U.S. Fish and Wildlife Service, Washington, D.C.) lists only 31 species observed in Desert Tortoise burrows. From this list we can conclude that virtually all desert vertebrates will use or modify a Desert Tortoise burrow for shelter, while only a few arthropods have been noted. This is rather surprising as more than 350 animals have been observed using burrows of the Gopher Tortoise (*Gopherus polyphemus*), with roughly 300 of these being invertebrates (Jackson and Milstrey 1989. *In* Diemer et al. [eds.], Gopher Tortoise Relocation Symposium Proceedings, pp. 86–98. State of Florida Game and Fresh Water Fish Commission Nongame Wildlife Program Technical Report No. 5). It is likely that part of this large discrepancy between the two species of tortoises' burrow associate fauna is based on the fact that the southwestern deserts of the United States are less diverse than the southeast, where the Gopher Tortoise is found. However, we believe that more invertebrates should be making use of Desert Tortoise burrows, despite the conclusions of Grant (1936. Zoologica 21:225–229) that burrow associates of the Desert Tortoise are not important.

On 13 November 2007 at 1200 h at a study site in the west Mojave Desert northeast of Barstow, San Bernardino County, California (Walde et al. 2007. West. N. Am. Nat. 67:147–149) we observed a tarantula (Araneae, Mygalomorphae, Theraphosidae) in a Desert Tortoise burrow. The tarantula was brown with a carapace of ca. 25 mm and was considered to be a male because of the relatively small abdomen. There are two species of tarantula in this area, *Aphonopelma mojave* and *A. iodius* (Prentice 1997. J. Arachnol. 25:137–176). These two species are easily distinguished as *A. mojave* is black and small, while *A. iodius* is larger and has a light to medium brown carapace with variably colored legs from medium to dark brown, to black (Prentice, *op. cit.*). Therefore, we can conclude that the tarantula observed in the burrow was *A. iodius*. These species are both fall breeders, a time when males go in search of females (Prentice, *op. cit.*), therefore it is likely that this *A. iodius* took refuge in the burrow during its mate searching, although it may have been looking for food. The burrow was an overwintering burrow for an adult female Desert Tortoise.

Previously, an unknown species of tarantula was documented in a Desert Tortoise burrow during a study in Nevada (Burge 1978. *In* Trotter [ed.], Desert Tortoise Council Proceedings of 1978 Symposium. pp. 80–111). To our knowledge, the only other spider documented in Desert Tortoise burrows is the Black-widow Spider (*Lactrodectus mactans*) which has been observed in California and Nevada (Burge, *op.cit.*; Luckenbach, *op. cit.*). The presence of these highly effective predators in the burrows of Desert Tortoises suggests that additional species of invertebrates are likely utilizing the burrows as well.

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GOPHERUS AGASSIZII (Desert Tortoise). **PREDATION BY MOUNTAIN LION**. During a long-term study on tortoise growth within three fenced 9-ha enclosures in Rock Valley, Nevada Test Site (NTS), Nye County, Nevada, USA, tortoises have been captured annually since 1964 (Medica et al. 1975. Copeia 1975:630–643; Turner et al. 1987. Copeia 1987:974–979). Between early August and mid October 2003 we observed a significant mortality event. The Rock Valley enclosures were constructed of 6 x 6 mm mesh 1.2 m wide hardware cloth, buried 0.3 m in the soil with deflective flashing on both sides on the top to restrict the movement of small mammals and lizards from entering or leaving the enclosures (Rundel and Gibson 1996. Ecological Communities and Process in a Mojave Desert Ecosystem: Rock Valley, Nevada, Cambridge University Press, Great Britain. 369 pp.).

On 6 August 2003, the carcass of an adult female Desert Tortoise #1411 (carapace length 234 mm when alive) was collected while adult male tortoise #4414 (carapace length 269 mm) was observed alive and in good health on the same day. Subsequently, the carcass of #4414 was found on 16 October 2003. Between 16–17 October 2003, the remains of six (five adult and one juvenile) Desert Tortoises were found, some within each of the three enclosures in Rock Valley. A seventh adult tortoise was found on 26 September 2006, its death also attributed to the 2003 mortality event based upon the forensic evidence. Each of the seven adult Desert Tortoises had the central portion of their carapace broken open approximately to the dorsal portion of the marginal scutes while the plastron was still intact (Fig. 1A). Adjacent to seven of the eight remains, we located numerous bone fragments including parts of the carapace and limbs as well as dried intestinal content in nearby Range Rhatany (*Krameria parvifolia*) shrubs (Fig. 1B). The significance of the frequent use of this shrub is puzzling. Three of the Desert Tortoise shell remains possessed distinctive intercanine punctures measuring 55–60 mm center to center indicating that this was an adult sized Mountain Lion (*Puma concolor*). By comparison, a two-year old male Mountain Lion salvaged on NTS had an upper intercanine bite width of 45 mm, and a six-month old kitten measured 35 mm, respectively. The Mountain Lion is the only predator that exists in southern Nevada that could possibly have a bite with such a large gap between its upper canine teeth (Murmann et al. 2006. J. Forensic Sci. 51:846–860).

The appearance of the shell remains in Fig. 1A is similar to that depicting Jaguar (*Panthera onca*) predation on the Amazonian Red-footed Tortoise (*Geochelone denticulata*) as illustrated by Emmons (1989. J. Herpetol. 23:311–314), with the majority of the carapace broken open and the plastron still intact. Predation of Desert Tortoises by Mountain Lions was also documented in 1993 in southern Arizona (Little Shipp Wash Plot), where seven of eight carcasses found were attributed to Mountain Lion predation (Averill-Murray et al. 2002. *In* T. R. Van Devender [ed.], The Sonoran Desert Tortoise: Natural History, Biology, and Conservation, pp. 109–134. University of Arizona Press and Arizona-Sonora Desert Museum, Tucson, Arizona). Similarly, predation by a Mountain Lion has been reported on the Argentine Tortoise (*Chelonoidis chilensis*) in Argentina (Acosta et al. 2004. Herpetol. Rev. 35:53–54), and a Mountain Lion kitten was observed to kill and consume a portion of the carapace of a Texas Tortoise (*Gopherus berlandieri*) in west Texas (Adams et al. 2006. Southwest. Nat. 51:581–582).

Over the past 45 years this Desert Tortoise population has been monitored yearly, with no prior evidence of predation to tortoises within the fenced enclosures. On several occasions other predators such as Bobcats (*Lynx rufus*) have been observed within the study enclosures for as long as a week. Evidence of Kit Fox (*Vulpes macrotus*) sign has been observed on numerous occasions, and a Spotted Skunk (*Spilogale putorius*) and Longtail Weasels (*Mustela frenata*) have been captured and released (Medica 1990. Great Basin Nat. 50:83–84; B. G. Maza, pers. comm.), while Coyotes (*Canis latrans*) were never observed within the fenced enclosures. Prior to this predation event in Rock Valley, 17 Desert Tortoises were alive between 2000 and 2002, only 7 were known to be alive in 2004, while 2 tortoises have not been seen since 2002. Predation studies of Mountain Lions indicate that these events may be an example of a learned behavior of individual animals developing
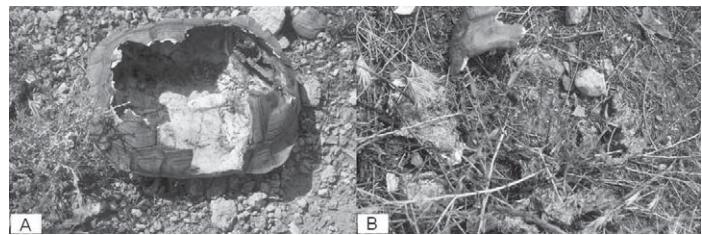

Fig. 1. A) Shell remains of an adult female Desert Tortoise (#1411) characteristic of Mountain Lion predation. B) Pieces of Desert Tortoise carapace and remnants of intestinal content found in a *Krameria parvifolia* shrub.

a preference for a prey (Logan and Sweanor 2001. Desert Puma: Evolutionary Ecology and Conservation of an Enduring Carnivore. Hornocker Wildlife Institute, Island Press, Washington. 463 pp.; Creeden and Graham 1997. Desert Bighorn Council Transactions, pp. 37–43), or the plight of a large predator locating an available source of food while passing through low elevation Mojave Desert habitat in late summer or early fall. Several Mountain Lion sightings were recently recorded in late summer and early spring (5 and 26 July 2006; 15 March 2007) at lower elevations (1300 m) in *Larrea/Ambrosia* habitat on the NTS, 8–10 km NE of Rock Valley in canyons near the base of Skull Mountain. Predation upon Desert Tortoises and their nests is also perpetrated by smaller carnivores, e.g., Coyotes, Kit Foxes, and Badgers (Grover and DeFalco 1995. Desert Tortoise (*Gopherus agassizii*): Status-of-knowledge Outline with References. U.S. Department of Agriculture, Forest Service Report INT-GTR-316, pp.76–79). Predation by these smaller carnivores generally leaves the carapace intact and the head and legs are gnawed off, sometimes leaving the upper portions of the appendages still connected to the carcass. The carcass of an adult male tortoise #1212 (carapace length 289 mm when last captured alive) was found in this condition on 15 October 2004. Such predation events upon alternate prey such as the Desert Tortoises appear to take place toward the end of the summer season and coincide with a combination of drought years and the reduced density of typical prey such as small mammals. Localized predation events by a large predator such as Mountain Lions can have a significant impact upon on a small population of prey, e.g., the reduction of the population of bighorn sheep in the Granite Mountains during drought 1989–1991 (Wehausen 1996. Wildl. Soc. Bull. 24:471–479). The Mountain Lion predation event that took place in Rock Valley during 2003 was likely a chance happening but has had a profound impact upon the local population. The presence of Bighorn Sheep (*Ovis canadensis*) in the adjacent Specter Range since their introduction in the fall of 1990 may have influenced the distribution of Mountain Lions.

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GOPHERUS POLYPHEMUS (Gopher Tortoise). **EMERGENCE BEHAVIOR**. Female Gopher Tortoises often place their nests in a mound of soil or bare area (referred to as the "apron") located immediately in front of their burrows (studies reviewed in Mushinsky et al. 2006. *In* Meylan [ed.], Biology and Conservation of Florida Turtles, pp. 350–375. Chelonian Research Foundation, Lunenburg, Massachusetts). However, observations of nest emergence and subsequent behavior of hatchling Gopher Tortoises are few. To our knowledge, Ashton and Ashton (2008. The Natural History and Management of the Gopher Tortoise. Krieger Publishing Company, Malabar, Florida) provide the only account of a hatchling Gopher Tortoise entering an active adult burrow immediately following nest emergence. We observed a hatchling Gopher Tortoise emerge from a nest located on a female tortoise burrow apron while an adult male courted the resident female and document the hatchling's emergence, the male's response, and the hatchling's post-emergence use of the active adult burrow.

We made our observation using an automated video system focused on an adult female burrow at the Camp Shelby Joint Forces Training Center in southern Mississippi, USA. On 26 August 2006 at 1229 h (CST; overcast skies; ambient air temperature [T_a] = 30°C), an adult male was on a burrow apron courting an adult female that was inside her burrow as a hatchling Gopher Tortoise emerged from its nest, located about ~10 cm in front of the male. The female, which entered her burrow earlier, did not emerge while the hatchling was present. The male head bobbed intermittently before, during, and after the emergence event. Although he was directly facing the hatchling and head bobbing in its direction, he was probably directing this behavior toward the female's burrow, which was also in front of him. The male extended his head toward the hatchling three times. All but the third head extension could easily have been part of the courtship ritual, but the third appeared to be clearly in response to the hatchling as the male extended his head far forward and touched the small turtle with its nose for several seconds. To our knowledge, this is the first report of an adult Gopher Tortoise responding to the presence of a hatchling. We did not identify any other unambiguous response by the adult toward the hatchling. The hatchling moved toward the male, and the male also moved slightly toward it (and the female burrow) until the hatchling was just in front of the male's gular and left forelimb. The two tortoises appeared to repeatedly make random contact before the hatchling walked away.

The male then proceeded toward the burrow, inadvertently pushing the hatchling that was still in his path with his forelimb and shell as he walked by. The hatchling, now behind the male, followed. The male continued to head bob toward the female's burrow and disappeared into the burrow at 1241 h. The hatchling appeared to enter the burrow at 1242 h, but it is unknown if it completely entered the burrow because the camera was positioned slightly behind the burrow entrance. The hatchling intermittently appeared in the burrow entrance until 1246 h, when it was no longer visible. A short while later, a small tortoise, possibly the same hatchling, emerged from the burrow entrance before going back inside. At 1255 h, shortly after it started to rain, the male emerged from the burrow and left the apron and the video-taped area. At 1305 h (T_a = 27°C), while it was still raining, a small tortoise (possibly the same hatchling) emerged from the burrow entrance. After beginning to leave the apron, it turned around and somehow, perhaps due to the slope of the terrain, overturned onto its carapace. Thirty seconds later, the hatchling righted itself, left the apron, and went into some dense vegetation before going out of view for the final time at 1329 h. Neither the male nor the hatchling returned to the burrow later that day before the video system stopped recording at 2030 h.

Ashton and Ashton (*op. cit.*) report an event in which a hatchling entered an active adult burrow immediately upon emerging from its nest. It is unknown whether a hatchling that is at the surface can determine whether a burrow contains an adult tortoise. Our observation of a hatchling following an adult tortoise into a burrow entrance is notable because it provides unambiguous evidence that upon emergence, some hatchlings use adult burrow entrances (and probably deeper portions of burrows also) regardless of activity status or adult presence at the burrow mouth. Adult Gopher Tortoise burrows may provide newly-emerged hatchlings with a convenient, temporary refuge from hot and dry surface conditions from which they can leave to construct their own burrows when conditions are favorable for extended above ground activity.

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GOPHERUS POLYPHEMUS (Gopher Tortoise). **NESTING.** *Gopherus polyphemus* is endemic to the Longleaf Pine ecosystems of the Gulf Coastal Plain of the southeastern USA. Oviposition in this species usually occurs between May and early July when eggs are deposited in a nest cavity usually located on the apron of

the burrow. In the DeSoto National Forest (DNF), female tortoises construct nest cavities on average 55 cm from the mouth of the burrow, 17 cm deep, and containing 5 eggs (Noel 2006. Unpubl. MS thesis, University of Southern Mississippi, Hattiesburg). During the summer of 2008, we searched burrow aprons in the DNF for clutches of eggs on a daily basis. Each clutch that was found was excavated and removed from the nest cavity and moved to man-made nests at different burrows, as part of an experiment to evaluate environmental influences on hatching success. Following excavation and egg removal, nest cavities were re-filled with the loose soil that had been earlier removed. Because of the soil composition and hard-setting nature of most burrow aprons (mean soil composition of nests: 83.2% sand, 12.7% silt, and 4.1% clay), these nest cavities often remain detectable by feel (i.e., a hard-sided cavity filled with loose, friable soil) for several weeks or longer.

On 24 May 2008, a clutch (N = 5 eggs) was found and excavated at a burrow (#7032 in the DNF database) at our McLaurin site (31.14992 N°, 89.2005 W°) that was ca. 70 cm from the burrow mouth and 17 cm deep. Ten days later on 3 June 2008, a second clutch (N = 6) was discovered within the same nest cavity, with only minor modifications to the original shape. A third clutch (N = 5) was excavated from the same nest cavity just two days later on 5 June 2008 with slightly more substantial modifications to the original cavity. The final clutch (N = 5) was discovered on 16 June 2008 at the original cavity location; however the cavity was highly modified from the original shape and size. To our knowledge, this is the first report of multiple clutches being laid not only at the same burrow but also in the same nest cavity within a given year. We presume that these four clutches were oviposited by four different females, since there are no published accounts of multiple clutches in one season for *G. polyphemus*, and it seems highly unlikely that a female could produce a subsequent clutch in as few as two to eleven days. This is perhaps not a naturally occurring phenomenon, since we removed each previous clutch, the presence of which may have prevented subsequent females from excavating and ovipositing in the same location. Alternatively, it is possible that subsequent females may have used the same location even without our alterations, perhaps destroying the prior clutch(es) during their excavation of a nest cavity. During our five years (2003–2007) of searching for nests at the same sites, we have never found a nest cavity utilized more than once but have found, on several occasions, two clutches oviposited in the same apron. These observations suggest that particular burrow aprons could be more favorable, and nesting *G. polyphemus* may exhibit preference for these locations.

The research that led to this observation was conducted under a Mississippi Administrative Scientific Research Collection Permit for nesting experiments with *G. polyphemus*. This research was funded by the U.S. Army Corps of Engineers Construction Engineering Research Laboratory, contract number W9132T-06-2-0021, and in earlier years (2003–2005) by the Mississippi Department of Wildlife, Fisheries, and Parks. We thank Brian Kreiser for reviewing this document.

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GRAPTEMYS FLAVIMACULATA (Yellow-blotched Map Turtle). **UNUSUAL BASKING DISTURBANCE.** Members of the genus *Graptemys* are noted for their proclivity to bask aerially and wariness while basking on emergent deadwood (Boyer 1965. Ecology 46:99–118). Basking disturbances for this species have been studied, but focused on human recreational disturbance (Moore and Seigel 2006. Biol. Cons. 130:386–393). Here we report multiple observations of *G. flavimaculata* basking disturbances caused by unnatural floating debris.

On 23 June 2007, three male *G. flavimaculata* (West Pascagoula River, Jackson County, Mississippi) were observed to flee their basking locations in response to a large piece of polystyrene foam (ca. 90 x 90 x 90 cm) floating downstream at 1755 h. One of these turtles was basking in a fallen tree crown and two were basking on the trunk portion of the same fallen tree. Also, on 22 April 2008 (same locale), two female, one male, and one juvenile female *G. flavimaculata* were not disturbed by a medium-sized piece of floating polystyrene foam (122 x 45 x 20 cm) floating downstream at 1339 h. However, this floating debris got caught in an eddy current and began moving back upstream and only then (1343 h) did all four individuals evacuate their basking locations on trunk portions of fallen trees. Later that afternoon at 1730 h, three female *G. flavimaculata* were disturbed by a small piece of Styrofoam (45 x 15 x 10 cm) floating downstream.

On 20 April 2008, a large female *G. flavimaculata* (same locale) was disturbed from her basking location because of a large television floating downstream at 1304 h. Further, it was also noted that two *G. flavimaculata* males basking downstream were not disturbed by the same floating television at 1310 h.

Within the Lower Pascagoula River, there are many floating houseboats and these usually have large blocks of polystyrene foam that are used for floatation. Following Hurricane Katrina, many of these houseboats were destroyed (by wind and storm surge) and there was a plethora of floating debris including plywood, couches, polystyrene foam, and other items. For all observations, objects passed within 5–10 m of the basking turtles, and therefore, it is unknown if objects floating at greater distance would elicit the same response. However, it is clear from these observations that this species is quite wary of unnatural floating items in the river.

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GRAPTEMYS FLAVIMACULATA (Yellow-blotched Map Turtle). **BASKING AND PARASITE REMOVAL**. Aerial basking in turtles is thought to be primarily for thermoregulatory reasons (Boyer 1965. Ecology 46:99–118). However, a recent observation (Selman et al. 2008. Herpetol. Rev. 39:216) supports the secondary role of basking as a method to rid turtles of ectoparasites (Cagle 1950. Ecol. Monogr. 20:31–54; Neill and Allen 1954. Ecology 35:581–584; Vogt 1979. Auk 96:608–609). Here, we provide a second observation of voluntary leech removal from a different species in the genus *Graptemys*.

On 27 May 2008 (1127 h), WS observed a juvenile female *Graptemys flavimaculata* (~10 cm, 200 g) basking on a branch of a fallen tree-crown (West Pascagoula River, Jackson Co., Missis-

sippi, USA). It was unknown how long the individual had been emerged from the water, but the shell was completely dry when first observed. Also, a large leech (*Placobdella* sp.) was noted on the posterior right portion of the carapace and it was in a ball shaped posture, presumably for water conservation. After 6 minutes of observation (1133 h), the leech terminated the ball-shape and moved slowly toward the posterior of the carapace. Over the next minute, the leech removed one end of its body from of the turtle and began to 'search' below toward the branch, while the other end was still attached at the rear margin of the carapace. The leech tried to reach for the branch multiple times to remove itself, but was unsuccessful because the turtle was 'swiping' her hind legs, preventing the leech from attaching to the log. At 1134 h, the leech began to 'search' again for the branch and the turtle flipped the leech off its shell with a swipe of its right hindlimb into the water.

At the time of basking, the air temperature was 27.2°C and log surface temperature was 28.2°C. Therefore, the carapace temperature of the *G. flavimaculata* juvenile female was likely hot enough to induce the leech to voluntarily release itself from its host organism. It is unlikely that the leg swiping was related to the leech's presence, but instead a normal behavior associated with basking in other turtle species (Auth 1975. Bull. Florida St. Mus. 20:1–45). We assume that the leech eventually would have removed itself in a manner similar to our previous observation (Selman et al. 2008, *op. cit*.) had the turtle not assisted. This is the second documented observation of voluntary parasite release during basking and first observation for this species.

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MACROCHELYS TEMMINCKII (Alligator Snapping Turtle). **ADULT BASKING BEHAVIOR**. *Macrochelys temminckii* is the largest freshwater turtle in North America, inhabiting rivers and associated waters (e.g., cypress swamps and smaller tributaries) that drain into the Gulf of Mexico (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institute Press, Washington, D.C. 578 pp.). Little is known concerning the behavior of this secretive turtle, but there have been reports of *M. temminckii* hatchlings and juveniles basking aerially (Ewert 1976. Herpetologica 32:150–156; Farr et al. 2005. Herpetol. Rev. 36:168; Shelby and Jenson 2002. Herpetol. Rev. 33:304). Here we report the first known aerial basking observation of an adult *M. temminckii*.

On 3 April 2008 (1400 h), WS and BD observed an adult *M. temminckii* (ca. 40–50 cm carapace length) basking on a bank of the Leaf River (Forrest County, Mississippi, USA). The individual was observed via spotting scope (ca. 100 m distant), ca. 1.8 m above the water's surface on the opposite, cut bank side of the river. The individual was facing upslope and appeared lifeless, with head extended completely and resting on the sand bank (to the extent that we could seeing the complete dorsal profile of the head). The sandy bank was fully exposed to sun, non-vegetated, had a slope of ca. 45–60°, and faced to the southwest. Conditions were mostly sunny, with a water temperature of 22°C and an ambient air temperature of 28°C (31°C in direct sunlight). After observa-

tion of this turtle basking for ca. 5 minutes, it turned around and retreated to the water. The route back to the water seemed to be a "controlled fall" on the steep slope and the turtle hesitated slightly before re-entering the water.

It is unlikely that this behavior was associated with female reproductive activity because reports indicate that nesting of *M. temminckii* occurs in Florida during late April to early May (Ewert and Jackson 1994. Unpubl. report to Florida Game and Freshwater Fish Commission) and in Georgia until early June (Powders 1978. Copeia 1978:134–140). Furthermore, subsequent searches did not reveal any nest sites at the basking location. It is difficult to determine what initiated this behavior because there are no other reports for adult basking behavior. We could not determine how long the individual had been basking before our initial observation or why the turtle was basking so far and high from the water's edge on a steep inclined river bank, as opposed to near the water's edge. However, we presume that basking behavior could have been initiated due a combination of factors. The day of observation was mostly sunny, preceded by three days of cloudy conditions. Water temperatures were relatively low, and river flows peaked during the day of observation, preceded by two days of rising water levels following heavy rains. Additionally, the individual might have had an injury or illness and might have been basking to increase body temperature to fight infection.

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PSEUDEMYS CONCINNA (River Cooter). **MAXIMUM BASKING TIME.** *Pseudemys concinna* is a large, herbivorous, freshwater turtle that is found predominantly in the southeastern United States (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press, Washington, D.C. 578 pp.). It is prone to aerial basking and this behavior has been observed in West Virginia populations from March to September (Buhlman and Vaughan 1991. J. Herpetol. 25:72–78), with basking peaking during midday (1200 h) for Florida populations (Pritchard and Greenhood 1968. Int. Turtle Tortoise Soc. J. 2:20–25, 34). Even though it is known that basking behavior is common in this species, the maximum amount of time an individual will spend once emerged from the water is unknown. Here we report a maximum basking time for this species.

On 15 April 2008 (Leaf River, Forrest County, Mississippi, USA), a *P. concinna* (ca. 15–20 cm CL) was noted emerging onto a branch at 0950 h, which was the first favorable sunlight conditions for basking. This individual basked without re-entering the water until 1755 h (8 h, 5 minutes). At the time of emergence, the water temperature was 16.3°C and the ambient air temperature was 12°C (26.6°C in sunlit conditions). At submergence, water temperature was 20.0°C and ambient air temperature was 17.4°C (33.7°C in sunlit conditions). Furthermore, it was sunny throughout the day; the water temperature peaked at 20.0°C and ambient air temperatures peaked at 18.1°C (sunlit temperatures at 34.7°C).

Throughout the day, many *P. concinna* were observed basking

for extended periods of time (4–6 h). Also, 44 *P. concinna* were noted basking at 1400 h along a 310-m section of river. This was the most observed during any hourly count at this location throughout the year (April–October). Therefore, early spring, when water temperatures are cool and air temperatures are warming, is apparently highly conducive to *P. concinna* basking for long periods of time.

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TERRAPENE ORNATA LUTEOLA (Desert Box Turtle). **CARRION FEEDING**. *Terrapene ornata* is known to eat a variety of food items, although its diet mainly consists of insects under natural conditions (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press, 578 pp.; Legler 1960. Univ. Kansas Publ., Mus. Nat. Hist. 11:527–669). Included in the diet of the species is carrion (Dodd 2001. North American Box Turtles: A Natural History. Univ. of Oklahoma Press, Norman, 231 pp.). *Terrapene ornata luteola* occurs in desert habitats of New Mexico, Texas, Arizona, and adjacent parts of Mexico. Most information on the diet of *T. ornata* has been gathered on the grassland-inhabiting subspecies *T. o. ornata*. Here I report on an instance of carrion feeding in *T. ornata luteola*.

On 22 July 2008 at 0716 h, at the Sevilleta National Wildlife Refuge (ca. 67 km S of Albuquerque, New Mexico, USA), I found an adult female *T. ornata luteola* (130 mm straight-line carapace length, 583 g) on a dirt road with the head of a recently deceased Round-tailed Horned Lizard (*Phrynosoma modestum*) in its mouth. When I drove up to the turtle, she started to move off the road with the lizard still in her grasp. The female held onto the lizard for about 30 s as I tried to photograph her. Once she dropped the lizard, I placed turtle and lizard in a holding box. A small (about 4 mm) chunk of the anterior portion of the head of the lizard had been removed. The horned lizard (58 mm snout–vent length, 6.2 g) was still pliable and may have been a recent roadkill. However, a caged *T. o. ornata* was found to have partially eaten a living Texas Horned Lizard (*P. cornutum*) caged with it (Eaton 1947. Copeia 1947:270). Under natural conditions, though, it seems unlikely that a turtle could catch a living horned lizard.

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TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider). **MAXIMUM BASKING DURATION**. *Trachemys scripta* is a large, omnivorous, freshwater turtle that is found predominantly in the southeastern and central United States (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press, Washington, D.C. 578 pp.), although it has been introduced to many places worldwide via the pet and food trades (Emer 2004. Herpetol. Rev. 35:34–35; Lever 2003. Naturalized Reptiles and Amphibians of the World. Oxford University Press, Oxford; Perry et al. 2007. Applied Herpetol. 4:88–89). Aerial basking is highly developed in this species with peak basking time occurring around 1400 h; maximum

basking duration also has been noted at over 200 minutes during the fall months (Auth 1975. Bull. Florida St. Mus. 20:1–45). Here we report a new maximum basking time for this species.

On 15 April 2008 (Leaf River, Forrest County, Mississippi, USA), a *T. s. elegans* (ca. 20 cm CL) was noted emerging onto a branch at 0955 h—the first favorable sunlight conditions for basking. This individual basked without re-entering the water until 1705 h (7 h, 10 minutes). At the time of turtle emergence, water temperature was 16.4°C and the ambient air temperature was 12.4°C (26.4°C in sunlit conditions). At submergence, water temperature was 19.9°C and ambient air temperature was 17.5°C (33.6°C in sunlit conditions). Further, it was sunny throughout the day; water temperature peaked at 20.0°C and ambient air temperatures peaked at 18.1°C (sunlit temperatures at 33.6°C).

Throughout the day, many turtles of several species were noted to bask for extended periods of time (4–6 h). Therefore, early spring, when water temperatures are cool and air temperatures are warm, appear highly conducive to extended basking in *T. s. elegans* and other co-occurring turtle species.

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CROCODYLIA — CROCODILIANS

CAIMAN CROCODILUS (Spectacled Caiman). **OPPORTUNISTIC FORAGING.** We document opportunistic foraging behavior by *Caiman crocodilus* in a post-inundation forest at Estacíon Biologíca Caño Palma, Costa Rica. Estacíon Biologíca Caño Palma is a 40-ha reserve located on the northeast coast of Costa Rica, south of Barra del Colorado. This reserve and the surrounding area is lowland tropical wet forest (*fide* Holdridge 1967. Lifezone Ecology, Tropical Science Center, San José, Costa Rica. 206 pp.) comprised predominantly of *Manicaria* swamp forest (Myers 1990. *In* Lugo et al. [eds.], Ecosystems of the World, pp. 267–278. Elsevier, Oxford, UK). Bounded by large catchment rivers to the north, south, and west with a blackwater channel to the east, the forest inundates seasonally (November–December and May). *Manicaria* forests typically exhibit a prominent biannual polymodal inundation during the wettest season (Junk et al. 2000. The Central Amazon Floodplain: Actual Use and Options for a Sustainable Management, Backhuys Publishers, Leiden, Holland. 584 pp.). The seasonal inundation event that engulfs Estacíon Biologíca Caño Palma is also coupled with local tidal flow patterns (Kelso 1967. Unpubl. M.Sc. thesis, Univ. Florida, Gainesville. 156 pp.). Once inundation subsides, numerous temporal pools remain in the forest; these generally disappear during the warmer (and drier) months of the year.

In December 2002 and again in January 2004, during three months of weekly diurnal visual-encounter transects of post-inundation *Manicaria* forest, 5 adult and 7 juvenile caiman (2002) and 4 adult and 3 juvenile caiman (2004), respectively, were located well into (often > 100 m) the forest. Once disturbed, they retreated terrestrially toward the channel associated with riparian habitat, rapidly slipping in and out of temporary pools as they headed in an easterly direction toward the main blackwater channel bordering the property.

Caiman reproduction, which generally occurs during the rainy season in this region of Costa Rica (November–February), involves construction of vegetation mounds in forested environments to incubate the eggs (Allsteadt 1994. J. Herpetol. 22:12–19). As in other crocodilians, caiman exhibit well-developed parental care and will defend nests from predators, the primary threat to their eggs (Leenders 2001. A Guide to Amphibians and Reptiles of Costa Rica. Zona Tropical, Miami, Florida. 305 pp.). We detected no evidence of nests or nest-guarding behavior in the areas where we sighted caiman. However, these areas, still saturated by water, were frequently found to be full of suffocating fish trapped in desiccating flood pools or anurans utilizing these ponds for breeding. Fish species present included: *Archocentrus nigrofasciatus* and *Parachromis managuensis* (Cichlidae), *Rhamdia guatemalensis* and *Rhamdia rogersi* (Pimelodidae), and *Astyanax aeneus* (Characidae). *Atractosteus tropicus* (Order: Semionotiformes) were also hunting in these pools and may have constituted prey. That caiman were feeding on the diverse prey within these seasonally restricted environments seems likely. Fish are an important prey species for many crocodilians (Magnusson 1987. J. Herpetol. 21:85–95) and can make up over 25% of total prey items in sub-adult and mature adult caiman (Thorbjarnarson 1993. Herpetologica 49:108–117; Velasco et al. 1994. Crocodile Specialist Group Newsletter 13:20–21). In tropical blackwaters Cichlidae, Pimelodidae, and Characidae can make up 10–27% of the composition of fish species consumed (Santos et al. 1996. Herpetol. J. 6:111–117; Thorbjarnarson 1993. Herpetologica 49:108–117) and possibly more when increases in water level like that which occurred along the Caño Palma allow more fish access to greater volumes of water and increased predation susceptibility (Silveira and Magnusson 1999. J. Herpetol. 33:181–192).

Caiman now occur in diverse habitats such as marshes, rivers, channels, and lakes in both the Caribbean and Pacific lowlands of Costa Rica, particularly as a result of the now-diminished ranges of sympatric competitors (*Crocodylus acutus*) (Magnusson 1982. Crocodiles, pp. 108–116. Proc. 5th IUCN/SSC Croc. Spec. Group, Gland, Switzerland). They are commonly found in the canals, dykes, and channel networks in forested floodplain habitats (Allsteadt and Vaughan 1992. Brenesia 38:65–69; Guyer 1994. *In* McDade et al. [eds.], La Selva: Ecology and Natural History of a Neotropical Rain Forest, pp. 210–216. Univ. Chicago Press, Chicago, Illinois; Guyer and Donnelly 2005. Amphibians and Reptiles of La Selva, Costa Rica and the Caribbean Slope. Univ. California Press, Berkeley, California. 299 pp.; Ouboter and Nanhoe 1988. J. Herpetol. 22:283–294; Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. Univ. Chicago Press, Illinois. 934 pp.). This species is known to establish territories in local channel networks where they exhibit high site tenacity (Savage, *op. cit.*), especially in areas that provide a sustainable food resource. Opportunistic seasonal shifts in habitat use has not been widely reported in *Caiman crocodilus*. Our observations imply that these habitat shifts provide enhanced feeding opportunities that may be unavailable the rest of the year. We present two models that may explain these habitat shifts. In the first, caiman may periodically abandon their territories within the permanent channel network during episodic inundation to specifically forage for trapped fish within temporary pools in the forest. The second

model proposes that caiman along with other fauna advance into the forest during inundation following the expanding shoreline. As the water recedes, some aquatic animals are trapped in pools where they are vulnerable to amphibious predators, such as caiman. Caiman are able to escape back to traditional channel-margin habitat as the pools disappear. Which is correct provides an interesting question for further research.

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LACERTILIA — LIZARDS

AMEIVA FESTIVA (Middle American Ameiva). **ENDOPARASITES.** *Ameiva festiva,* a diurnal forest species, occurs in humid lowlands from Tabasco, Mexico to northern Colombia (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.). To our knowledge, only one report exists of helminths in *A. festiva*; Bursey et al. (2006. J. Parasitol. 92:350–353) reported the nematode *Oswaldocruzia nicaraguensis*, physalopterid (nematode) larvae and an acanthocephalan cystacanth from *A. festiva* collected in Nicaragua. The purpose of this note is to add the nematode *Physaloptera retusa* to the list of endoparasites for *A. festiva*.

Only the stomach of one *A. festiva* female (90 mm SVL) deposited in the Natural History Museum of Los Angeles County, Los Angeles, California, USA as LACM 72804 (from Colombia, Chocó Province, upper Rio del Valle, 06.7572°N, 77.5636°W, WGS84; elev. 50 m) collected in 1971 was opened and examined for helminths. Found were 5 adult (4 male, 1 female) nematodes, which were cleared in a drop of glycerol on a glass slide, cover-slipped and identified using a compound microscope as *Physaloptera retusa*. Nematodes were deposited in the United States National Parasite Collection, Beltsville, Maryland as: *Physaloptera retusa* (USNPC 101082).

Physaloptera retusa is widely distributed among lizards in the western hemisphere (Baker 1987. Mem. Univ. Newfoundland, Occas Pap. Biol. 11:1–325; Goldberg et al. 2007. Comp. Parasitol. 74:327–342). Physalopterid nematodes utilize insects as intermediate hosts; lizards become infected by ingesting insects containing infective larvae (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission, 2nd ed. CABI Publishing, Oxfordshire, UK. 650 pp.). *Ameiva festiva* represents a new host record for *P. retusa*. Colombia is a new locality record.

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AMEIVA UNDULATA (Rainbow Ameiva). **ENDOPARASITES.** *Ameiva undulata* is known from Tamualipas and Nayarit, Mexico, south to Nicaragua (Savage 2002. The Amphibians and Reptiles of Costa Rica; A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. 934 pp.). To our knowledge, only one report exists of an endoparasite from this species. Caballero (1951. Ann. Instit. Biol. Univ. Nac. Aut. Mexico 20:141–158) reported the nematode *Physaloptera retusa*. The purpose of this note is to add the nematode *Physalopteroides venancioi* and an acanthocephalan (Oligacanthorhynchidae) cystacanth to the list of endoparasites from *A. undulata*.

The coelomic cavities of 28 *A. undulata* from Guanacaste Province, Costa Rica in the herpetological collection of the Natural History Museum of Los Angeles County were examined for helminths. The body cavity was opened and the coelomic cavity and visceral organs were examined. Three female nematodes were found, two from LACM 166050 (male, 76 mm SVL) and one from LACM 166081 (male, 68 mm SVL) both collected 1964 (vic. Liberia, 10.6333°N, 85.4333°W, WGS84; elev. 176 m) and one acanthocephalan cystacanth was found in LACM 166089 (male, 103 mm SVL) collected 1983 (vic. Bagaces, 10.3333°N, 85.3333°W; elev. 400 m). Nematodes were cleared in a drop of glycerol on a glass slide, cover-slipped and identified using a compound microscope as *P. venancioi*. The acanthocephalan was regressively stained in hematoxylin, mounted on a glass slide in a drop of Canada balsam, cover-slipped and identified using a compound microscope as a cystacanth belonging to the Oligacanthorhynchidae. Endoparasites were deposited in the United States National Parasite Collection, Beltsville, Maryland as: *P. venancioi* (USNPC 101073) and (Oligacanthorhynchidae) cystacanth (USNPC 101074).

Physalopteroides venancioi was described from *Bufo paracnemis* (currently *Rhinella schneideri*) from Paraguay (Lent et al. 1946. Mem. Instit. Oswaldo Cruz. 44:195–214) and is also known from anurans and lizards from Peru as well as lizards from Brazil (Bursey et al. 2005. Comp. Parasitol. 72:50–68). It is in the family Physalopteridae which typically utilize insect intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates; Their Development and Transmission, 2nd ed. CABI Publishing, Oxfordshire, UK. 650 pp.). The cystacanth, a larval acanthocephalan, also requires an arthropod intermediate host (Kennedy 2006. Ecology of the Acanthocephala. University Press, Cambridge, UK. 249 pp.). *Ameiva undulata* represents a new host record for *P. venancioi* and oligacanthorhynchid cystacanth.

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AMPHIBOLURUS MURICATUS (Jacky Dragon). **AVIAN PREDATION.** The Jacky Dragon, a medium-sized agamid lizard (100 mm SVL; tail length: ~200% SVL), is common in heathland regions of southeastern coastal Australia. As with many agamids, they rely heavily on their motion vision system for survival. They adopt a sit-and-wait strategy to identify insect prey, waiting for movement to attract their attention. They also respond to the movement of larger animals that may pose a threat, including birds, larger reptiles, and mammals. While Jacky Dragons are abundant and detailed knowledge of their behavior and reproductive biology exists (e.g., Harlow and Taylor 2000. Austral Ecol. 25:640–652; Peters et al. 2007. Curr. Biol. 17:1231–1234; Warner and Shine 2008. Nature 451:566–568), scant data exist on predation. To our knowledge, there is only a recent note on predation by varanid lizards *Varanus rosenbergi* and *V. varius* (Warner 2007. Herpetol. Rev. 38:449). That report describes predation following raids on nests that were likely identified using chemical cues. Though larger reptiles such as varanid lizards and snakes may feed opportunistically on agamid lizards (e.g., Shine 1977. Can. J. Zool. 55:1118–1128), our observations in the field suggest that Jacky Dragons are particularly responsive to potential aerial predators. Indeed, raptors such as Australian (Nankeen) Kestrels (*Falco cenchroides*) and White-bellied Sea-eagles (*Haliaeetus leucogaster*) frequently hover and circle above our outdoor field enclosures and are watched intently. Dietary analyses of many Australian raptors provide evidence that agamid lizards are preyed upon (Marchant and Higgins 1993. Handbook of Australian, New Zealand and Antarctic Birds. Vol 2. Raptors to Lapwings. Oxford University Press, Melbourne, Australia. 984 pp.), but identification of remains has not reached the species level. Here we document predation on a Jacky Dragon by another common Australian bird, the Laughing Kookaburra (*Dacelo novaeguineae* – hereafter Kookaburra).

The Kookaburra is an ambush predator and, although primarily insectivorous, they will take vertebrates, including snakes of more than twice their weight (Blomberg and Shine 2000. Behav. Ecol. Sociobiol. 48:484–489). Small prey are swallowed whole, whereas larger prey are first killed by being beaten against the ground or a tree branch. During the afternoon of 14 September 2006, we observed a Kookaburra manipulating a live adult Jacky Dragon in

Fig. 1. A Jacky Dragon (*Amphibolurus muricatus*) in the beak of a Laughing Kookaburra (*Dacelo novaeguineae*).

its beak at Tura Head Coastal Reserve, New South Wales, Australia (36.82°S, 149.93°E; elev. 20 m) (Fig. 1). The kookaburra remained on the same perch, occasionally beating the Jacky Dragon against the tree branch, and consuming it over the following two hours.

Jacky Dragon color patterns ensure that they remain cryptic while basking motionless in dense habitats; territorial defense behavior, however, quickly disrupts their camouflage. This suggests a direct cost for intra-species aggression. Like many lizards, Jacky Dragons make use of their motion vision system by relying on movement to communicate. In response to potential rivals, they perform a stereotyped display comprising several motor patterns, including tail flicking, foreleg waves and push ups (Peters and Ord 2003. Austral Ecol. 28:499–506). Bouts of these displays are often repeated after moving to a new location. While their displays attract the attention of conspecifics, they can also attract the attention of potential predators.

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ASPIDOSCELIS COSTATA BARRANCARUM (Barranca Whiptail). **DIET**. Little is known about the diet of any of the subspecies of *Aspidoscelis costata* (*sensu* Duellman and Zweifel 1962. Bull. Am. Mus. Nat. Hist. 123:155–210; Wright 1993. *In* Wright and Vitt [eds.], Biology of Whiptail Lizards [genus *Cnemidophorus*], pp. 27–81. Oklahoma Mus. Nat. Hist., Norman, Oklahoma). We describe prey items removed from specimens of *A. costata barrancarum*, a subspecies described as *Cnemidophorus sacki barrancorum* from 28 specimens from adjacent parts of Sonora and Chihuahua, México (Zweifel 1959. Bull. Am. Mus. Nat. Hist. 117:57–116). The 14 individuals used in this study were collected by JALE in southwestern Chihuahua, México and transferred to the University of Colorado. They were then shipped to the University of Arkansas by HMS, their stomach contents were removed by JMW and identified by MAP, and they were catalogued into the Herpetological Collection of Unidad de Biología, Tecnología y Prototipos (UBIPRO) as follows: N of Batópilas at km 50.5 on Chihuahua Hwy 75 from Samachique to Batópilas (27.1149°N, 107.6646°W, WGS84; elev. 687 m, 16 June 2001 [UBIPRO 7316]; 17 June 2001 [UBIPRO 7318]); Satevo (26.9905°N, 107.7647°W, 567 m, 18 June 2001 [UBIPRO 7328–7330]); Arroyo El Camuchil (27.0261°N, 107.7625°W, 435 m, 19 June 2001 [UPIBRO 7369]); Ejido Gorojaki (27.4266°N, 108.5550°W, 450 m, 21 July 2003 [UPIBRO 11475, 11476, 11478, 11479, 11505]); Chínipas (27.3944°N, 108.5360°W, 469 m, 23 July 2003 [UPIBRO 11528, 11530, 11533]). Lemos-Espinal et al. 2003. (Herpetol. Rev. 34:365–366) provided a description of habitat in which *A. costata barrancarum* forages and engages in other activities; mean SVL of 10 gravid females was 82.7 ± 2.9 (range 67–97); mean SVL of 4 males was 101.5 ± 4.6 (range 97–104). Stomach contents

TABLE 1. Diet of 14 *Aspidoscelis costatus barrancarum* collected from southwestern Chihuahua, México. Arthropod orders are capitalized. Three hundred fifty-two prey items comprising 18,060 mm³ total volume were recorded.

Prey Taxon	% by Number	% by Volume	% of Stomachs Containing
ARANEAE	4.8	6.4	35.7
ORTHOPTERA			
Acrididae	1.7	5.3	35.7
Gryllidae	0.6	3.5	14.3
Tetrigidae	0.3	0.3	7.1
Blattidae	0.3	2.1	7.1
ISOPTERA	6.5	0.5	28.6
COLEOPTERA			
Adults	5.4	10.4	42.9
Larvae	3.7	6.0	42.9
LEPIDOPTERA			
Adults	0.6	0.8	7.1
Larvae	9.1	26.2	78.6
NEUROPTERA	0.3	0.2	7.1
DIPTERA	0.3	0.6	7.1
HYMENOPTERA			
Formicidae	63.9	9.2	50.0
PUPAE	1.7	28.3	21.4
Unidentifiable	0.9	0.1	21.4

were dissected from each specimen and preserved in separate vials containing 70% ethanol until analyzed. Each prey item was identified to at least order (often family) and its length and width measured to the nearest 0.1 mm to estimate prey item volume using the formula $V = 4/3 \, (0.5 \, \text{length}) \times (0.5 \, \text{width})^2$ (Vitt et al. 2003. J. Zool. 71:2391–2400).

Ants (Formicidae) were the numerically dominant prey taxon as one lizard consumed 92, a second consumed 80, and a third consumed 31 (together comprising more than half of all the prey items identified; Table 1). The dominant prey by volume were insect pupae, caterpillars (Lepidoptera larvae), beetles (Coleoptera adults), and ants. Caterpillars were the only prey taxon consumed by a majority of lizards surveyed (though ants were consumed by half the lizards). The only other study of *A. costata* diet of which we are aware, Brooks and Mitchell (1989. Southwest. Nat. 34:541–546), which was based on lizards collected from the Alamos Region of Sonora, México, reported termites as the numerically dominant prey. However, similar to our study, they found that beetles, caterpillars, and ants made up most of the volume of lizard prey consumed. Having ants constitute such a large part of the diet is unusual for a whiptail lizard (Mitchell 1979. Can. J. Zool. 57:1487–1499; Paulissen et al. 2003. Southwest. Nat. 38:377–381).

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CTENOSAURA SIMILIS (Black Spiny-Tailed Iguana), ***GOPHERUS POLYPHEMUS*** (Gopher Tortoise). **CONCURRENT BURROW USE.** *Ctenosaura similis* is exotic to Florida (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida, Krieger Publ. Co., Malabar, Florida. 155 pp.), whereas *Gopherus polyphemus* is listed as a species of special concern by the state of Florida (Florida Wildlife Code Chap. 39 F.A.C.), and as a threatened species by the Florida Committee on Rare and Endangered Plants and Animals (FCREPA) (Moler 1992. Rare and Endangered Biota of Florida: Volume III, Reptiles and Amphibians. University Press of Florida, Gainesville, Florida. 291 pp.). Three *C. similis* were introduced to Gasparilla Island (Charlotte and Lee counties) ca. 30–35 years ago, where the species is now abundant (Krysko et al. 2003. Florida Sci. 66:141–146). Among the many concerns about the high density of ctenosaurs on Gasparilla Island are their impacts to threatened and endangered species (Krysko et al. 2003. Florida Sci. 66:141–146). *C. similis* is well-known to occupy *G. polyphemus* burrows, but apparently *G. polyphemus* cohabitation has not been observed following their occupation by ctenosaurs (McKercher 2001. Unpubl. M.Sc. thesis, Univ. Florida, Gainesville, Florida. 117 pp.). We report here observations of ctenosaur usage of active *G. polyphemus* burrows and the effects on *G. polyphemus*.

From 14–28 February 2008 we made a series of observations on Gasparilla Island, Florida at a 0.1-ha site of undeveloped habitat surrounded by a neighborhood of homes with manicured landscaping. Approximately 14 adult *G. polyphemus* resided in this small area, with a similar number of adult *C. similis*. As part of an invasive species removal effort, and to avoid impacting tortoises during the invasive species removal operations, observations on burrow usage were made on 12 days during the time span.

Ctenosaurs would actively move among the burrows (created by *G. polyphemus*), appearing to purposefully investigate other burrows holding other ctenosaurs. Ctenosaurs would readily enter burrows already occupied by a tortoise (or another ctenosaur). If a tortoise was situated at the burrow entrance, an iguana would not hesitate to scramble over or around the tortoise to enter the burrow, without causing the tortoise to exit. Typically, a tortoise would readily enter a burrow already holding a ctenosaur. However, we observed that a burrow which appeared to be regularly occupied by four ctenosaurs was not observed, either directly or from tracks, to be entered by a tortoise. Once 12 *C. similis* were removed from the site (and only one or two adult *C. similis* remained on the entire site), that burrow no longer was occupied by ctenosaurs and *G. polyphemus* resumed using it. Thus, some low level of burrow sharing appears to be tolerated by *G. polyphemus*, but they also seem to be repelled from burrows at some level of *C. similis* activity.

Our observations relate only to the willingness to share burrows. Other potentially negative aspects of *C. similis* activity such as *G. polyphemus* nest destruction was not addressed. Examination of the stomach contents of *C. similis* removed from Gasparilla Island will be examined for *G. polyphemus* eggs and examination of *G. polyphemus* burrow aprons for *G. polyphemus* nests that were intentionally (e.g., predation) or accidentally (e.g., byproduct of ctenosaur nesting) disturbed or destroyed by *C. similis* will help identify other negative aspects of their activities.

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CTENOSAURA SIMILIS (Black Spiny-Tailed Iguana), ***COLUBER CONSTRICTOR PRIAPUS*** (Southern Black Racer). **NON-PREDATORY KILLING.** *Ctenosaura similis* is exotic to Florida (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 155 pp.). In particular, three individuals were released on Gasparilla Island (Charlotte and Lee counties) ca. 30–35 years ago, where they are now abundant (Krysko et al. 2003. Florida Sci. 66:141–146). This species may pose a threat to a number of endemic threatened and endangered species on Gasparilla Island such as eggs and young of nesting shorebirds, beach mice, hatchling sea turtles and Gopher Tortoises (*Gopherus polyphemus*) (Krysko et al., *op. cit.*). We report evidence that *C. similis* may also pose a threat to snakes.

On 10 November 2007, MK observed a ca 60 cm (total length) adult male *C. similis* attack a similarly long *Coluber constrictor priapus*. The iguana was basking on a rock at 1400 h on a warm (ca. 28°C) afternoon, when it attacked the racer as it approached within 2 m of the lizard's position. The ctenosaur rushed the snake and grabbed it in its mouth and shook it vigorously, much as dogs are prone to do. Once the snake was limp and appeared dead, the lizard dropped it and backed off 30–40 cm. When it noticed the snake's body twitching, it again rushed it and shook it, and again dropped it and backed off 30–40 cm. Further twitching of the snake's body resulted in another rush and even more vigorous shaking of the snake with the lizard backing off about 2 m this time, but additional twitching triggered another rush and shaking. Once the racer ceased to move, the iguana ignored it. The scene was observed for 20 min more to see if the ctenosaur would eat the racer, but it did not. The next morning its carcass was in the same spot.

We cannot clearly explain the ctenosaur's behavior towards the racer, but a defense mechanism towards snakes seems plausible. Janzen and Brodie (1995. J. Herpetol. 29:132–136) studied color cues in ctenosaur foraging by using different color patterns on snake replicas. They found brightly colored replica snakes (red, yellow, black) elicited the most attacks, but concluded the lizards

perceived the replicas as colored flowers or fruits because snakes were unknown in ctenosaur diet studies and snakes with such coloration could pose a hazard to the lizards (Janzen and Brodie, *op. cit.*). Our observation clearly shows the willingness of a ctenosaur to attack a snake, even though the racer most closely resembled the monotone color pattern that elicited the fewest attacks in the Janzen and Brodie study. More importantly, this behavior may have implications regarding the potential for *C. similis* to impact threatened or endangered species. If this behavior is innate in *C. similis,* juvenile *Drymarchon corais couperi* (Eastern Indigo Snakes), a threatened species (Moler 1992. Rare and Endangered Biota of Florida, Vol III, Amphibians and Reptiles. University Press of Florida, Gainesville, Florida. 291 pp.), could be severely impacted. A high-density population of *C. similis*, such as found on Gasparilla Island, could negatively affect snake recruitment through such behavior.

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DIPLOLAEMUS DARWINI (NCN). **SAUROPHAGY**. *Diplolaemus darwini* is a poorly known leiosaurid lizard found in Patagonia south of 44°S latitude. Data on the diet of this species is sketchy, though some authors mention it to be insectivorous (Cei 1986. Reptiles del Centro, Centro-Oeste y Sur de la Argentina, Mus. Reg. Sci. Nat. Torino, Monogr. IV:1–527). Here we report an observation of interspecific saurophagy by an adult *D. darwini* on an adult *Liolaemus lineomaculatus*.

On 17 January 2008 during a field trip to Sierra del Bagual (49.40ºS, 71.83ºW; WGS84; elev. 601 m), Lago Argentino Department, Santa Cruz Province, southern Patagonia, Argentina; we observed an adult female *D. darwini* (92.9 mm SVL, 61.6 mm tail) basking on a rock in shrub-steppe habitat. When we chased it, the lizard ran under a rock where we captured it by hand. A few hours after we had temporarily placed this lizard in a plastic container, it regurgitated the remains of a female *L. lineomaculatus* (26.6 mm long × 12.5 mm wide). We estimated the original size of the *L. lineomaculatus* by comparison with other preserved *L. lineomaculatus* to be ca. 60 mm SVL. We also examined the remaining stomach contents of the *D. darwini* and found it to contain two tenebrionid beetles (*Nyctela* sp.). These two lizard species are synoptic in this area of Patagonian steppe and usually share similar habitats. Saurophagy has not been previously documented in the field for *D. darwini*.

D. R. Perez verified the identifications and the *D. darwini* (LJAMM 9390) and the *L. lineomaculatus* (LJAMM 7292) were deposited in the Herpetological Collection LJAMM (Luciano Javier Avila Mariana Morando) of the Centro Nacional Patagónico (CENPAT), Puerto Madryn, Chubut.

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GAMBELIA COPEI (Cope's Leopard Lizard). **ENDOPARASITES.** *Gambelia copei,* a near-endemic to Baja California, ranges from extreme southern San Diego County, California, south to the northern Cape Region, Baja California Sur, Mexico (Grismer 2002. Amphibians and Reptiles of Baja California Including its Pacific Islands and the Islands in the Sea of Cortés. Univ. California Press, Berkeley, California. 399 pp.). To our knowledge, no reports of helminths exist for this species. The purpose of this note is to document the nematode *Thubunaea iguanae* from *G. copei*.

One *G. copei* female (108 mm SVL) collected in 1949 and deposited in the Natural History Museum of Los Angeles County (LACM), Los Angeles County, California, USA (LACM 4005, vic. Cerro Elefante, Vizcaino Desert, 27.2966°N, 114.3750°W, WGS84; elev. 335 m) was examined for helminths. The body cavity was opened and the coelomic cavity and visceral organs were examined. One nematode was found. It was cleared in a drop of glycerol on a glass slide, cover-slipped and identified as an adult female *T. iguanae* and deposited in the United States National Parasite Collection, Beltsville, Maryland as USNPC 101071.

Thubunaea iguanae is widely distributed among lizards from the southwestern United States and Mexico and has been reported from crotaphytids, gekkonids, phrynosomatids, teiids, and xantusiids (Telford 1965. Jpn. J. Exp. Med. 35:111–114) as well as colubrid snakes (Goldberg and Bursey 2001. Bull. South. California Acad. Sci. 100:109–116). It is in the family Physalopteridae, which utilize insect intermediate hosts (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission, 2nd ed. CABI Publishing, Oxfordshire, UK, 650 pp.). *Gambelia copei* is a new host record for *T iguanae*.

We thank Christine Thacker (LACM) for permission to examine *G. copei*.

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GLAPHYROMORPHUS NIGRICAUDUS (NCN). **PREY PIRACY.** Prey piracy, the opportunistic theft of prey from another predator or another indirect source, is known for a broad range of diurnal reptilian taxa. In this note I report on an incidence of prey piracy in the skink *Glaphyromorphus nigricaudus*.

Glaphyromorphus nigricaudus is a secretive species restricted to tropical northeast Queensland, Australia. Like most of its genus, it prefers shaded moist habitats and is reported to be nocturnal-

crepuscular, but is sometimes active during the day (Cogger 2000. Reptiles and Amphibians of Australia, Reed Publishing, Sydney, Australia. 808 pp.). While conducting fieldwork at Trinity Beach in north-eastern Australia (145.6978°E, 16.7861°S; WGS84; elev. 3 m) at 1453 h EST on the 17 February 2001, I observed an adult *G. nigricaudus* patrolling 5–10 cm from a well-established Green Ant (*Oecotsylla smaragolia*) column oriented in an eastward direction. Many of the ants were transporting prey back to a nest located in a nearby tree. Over a period of 18 min, I observed the lizard lunge quickly at individual ants carrying specific prey. Following each successful lunge, the lizard would retreat a short distance from the column (20–40 cm) to consume the prey. From a nearby vantage point, I determined that the majority of prey items targeted by the lizard were lepidopteran larvae.

The cryptic nature and high diversity of Australian skinks (Cogger, *op. cit.*) implies that the frequency with which prey piracy occurs among Australian skinks may be substantially underestimated. Nonetheless, at least four other cases of skink species opportunistically stealing prey (directly or indirectly) from other predators have been reported. Three of these records involve cases of direct piracy from ant columns by the diurnal species *Carlia munda* (Bedford 1995. Herpetol. Rev. 26:99–100), *Cryptoblepharus virgatus* (Greer 1989. The Biology and Evolution of Australian Lizards. Surrey Beatty and Sons, Chipping Norton, Sydney. 264 pp.), and *Morethia boulengeri* (as *Ablepharus lineoocelatus*) (Chisholm 1923. Aust. Zool. 3:60–71). A fourth observation was the theft of arthropod prey from eumenid mud-wasp nests involving *Cryptoblepharus virgatus* (Phillips 2005. Herpetofauna 35:120). Members of the genus *Glaphyromorphus* are almost entirely terrestrial, crepuscular and secretive in habit (Greer, *op. cit.*), suggesting that high energy prey, such as lepidopteran larvae, may be only infrequently available. If this is indeed the case, instances of prey piracy, as I report here, may provide such species with an additional and energetically favorable form of prey.

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GLAPHYROMORPHUS PUNCTULATUS (NCN). **ENTRAPMENT.** At 0847 h (EST) on 22 March 2008 while observing a heliothermic skink assemblage (*Carlia rhomboidalis, Eulamprus brachysoma*) at Cape Hillsborough Nature Reserve, Queensland, Australia (20.9217°S, 149.0453°E; WGS84; elev. 10 m), we observed a small skink moving in a conspicuous hapless manner through the leaf litter substrate. The lizard was making considerable noise for an animal of its small size. Closer inspection revealed the skink to be a juvenile *G. punctulatus* with a seed casing of the fruit of the Peanut Tree (*Sterculia quadrifida*) completely enclosing the anterior portion of its head. Initial attempts to loosen and remove the seed casing failed and it appeared the casing had been on the skink's head for a couple of days and had dried to some degree, contracting over its head and neck. The thickness of the seed casing and the absence of holes (apart from the one in which the lizard inadvertently inserted its head) suggests the lizard had no ability to see while the seed casing was on its head. This was further evident by the lizard's abnormal and risk-prone activity, such as wandering through exposed areas of the open forest. As the seed casing was likely to tighten due to further drying, it seemed unlikely that the lizard would have been able extricate itself from the casing on its own, which ultimately would have resulted in the skink's death, directly or indirectly (predation). Careful work made it possible to fracture the casing along three small cracks to allow removing it from the lizard's head. After removal, the lizard was examined for injuries. Minor injury existed to the scales, presumably from rubbing contact with the seed, and minor cuts existed around the lizard's head and neck. Following removal, the lizard was weighed (to ± 0.1 g) and measured (± 0.1 mm) prior to release at the site of capture. The skink weighed 0.5 g and was 36.1 mm SVL with a total unbroken tail length of 46.7 mm. When released, the lizard moved and behaved as typical for a member of this genus. Head trapping by a plant seed casing similar to that reported here was observed in a specimen of *Lampropholis guichenoti* (Langkilde et al. 2002. Herpetofauna 32:131), implying that such entrapment might be more widespread than realized, but rarely observed in nature.

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HEMIDACTYLUS PALAICHTHUS (Spiny House Gecko). **EGG AGGREGATION**. *Hemidactylus* geckos lay clutches of only one or two eggs (Krysko et al. 2003. Amphibia-Reptilia 24:390–396; Fitch 1970. Misc. Pub. Univ. Kansas Mus. Nat. Hist. 52:1–247), but several clutches may be produced annually, greatly elevating reproductive capacity. As many as 20 clutches have been reported to be produced annually (Hernández et al. Especies Exóticas Invasoras. http://www.geocities.com/otecbio_especies/ [consulted 22 February 2006]). Further, egg aggregations (communal nesting and/or repeated use of oviposition site by single females) that locally increase the number of eggs that may offer other advantages, e.g., predator-satiation (Eckrich and Owens 1995. Herpetologica 51:349–354) or thermoregulation (Booth and Astill 2001. Austr. J. Zool., 49:71–48). Large numbers of eggs are typically interpreted as communal nesting, but larger aggregations of gecko eggs may also represent repeated use of oviposition site by individual females or some combination of both (Bock 1996. Herpetol. Rev. 27:181–183).

Large egg aggregations are known for several species of *Hemidactylus*: *H. mabouia*, 6–60 eggs (Dixon and Soini 1986. The Reptiles of the Upper Amazon Basin, Iquitos Region, Peru. Milwaukee Public Museum, Milwaukee. 154 pp.; FitzSimons 1943. The Lizards of South Africa. Transvaal Mus. Mem.,1:1–528; Krysko et al. 2005. Carib. J. Sci. 41:169–172; Rivas et al. 2005. Herpetol. Rev. 36:121–125); *H. turcicus* with up to 20 eggs (Selcer 1986. Copeia 1986:956–962); and *H. brookii* with 16 eggs (Shanbhag 1999. Herpetol. Rev. 30:166). However, we are unaware of any literature recording this or any other aspect of the reproductive biology of *H. palaichthus*.

On 2 February 2006 at 0800 h, during field work on the herpetofauna of north Amazonas, Venezuela (12 km S of Puerto Ayacucho, road to Gavilán, Estado Amazonas, Venezuela; 5.5741667°N, 67.5358333°W, datum: La Canoa; elev. ± 80 m), a pair of adult

H. palaichthus (female: 60 mm SVL; male: 65 mm SVL) were encountered inside a small abandoned doghouse. Next to these animals was 23 apparently viable eggs. Shell fragments of two other eggs that had already hatched and one older-appearing damaged egg were also found. Eight eggs from the aggregation contained embryos in the final stages of development (evident from shell translucency and intense pigmentation of the embryos). The remaining 15 eggs had white or light pink shells and lacked distinguishable embryos. Additionally, we found an apparent recent hatchling (26 mm SVL) next to the nest.

The nest was located on the ground, in a narrow space (ca. 1 cm) under a cement brick inside the dog-house. The eggs were surrounded by scattered leaf litter and the remains of a plastic bag. Air temperature in the nest was of 28.9°C and relative humidity was 76%.

Presence of an adult pair (male and female) near the nest, and the absence of other females nearby, may indicate that this site is repeatedly used by this female rather than as a communal nest (i.e., at least two females). The large number of eggs may also indicate a high annual fecundity. Bock (*op*. *cit*.) established (in *H. mabouia*) that aggregations of up to 10 incubating eggs likely result from both communal nesting and repeated use of the same site by individual females; additional observation would be needed to identify the basis of the large number of eggs we found. Finally, the finding of shells of only two eggs suggests that *H. palaichthus* eggs tend to hatch in pairs, implying that the female lays both eggs of a single clutch simultaneously.

The geckos were released after taking measurements and photographs. J. Celsa Señaris verified the species identification. We gratefully acknowledge funding provided by the National Science Foundation (grant no. DEB-0416160) to Eric N. Smith. We also thank Gabriel Ugueto for suggestions on this note.

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HOPLOCERCUS SPINOSUS (NCN). **ENDOPARASITES.** *Hoplocercus spinosus* is a poorly known lizard distributed from the Mato Grosso and Mato Grosso do Sul region of Brazil to adjacent Bolivia (Wiens and Etheridge 2003. Herpetologica 59:375–398). To our knowledge, no parasite records have been published for *H. spinosus*. Hence, here we report the presence of *Cruzia rudolphii* in *H. spinosus*.

We examined 5 adult *H. spinosus* (mean = 80.4 mm SVL, ± 12.3 mm SD) deposited in the Coleção Zoológica de Referência, Laboratory of Zoology, Campus of Corumbá, Universidade Federal de Mato Grosso do Sul (UFMS) (CEUCH 2888, 2892, 3374, 3375, and 3460) for endoparasites. Lizards were captured in November 2003 and February 2004 in pitfall traps with drift fences in a remnant fragment of Cerradão (forest savanna-like vegetation) of Dois Irmãos do Buriti and Terenos (55.30ºW, 20.50ºS; WGS84; elev. 300 m) between the municipality of Aquidauna and Campo Grande, Mato Grosso do Sul, Brazil. Lizards were euthanized

and the body cavity, esophagus, stomach, lungs, small and large intestines were opened and separately examined for helminths under a stereomicroscope. Endoparasites were cleared in phenol, identified and deposited in the Coleção Helmintológica do Instituto de Biociências da Unesp de Botucatu as *C. rudolphii* (CHIBB 1052). Three adult females of *C. rudolphii* were recovered and the observed prevalence (infected lizards/examined lizards × 100) was 20%.

Species of *Cruzia* have been reported in many taxa, such as mammals (Quintão e Silva and Costa 1999. J. Wildl. Dis. 35:371–374) and reptiles (Vicente et al. 1993. Rev. Bras. Zool. 10:1–183). *Cruzia rudolphii* was originally described from the colubrid snake *Erythrolamprus aesculapii* in southeastern Brazil (Ruiz 1947 in Vicente et al. 1993, *op*. *cit*.). *Hoplocercus spinosus* represents a new host record for *C. rudolphii* and Mato Grosso do Sul, Brazil is a new locality for the parasite.

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LEIOCEPHALUS CARINATUS ARMOURI (Northern Curlytail Lizard). **MORTALITY.** *Leiocephalus carinatus armouri* is a well established, exotic species in Florida (Meshaka et al. 2004. The Exotic Amphibians and Reptiles of Florida. Krieger Publ. Co., Malabar, Florida. 155 pp.; Meshaka et al. 2005. Southeast. Nat. 4:521–526; Smith and Engeman 2004a. Florida Field Nat. 32:107–113); but few causes of mortality, including vertebrate predators, have been documented within its introduced range (Smith and Engeman 2003. Herpetol. Rev. 34:245–246; Smith and Engeman 2004a. *op cit*.; Smith and Engeman 2004b. Herpetol. Rev. 35:169–170; Dean et al. 2005. Herpetol. Rev. 36:451; Smith et al. 2006a. Herpetol. Rev. 37:224). Only surface paving (Smith and Engeman 2004a, *op*. *cit*.), vehicle-related road-kill (Smith et al. 2006b. Herpetol. Rev. 37:87), and entanglement in persistent human-made debris (Dean et al. 2005. Herpetol. Rev. 36:179–180) have been reported as abiotic sources of mortality. Here, we quantify extensive mortality to an entire *L. c. armouri* colony resulting from parking lot sealing and repaving.

At ca. 1300 h on 10 July 2006, surface sealing and repaving of a parking area off Woolbright Road was initiated at the location of a colony of *L. c. armouri* in Boynton Beach, Florida (see Smith and Engeman 2003, *op*. *cit*.; Smith and Engeman 2004a, *op*. *cit*. for site descriptions of this colony). On the two previous days (8–9 July), a total of 81 active *L. c. armouri* burrows had been located

within the proposed work area. As with standard Gopher Tortoise (*Gopherus polyphemus*) surveys (Cox et al. 1987. Ecology and Habitat Protection Needs of Gopher Tortoise [*Gopherus polyphemus*] Populations on Lands Slated for Large-scale Development in Florida. Nongame Wildlife Program Tech. Rept. No. 4, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida), active lizard burrows were similarly identified by fresh dirt piled outside their entrances, and tail drags and/or lizard footprints entering them. Lizards were also observed fleeing into several burrows during the survey. The 10 July repaving work affected the entire south side of the study area colony, which contained 43 active burrows. On the morning of 11 July, 39 of these 43 burrows (91%) were either flooded with liquid sealer/tar or had the substance at least partially extending into the burrow entrance. No lizards were observed at the entrances, or around, these 39 burrows. The 4 unimpacted burrows appeared active. Repaving continued throughout 11 July to include the additional south and east areas, and on 12 July the colony was resurveyed. The 12 July survey revealed that 45 of 51 burrows (88%) in those areas were now entombed. The 4 active burrows found on 11 July were still active for a total of 6 active burrows in those areas. Surveys were not conducted on the mornings of 13–14 July, but by 15 July, the north side of the colony had now been repaved. A survey on that morning revealed 56 of 65 burrows (86%) entombed. Nine burrows were active, including the 6 found on 11 and 12 July. By Sunday 16 July, the treatment had been completed on the west side of the colony and 71 of the 81 burrows (88%) were now entombed, and ten were active. Additional construction and curb painting at the site on 18 July forced an end to all surveys when most burrow markers were lost.

Burrow collapse and entombment of animals is recognized as a factor in animal mortality by off-road vehicle use (Brock and Kelt 2004. Biol. Cons. 118:633–640; Luckenbach and Bury 1983. J. Appl. Ecol. 20:265–286). While entombment of burrowing animals during road construction or repaving may be acknowledged as a cause of animal mortality in many environmental assessments, impact statements, and federal rulings (USFWS 2000. Federal Register 65:57242–57264.; USFWS 2003. Federal Register 68:13498–13520.), the actual numbers of animals in an impacted area are frequently unknown.

Biotic factors impacting exotic herpetofauna populations (e.g.; predation, disease, parasites) are often described in the literature (see extensive species accounts in Meshaka et al. 2004, *op. cit.*). However, abiotic sources of mortality for exotic herpetofauna remain poorly known, or underreported, especially at the colony-site or deme level. Meshaka et al. (2005, *op. cit.*) noted that for some invasive species such as *L. c. armouri,* which utilizes heavily human-modified coastal habitat to provide "**…**open sunny conditions and cement analogues to the rocky substratum to which it is adapted," abiotic mortality factors may likewise be more of a limiting factor to exotic populations than biotic factors.

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LEIOCEPHALUS CARINATUS ARMOURI (Northern Curlytail Lizard). **PREDATION.** Although several avian predators are documented (Smith and Engeman 2004a. Herpetol. Rev. 35:169–170; Smith et al. 2006a. Herpetol. Rev. 37:224; Smith et al. 2006b. J. Kansas Herpetol. 19:9), virtually nothing is known about the mammalian predators and scavengers of *Leiocephalus carinatus armouri* within its introduced range in Florida. To date, only one mammalian predator, feral cat (*Felis catus*) (Smith and Engeman 2004b. Florida Field Nat. 32:107–113), and one mammalian scavenger, Gray Squirrel (*Sciurus carolinensis*; Smith et al. 2006c. Herpetol. Rev. 37:87) have been verified. Here we report the predation of a juvenile *L. c. armouri* by a second mammalian predator in Florida, the domestic dog (*Canis familiaris*).

At 1435 h on 17 December 2006 (a warm [ca.75°F] sunny day), HTS observed an unleashed ca. 10-kg mixed-breed dog chase a juvenile (ca. 5 cm SVL) *L. c. armouri* through the south side of the Woolbright Road colony of *L. c. armouri* located in Boynton Beach, Florida (see previous site descriptions in Smith and Engeman 2003. Herpetol. Rev. 34:245–246; Smith and Engeman 2004b, *op. cit.*). The chase was a rapid, straight-line run of about 10 m with the dog gaining ground. The *L. c. armouri* reached the south wall of a building, could not find its burrow entry quickly enough, and was captured in the dog's jaws. The dog then thoroughly macerated the lizard for 30–45 sec before swallowing it.

Feral cats were frequent predators of *L. c. armouri* at this colony (Smith and Engeman 2004b, *op. cit.*) from 1993 until property management changed in 2005 at which time free-living feral cats were aggressively removed, and pet dogs were allowed to condominium residents. Observations of domestic dogs preying on other iguanid lizard species have been reported (Iverson 1978. Biol. Conserv. 14:63–73; Henderson 1992. Carib. J. Sci. 28:1–10). The effects of domestic dog predation on *L. c. armouri* colony population dynamics and recruitment are unknown.

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LEIOCEPHALUS PSAMMODROMUS (Turks and Caicos Curly-Tailed Lizard). **CONSPECIFIC NECROPHAGY**. At 1200 h on 6 December 2007 on Big Ambergris Cay in the Turks and Caicos Islands (21.299°N, 71.633°W; elev. 11 m), I documented a young adult female *Leiocephalus psammodromus* (ca. 60 mm SVL) feeding on the carcass of a road-killed adult male conspecific (ca. 85 mm SVL). The condition of the carcass, considerably flattened and dried out, indicated that the male was likely recently killed by construction traffic and repeatedly run over. The observation, which lasted 4 min, was made at a distance of 4 m from the carcass, which lay on the side of a small dirt road. During this time, the female tilted her head sideways and down to take quick bites of the carcass, rapidly returning to a vigilant head-up position to swallow small pieces. I observed a total of six feeding motions during the observation period, which ended when another male entered the area and the female retreated.

Little has been reported on the diet of *L. psammodromus*, though it has been assumed to resemble that of other members of the genus in the Bahamian Archipelago. Other *Leiocephalus* species have been reported to feed on hymenopterans, lepidopteran larvae, coleopterans, blattarians, a substantial amount of plant matter such as fruits and buds, as well as demonstrate heterospecific saurophagy (Schoener et al. 1982. Oecologia 53:160–169) and cannibalism (Jenssen et al. 1989. Anim. Behav. 38:1054–1061), but conspecific necrophagy was previously unreported in this genus. *Leiocephalus* are known to have highly opportunistic food habits (Schoener et al., *op. cit.*), and recently deceased conspecifics may provide an easily accessible source of protein for young adults of this species.

I thank the Turks and Caicos Sporting Club at Ambergris Cay for logistical support and M. Hayes for suggestions. Financial support provided by the Department of Ecology and Evolutionary Biology, University of Tennessee, Knoxville.

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LEIOSAURUS BELLI (NCN). **PREDATION**. Birds are often reported to prey on lizards (e.g., Pérez and Avila. 2005. Herpetol. Rev. 36:451–452; Terres 1991. The Audubon Society Encyclopedia of North American Birds. Wing Books, New York, New York, USA. 1109 pp.; Trejo et al. 2003. Herpetol. Rev. 34:145), but such predation events typically occur rapidly so that the field observation of the event is rarely recorded. Hence, we report an observation of White-throated Cacholote (*Pseudoseisura gutturalis*) preying on *Leiosaurus belli* from southeast Argentina.

Observations were made near Puerto Madryn, Biedma Department, Chubut province (42.34ºS, 64.09ºW, WGS84; elev. 20 m) using 8 × 30 binoculars. At ca. 1315 h on 23 October 2007, CHFP observed an adult male *P. gutturalis* arriving at the nest carrying remains of the hind leg of *L. belli* in its bill. Within 5 min, both members of the pair brought the remainder of the tail. Both birds hesitated briefly before entering the nest to feed the nestlings, presumably due to the presence of the observer close to the nest (less than 3 m). This allowed identification of the lizard and photography. Based on photographs of the leg, the size of the *L. belli* was estimated to be ca. 85 mm SVL. The nest contained four nestlings about 8 days old weighing 31–46 g.

Leiosaurus belli is a moderate-sized (<100 mm SVL) diurnal and relatively aggressive lizard inhabiting shrubby areas in Monte and Patagonian steppe of the Mendoza, Neuquén, La Pampa, Río Negro and Chubut provinces, Argentina (Cei 1986. Museo Regionale di Scienze Naturali Torino, Monographie 4:1–528). The only a report of its bird predators is based on remains found in pellets (Udrizar Sauthier et al. 2007. Herpetol. Rev. 38:78–79). The White-thoated Cacholote is an active diurnal bird weighing 63–79 g, endemic to the Monte and Patagonia steppes in Argentina (Remsen 2003. *In* del Hoyo et al. [eds.], Handbook of the Birds of the World, vol 8, pp. 162–357. Lynx Edicions, Barcelona, Spain). To date, small vertebrates were not known to be part of the diet of the White-throated Cacholote or any other member of the genus *Pseudoseisura*, which are regarded as predators primarily on invertebrates (Remsen, *op. cit.*).

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LIOLAEMUS ROTHI (NCN). **CANNIBALISM**. *Liolaemus rothi* is a stout, medium-sized liolaemid lizard found in northern Patagonia (Neuquén, Río Negro, and Chubut provinces) in steppe or steppe-Monte ecotone habitats on rocky substrates. Though some authors mention it to be insectivorous, dietary data are scarce (Cei 1986. Reptiles del Centro, Centro-Oeste y Sur de la Argentina, Monogr. IV, Mus. Reg. Sci. Nat. Torino, Italy. 527 pp.). Here, we report an observation of intraspecific saurophagy in *L. rothi*.

Around 1100 h on 20 February 2008, during an ecological study of this species at a location 20 km N of Gan Gan (42.4071°S, 68.2634°W; datum: WGS84; elev. 1071 m), Departamento Telsen, Chubut, Argentina, we observed and filmed (for 3 min) an adult (81 mm SVL) male *L. rothi* eating a conspecific juvenile. When first observed, the adult was swallowing the juvenile. Only the hindlimbs and tail of the juvenile were visible, but enough features could be observed for accurate identification.

In the genus *Liolaemus*, cannibalism has been only reported for *L. darwinii* (Ripoll and Acosta 2007. Herpetol. Rev. 38:459). The causes of this behavior in liolaemid lizards merit investigation.

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OPHIODES FRAGILIS (Cobra-de-Vidro). **CANNIBALISM**. *Ophiodes fragilis*, a medium-sized anguid (228 mm max SVL) distributed in southern and southeastern Brazil and northeastern Argentina (Misiones Province), inhabits forested areas (Borges-Martins 1998. Unpubl. Ph.D. dissertation. Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil. 239 pp.). Though anguids are generally recognized as carnivorous and are known to feed on insects, small mammals, other lizards, and molluscs (Smith 1946. Handbook of Lizards. Comstock Publ. Associates, Ithaca, New York. 557 pp.; Pough et al. 2001. Herpetology, 2nd ed. Prentice Hall, Upper Saddle River, New Jersey. 612 pp.; Pianka and Vitt 2003. Lizards: Windows to the Evolution of Diversity. University of California Press, Berkeley, California. 333 pp.), little is known about the diet of *O. fragilis*. The only existing dietary study recorded only small arthropods (Marques and Sazima 2004. *In* Marques and Duleba [eds.], Estação Ecológica Juréia-Itatins: Ambiente Físico, Flora e Fauna, pp.

257–277. Editora Holos, Ribeirão Preto, São Paulo, Brazil.). Here, we report the first record of cannibalism in *O. fragilis*.

In January 1994, Ivan Rubens Brum found an already dead adult male *O. fragilis* (184 mm SVL), at Canela, Rio Grande do Sul, Brazil (29.3638°S, 50.8100°W; WGS84; elev. 835 m), that contained four almost undigested conspecific juveniles (110 mm total length).

The adult male *O. fragilis* (MCP 5987) and juveniles (MCPAN 1856) it had eaten were deposited in the collection of Museu de Ciências e Tecnologia da Pontifícia Universidade Católica do Rio Grande do Sul.

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PHELSUMA MADAGASCARIENESIS GRANDIS (Madagascar Day Gecko). **PREY**. *Phelsuma madagascarienesis grandis* is native to northern Madagascar (Henkel and Schmidt 2000. Amphibians and Reptiles of Madagascar and the Mascarene, Seychelles, and the Comoro Islands. Krieger Publ. Co., Malabar, Florida. 319 pp.) and has been introduced into the United States in Hawaii (Kraus 2002. Bishop Mus. Occ. Pap. 69:48–52) and Florida (Krysko et al. 2003. Florida Sci. 66:222–225). *Phelsuma m. grandis* is diurnal and arboreal, and feeds primarily on nectar, pollen and arthropods (Krysko et al., *op. cit.*; Krysko and Hooper 2007. Gekko 5:33–38; Tytle 1992. Vivarium 2:15–19, 29), but adults occasionally eat hatchling *Phelsuma* (Krysko et al., *op. cit.*) and *Hemidactylus* geckos (García and Vences 2002. Herpetol. Rev. 33:53–54; Krysko and Hooper, *op. cit.*). Herein, we report *P. m. grandis* preying upon the nonindigenous Northern Curly-tailed Lizard (*Leiocephalus carinatus*) in Florida.

At 1420 h on 30 August 2008, an adult male *Phelsuma m. grandis* was observed in Lake Worth, Palm Beach County (26.625634°N, -80.05083°W, WGS84, elev. <1 m) on a building wall. Upon closer examination, the gecko was holding a neonate (ca. 30 mm SVL) *Leiocephalus carinatus* in its mouth. After being photographed (photographic voucher UF 153515) the gecko retreated into a stand of *Heliconia* sp., and ca. 1 h later the gecko reemerged and appeared fat. This is the first record of *Phelsuma m. grandis* consuming *Leiocephalus carinatus*, and the first record of this gecko in Palm Beach County, Florida.

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PHRYNOSOMA CORNUTUM (Texas Horned Lizard). **NESTING; HATCHLING BEHAVIOR; PREDATION**. At 1245 h CDT on 3 June 2008, we observed a young female (37.6 g; ca. 65 mm SVL) *Phrynosoma cornutum* digging a first nest in caliche soil in Randall County, Texas (vicinity of 34.98°N, 101.93°W, NAD27; elev. 1080 m). The nest was completed by 1100 h on 4 June on a 9.5° slope facing SW. The lizard weighed 20.7 g after oviposition, having lost 44.9% of her pre-oviposition weight (similar to reports by Allison and Cepeda (2009. Southwest. Nat. 54[2]: *in press*) and Sherbrooke 2002. Herpetol. Rev. 33:206–208). Twenty-four hatchlings (of 25 total eggs recovered from excavating the nest on 18 August) emerged between 2000 h on 6 August and 1400 h on 7 August from one exit hole 3 cm × 2 cm. We weighed 14 of the hatchlings (mean = 0.71 g, ± 0.11 SD), and variation in mass was similar to that reported by Sherbrooke (2002).

Emerging hatchlings were more alert and active than those we have previously observed from other nests. At times, several hatchlings waited to emerge from the nest, climbing over one another to exit. One ate tiny ants (<4 mm) before and while exiting the nest opening. Several hatchlings were seen sand-diving at the exit or immediately after exiting the nest, or when dispersing further when a threat was perceived. At 1136 h on 7 August, a Blue Jay (*Cyanocitta cristata*) flew low to the ground over the nest site. At 1148 h, the jay landed at the site and a hatchling that had just emerged immediately crouched at the approach of the bird. The crouching hatchling was snatched up by the jay, and 3 other hatchlings inside the exit hole immediately froze. The jay wrestled the first hatchling in its beak for 10 sec, and manipulated the now apparently dead hatchling into its beak over the next 12 sec. The other 3 hatchlings remained motionless. With the first hatchling still in its beak, the jay stood out of sight of the remaining hatchlings, appeared to listen for activity inside the nest and, within 3 sec, snatched a second hatchling head-first from within the exit hole. The 2 hatchlings left at the exit hole remained motionless.

At the time of the predation episode, 18 hatchlings had emerged, and 10 hatchlings were within 2 m of the nest site. A period of sunshine during a mostly cloudy morning may have initiated a period of greater hatchling activity that caught the attention of the jay. In contrast to the hatchlings freezing at the jay's approach, our arrival at the nest caused one hatchling to dive back into the nest and the other to bury itself inside the exit hole.

Lizards were weighed, measured, and immediately released in accordance with permit SPR-0294-659 issued by the Texas Parks and Wildlife Department.

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SPHENOMORPHUS CHERRIEI (Striped Litter Skink, Chirbala Lisa). **ENDOPARASITES.** *Sphenomorphus cherriei* is a litter-dwelling skink known from central Veracruz, México to extreme western Panama (Savage 2002. The Amphibians and Reptiles of Costa Rica; A Herpetofauna Between Two Continents Between Two Seas. Univ. Chicago Press, Chicago, Illinois. 934 pp.). To our knowledge, only one report of endoparasites for *S. cherriei* exists;

Goldberg and Bursey (2007. Herpetol. Rev. 38:83–84) reported one species of Digenea *Mesocoelium monas* and three species of Nematoda *Oswaldocruzia nicaraguensis, Physaloptera* sp., and acuariid larvae.

The coelomic cavity of one mature female *S. cherriei* (64 mm SVL) from the herpetological collection of the Natural History Museum of Los Angeles County (LACM 162570) collected in Puntarenas Province, Costa Rica (9.22246°N, 83.84309°W, WGS84; elev. 50 m) in 1973 was examined for helminths. The body cavity was opened and the visceral organs examined under a dissecting microscope. One larva was found encysted in the liver. It was excised, cleared in a drop of undiluted glycerol on a glass slide, examined under a compound microscope and assigned to the genus *Porrocaecum*. The larva was deposited in the United States National Parasite Collection, Beltsville, Maryland as USNPC 100569.

Adults of *Porrocaecum* live in the intestines of birds; eggs pass with the feces and are eaten by earthworms in which they hatch (Anderson 2000. Nematode Parasites of Vertebrates: Their Development and Transmission, 2nd Ed. CABI Publishing, Oxfordshire, UK, 650 pp.). Vermivorous vertebrates may act as paratenic (= transport) hosts; larvae mature when ingested by an appropriate host (Anderson, *op. cit.*). *Sphenomorphus cherriei* represents a new paratenic host record for *Porrocaecum* sp. and can be added to the list of poikilothermic Costa Rican vertebrates serving as paratenic hosts in Goldberg and Bursey (2008. Herpetol. Rev. 39:350).

We thank Christine Thacker (LACM) for permission to examine the *S. cherriei* that is part of the CRE collection donated in 1998 by Jay M. Savage.

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TILIQUA ADELAIDENSIS (Pygmy Bluetongue Lizard). **MATING BEHAVIOR.** *Tiliqua adelaidensis* is an endangered scincid lizard found exclusively in remnant fragments of native grassland habitat in mid-north South Australia (Armstrong et al. 1993. Rec. S. Austral. Mus. 36:53–55; Hutchinson et al. 1994. Trans. Roy. Soc. Ser. A. 118:217–226). The smallest member of the genus *Tiliqua* (adult SVL ca. 95 mm), males have shorter body lengths and longer, wider heads than females (Hutchinson et al., *op. cit.*). The lizards live in burrows constructed by lycosid and mygalomorph spiders, which they use for both shelter and vantage points for ambushing passing prey (Milne et al 2003. Wildl. Res. 30:523–528). Mating occurs in late October to early November and 2–4 live young are born in late January to mid March (Hutchinson et al., *op. cit.*; Milne et al., *op. cit.*).

Milne et al (*op. cit.*) video-recorded burrow entrances and filmed one episode of mating where a male entered a female burrow and dragged her from the burrow by her head. At the surface, the lizards rolled vigorously until the male eventually grasped the female, and proceeded to mate, copulation lasting 30 sec. The female then entered her burrow and the male remained at the burrow entrance for 30 min, making occasional attempts to pull the female out again. During another study that involved filming the behavior of wild *T. adelaidensis* on closed circuit video cameras (CCTV), we recorded a second mating event that differed from the first observation by Milne et al (*op. cit.*). The purpose of this note is to detail these observations.

At 1000 h on 11 November 2007, we were recording a adult (ca. 85 mm SVL) male *T. adelaidensis* at his burrow entrance. The view frame for the camera was about 1 m². A adult (ca. 85 mm SVL) female entered the frame of view and within 5 sec the male had left his burrow and grasped the female on the left shoulder with his jaws. The male appeared to try and subdue the female who was attempting to escape the grasp of the male. The initial struggle lasted 35 sec, until the male managed to move his body on top of the female, while vigorously waving his rear left leg as if trying to raise the female tail. By this time, the female was in a 'C' position with the male on top, also in a 'C' position over her. The male eventually raised the tail of the female and aligned his cloaca with hers. He appeared to lock the female tail between his tail and body to hold his position for 37 sec while mating. The male maintained his grasp of the female shoulder throughout the mating. The female started struggling vigorously towards the end of the mating and the male eventually released his grasp. The entire mating sequence lasted 77 sec. Both the male and female then ran into the male burrow where they remained. After 10.5 min, a second adult (ca. 90 mm SVL) male lizard entered the frame of view from the same direction as the female had. This male tongue flicked about 20 times as it moved towards the burrow. At 1012 h, this male partially (to mid-body) entered into the burrow and the posterior part of its body could be seen thrashing around. The second male then emerged, dragging the female out of the burrow with him, grasping her by the left rear leg. When she was completely outside the burrow, he flung her to one side, briefly releasing his grip. She sat motionless near the burrow entrance for 5 sec before moving rapidly away in the opposite direction from where she had come and away from the burrow. The second male re-entered the burrow after 5 sec and remained completely inside the burrow for 70 sec before re-emerging. He then circled once around the burrow tongue flicking about 38 times in 30 seconds, before re-entering the burrow for a third time. He emerged once more after 10 sec, and slowly (50 sec to move 50 cm) left the area in the same direction he had come, tongue flicking 16 times on the way. The original male emerged from the burrow after another 70 sec and basked at the burrow entrance with his head and forearms exposed. Seventy-six min later, the second male (or one of similar size and appearance) returned to the burrow. The first male retreated into the burrow followed by the second male, who remained in the burrow for 15 sec. The second male then emerged and left the frame 20 sec later. After another 15 sec, the first male emerged and continued to bask as before. No further interactions were observed over the 3 h of filming.

Though the copulation time of ca. 30 sec was similar to that reported by Milne et al (*op. cit.*), our observation of mating differed in one major aspect. In the former episode, a male initiated mating by entering a burrow occupied by a female. Here, the first male was at his burrow entrance and seized a passing female. The second male behaved in a manner similar to the episode described by Milne et al. (*op. cit.*), though no mating occurred. However, the appearance of a second male in the current observation implies that

pheromone trailing or some other olfactory cue may be being left by receptive females. Our observation also suggests that at least two mating strategies exist for *T. adelaidensis*, the first more selective (when a male approaches a female) and the second more opportunistic. However, both observations suggest that females have little choice in mate selection. Understanding the mating behavior of threatened species is crucial, as it enables better management and conservation strategies to be developed, particularly for captive breeding programs and translocations and reintroductions.

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TUPINAMBIS MERIANAE (White Tegu), ***TUPINAMBIS TEGUIXIN*** (Golden Tegu). **PREDATION ON SNAKES.** Lizards of the genus *Tupinambis* are omnivores; their diet includes invertebrates, vertebrates, eggs, and diverse fruits (Presch 1973. Copeia 1973[4]:740–746; Sazima and Haddad 1992. *In* L.P.C. Morellato (ed.), Répteis da Serra do Japi: Notas Sobre a História Natural, pp. 212–235. Unicamp/FAPES: Campinas, SP, Brazil). These diurnally active lizards are known to be ophiophagous, but few data exist on the species of snakes upon which they feed. Here, we report two events of predation by *Tupinambis* where the snakes were identified from the Brazilian Pantanal and southern Brazil.

At 1252 h on 22 September 2006, we observed an adult *Tupinambis merianae* near a small lake on a restinga located on the coastal plain of the State of Santa Catarina, southern Brazil (27.83°S, 48.62°W; elev. 5 m). The tegu was regurgitating its stomach contents and fled quickly upon our approach. In the stomach contents we found remains of plants, insects, and an intact adult male *Sordellina punctata* (total length of 30 cm). We deposited the *S. punctata* in the herpetological collection of the Universidade Federal de Santa Catarina (CHUFSC) (Kunz et al. 2007. Biotemas 20:127–132).

At 1310 h on 27 November 2007, we observed an adult *T. teguixin* preying on an adult *Leptophis ahaetulla* (ca. 1 m TL), on the shore of the Vermelho River, Pantanal, State of Mato Grosso do Sul (19.60°S, 56.90°W; elev. 200 m). We observed the event for 98 sec. During this period, the *T. teguixin* caught and bit the snake ca. 30 cm from the end of its tail. The *T. teguixin* had a short struggle with its prey, which tried to bite the tegu three times. After this, the lizard left rapidly with the snake in its mouth.

Our data indicate that both *Tupinambis* species have the ability to subdue aglyphous adult snakes with semi-aquatic (*S. punctata*) and arboreal habits (*L. ahaetulla*).

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VARANUS VARIUS (Lace Monitor). **PREDATION**. *Varanus varius*, Australia's largest lizard based on mass, is widespread over eastern continental Australia and selected offshore islands (Cogger 2000. Reptiles and Amphibians of Australia, 6th ed.. Reed New Holland, Frenchs Forest, Australia. 808 pp.). A large terrestrial and arboreal carnivore taking a broad range of prey, *V. varius* is similar to most varanids in being regarded as strictly diurnal (Cogger, *op. cit.*). Here we report a nocturnal observation of arboreal predation by *V. varius* on an adult Common Brushtail Possum, *Trichosurus vulpecula*.

On two occasions between 3 and 17 January 2008, JR observed a very large *V. varius* (ca. 1 m SVL, ca. 30 cm across the dorsum at widest point) active by day foraging and scavenging food scraps left by campers at Tathra Beach Motor Village, Andy Poole Drive, a caravan park located ca. 1 km N of Tathra, on the south coast of New South Wales, Australia. This individual, likely a female, is a well-known long-term resident of the area recognizable from a cataract in its left eye; this animal has often been observed in previous years during the holiday season. A population of *T. vulpecula* were also locally resident, and their noisy vocalizations and movements across roofs of cabins and recreational vehicles were frequently heard at all times of the night. At ~0030 h (EST) on 13 December 2007 (a warm, humid, and starlit but moonless night), JR heard the typical *T. vulpecula* advertisement call, but it soon changed to a loud alarm call. When JR looked out through cabin window, he observed the aforementioned *V. varius* in a ~6 m high *Eucalyptus* sp. tree (36.71829°S, 149.97608°E; WGS84; elev. 1 m) located ~6 m E of the cabin. The *V. varius* was situated on a major lateral branch above the main fork of the trunk, which was ~4.5 m above the ground at the base of the canopy, with an adult *T. vulpecula* situated among foliage at the end of the same branch. At this point, JR went to retrieve a camera with a nightscope function (Panasonic Lumix™), during which time the alarm call was abruptly cut off. Upon his return, JR observed the *V. varius* through the camera with the *T. vulpecula* in its mouth, in the process of swallowing it, a process completed in ~5 min. Whether the lizard was actively hunting, or had opportunistically seized the *T. vulpecula* while resting in the tree when the latter was moving about is unknown. Habitat consisted of an open cleared area with several permanent cabins and scattered *Eucalyptus* trees (either remnant or planted), located adjacent to a remnant ~20 m-wide strip of dense coastal heath/dry sclerophyll woodland. This strip of woodland was located on the west side of a paved road, which had another ~40 m wide strip of similar woodland on its east side behind the edge of the beach. The eastern edge of this camping area was located ~150 m inland from the high tide mark.

Varanus varius is a diurnal predator on a wide range of reptiles, birds, and mammals, including *T. vulpecula* captured by day in tree-hollow refugia and is a well-known scavenger of roadkills, farm animal mortalities, and food scraps left by humans (Cogger, *op. cit.*; DM, pers. obs.), but predation at night has been hitherto unreported. More observations will be needed to determine whether noctural predation by *V. varius* represents an active hunting strategy.

We thank M. Hayes for editorial suggestions.

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XENOSAURUS PHALAROANTHEREON (NCN). **DIET**. Few data exist on the feeding habits of knob-scaled lizards (genus *Xenosaurus*). Lemos-Espinal et al. (2003. Southwest. Nat. 48:119–122) indicated that *Xenosaurus grandis*, *X. platyceps*, and *X. newmanorum* consume primarily insects, though they found remains of a mammal in one *X. newmanorum*. Here, we report a second instance of mammal predation among xenosaurine lizards.

On 16 May 2004, we captured an adult (102.7 mm SVL) male *Xenosaurus phalaroanthereon* 6.1 km SW by road of San Juan Acaltepec, (16.2478°N, 95.9607°W, WGS84; elev. 2160 m) the type locality of this species in the Sierra Madre del Sur, Oaxaca, México. We obtained a fecal sample and released the animal at the point of capture. Using the technique of Arita and Aranda (1987. Técnicas para el Estudio y Clasificación de los Pelos. Inst. Nal. de Inv. Sobre Rec. Bióticos, Xalapa Veracruz. 21 pp.) and data from Baca (2002. Catálogo de Pelos de Guardia Dorsal en Mamíferos Terrestres del Estado de Oaxaca, México. México D.F. 100 pp.), we identified hair from the fecal sample as belonging to an unidentified species of harvest mouse (genus *Reithrodontomys*).

We cannot distinguish whether the mouse eaten was the result of the lizard capturing a live animal or scavenging a dead one. As the only small mammal previously reported is from the diet of *X. newmanorum* (Lemos-Espinal et al. 2003, *op. cit*.) and no other dietary data exist for *X. phalaroanthereon* (Lemos-Espinal and Smith 2005. Phyllomedusa 4:133–137), more information on *X. phalaroanthereon* diet will be necessary to properly evaluate our observation.

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SERPENTES — SNAKES

AGKISTRODON PISCIVORUS LEUCOSTOMA (Western Cottonmouth). **DIET**. *Agkistrodon piscivorus leucostoma* eats a wide variety of prey including rodents, birds, bird eggs, snakes, frogs, and numerous species of fish (Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History, University of Texas Press, Austin, Texas. 437 pp.). We add a new species of lizard to this list. On 14 September 2006, a recently killed juvenile *A. p. leucostoma* (239.0 mm SVL, 289.0 mm TL, 13.1 g; TNHC 67394) was turned in to the San Angelo Nature Center from a residence on the shores of Lake Nasworthy, Tom Green County, Texas. Although the snake was beheaded, both the body and head were vouchered. Upon further examination, the snake's stomach contained a juvenile *Sceloporus olivaceus* (48.0 mm SVL, 113.0 mm TL, 3.42 g; cataloged separately as TNHC 67395), swallowed headfirst.

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BOGERTOPHIS SUBOCULARIS (Trans-Pecos Ratsnake). **ARBOREALITY.** *Bogertophis subocularis* inhabits the Chihuahuan Desert of west Texas, New Mexico, and northern Mexico (Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. University of Texas Press, Austin). Within this region, it is known to occupy subterranean and terrestrial habitats with most field-collected specimens found amongst rocky slopes and outcrops (Werler and Dixon, *op. cit*.). Although these snakes are known to be adept climbers in rocky habitat, similar climbing activity has not been reported from arboreal settings. Here we report on two observations of arboreal activity in this species.

On 1 July 2007, we observed two male *B. subocularis* at approximately 1378 m elevation in Box Canyon, Sierra Vieja, Presidio County, Texas. The first (790 mm SVL, 920 mm TL, 146 g) was found at 0005 h crawling amongst the outer branches of an *Acacia greggii* (Catclaw Acacia) ca. 1.75 m above the ground. This acacia was one of several in a bunch ca. 2 m from the edge of a dry wash (30.5501°N, 104.6592°W). Twenty minutes later and ca. 150 m from the first snake, we found a second *B. subocularis* (724 mm SVL, 839 mm TL, 112 g) crawling down a ca. 10 cm diameter branch of a *Quercus emoryi* (Emory Oak) ca. 4 m above the ground. The *Q. emoryi* is near the confluence of Box Canyon and Fox Hollow (30.5498°N, 104.6588°W) and equidistant (ca. 4 m) from the edge of each wash. Although previous authors note that most *B. subocularis* are active between sunset and midnight on nights with little moonlight (Tennant 1984. The Snakes of Texas. Texas Monthly Press, Austin; Werler and Dixon, *op. cit*.), these two individuals were observed after midnight during the full moon. Additionally, the snake found in the oak tree was parasitized by a single tick, which we presume was *Aponomma elaphensis*, whose only known host is *B. subocularis* (Degenhardt and Degenhardt 1965. Southwest. Nat. 10:167–178).

We thank the Miller family for supporting and encouraging biological research on their ranch.

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BOIGA SIAMENSIS (Grey Cat Snake). **DIET**. Pauwels et al. (2005. Russ. J. Herpetol. 12:102–106), recently placed *Boiga ocellata* (Grey Cat Snake) in the synonymy *Boiga siamensis*. The species is known from Bangladesh, northeast India (westwards up to Bengal), Myanmar, Thailand, Cambodia, Laos, and Vietnam (Orlov and Ryabov 2002. Russ. J. Herpetol. 10:217–240; Teynié et al. 2004. Hamadryad 29:33–62; Stuart and Emmett 2006. Fieldiana Zool. new ser. 109:1–27; Teynié and David 2007. Russ. J. Herpetol. 14:39–44). *Boiga siamensis* is known to consume birds and their eggs (Cox et al. 1998. A Photographic Guide to Snakes and other Reptiles of Peninsular Malaysia, Singapore and Thailand. Ralph

Curtis Publishing, Inc., Sanibel Island, Florida).

On 23 May 2004 at ca. 1940 h we found a *B. siamensis* (1600 mm total length) attempting to consume a *Acridotheres tristis* (Common Myna) within the branches of a *Leucaena leucocephala* (White Popinac) behind the research house in Huay Khayenk Village (14.607889ºN, 98.582167ºE), Huay Khayenk Subdistrict, Thong Pha Phum District, Kanchanaburi Province, Thailand. The snake bit the bird at the wing and tried to kill it by constricting it. At ca. 2000 h the snake was disturbed and it released the bird. The snake was photographed and released.

We thank G. Vogel for assistance.

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BOTHROPS ASPER (Fer-de-lance). **DEFENSIVE BEHAVIOR.** *Bothrops asper* is an abundant pitviper widespread throughout much of Central America (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere. Cornell Univ. Press, Ithaca, New York), and is the species responsible for most snakebite fatalities in the region (Hardy 1994. Biotropica 26:198–207; Saborío et al. 1998. Toxicon 36:359–366). However, published accounts of the circumstances surrounding such snakebites are rare, and the majority of such cases occur when the snake is accidentally grabbed or trod upon (Hardy 1994. Herpetol. Nat. Hist. 2:67–82). Here we report a case of defensive behavior by an unmolested adult *B. asper* at La Selva Biological Station, Puerto Viejo de Sarapiquí, Herédia Province, Costa Rica (10.4313°N, 84.0036°W).

At 2110 h on 6 March 2005, we were radiotracking *B. asper* and encountered a non-telemetered female (1.7 m total length). The animal was moving slowly through undergrowth when encountered and showed no obvious response when cautiously approached to a distance of ca. 2.5 m. After being quietly observed for about 3 min and continuing to move away, the snake suddenly recoiled as if startled, although no stimulus was observed. It immediately turned 180° and began to advance rapidly with the head slightly raised towards us, causing us to quickly retreat. The snake proceeded to follow the exact nonlinear retreat path of one of us (JBL) for ca. 4 m, at which point it stopped, lowered its head, and did not immediately retreat but after ca. 30 sec resumed gradual slow movement in its original direction of travel. This sequence appeared similar to the "type I offensive advance" described for elapids (Whitaker and Shine 1999. Wildl. Res. 26:689–704).

Although the species is often depicted in popular literature and folklore as highly prone to unprovoked aggression, no similar reactions or attempted strikes were witnessed by DKW over more than 4500 similar observations of adult *B. asper*. A nocturnal ambush predator, fer-de-lance tended to flee in response to human approach at night, and usually displayed no visible reaction at all during the day, relying instead on crypsis. The present case seems atypical in that the snake was neither handled nor restrained, stimuli which can elicit defensive behavior in other pitvipers that otherwise appear similarly hesitant to strike (Gibbons and Dorcas 2002. Copeia 2002:195–198; Prior and Weatherhead 1994. J. Herpetol. 28:255–257). Factors influencing the described event remain unclear, although the fact that the snake was moving when encountered should be considered.

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BOTHROPS ASPER (Terciopelo). **DIET**. *Bothrops asper* occupy an important position in the food chain of tropical ecosystems. At Los Tuxtlas region (Veracruz, Mexico) adult *B. asper* feed on medium to large food items such as rodents (*Rattus* sp., *Didelphis* sp.), small birds, and juvenile conspecifics, whereas juveniles feed on smaller prey such as anurans (*Craugastor rhodopis*, *Smilisca baudini*), lizards (*Ameiva undulata*), and arthropods (Buttenhoff and Vogt 1997. *In* Gonzáles-Soriano et al. [eds.], Historia Natural de Región se Los Tuxtlas, pp. 478–480. Universidad Nacional Autónoma de México, Districto Federal, México; Pérez-Higareda et al. 2007. Serpientes de la Región de Los Tuxtlas, Veracruz, México. Universidad Nacional Autónoma de México, D.F., México). Herein I report the first record of *B. asper* eating a *Lepidophyma tuxtlae* (Tuxtla Tropical Night Lizard).

On 12 April 2005 at 2210 h, I found at Los Tuxtlas rainforest (18.53°N, 95.1°W) two subadult of *B. asper* approximately one meter apart and 20 m from the forest edge. One of these individuals fled but the other (ca. 835 mm SVL) had a half-swallowed *L. tuxtlae* (ca. 73 mm SVL) in its mouth. A color photographic voucher (MZFC-ID 1603) has been deposited in the herpetological collection of Museo de Zoología, Facultad de Ciencias, Universidad Nacional Autónoma de México.

I thank V. H. Reynoso and U. O. García-Vazquez for assistance.

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CARPHOPHIS AMOENUS HELENEA (Midwest Worm Snake). **DEFENSIVE BEHAVIOR**. Very little is known about the defensive behaviors of small fossorial snakes, including *Carphophis amoenus*. Most noted behaviors, other than escaping, include prodding with the pointed tail-tip and a flattened body posture with a partially buried head under coils (Clark 1970. Univ. Kansas Publ. Mus. Nat. Hist. 19:85–194).

On 10 May 2007 at Beech Fork State Park in Wayne County, West Virginia (38.28488°N, 082.41875°W), a non-gravid female *C. amoenus* was found under a large dome shaped rock. After handling the specimen, it was placed on the ground and proceeded to remain still in a loosely coiled pattern with its head partially buried under part of its body. The tail was positioned on top of the coils and the tail-tip oriented vertically as if it were mimicking the head. The tail tip remained motionless, as did the rest of the main

body, for the duration of the time photographed after which it was replaced under the cover object. This is the first report of a worm snake species exhibiting this type of defensive behavior.

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CORONELLA AUSTRIACA (Smooth Snake). **PARAPHIMOSIS.** Paraphimosis is a common condition in captive reptiles (Bennet 1996. *In* Mader [ed.], Reptile Medicine and Surgery, pp. 355–357. W.B. Saunders Co., Philadelphia, Pennsylvania) and occurs as a result of inflammation of the hemipenis, or hemipenes, making retraction through the cloaca impossible (DeNardo 1996. *In* Mader, *op. cit.*, pp. 212–224). Although common in captivity, this condition has not, to our knowledge, been recorded in a wild snake. Here, we report a wild *Coronella austriaca* showing clinical signs of paraphimosis.

On 10 August 2006 at 1159 h an adult male *C. austriaca* (433 mm SVL, 138 mm tail length [TL], 42 g) was captured at a lowland heath site in Dorset, United Kingdom. While collecting morphometric data as part of an ongoing mark-recapture study, we noticed that the blackened and necrotic left hemipenis was extruding from the cloaca (Fig. 1). The snake was in an otherwise healthy condition and showed no outward signs of any secondary infection that commonly accompany physical traumas (Cooper and Jackson 1981. Diseases of the Reptilia, Academic Press, London). The snake had been previously captured on 31 May 2006 (433 mm SVL, 138 mm TL, 45 g) when paraphimosis was not evident. The animal was released at the point of capture following data collection and subsequently recaptured on 2 August 2007 at 0957 h near the original locality. The necrotic mass was absent and there was minimal scar tissue present at the scales surrounding the cloaca. The snake was in a healthy condition (471 mm SVL, 140 mm TL, 54 g) and was again released at the point of capture.

Fig. 1. Lateral and ventral views of a necrotic prolapsed hemipenis observed on a wild *Coronella austriaca*.

The most common injuries observed in *C. austriaca* are physical traumas and damage to tails (Cooper and Davies 1997. Herpetol. J. 7:19–22), which can reduce survival and predispose individuals to infection (Cooper and Jackson, *op. cit.*). Paraphimosis did not appear to produce secondary infection in this instance and is unlikely to prevent the individual from reproducing, since the reproductive organs on each side of the body are morphologically and functionally separate. Contralateral hemipenis use in successive reproductive events has been observed in both kingsnakes (*Lampropeltis getula*; Zweifel 1997. J. Herpetol. 31:459–461) and gartersnakes (*Thamnophis sirtalis*; Shine et al. 2000. Behav. Ecol. 11:411–415) which, if present in *C. austriaca*, may place individuals such as this at a competitive disadvantage in future breeding seasons.

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CROTALUS SCUTULATUS SCUTULATUS (Mojave Rattlesnake). **DEFENSIVE BEHAVIOR/SALTATION AND HEAD HIDING**. Head hiding/coiling defensive behavior has not been previously documented in *Crotalus scutulatus scutulatus*. On 21 April 1994, several unusual behaviors were exhibited by an adult male *C. s. scutulatus* ca. 850–900 mm SVL (snout–vent length) in Fenner Valley, San Bernardino County, California, USA. At 0840 h (air temperature 27°C), a resting, fully coiled, slightly buried, adult male was observed in a gravelly wash, partially shaded by a large shrub (Fig.1A). After I took numerous photos from different compass directions, the snake remained motionless until it struck at me without rattling or moving into an aggressive striking position, and became airborne. The snake struck directly at me from the position facing 90° to my left (Fig.1A), a distance greater than its full body length. As the snake struck, it came completely off the ground (at least 15–20 cm) and propelled itself forward landing between my feet. A similar type of saltation behavior was
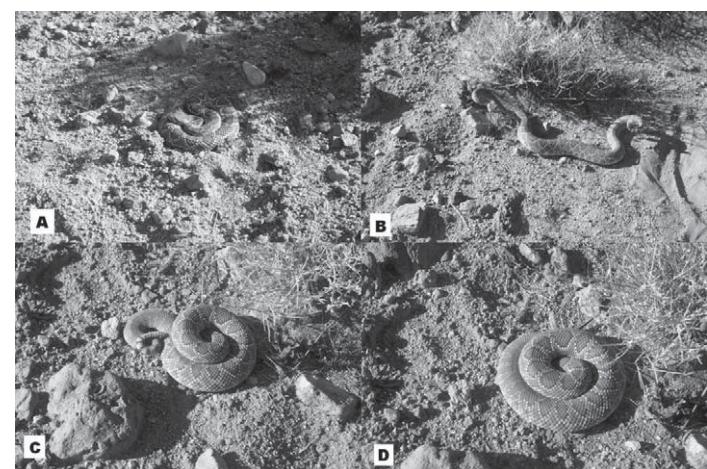

Fig. 1. Male Mojave Rattlesnake (*Crotalus s. scutulatus*) behavioral sequence of head-hiding: A) resting coil; B) saltation and aggressive behavior; C) head hidden and coiling; D) coiling completed, rattle extended upward but not vibrating.

described by Bartholomew and Nohavec (1995. Great Basin Nat. 55:282–283) in reference to flight behavior of a *C. s. scutulatus* from Mohave County, Arizona. Additionally, this type of saltation behavior has been observed in *C. scutulatus salvini* (Armstrong and Murphy 1979. The Natural History of Mexican Rattlesnakes. Univ. Kansas Mus, Nat. Hist., Spec. Publ. No. 5. 88 pp.): "This rattlesnake is one of the most aggressive species we encountered. Several struck so violently that their entire body appeared to be momentarily air borne." The present observation parallels that of Armstrong and Murphy (1979, *op. cit.*). In my observations of hundreds of active rattlesnakes, the distance they could strike is about 2/3 of its body length; B. H. Brattstrom (pers. comm.) corroborated this estimate as well. Klauber (1982. Rattlesnakes. Their Habits, Life Histories, and Influence on Mankind. Abridged edition, p. 93. University of California Press, Berkeley, California) stated: "A rattler can strike only a short distance from its resting coil—only the distance involved in straightening the S-shaped section of the neck;" and Klauber (*op. cit.*) p. 96. "From my own experience I should say that a rattler will rarely strike more than half its length, measured from the front of the anchor coil, and almost never beyond three-quarters of that length." Mattison (1996. Rattler! A Natural History of Rattlesnakes. Sterling Publ. Co. Inc., New York. 144 pp.) notes "A rattler's strike is rapid—about 2–3 m (6–10 ft) per second—and can reach a distance of about half its body length. The strike is sometimes so violent that its whole body slides forward and, under exceptional circumstances, it may completely leave the ground." This particular male Mojave Rattlesnake did not follow the distance axioms estimated above.

Following the active saltation display, the snake became agitated and began body bridging, looping coils, rattling violently, and repeatedly striking in any direction as I tried to lift it with a stick to move it to a safe location. Most rattlesnakes are easily picked up near midbody with a stick and balance themselves well so they can safely be moved. This particular snake would not stay balanced on the stick and repeatedly fell off and continued to act aggressively, striking and rattling violently (Fig. 1B). This aggressive behavior continued for several minutes, with each attempt to pick up the snake eliciting continued striking, thrashing, and falling to the ground. On my final attempt to pick up the rattlesnake it began to display an unusual coiling behavior, placing its head on the ground and initiating a clockwise coiling motion on top of its head (Figs. 1D, 1E). In this position the snake's head was on the ground and completely buried under the center of its coils with the rattle erect and not vibrating. The snake stayed motionless in this position for approximately 5 minutes. Then I reached out with the stick to pick the snake up and attempt to move it again, this time the snake became docile while I moved it to a nearby wash 100 m west and released it next to a rodent burrow, into which it rapidly crawled.

A second head-hiding observation was made on 18 May 1999 of a smaller *C. s. scutulatus* (female ca. 650–700 mm SVL) in Piute Valley, Clark County, Nevada, USA. I attempted to move this snake from where I had set up some equipment. The snake repeatedly fell off the stick with which I had attempted to move it and was not striking violently as described earlier. After a number of attempts to move this snake it behaved similarly to the male specimen and hid its head (Fig. 2A), attempted to coil its body over the head, though not quite concealing it as well as the male
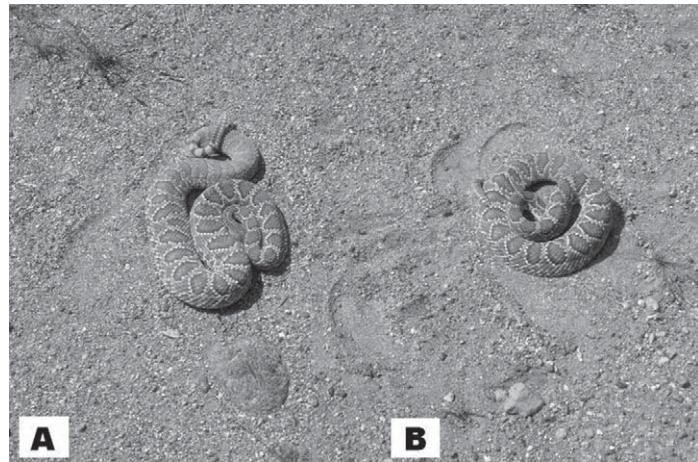

Fig. 2. Female Mojave Rattlesnake (*Crotalus s. scutulatus*) behavioral sequence of head-hiding: A) initiating head-hiding behavior; B) coiling completed, rattle silent.

specimen described earlier (Fig. 2B).

Head hiding in rattlesnakes is apparently uncommon and was not documented in Carpenter and Ferguson (1977. *In* C. Gans and D. W. Tinkle [ed.], Biology of the Reptilia Vol. 7. pp. 335–554. Academic Press, New York). Subsequently, several instances of head hiding have been recorded as a result of human or predator interaction with rattlesnakes. An account of intimidation of a Western Diamondback Rattlesnake (*Crotalus atrox*) was reported (Cowles 1977. Desert Journal: A Naturalist Reflects on Arid California. Univ. California Press, Berkeley. 263 pp.) where several snakes were individually intimidated by placing a flattened hand into the face making the snake lower its head and hiding it under a coil. This behavior apparently is an attempt to avoid an attacker by escaping and to protect its head from imminent danger. A slightly different posture of head hiding behavior has been documented in *C. atrox* as an escape from predation after being confronted by a Roadrunner (*Geococcyx californianus*). After the snake struck numerous times at a Roadrunner and became exhausted, it protected its head by tucking it under its coils (Cornett 2001. The Roadrunner. Nature Trails Press, Palm Springs, California. 64 pp.; Meinzer 1993. The Roadrunner. Texas Tech Univ. Press, Lubbock, Texas. 104 pp.; Sherbrooke and Westphal 2006. Southwest Nat. 51:41–47). Head-hiding behavior has also been documented in the Prairie Rattlesnake (*Crotalus viridis viridis*) in response to human interaction (Duval et al. 1985. Nat. Geogr. Res. 1:80–111; Alcock 1998. Animal Behavior: an Evolutionary Approach. Sinauer Associates, Inc. Sunderland, Massachusetts. 640 pp.); and in the Red Diamond Rattlesnake (*Crotalus ruber*) by Rubio 1998. Rattlesnake: Portrait of a Predator. Smithsonian Institution Press, Washington, D.C. 240 pp.). Head-hiding behavior in conjunction with defensive tail displays is widespread in snakes (Greene 1973. J. Herpetol. 7:143–161). The significance of head hiding behavior in rattlesnakes and lack of rattle vibration appear to simply be a defensive measure to protect the snake and its head from human intimidation and/or possible predation.

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DINODON RUFOZONATUM RUFOZONATUM (Asian King Snake). **DIET AND BEHAVIOR**. *Dinodon rufozonatum rufozonatum* occurs in parts of eastern China, Korea, Japan (Szczerbak 2003. Guide to the Reptiles of the Eastern Palearctic. Krieger Publishing Company, Florida. 260 pp.) and Taiwan (Lue et al. 2002. The Transition World – Guidebook of Amphibians and Reptiles of Taiwan. Swan, Taipei. 350 pp. [In Chinese]). Previously reported prey include: a chick, *Bufo bankorensis*, *Bufo melanostictus*, *Rana adenopleura*, skinks, snakes, and a beetle (Lee and Lue 1996. Biol. Bull. Natl. Taiwan Normal University 31:119–124. [In Chinese]; Lee and Lue 1996. J. Taiwan Mus. 49:137–138; Lin et al. 1995. Newsletter of Wildlifers 3:19–21 [In Chinese]; Norval and Mao 2004. Herpetol. Rev. 35:65; JJM, unpubl. obs.).

On the evening of 21 September 2007, an adult male *D. r. rufozonatum* (775 mm SVL, 169 mm tail length [TL], 198.8 g) was observed on a branch, ca. 2 m above the ground, overhanging a small concrete reservoir on the edge of a secondary forest in Santzepu, Sheishan District, Chiayi County, Taiwan (23.43ºN, 120.48ºE, WGS84). Our presence disturbed the snake and as it tried to flee it was captured. After it was measured we released it at the capture site. On 27 January 2008 at 2212 h, another adult male *D. r. rufozonatum* (729 mm SVL, 207 mm TL, 186.2 g) was observed at the reservoir, but this time on the reservoir wall. Again, our presence disturbed the snake and it tried to seek shelter under a fallen palm leaf that was lying on the wall. Numerous *Rhacophorus moltrechti* were calling from inside the reservoir, and there were some bubble-foam nests on the inside of the reservoir wall, as well as on the coconut palm leaf. The snake was captured and it was noted it had an enlarged abdominal region. After gentle palpation of the stomach region, the snake regurgitated two intact *R. moltrechti* (male: 50 mm SVL, 5.1 g; female: 56 mm SVL, 8.1 g) and ova, as well as an unidentifiable anuran (5.9 g) that was in an advanced digested state. In July 1997 in one night, we encountered several frogs and five *D. r. rufozonatum* in a large concrete reservoir in Donhe Dsitrict, Taitung County. We believe that *D. r. rufozonatum* have learned that these reservoirs provide a reliable food resource when *R. moltrechti* are breeding. To our knowledge this is the first report of *D. r. rufozonatum* predation on *R. moltrechti*.

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DRYMARCHON COUPERI (Eastern Indigo Snake). **NESTING HABITAT AND EGG DEPREDATION.** Little is known about the nesting ecology of *Drymarchon couperi* in the wild. In southern Georgia, *D. couperi* females are known to lay eggs from May through early June (Moulis 1976. Bull. New York Herpetol. Soc. 12:14–23; R. Moulis, pers. comm., 2006), but there is scant information detailing where the eggs are laid. In this note, we report the discovery of a *D. couperi* nest found in southern Georgia, USA.

On 3 June 2003, one of us (SLN) found a *D. couperi* nest (N = 10 eggs) near an active, adult *Gopherus polyphemus* (Gopher Tortoise) burrow in xeric sandhill habitat, Telfair County, Georgia. Evidently, the nest had recently been excavated and depredated (in part) by a predator when discovered. The shells of four *D. couperi* eggs that had been consumed by the predator, as well as three intact eggs, were found on the sandy surface of the tortoise burrow apron. Three additional intact eggs were found in the nest cavity, which was located ca. 10 cm deep in the sand beneath and beside a rotten *Quercus laevis* (Turkey Oak) log; numerous fresh *Procyon lotor* (raccoon) tracks were observed on the burrow apron. The intact *D. couperi* eggs (N = 6) were subsequently incubated in captivity where they all hatched on 3 October 2003 . We believe that SLN or his dog may have disturbed or frightened away the nest predator (probably a raccoon) before it had time to consume the entire clutch.

The few other published observations of *D. couperi* nests also suggest that *G. polyphemus* burrows are important sites for oviposition. In southern Georgia, a *D. couperi* that had been implanted with a radio transmitter and then released nested ca. 1 month later (N = 6 eggs; between 23–29 May) in an inactive tortoise burrow (burrow width = 12.7 cm) located in an open *Pinus elliottii* (Slash Pine) plantation (Speake et al. 1978. *In* Odum and Landers [eds.], Proc. Rare and Endangered Wildlife Symposium, pp. 64–73. Georgia Dept. Nat. Res., Game and Fish Tech. Bull. WL4, Atlanta). Smith (1987. Unpubl. master's thesis. Auburn University, Auburn, Alabama. 129 pp.) reported that three radio-transmittered gravid female *D. couperi* translocated to sandhill habitat on St. Marks NWR, Wakulla County, Florida, laid eggs in tortoise burrows soon after release. The discovery of a *D. couperi* eggshell on the apron of an active tortoise burrow in southern Georgia is also circumstantial evidence that tortoise burrows or burrow aprons are used by nesting *D. couperi* (Williamson and Moulis 1979. Survey of Reptiles and Amphibians on Fort Stewart and Hunter Army Airfield. Rept. to United States Army, Fort Stewart, Georgia. 343 pp.).

Our observation bolsters the limited available information regarding *D. couperi* nesting habitat and strongly suggests that raccoons may sometimes depredate nests. A possible risk for *D. couperi* nesting inside or immediately nearby an active *G. polyphemus* burrow would be disturbance or damage to the eggs by the digging activities or regular movements of the resident tortoise. Conversely, *D. couperi*, a federally threatened species, may benefit in its apparent nesting relationship with Gopher Tortoises and their burrows by virtue of having readily available refuges and recovery shelters for post-nesting adult females, as well as for the vulnerable hatchlings.

We thank N. Hyslop for assistance.

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EUNECTES MURINUS (Green Anaconda). **DIET**. *Eunectes murinus* is known to prey on a variety of species, including capybaras, white-tailed deer, and spectacled caiman as well as smaller anacondas (Rivas 1999. Life History of the Green Anaconda [*Eunectes murinus*] with Emphasis on its Reproductive Biology. Ph.D. dissertation. University of Tennesee at Knoxville. 235 pp.; Rivas and Owens 2000. Herpetol. Rev. 31:45–4).

In this note we report an observation made on 16 July 2006 of a large *E. murinus* (ca. 5 m total length) attempting to eat an adult *Boa constrictor* in the South Rupununi savannas of Guyana about 7 km N of Dadanawa Ranch (2.88°N, 59.53°W). From a boat on the Rupununi River, we spotted a large adult *E. murinus* hanging by its tail from the canopy of a tree in the gallery forest ca. 5 m above the river (Fig. 1A). The anaconda had partially ingested an adult *Boa constrictor* head-first, and was supporting its prey by doubling it over a coil in the anaconda's body (Fig. 1B). After 10 minutes of observation from a distance, we approached more closely, whereupon the anaconda attempted to regurgitate its prey, first by shaking the boa from its mouth and then by wrapping its coils behind its head to forcibly push its prey loose. After 15 minutes, the anaconda dropped the boa into the river and retreated up into the canopy.

We recovered the dead boa (1.78 m total length) from the river and it had the tail of a Green Iguana (*Iguana iguana*) protruding from its mouth. The anaconda likely encountered the boa in the tree while it was in the process of digesting the recent kill and in a vulnerable condition. It is interesting that the observation was made at the height of the rainy season when it is rare to spot anacondas.

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Fig. 1. A) Green Anaconda (*Eunectes murinus*) devouring Boa Constrictor (*Boa constrictor*) in gallery forest canopy. B) Close-up showing a bulge in the boa's body from a recently-ingested Green Iguana (*Iguana iguana*).

LAMPROPELTIS CALLIGASTER CALLIGASTER (Prairie Kingsnake). **DIET**. *Geomys bursarius ozarkensis* (Ozark Pocket Gopher) is an endemic that has only been reported in two counties in Arkansas (Elrod et al. 2000. J. Mammal. 81:852–864). Ozark Pocket Gophers maintain a closed underground burrow system and are rarely seen above ground. They inhabit pastureland, which is also favorable habitat for *Lampropeltis calligaster calligaster* (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp).

On 16 May 2007 at 1530 h, we discovered that a male *G. b. ozarkensis* (186 mm body length, 43.7 mm tail length, 84 g) that we were radiotracking had been consumed by a male *L. c. calligaster* (890 mm SVL, 298 g). The snake was ca. 1 m from the gopher's burrow system in a hay field off County Road 3 (36.0236°N, 91.9150°W) in Izard County, Arkansas. We did not observe the snake feeding, thus we do not know whether the snake preyed on the pocket gopher inside its burrow or above ground. The snake regurgitated the gopher and radio transmitter in captivity, ca. 3 hours later. Although small mammals, including *Geomys* sp., are common prey for *L. calligaster* (Ernst and Ernst 2003. Snakes of the United States and Canada, Smithsonian Books, Washington, DC. 668 pp; Fitch 1999. A Kansas Snake Community: Composition and Changes Over 50 Years, Krieger Publ. Co., Malabar, Florida. 165 pp; Trauth and McAllister 1995. Proc. Arkansas Acad. Sci.49:188–192), to the best of our knowledge *G. bursarius* has never been recorded in its diet.

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LEPTODEIRA SEPTENTRIONALIS (Cat-eyed snake). **DIET.** *Leptodeira septentrionalis* is widely distributed in the Americas. It is found at low and moderate elevations on the Atlantic and Pacific slopes from southern Texas and Sinaloa, south to Peru (Lee 1996. The Amphibians and Reptiles of the Yucatan Peninsula. Comstock Publishing Associates, Cornell University Press, Ithaca, New York).

On 21 July 2006 at 2109 h we observed a juvenile *Leptodeira septentrionalis polysticta* (247 mm SVL, 323 mm total length) on a plant on low vegetation, swallowing a female Leaf Litter Frog, *Craugastor* cf. *loki* (ca. 36 mm SVL). These observations took place in a tropical rainforest fragment (6.6 ha) at Los Tuxtlas, Veracruz, Mexico (18.5953°N, 95.1208°W, 433 m elev., WGS84). The snake was collected after feeding and deposited in Colección Nacional de Anfibios y Reptiles, Instituto de Biología, Universidad Nacional Autónoma de México (CNAR-IBH 21139).

Leptodeira septentrionalis consumes a broad range of anurans (and anuran eggs) and hunts on the ground, in low vegetation, in trees, and in water (Duellman 1963. Univ. Kansas Publ. Mus. Nat. Hist. 15:205–249; Henderson and Hoevers 1977. Copeia 1977:349–355; Lee, *op. cit.*; Pérez-Higareda et al. 2007. Serpientes de la Región de Los Tuxtlas, Veracruz, México. Guía de Identificación Ilustrada. Universidad Nacional Autónoma de México, Mexico City; Schmidt and Andrews 1936. Field. Mus. Nat. Hist. Publ. Zool. Ser. 20:167–187; Stuart 1948. Misc. Publ. Mus. Zool. Univ. Michigan 69:109). This is the first record of *Craugastor* in the diet of *L. septentrionalis*. Frogs of the genus *Craugastor* are the most abundant amphibian species living on leaf litter at Los Tuxtlas.

Submitted by **ELISA CABRERA-GUZMÁN, FAHD HENRRY CARMONA-TORRES,** and **VÍCTOR HUGO REYNOSO,** Colección Nacional de Anfibios y Reptiles, Departamento de Zoología, Instituto de Biología, Universidad Nacional Autónoma de México, Circuito exterior, Ciudad Universitaria, México D.F. C.P. 04510 (e-mail: anfisbenido@yahoo.com).

LIOPHIS POECILOGYRUS (Yellow-bellied Liophis). **DIET.** *Liophis poecilogyrus* is a widely distributed colubrid snake found in South America (Dixon 1989. Smithson. Herpetol. Infor. Serv. 79:1–40). Its diet includes amphibians, lizards, insects, fishes, and rodents (Achaval and Olmos 2003. Anfíbios y Reptiles del Uruguay. 2nd ed. Graphis Impresora, Montevideo, Uruguay, 136 pp.). On 15 April 2007 at 1745 h a young *L. poecilogyrus* (220 mm SVL, 40 mm tail length) was found under a branch at the border of a lake in Campo Belo do Sul municipality, Santa Catarina State, Brazil (27.5651°S, 50.4128°W, 972 m elev., SAD 69). After a few minutes of handling for photographs, it regurgitated a partially ingested anuran, the semi-fossorial *Elachistocleis ovalis* (Common Oval Frog). The anuran was collected and the snake liberated after photographs.

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LYCODON RUHSTRATI RUHSTRATI (Mountain Wolf Snake). **ENDOPARASITES**. The pentastomid *Raillietiella orientalis* naturally occurs in Taiwan and has been recorded as an endoparasite of *Amphiesma stolatum*, *Bungarus multicinctus multicinctus*, *Deinagkistrodon acutus*, *Elaphe carinata*, *Elaphe taeniura friesei*, *Naja atra*, *Protobothrops mucrosquamatus*, and *Ptyas mucosa* (Kuo 1999. Helminths and Pentastomids of Snakes in Taiwan. Master's thesis, Veterinary School, National Chung Hsing University, Taichung [in Chinese]).

On 18 February 2006 at 1038 h a DOR *Lycodon ruhstrati ruhstrati* (626 mm SVL, 153 mm tail length [TL], 46.3 g prior to dissection) was found on a road in Santzepu, Sheishan District, Chiayi County (23.43°N, 120.48°E, WGS84). On 21 April 2006 we captured another *L. r. ruhstrati* (587 mm SVL, 178 mm TL, 22.3 g prior to dissection) in the same area and maintained it in captivity until its death on 30 May 2006. Both specimens were dissected and inspected for parasites. Parasites were found in the vicinity of the trachea, lungs, liver, and fat reserves. All of the parasites were identified as *R. orientalis* and deposited in the United States Parasite Collection, Beltsville, Maryland (USNPC 100468). To our knowledge this is the first report of *R. orientalis* parasitizing *L. r. ruhstrati*.

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MICRURUS ANCORALIS (Regal Coralsnake). **DIET**. Snakes of several phylogenetic groups and some raptorial birds are known to prey on caecilians (Taylor 1968. The Caecilians of the World. A Taxonomic Review. University of Kansas Press, Lawrence. 848 pp.). Specimens of *Micrurus corallinus* and *M. ancoralis* with caecilians in their stomachs have been reported (Boulenger 1913. Proc. Zool. Soc. London 1913:1019–1038). There are also reports of caecilian consumption by colubrids and other fossorial elapids (Gower et al. 2004. Afr. J. Ecol. 42:83–87). According to Roze (1996. Coral Snakes of the Americas: Biology, Identification, and Venoms. Krieger Publishing Co., Malabar, Florida. 328 pp.), at least nine species of coralsnake prey upon caecilians, and some appear to be caecilian specialists (e.g., *M. mipartitus* and *M. bocourti*). Here we present two additional observations of coralsnakes (*Micrurus*, Elapidae) feeding on caecilians.

On 2 May 2002 at 1530 h one of us (JFF) along with J. A.

Chaves observed a *Micrurus ancoralis ancoralis* (ca. 1300 mm TL) struggling with a *Caecilia* cf. *nigricans* at Bilsa Biological Station (0.46°N, 79.8°W, 400 m elev.), Esmeraldas Province, Ecuador. The *M. ancoralis* was biting the caecilian by the latter's lower jaw, while the caecilian had a hold of the snake's upper jaw. The pair struggled for over an hour. When we left the site both animals were still entangled. The tail of the caecilian was in a burrow but we estimate the caeclian's total length to be longer than the coral snake (ca. 1500 mm TL).

Campbell and Lamar (2004. The Venomous Reptiles of the Western Hemisphere. Volume I. Comstock Publishing Associates, Ithaca, New York. 898 pp.) suggest that *M. ancoralis* feeds on small snakes. Our observations and those of Boulenger (*op. cit.*) suggest that caecilians may comprise an important component of *M. ancoralis* diet. Direct observation of coralsnake predation upon caecilians is rare (Burger 1997. Bull. Chicago Herpetol. Soc. 32:145., Kupfer et al. 2003. Amphibia-Reptilia 24:212–215.). Our observation of headfirst ingestion is consistent with the inference that this is the most common pattern (Gower et al., *op. cit.*). Nevertheless, we believe this is the first observation of a caecilian struggling with a coralsnake after it appeared to have been envenomated.

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NERODIA ERYTHROGASTER (Yellow-bellied Watersnake). **DIET.** The diet of *Nerodia erythrogaster* consists almost entirely of fish and amphibians, with this species consuming more amphibians than other watersnake species (Gibbons and Dorcas 2004. North American Watersnakes: A Natural History. University of Oklahoma Press, Norman. 438 pp.). Moreover, a Louisiana population exhibited an ontogenetic shift in which snakes under 500 mm SVL largely consumed fish whereas individuals over 500 mm SVL largely consumed anurans (Mushinsky et al. 1982. Ecology 63:1624–1629). Here, we report a new anuran prey species for *N. erythrogaster* that was consumed by a snake under 500 mm SVL.

On 18 July 2006 at ca. 0020 h we collected a male *N. erythrogaster* (342 mm SVL, 536 mm total length, 23.4 g after prey removal) in a flooded, temporary wetland on the north side of Farm-to-Market Road 253, 2.0 road miles W of Texas Highway 87, Newton Co., Texas (30.4275°N, 93.8369°W). Numerous *Hyla squirella* were calling in the wetland. The abdominal region of the snake was noticeably distended, and later examination of the stomach contents revealed five adult male *H. squirella* with some decomposition to the head and forelimbs of the most posteriorly positioned treefrog. The combined mass of the five *H. squirella* was 10.5 g yielding a combined relative prey mass of 0.45. Although *H. chrysoscelis* and *H. cinerea* have been reported as prey items

of *N. erythrogaster*, to the best of our knowledge this is the first time *H. squirella* has been reported as a prey item. All specimens were deposited in the Texas Natural History Collection (TNHC 65206).

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NOTECHIS SCUTATUS (Australian Tiger Snake**). INJURIES.** Carnac Island in Western Australia hosts a large population of *Notechis scutatus* (Bonnet et al. 1999. Behav. Ecol. Sociobiol. 46:267–272). Adult *N. scutatus* in this population feed primarily on *Larus novaehollandiae* (Silver Gull) chicks. Adult *L. novaehollandiae* defend their progeny by pecking at the snake's head. Consequently, many snakes sustain head injuries, and of the estimated 400 adult snakes that appear to thrive on Carnac Island, 7.5% are totally blind and 6.6% half blinded. However, sight does not appear to be critical to the capture of their primary prey, abundant and sessile *L. novaehollandiae* chicks (Aubret et al. 2006. Austr. J. Zool. 303:894–903). This may explain why these injured snakes survive, eat and reproduce just as well as their intact counterparts (Bonnet et al., *op. cit.*). Here we present evidence of comparable injuries in two other island populations of *N. scutatus*.

In July 2007, an adult female *N. scutatus* with a large (ca. 2.5 x 2.5 cm), healed scar on the left side of her head was captured on Hopkins Island, South Australia (34.964°S, 136.060°E). A large area of tissue and bone as well as the left eye were missing. The left fang was embedded in scar tissue and non-functional. The snake had a low body mass for its length (1130 mm SVL, 356 g), however this was the case for most of the snakes on the island (pers. obs.). The injury appeared to be quite old, indicating that this snake has continued to survive despite its severe head injuries. A large adult male *N. scutatus* with a large, healed scar at mid-body was also captured on Hopkins Island. We presume that such injuries are due to attacks by large predatory birds. No other terrestrial snake predators occur on Hopkins Island. *Haliaeetus leucogaster* (White-breasted Sea Eagle) and *Aquila audax* (Wedge-tailed Eagle) are both present on Hopkins Island and both appear capable of attacking adult *N. scutatus* and inflicting severe injuries.

Furthermore, on a recent (January 2008) trip to Christmas Island (39.687°S, 143.831°E) off the coast of King Island, Tasmania, we captured and measured 33 adult *N. scutatus* (17 males, 16 females) and found that three large adult males presented injuries to their heads. Such injuries were characteristic and recognized (from numerous observations on Carnac Island tiger snakes) as being attacks from nesting birds defending their chicks. Many bird species nest on Hopkins islands, including *Puffinus tenuirostris* (Short-Tailed Shearwater), *Eudyptula minor* (Little Penguin), and *L. novaehollandiae*. Chicks of all three of these species are preyed upon by *N. scutatus*. However there is no evidence that shearwaters or penguins defend their hatchlings from the snakes, whereas *L. novaehollandiae* have been observed defending their hatchlings (Bonnet et al., *op. cit.*).

These observations further demonstrate the surprising ability of wild snakes to withstand large injuries and survive despite the loss of sensory (eye) or predatory (fang) equipment.

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OXYBELIS AENEUS (Narrow-Headed Brown Vine Snake). **BEHAVIOR.** *Oxybelis aeneus* diet consists of lizards, frogs, birds, and mammals (Savage 2002. The Amphibians and Reptiles of Costa Rica. University of Chicago Press, Chicago, Illinois. 934 pp.). Here we report a possible predation event by *O. aeneus* upon the non-native gecko, *Hemidactylus frenatus* (House Gecko).

On 20 July 2007, we found an *O. aeneus* perched on a wall with a *H. frenatus* in its mouth on the Gandoca-Manzanillo Wildlife Refuge, Limón Province, Costa Rica (9.637889°N, 82.705222°W, WGS84; 3 m elev.). The snake was in a vertical, head down position and had seized the gecko's left hindlimb; the gecko was simultaneously biting the snake on the head (Fig. 1). The snake moved up and out of sight while the two were interlocked. Although not confirmed, we assume that the snake consumed the gecko. *Hemidactylus frenatus* has recently invaded Costa Rica and is commonly encountered in buildings, it is an abundant accessible prey for a variety of predators. However, only *Troglodytes aedon* (House Wren) has been reported preying on *H. frenatus* in Costa Rica (Barquero and Hilje 2005. Wilson Bull. 117:204–205). Our observation is noteworthy because it is the first report of apparent predation by a native reptile on non-native *H. frenatus* in Costa Rica.

Fig. 1. *Oxybelis aeneus* attempting to consume *Hemidactylus frenatus* at Gandoca-Manzanillo Wildlife Refuge, Limón Province, Costa Rica.

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PORTHIDIUM HESPERE (Western Hognose Pitviper). **DIET.** *Porthidium hespere* is a rare pitviper known only from two specimens collected in the coastal plain of Colima and Michoacan, México (Campbell and Lamar 2004. Venomous Reptiles of the Western Hemisphere. Cornell University Press, Ithaca, New York. 898 pp.). Very little is known about its ecology or natural history. On the night of 11 August 2005, a specimen (MZFC 19742) was found DOR in the vicinity of El Faro de Bucerias, Municipality of Aquila, Michoacan, Mexico (Goldberg et al. 2008. Herpetol. Rev. 39:99). Posterior examination of stomach contents revealed the remains (hind legs and vertebrae) of an *Ameiva undulata* (Rainbow Ameiva). Other members of the genus *Porthidium* prey on *Ameiva* and other lizards (Campbell and Lamar 2004, *op. cit.*). This is the first reported prey of *P. hespere* and only the third known specimen with precise locality data.

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PSEUDONAJA TEXTILIS (New Guinea Brownsnake). **ATTEMPTED OPHIOPHAGY.** *Pseudonaja textilis* is a widely distributed and commonly encountered medically important elapid in eastern Australia. It was first collected in Papua New Guinea (PNG) in 1953, by the 4th Archbold Expedition to northern Milne Bay Province, (McDowell 1967. J. Zool. 151:497–543), and assumed to represent a WWII or post-war introduced population (Slater 1968. A Guide to the Dangerous Snakes of Papua. 2nd ed. V. P. Bloink, Port Moresby. 22 pp.). Additional records exist for Milne Bay, Oro and Central Provinces (O'Shea 1996. A Guide to the Snakes of Papua New Guinea. Independent Group, Port Moresby. 239 pp.; Williams et al. 2008 Zootaxa 1703:47–61), but it is uncommon in PNG. It has been reported as common in southeastern West Papua (Indonesia) (Kuch and Yuwono. 2002 Herpetozoa 15:75–78.). Recent work on the zoogeographical history and distribution of *P. textilis* in New Guinea suggests a natural origin rather than an introduction (Williams et al., *op. cit.*).

This note constitutes the first field-based feeding record for *P. textilis* from PNG and also represents deviation from the typical prey preferences of adult *P. textilis*. Australian *P. textilis* exhibit catholic diets, summarized as 9% frogs, 49% reptiles (3.7% snakes), 1% reptile eggs, 2% birds, and 39% mammals (Shine 1991. Australian Snakes: A Natural History. Reed, Sydney. 223 pp.), although an ontogenetic shift in diet preferences exists (Shine 1989. Herpetologica 45[2]:195–207). Snakes up to 600 mm SVL prey on ectotherms, while endotherms are the preferred prey of adult snakes. Most reptiles in the diet are lizards, with occasional reports of elapids being taken: *Denisonia devisi* (×1), and *P. textilis* (×2), and unidentified elapids (×3) in New South Wales (Shine 1989, *op. cit.*) and *P. textilis* (×1) in captivity (Neindorf, pers. comm.).

Between 21–23 October 2003, MOS visited Heropa oil-palm mini-estate, near the Popondetta to Buna road (8.75°S, 148.39°E) and part of Higaturu Plantations, Oro Province, PNG, to collect live *P. textilis* for a snakebite and venom research project, under the auspices of the Australian Venom Research Unit (AVRU), University of Melbourne. Six *Pseudonaja* were sighted and three

Fig. 1. *Candoia paulsoni mcdowelli* (top), succumbed to envenomation during a predation attempt by a *Pseudonaja textilis*. The *Candoia* had previously consumed a *Sphenomorphus jobiensis* (bottom). Photograph by Mark O'Shea.

captured, the first Oro Province specimens collected since the mid-1960s.

One specimen, a female (981 mm SVL, 1210 mm TTL), was sighted at 1100 h, following a period of light rain, lying alongside and parallel with a low 'frond-row' of dead palm fronds, between oil-palms. It was in the process of swallowing a *Candoia paulsoni mcdowelli* (McDowell's Bevel-nosed Ground Boa) that had been envenomed but was still alive. Although Australian *P. textilis* are reported to use constriction to subdue prey, the *Pseudonaja* was lying almost full length and was not constricting or restraining the *Candoia*, two thirds of which protruded from its mouth. Disturbed, the *Pseudonaja* regurgitated the *Candoia* and attempted to flee, but was caught. The *Candoia*, a female (445 mm SVL, 525 mm TTL) was also collected, but rapidly succumbed to the venom. It contained a *Sphenomorphus jobiensis* (Jobi Skink; 85 mm SVL, 180 mm TTL) (Fig. 1).

Snakes are representative of the limbless, elongate 'Type IIb' prey taken by many elapids (Cundall and Greene 1999. *In* Schwenk [ed.], Feeding: Form, Function, and Evolution in Tetrapod Vertebrates, pp. 293–333. Academic Press, San Diego, California) but adult Australian *P. textilis* are not noted to be especially ophiophagous, showing a preference for 'Type III' prey such as small mammals. All three New Guinea *P. textilis* collected by MOS fed readily on rat pups within 10 days of captivity. This record of ophiophagy is the first wild feeding record for PNG *Pseudonaja* and the first record of a *Pseudonaja* preying on a boid, although the endemic New Guinea elapid *Micropechis ikaheka* has previously been reported to prey on *Candoia aspera* (O'Shea 1994. Herpetol. Rev. 25:70).

We thank Wolfgang Wüster, Graham King, John Hula, Gabby Chris, Rick Shine, and Rex Neindorf.

Submitted by **MARK O'SHEA** (e-mail: osheam@unimelb. edu.au) and **DAVID WILLIAMS** (e-mail: d.williams4@pgrad. unimelb.edu.au), Australian Venom Research Unit, Department of Pharmacology, University of Melbourne, Parkville, Victoria, 3010, Australia.

PSEUSTES POECILONOTUS (Bird-eating Treesnake). **PREDATORS.** The diet of *Pseustes poecilonotus* is known to include birds and bird eggs (Campbell 1998. Amphibians and Reptiles of Northern Guatamala, the Yucatan, and Belize. University of Oklahoma Press, Norman. 380 pp.). However, other than antbirds (Thamnophilidae), interactions with specific avian prey species appear to be lacking in the literature (Oniki 1979. Biotropica. 11:60–69; Weatherhead and Blouin-Demers 2004. J. Avian Biol. 35:185–190; Willis 1972. Ornithol. Monogr. 10:1–162).

On 11 August 1996 at approximately 1400 h I watched two adult *Ramphastos swainsonii* (Chesnut-mandibled Toucans) dive repeatedly at a nest hole cavity located ca. 15 m high in the trunk of a dead tree near the 300 meter mark of the Sendero Oriental Trail at La Selva Biological Station, Costa Rica (10.43°N, 83.98°W). Observation with binoculars revealed that a *P. poecilonotus* (ca. 1.4 m total length) was clinging to the tree trunk just outside the nest hole opening. The two *R. swainsonii* continued to dive at and harass the snake for several minutes before the snake fell from the tree and landed on a log a few meters from where we were standing. I could not tell whether the snake had lost its grip or whether it had been knocked off the tree by the *R. swainsonii*. The snake's head had blood on it, but it wasn't clear if its injuries were sustained from the fall, or from the toucans. The *P. poecilonotus* was momentarily stunned, and I grabbed it by the tail, whereupon it spread its neck and began striking at me. I released the *P. poecilonotus* at the capture site.

I could find no records in the literature of *P. poecilonotus* attempting to prey on *R. swainsonii* or any other toucan species. Further, foraging observations documented in the literature seem to indicate that *P. poecilonotus* is most often seen foraging in lower level vegetation (Willis, *op. cit.*), so seeing one attempting to predate a nest high in the canopy may represent an unusual event (D. Graham, pers. comm.). Alternatively, it may be that human observations of *P. poecilonotus* tend to be limited to lower vegetation, missing possible foraging by the snake at higher levels of the canopy.

I thank D. Graham for assistance.

Submitted by **DONALD LYMAN, JR.**, Biology Department, Merrimack College, North Andover, Massachusetts, 01845, USA; e-mail: donlyman@ix.netcom.com.

RHINOCHEILUS LECONTEI TESSELATUS (Texas Long-nosed Snake). **LONGEVITY.** On 25 June 1980, I collected a male *Rhinocheilus lecontei tesselatus* (ca. 260 mm SVL) at a public camping ground adjacent to the Pecos River (Jim White Campground, now Lake Carlsbad Recreation Area), Carlsbad, Eddy County, New Mexico. I maintained this animal in captivity until its death on 12 August 2007. From the time of its capture until August 1989, the snake was fed a diet of *Sceloporus occidentalis* (Western Fence Lizard), *Uta stansburiana* (Side-blotched Lizard), and *Eumeces skiltonianus* (Western Skink). Refused prey items included *S. occidentalis* eggs and subadult *Elgaria multicarinata* (Southern Alligator Lizard). From August 1989 until its death, the snake was fed weanling *Mus musculus* and neonate *Rattus nor-*

vegicus. At time of death, the snake measured 645 mm SVL and 105 mm tail length. The size at time of collection, indicates that it likely hatched in 1978 or earlier, making this snake at least 29 years old when it died. Previous records for this species (Slavens 1981. Inventory of Live Reptiles and Amphibians in North American Collections, Current January 1, 1981. Woodland Park Zoological Gardens, Seattle, Washington; Snider and Bowler 1992. Longevity of Reptiles and Amphibians in North American Collections, 2nd ed. Herpetol. Circ. 21) do not indicate a specimen older than 22 years. The specimen is deposited in the Texas Natural History Collections (TNHC 66571).

Submitted by **STEPHEN J. MULLIN**, Department of Biological Sciences, Eastern Illinois University, Charleston, Illinois 61920, USA; e-mail: sjmullin@eiu.eiu.

SIBON LONGIFRENIS (Drab Snail-eater). **REPRODUCTION.** The genus *Sibon* is one of four groups of neotropical snake specialized for foraging on snails, slugs, and also amphibian eggs (Montgomery et al. 2007. Herpetol. Rev. 38:343). *Sibon longifrenis* is a small nocturnal and arboreal species previously found in Honduras, Costa Rica, and Panama. In Costa Rica it inhabits undisturbed Atlantic Lowland Wet and Moist Forests, Premontane Wet Forests, and Rainforest. It is a seldom seen snake that inhabits deep shady forest (Leenders 2001. A Guide to the Reptiles and Amphibians of Costa Rica. Zona Tropical, Miami, Florida. 305 pp.; Savage 2002. Amphibians and Reptiles of Costa Rica. University Chicago Press, Chicago, Illinois. 934 pp.).

On 14 November 2002, while conducting transect-based surveys, I found a female *S. longifrenis* (288 mm SVL, 135 mm tail, 9.7 g) in the forests of Caño Palma Biological Station, Tortuguero, Limón Province. The snake was moving across a palm tree leaf (*Manicaria saccifera*) at a height of ca. 2 m in an area of wet primary swamp forest (25.4°C, 97%RH). I captured the snake and held it overnight in order to verify identification and measure it. During the night the snake laid two elongate, white eggs (10.0 x 26.1 mm, 1.24 g; 10.1 x 24.8 mm, 1.25 g) in a terrarium. After laying her eggs, the snake weighed 7.1 g. The eggs were placed inside a small terrarium in conditions intended to mimic natural circumstances. Unfortunately by 25 December 2002 both eggs had brown fungi on their surfaces and inspection revealed partially developed dead embryos inside.

Guyer and Donnelly (2005. Amphibians and Reptiles of La Selva, Costa Rica and the Caribbean Slope. University of California Press, Berkeley. 367 pp.) reported *S. longifrenis* as 'presumably an egg-layer.' To the best of my knowledge, this is the first report of clutch size in *S. longifrenis*. Egg-laying has been reported for only a handful of *Sibon* species, but all previously reported clutch sizes range from 2–9 eggs (Kofron 1987. J. Herpetol. 21:210–225; McCoy 1990. Carib. J. Sci. 26:162–166; Campbell 1998. Amphibians and Reptiles of Northern Guatemala, the Yucatan, and Belize. University of Oklahoma Press, Norman, Oklahoma. 380 pp.). November and December are wetter periods for the Tortuguero region and Caño Palma Biological Station receives most of its rainfall around this time.

I thank the Canadian Organization for Tropical Education and Rainforest Conservation, Ministerio de Recursos Naturales Energia y Minas, and Farnborough College of Science and Technology for permissions and assistance.

Submitted by **TODD R. LEWIS**, 4 Worgret Road, Wareham, Dorset, BH20 4PJ, United Kingdom; e-mail: biotropical@gawab.com.

THAMNOPHIS ATRATUS ATRATUS (Santa Cruz Gartersnake). **DIET**. The interaction between the newt *Taricha granulosa* and the gartersnake *Thamnophis sirtalis* provides a model system for the study of predator-prey coevolution (e.g., Brodie and Brodie 1999. Bioscience 49:557–568). Newts of the genus *Taricha* possess tetrodotoxin (TTX) in their skin and other tissues (Mosher et al. 1964. Science 144:1100–1110; Wakely et al. 1966. Toxicon 3:195–203), which acts as a powerful chemical defense against nearly all potential predators (Brodie 1968. Copeia 1968:307–313). Despite the fact that TTX is a potent neurotoxin, *T. sirtalis* in a number of California and Oregon populations prey on *T. granulosa* (Brodie and Brodie 1990. Evolution 44:651–659; Brodie and Brodie 1991. Evolution 45:221–224). In fact, concentrations of TTX in *T. granulosa* and levels of resistance in *T. sirtalis* generally covary over much of the West Coast in a pattern consistent with an evolutionary arms-race of adaptation and counter-adaptation (Brodie et al. 2002. Evolution 56:2067–2082; Hanifin et al. 2008. PLoS Biol. 6:e60). Until recently, this TTX-mediated coevolution was thought to include only two ecological partners, *T. sirtalis* and *T. granulosa*. However, a similar interaction between gartersnakes and newts was recently discovered in the Sierra Nevada Mountains of California; *T. couchii* prey on both *T. torosa* (Brodie et al. 2005. J. Chem. Ecol. 31:343–356) and *T. sierrae* (Wiseman and Pool 2007. Herpetol. Rev. 38:344–345) and are resistant to TTX at levels concordant with toxicity in sympatric *T. torosa* (Brodie et al. 2005, *op. cit.*). Here we detail a field observation of a *T. atratus* preying on a *T. granulosa*. Our report is significant because it is the first to document predation by *T. atratus* on metamorphosed *Taricha* in the wild, and hints at yet a third arms-race between gartersnakes and newts.

On 13 October 2006 at 1411 h, at Monte Bello Pond (MB05) in the Santa Cruz Mountains, Santa Clara County, California (37.32108°N, 122.18548°W; 576 m elev.), RRG observed an adult *T. atratus atratus* (~ 75 cm SVL) swim ashore with a subadult *T. granulosa* (~ 5 cm SVL) firmly held in its mouth (Fig. 1). The snake settled on the south edge of the pond, characterized by a gentle grade and only sparse vegetation, where it held the newt high off the substrate (~ 15 cm) but kept the majority of its own body anchored in the shallows. The snake gripped the newt through the midsection and proceeded to manipulate the prey deeper into its mouth. The newt struggled to free itself and appeared to exude a milky white liquid along its dorsal surface (glandular secretions including TTX; Cardall et al. 2004. Toxicon 44:933–938), but by 1414 h (3 min) the snake had already succeeded in swallowing the newt tail-first. The snake briefly rested (1 min) before turning back into the pond and slowly swimming away, apparently unaffected by its prey.

Taricha larvae have been reported in the diet of *T. atratus* (Fitch 1940. Univ. California Publ. Zool. 44:1–150; Fitch 1941. California Fish Game 27:2–32; Fox 1951. Univ. California Publ. Zool. 50:485–530; Kuchta 2005. *In* Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Populations

Fig. 1. An adult Santa Cruz Gartersnake (*Thamnophis atratus atratus*) consuming a subadult Rough-skinned Newt (*Taricha granulosa*) in Monte Bello Pond, Santa Clara County, California (MVZ 257750).

Vol. 2, pp. 904–908. Univ. California Press, Berkeley, California). However, newts possess little if any TTX before metamorphosis (Twitty and Johnson 1934. Science 80:78–79), so predation of newt larvae may occur commonly by sympatric gartersnakes and probably does not indicate physiological resistance to TTX. The only account that mentions consumption of transformed *Taricha* by *T. atratus* suggests this occurred in captivity and provides no information on the source of the specimens (Fox 1951, *op. cit.*). Even naïve gartersnakes that do not co-occur with some toxic amphibians will attempt to eat such deadly prey in the laboratory (e.g., Brodie at al. 1991. Biotropica 23:58–62), so captive observations are not especially revealing. Furthermore, because of extensive geographic variation in newt potency (Hanifin et al. 2008, *op. cit.*), locality information is critical in understanding the complex pattern of match and mismatch (hotspots and coldspots) between newt toxicity and TTX resistance across the landscape (Brodie et al. 2002, *op. cit.*). Our account of a natural predation event by *T. atratus* on a transformed *T. granulosa* suggests another parallel arms-race between gartersnakes and newts and could lead to a number of exciting evolutionary and ecological investigations. We hope other naturalists will continue to add pieces to this fascinating and unfolding coevolutionary puzzle (e.g., Fellers et al. 2007. Herpetol. Rev. 38:317–318).

We thank E. D. Brodie, Jr for verifying newt species, and C. L. Spencer for accessioning photo vouchers (MVZ 257749–257754).

Submitted by **RICHARD R. GREENE,** 221 Gladys Ave #7, Mountain View, California 94043, USA (e-mail: corvus@sbcglobal.net); and **CHRIS R. FELDMAN,** Department of Natural Resources & Environmental Science, University of Nevada, Reno, Nevada 89512, USA (e-mail: ophis@cabnr.unr.edu).

TROPIDOPHIS PAUCISQUAMIS (Brazilian Dwarf Boa). **DIET AND CAUDAL LURING**. *Tropidophis paucisquamis* is a semi-arboreal snake typically found in bromeliads in the Atlantic forests of Brazil (Carvalho 1951. Rev. Bras. Biol. 11:239–248).

However, basic aspects of its biology remain unknown, since it is rarely observed and specimens are rare in collections (Amaral 1930. Bol. Mus. Nac. 4; Hedges 2002. Bull. Nat. Hist. Mus. Lond. [Zool.] 68:83–90). Feeding and behavioral information are restricted to captive specimens or are speculative (Amaral 1978. Serpentes do Brasil: Iconografia Colorida. Brazilian Snakes: a Color Iconography. Melhoramentos/EDUSP, São Paulo, Brazil; Carvalho, *op. cit.*). Here, we present the first report of feeding and tail displays by two wild *T. paucisquamis* recorded on the same night and location.

On 17 December 2004 at 2030 h at Pilar do Sul Municipality, São Paulo State, Brazil (23.93ºS, 47.67ºW, 780 m elev.) we watched as an adult *T. paucisquamis* (315 mm SVL, 42 mm tail length) left the shelter of a leaf (*Bathyza* sp., ca. 1.5 m above ground) and defecated. The snake stayed perched and immobile we collected it at 0230 h on 18 December 2004. Upon collection, the snake regurgitated a *Hypsiboas caipora* (33 mm SVL, 2.5 g) which it had swallowed headfirst. It was raining and the air temperature was 18–19°C. The following day the snake was found coiled in a ball. The snake was photographed and released and the treefrog (CFBH 9336) was deposited in Célio Fernando Baptista Haddad collection, Laboratório de Herpetologia, Instituto de Biociências, Universidade Estadual Paulista, Rio Claro, São Paulo State, Brazil.

A second snake was foraging a few m away and we observed it from 2000 h on 17 December 2004 until 0230 h on 18 December 2004. This snake stopped on two occasions and lured with its tail. On the first occasion, the snake was stretched out on a leaf of *Calathea communis* (Marantaceae), except for the tail, which was elevated and undulated in a sinusoidal manner for ca. one minute. On the second occasion, the body was again stretched out. However, in this case the sinusoidal undulations of the tail were made while the tail was in contact with the plant stem, and the tail was dragged along the stem for ca. 30 seconds. In both cases tail movements were made from a stationary position and in the presence of two male *Hypsiboas caipora* (ca. 3 m from the snake). The contrasting color of the tail (with the body) and the observations of tail displays in the presence of prey by *T. paucisquamis* indicate that the species uses its tail as a lure, although additional observations are necessary to confirm this hypothesis.

Submitted by **ANDRÉ PINASSI ANTUNES** (e-mail: aapardalis@gmail.com) and **CÉLIO FERNANDO BAPTISTA HADDAD**, Laboratório de Herpetologia, Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista, 1515, Rio Claro, 13506-900, São Paulo, Brazil.

TYPHLOPS BRONGERSMIANUS (Blindsnake). **OWL PREDATION**. *Typhlops brongersmianus* is relatively small (ca. 300 mm total length as adults) and occurs from Uruguay to Venezuela (Lema 1982. Iheringia 61:3–7.; Lema 1987. Acta Biologica Leopoldensia 9:225–240). The fossorial *T. brongersmianus* occurs in different enviroments, but primarily in sandy soils. In this habitat, it feeds on small terrestrial invertebrates (Freitas 2003. Serpentes Brasileiras. Bahia, Brazil. 119 pp.).

On 3 February 2007, I encountered a road-killed adult (sex not determined) Tropical Screech Owl (*Megascops choliba*) south of Rodovia do Sol at kilometer 32 on route ES 060. The area around

kilometer 32 is transitional between salt marsh and mangroves (Venturini et al. 1996. Aves e Mamíferos na Restinga Parque Estadual Paulo César Vinha Setiba. Guarapari, Espírito Santo. Secretaria de Estado do Desenvolvimento Sustentável. Governo do Estado do Espírito Santo, Vitória). During examination of the stomach contents of the owl on 7 November 2007, I found an adult male *T. brongersmianus* severed into two pieces. The anterior piece was 6.8 mm long, whereas the posterior one was 8.3 mm. Besides the *T. brongersmianus*, the stomach also contained two leptodactylid frogs (not further identifiable because of the degree of digestion), 14 ants, and two orthopterans.

Megascops choliba, a small (97–134 g) crepuscular owl, inhabits open habitats such as forest edges, Cerrado, rural fields, and some-times urban localities. It feeds on insects, especially orthopterans and beetles, and may also capture small rodents, snakes, lizards, and anurans (Motta-Junior 2002. J. Raptor Res. 36:332–334; Sick 1997. Ornitologia Brasileira. Ed. Nova Fronteira, Rio de Janeiro, Brazil. 862 pp.). Among the seven stomachs of *M. choliba* ana-lyzed, only one had vertebrate prey. This is the first record of *T. brongersmianus* in the diet of *M. choliba*.

The *T. brongersmianus* specimen (MBML 2203) was deposited in the Herpetological Collection of the Museu de Biologia Prof. "Mello Leitão." I thank Concessionária Rodosol S.A. for permits, Flávia Araújo for help in analysis, Thiago Maciel de Castro for species identification, Gustavo Machado Prado for valuable sug-gestions on the manuscript, and Luisa Maria Sarmento Soares for English translation.

Submitted by **MIKAEL MANSUR MARTINELLI**, Setor de Zoologia, Museu de Biologia Prof. "Mello Leitão," Avenida José Ruschi, 4, CEP 29650-000, Santa Teresa, Espírito Santo, Brazil; e-mail: mansurmartinelli@yahoo.com.br.

VIRGINIA PULCHRA (Mountain Earth Snake). **LONGEVITY, REPRODUCTION, AND GROWTH.** Longevity and growth data are lacking for *Virginia pulchra* (Ernst and Ernst 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C.; Slavens and Slavens 1997. Reptiles and Amphibians in Captivity: Breeding, Longevity, and Inventory Current January 1, 1996. Slaveware, Seattle, Washington; Snider and Bowler 1992. Longevity of Reptiles and Amphibians in North American Collections. 2nd ed. SSAR Herpetol. Circ. No. 21). Herein I report, to my knowledge, the first longevity record for *V. pulchra* as well as observations on reproduction and growth.

On 4 June 2004 a gravid female *V. pulchra* (225 mm SVL; 265 mm total length; 10 g) was found under rocks, on a sparsely veg-etated slope at State Game Land 86, Warren County, Pennsylvania, USA. The snake was maintained in captivity and produced a lit-ter of five young on 9 August 2004. This date is earlier than the earliest parturition date of 18 August observed by Pisani (1971. J. Herpetol. 5:207–208). All neonates were female, 88–93 mm total length, and the litter totaled 2.75 g (34.4% of female's postpartum mass). Richmond (1954. Ann. Carnegie Mus. 33:251–260) also reported an all-female litter born to a captive female *Virginia* sp. Furthermore, Bothner and Moore (1964. Copeia 1964:709–710) noted two of nine litters that contained skewed sex ratios (7 F:1M; 5F:1M). On 14 July 2007, after 3 years, 1 month, and 10 days in captivity the specimen was found dead in her enclosure. During

that time, she had increased in length by 13.3% (255 mm SVL, 300 mm total length) and weighed 11 g. Because this species matures during its second year (Ernst and Ernst 2003, *op. cit*.), it is reasonable to assume that this snake was at least five years old at the time of its death.

The specimen (TREC R-025) is deposited in the collection of the Tom Ridge Environmental Center, Erie, Pennsylvania. A shed skin (MHP 11835) obtained from the specimen is deposited in the Sternberg Museum of Natural History, Fort Hays University, Lawrence, Kansas.

I thank J. Beane, J. Collins, and M. Lethaby for assistance.

Submitted by **BRIAN S. GRAY**, 1217 Clifton Drive, Erie, Pennsylvania 16505, USA; e-mail: brachystoma@hotmail.com.

ZAOCYS DHUMNADES (Big-Eye Rat Snake). **DIET.** *Zaocys dhumnades* is a large diurnal snake from China and Taiwan that has been reported to eat amphibians, rodents, small fish, and lizards (Kuntz 1963. Snakes of Taiwan. Quart. J. Taiwan Mus. 16:15–17; Zhou and Jiang 2004. Cons. Biol. 18:1386–1394).

On 9 May 2007, a DOR male *Z. dhumnades* (1206 mm SVL, 599 mm tail length, 526 g) was found on the roadside, where it appeared to have been trapped on the road by a barrier in the Ilan section of the North Crossroad, Taiwan (24.6439ºN, 121.5119ºE, 600 m elev.). A partially digested female *Buergeria robustus* (Brown Treefrog) was protruding from the snake. According to previous dietary records, *Z. dhumnades* preys mainly on lentic anurans (e.g., *Bufo* or *Rana*; Pope 1935. Natural History of Central Asia. Volume X: The Reptiles of China. American Museum of Natural History, New York). *Buergeria robustus* typically inhabit trees and can be found up to 7 m above ground (Hou and Kuo 1996. Notes and Newsletter of Wildlifers 4:6–7). However, during the breeding season (late April–early June) they aggregate along mountain creek banks at elevations below 1000 m. *Trimeresurus stejnegeri* has been observed to use these localities as ambush sites (JJM, unpubl. obs.). Our observations suggest that seasonal breeding aggregations of some arboreal frogs on the ground provide an occasional food source for opportunistic ophidian predators. We believe this to be the first reported instance of *Z. dhumnades* predation on *B. robustus*.

Submitted by **JEAN-JAY MAO** (e-mail: jjmao@niu.edu.tw) and **WUN-BIN KUNG,** Department of Natural Resources, Na-tional Ilan University. No. 1, Sec. 1, Shen-Lung Rd., Ilan, Taiwan 260; and **GERRUT NORVAL**, Applied Behavioural Ecology & Ecosystem Research Unit, Department of Nature Conservation, UNISA, Private Bag X6, Florida, 1710, Republic of South Af-rica.

GEOGRAPHIC DISTRIBUTION

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

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

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

Please submit any geographic distribution records in the **standard format only** to one of the Section Co-editors: **Alan M. Richmond** (USA & Canada records only); **Jerry D. Johnson** (Mexico and Central America, including the Caribbean Basin); **Indraneil Das** (all Old World records); or **Gustavo J. Scrocchi** (South American records). Short manuscripts are discouraged, and are only acceptable when data cannot be presented adequately in the standard format. **Electronic submission of manuscripts is required** (as Microsoft Word or Rich Text format [rtf] files, as e-mail attachments)**.** Refer to inside front cover for e-mail addresses of section editors.

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

CAUDATA – SALAMANDERS

AMBYSTOMA TIGRINUM (Eastern Tiger Salamander). USA: INDIANA: Pike Co.: Madison Township: ca. 0.4 km W of Bowman on Hwy 56 (38.48867ºN, 87.35124ºW, NAD 83). 31 March 2008. Nathan Engbrecht. Verified by Chris Phillips. Photo voucher in Illinois Natural History Survey (INHS 2008.d). Adult female found on road at night. New county record (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Acad. Sci. 404 pp.)

Submitted by **NATHAN ENGBRECHT** (e-mail: nengbrecht@dnr.in.gov), **ANGIE GARCIA, BETHANY GEBOY,** and **ZACK WALKER**, Wildlife Diversity Section, Indiana Department of Natural Resources Division of Fish and Wildlife, 553 E. Miller Drive, Bloomington, Indiana 47401, USA.

EURYCEA BISLINEATA (Northern Two-lined Salamander). USA: MICHIGAN: Tuscola Co.: Murphy Lake State Game Area (43.2813291°N, 83.45363036°W). 12 April 2008. Nicole Soderberg, Ernest Szuch, and Teresa Yoder. Verified by James Harding. University of Michigan Museum of Zoology (UMMZ i7, photo voucher). Individual was gravid; therefore, she was photographed and released at site of capture. Three additional specimens were recorded from Tuscola County; UMMZ i10, i11, i12, i13 photo vouchers; UMMZ i1, i2; photo vouchers and UMMZ 239001. First state record (Petranka 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 587 pp.).

Submitted by **NICOLE SODERBERG**, **TERESA YODER,** and **ERNEST SZUCH**, Department of Biology, University of Michigan-Flint, Flint, Michigan 48502-1950, USA.

HEMIDACTYLIUM SCUTATUM (Four-toed Salamander). USA: MARYLAND: Somerset Co.: 5.0 km W of Princess Anne off Pine Pole Rd. (38.21102°N, 75.74951°W; WGS 84). 18 April 2008. Nathan H. Nazdrowicz. Verified by Traci Hartsell. USNM 565980. One female found under sphagnum moss around a clutch of 28 eggs, and one unattended clutch of eggs observed in a semi-open canopy, grassy wetland. New county record (White and White 2007. Amphibians and Reptiles of Delmarva. Revised ed. Tidewater Publishers, Centreville, Maryland. 243 pp.).

Submitted by **NATHAN H. NAZDROWICZ**, Department of Entomology and Wildlife Ecology, University of Delaware, Newark, Delaware 19716, USA; e-mail: spinifer@aol.com.

NECTURUS MACULOSUS LOUISIANENSIS (Red River Mudpuppy). USA: OKLAHOMA: McCurtain Co.: N side of Forest Road 53000 at Glover River (34.1009°N, 94.5445°W). 25 November 2008. P. Taggart. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ photographic voucher 31277). New county record; known previously from adjacent LeFlore and seven other eastern Oklahoma counties [Sam Noble Oklahoma Museum of Natural History, Division of Herpetology, Amphibians Database, http://129.15.20.101/collections-research/db/FMPro). Has also been reported immediately eastward from adjacent Little River and Sevier counties, Arkansas (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail: drctmcallister@aol.com); **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@suddenlink.net); **DAVID ARBOUR**, De Queen, Arkansas 71832, USA (e-mail: arbour@windstream.net); and **ROBERT BASTARACHE**, Okla-

homa Ranger District-Ouachita National Forest, Route 4, Box 2900, Broken Bow, Oklahoma 74728, USA (e-mail: rbastarache@fs.fed. us).

ANURA – FROGS

ACRIS CREPITANS (Northern Cricket Frog). USA: TENNESSEE: Rhea Co.: East side of Broyles Branch, 0.25 km downstream from Blythe Ferry Road, Dayton (35.4847667°N, 85.01695°W; WGS84). 12 October 2008. David Hedrick. Austin Peay State University Museum of Zoology (APSU 18942, color photo). Verified by A. Floyd Scott. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 11 November 2008] including links to data on amphibians in Tennessee having appeared since 1996).

Submitted by **DAVID HEDRICK**, 207 Hillcrest Avenue, Chattanooga, Tennessee 37411, USA; e-mail: d.hedrick@hotmail.com.

CERATOPHRYS JOAZEIRENSIS. BRAZIL: PERNAMBUCO: Municipality of Triunfo: Café do Brejo (07.83819°S, 38.10183S°W, WGS 84), 1004 m elev.). 14 April 2008. E. Maranhão dos Santos, G. Limeira da Silva, T. Freitas Campos, and A. M. Siqueira Quirino. Coleção Herpetologica da Universidade Federal Rural de Pernambuco, Unidade Acadêmica de Serra Talhada, Serra Talhada, Pernambuco, Brazil (CHUFRPE 902 adult specimen SVL 69.4 mm). Verified by M. Trefault Rodrigues. Previously known from Juazeiro municipality (type locality), Bahia (Mercadal 1986. Amphibia-Reptilia 7[4]:313–334); Araruna municipality, Paraiba, and Passa and Fica, Rio Grande do Norte (Vieira et al. 2006. Check List 2:28–29). First state record, fills the distributional gap and extends the known distribution 317 km NE from type locality and 299 km from Araruna municipality.

Submitted by **EDNILZA MARANHÃO DOS SANTOS**, Unidade Acadêmica de Serra Talhada, Universidade Federal Rural de Pernambuco, 56900-000, Serra Talhada, PE, Brazil; **GEANE LIMEIRA DA SILVA, THAMIRES FREITAS CAMPO & ANA MARIA SIQUEIRA QUIRINO**, Unidade Acadêmica de Serra Talhada, Universidade Federal Rural de Pernambuco, 56900-000, Recife, PE, Brazil.

CHIASMOCLEIS CARVALHOI (Central Humming Frog). BRAZIL: ESPÍRITO SANTO STATE: Setiba, Municipality of Guarapari (20.601900°S, 40.429192°W, 2 m elev., datum: Córrego Alegre). July 2004. T. Silva-Soares. Amphibian Collection, Universidade Federal do Rio de Janeiro, Departamento de Zoologia, Rio de Janeiro (ZUFRJ 9894–9899 five males, one female with eggs). Verified by C. A. Gonçalves da Cruz. Previously known only from Brazil, in the states of São Paulo, Rio de Janeiro, and Bahia, (Cruz et al. 1997. Alytes 15[2]:49–71; Pimenta et al. 2002. Herpetol. Rev. 33:219). First state record extends range ca. 360 km N from Magé municipality, Rio de Janeiro state (Cruz et al., *op. cit.*) and ca. 608 km S from Una municipality, Bahia state (Pimenta et al., *op. cit.*).

Submitted by **THIAGO SILVA-SOARES** (e-mail: thiagossoares@ufrj.br) and **PAULO NOGUEIRA DAS COSTAS** (e-mail: nogpj@yahoo.com.br), Universidade Federal do Rio de Janeiro, Departamento de Zoologia, Lab. de Anfíbios e Répteis, Caixa postal 68.044, CEP 21944-970, Cidade Universitária, Rio de Janeiro, Brazil; and **RODRIGO BARBOSA FERREIRA**, Museu de Biologia Mello Leitão, Av. José Ruschi, Nº 4, CEP 29.650-000, Santa Teresa, Espírito Santo, Brazil (e-mail: rodrigoecologia@yahoo.com.br).

CRAUGASTOR COFFEUS (Coffee Rain Frog). HONDURAS: CORTÉS: Sierra de Omoa: Parque Nacional El Cusuco, Santo Tomas Village (15.561111°N, 88.291667°W; WGS84), 674 m elev. 20 June 2007. Jonathan E. Kolby. Verified by Larry D. Wilson. USNM Herp Images 2689–2696 (one specimen). New department record and a ca. 100 km range extension NE of the type locality in Copan, Honduras, which is the only other viable population of this species known to exist (McCranie and Wilson 2002. The Amphibians of Honduras. SSAR Contr. Herpetol. 19: x + 625 pp.). The adult frog was found under a log in wet broadleaf forest ca. 2 km from approaching agricultural clearing activities.

Submitted by **JONATHAN E. KOLBY**, The Conservation Agency, 6 Swinburne Street, Jamestown, Rhode Island 02835, USA; e-mail: j_kolby@hotmail.com.

ELEUTHERODACTYLUS CYSTIGNATHOIDES (Rio Grande Chirping Frog). USA: TEXAS: Dallas Co.: Dallas, Great Trinity Forest southeast of downtown Dallas. 28 April 2008. Verified by Corey E. Roelke. Amphibian and Reptile Diversity Research Center at the University of Texas Arlington. UTA A-58153. New county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **CARL J. FRANKLIN** (e-mail: Franklin@uta. edu) and **ERICK A. P. CATALÁN**, Amphibian and Reptile Diversity Research Center at the University of Texas Arlington, 501 S. Nedderman, Arlington, Texas 76019, USA.

GASTROPHRYNE CAROLINENSIS (Eastern Narrow-mouthed Toad). USA: ALABAMA: Chilton Co.: 6.3 km S of CR 25 on CR 73 (33.01960°N, 87.52418°W; WGS84). 01 October 2007. J. Burling and J. Wicknick. Verified by Joseph R. Mendelson III. University of Montevallo Collection of Vertebrates (UMCV-AA0075). County record; fills a gap among Shelby, Bibb, and Perry counties and the Coosa River (Mount 1975. The Reptiles and Amphibians of Alabama. The University of Alabama Press, Tuscaloosa, 347 pp.). The Auburn University Museum Reptile and Amphibian collection contains one Chilton County specimen, unpublished to our knowledge and not listed on HerpNet, AUM 3398 collected on 20 June 1963 (online database accessed 19 September 2008 (http://www.auburn.edu/cosam/collections/reptiles_amphibians/index.htm#holdings). Collection made under Alabama Department of Conservation and Natural Resources collecting permit 4368 (JAW).

Submitted by **JILL A. WICKNICK**[1] and **JOHN W. BURLING**[2], Departments of Biology[1] and Psychology[2], University of Montevallo, Montevallo, Alabama 35115, USA (e-mail: wicknickja@montevallo.edu).

HYLA CINEREA (Green Treefrog). USA: ARKANSAS: Dallas Co.: roadside ditch off St. Hwy 8 in Manning (34.011120°N, 92.472411°W; NAD83). 05 June 1997. T. R. Davis. Verified by S. E. Trauth. Arkansas State University Herpetological Museum

(ASUMZ 31274). New county record filling a distributional gap between Cleveland (Robison and McAllister 2007. Herpetol. Rev. 38:245–246) and Clark counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.).

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail: drctmcallister@aol.com); and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA; e-mail: hwrobison@suddenlink.net.

HYLA GRATIOSA (Barking Treefrog). USA: TENNESSEE: Gibson Co.: Milan Army Ammunition Plant (35.8675°N, 88.7331°W). 08 October 2008. Eric Johansen, Nathan Parker, Seth McCormick, and Nathalie Smith. Verified by A. Floyd Scott. David H. Snyder Museum of Zoology, Austin Peay State University (APSU 18943 [juvenile] and APSU 18944 [metamorph]). Collected in fishless pond at 1100 h. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet [http://www.apsu.edu/amatlas/] versions, the latter accessed 02 June 2008).

Submitted by **ERIC PAUL JOHANSEN** (e-mail: ejohansen14@apsu.edu), **NATHALIE SMTIH**, and **SETH McCORMICK**, Department of Biology and Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee 37044, USA.

HYLA WRIGHTORUM (Arizona Treefrog). MEXICO: SONORA: Los Fresnos Ciénega, ca. 44 km NW Cananea (31.30845⁰N, 110.42915⁰W), 1534 m elev. 25 August 1990. Peter L. Warren. Verified by T. C. Brennan. Arizona State University voucher photograph (ASU HP.59). Northernmost record for this species in Sonora and a 235 km NNW range extension from the closest record at El Chorro, 8 km NE of Nacori Chico, Sonora (UAZ 45595), although the closest out-of-country record is ca. 13 km N in Arizona (Gergus et al. 2004. Copeia 2004:758–769). A locality dot pictured on a map in Duellman (2001. Hylid Frogs of Middle America, Vol. 2. SSAR Contrib. to Herpetol. 18:i–x, 695–1159), which appears close to Los Fresnos Ciénega, was an apparent misplacement for a record from Yécora, Sonora (W. E. Duellman, pers. comm.). Additional individuals were observed by us during August and October 2006 in surrounding wetlands situated within the grassland ecosystem characteristic of the Los Fresnos Ciénega region. Typical habitat for this species was reported to be in meadows or slow-moving streams within pine-oak and pine-fir forest (Gergus et al. 2005. *In* M. J. Lannoo [ed.], Amphibian Declines: The Conservation Status of United States Species, pp. 461–463. University of California Press, Berkeley).

Submitted by **BARUK G. MALDONADO LEAL**, Biodiversidad y Desarrollo Armónica, Calle Guadalupe Victoria #46 Int. 5 entre Veracruz y Tamaulipas, Col. Benito C.P., Hermosillo, Sonora, Mexico, 83190 (e-mail: baruk23@gmail.com); **PETER L. WARREN,** The Nature Conservancy, 1510 E Fort Lowell Rd, Tucson, Arizona 85719, USA (e-mail: PWarren@tnc.org); **THOMAS R. JONES** and **VALERIE L. BOYARSKI**, Arizona Game and Fish Department, 5000 West Carefree Highway, Phoenix, Arizona 85086, USA (e-mail: TJones@azgfd.gov; VBoyarski@azgfd.gov); and **JAMES C. RORABAUGH**, U.S. Fish and Wildlife Service, 201 N. Bonita Ave., Suite 141, Tucson, Arizona 85745, USA (e-mail: Jim_Rorabaugh@fws.gov).

INCILIUS MELANOCHLORUS (Wet Forest Toad). PANAMÁ: BOCAS DEL TORO: Distrito de Changuinola: Quebrada Caña de Laosa, El Guayabal, Río Changuinola (09.2075°N, 82.48023°W; WGS84), 164 m elev. 11 June 2007. César A. Jaramillo A., Andrew J. Crawford, Fidel E. Jaramillo A., Daniel Medina, Jhoana De Alba, and Eladio Quintero. Museo de Vertebrados de la Universidad de Panamá (MVUP 2041). Trail to Changuinola Arriba, Río Changuinola (09.19798°N, 82.47188°W; WGS84), 119 m elev. 12 June 2007. César A. Jaramillo A., Fidel E. Jaramillo A., Daniel Medina, Jhoana De Alba, and Eladio Quintero. Círculo Herpetológico de Panamá (CH 6222, 6225). Cerro Alto, El Guayabal, Río Changuinola (9.208051°N, 82.473504°W; WGS84), 165 m elev. 14 June 2007. César A. Jaramillo A., Fidel E. Jaramillo A., Daniel Medina, Jhoana De Alba, and Eladio Quintero. CH 6258. All specimens verified by Jay M. Savage. These specimens represent the first records for Panamá, extending the geographic range ca. 81 km (airline) SE of the nearest locality in Costa Rica (Savage 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas. University of Chicago Press, Chicago, Illinois. xx + 934 pp.). To view photographs of of all live specimens visit the Smithsonian Tropical Research Institute - Digital File Manager at http://biogeodb.stri.si.edu/bioinformatics/dfm. We thank the MWH company for field support.

Submitted by **CÉSAR A. JARAMILLO A.**[1,2,3] (e-mail: jaramilc@si.edu), **ANDREW J. CRAWFORD**[1,3], and **ROBERTO IBÁÑEZ D.**[1,3,4], [1]Smithsonian Tropical Research Institute, Apartado 0843-03092, Balboa, Ancón Panamá, República de Panamá; [2]Departamento de Histología y Neuroanatomía Humana, Facultad de Medicina, Universidad de Panamá, Panamá, Rep. de Panamá; [3] Círculo Herpetológico de Panamá, Apartado 0824-00122, Panamá, Rep. de Panamá; [4]Departamento de Zoología, Universidad de Panamá, Panamá, Rep. de Panamá.

ISCHNOCNEMA OEA (Espírito Santo Robber Frog). BRAZIL: RIO DE JANEIRO: Sophronitis Farm, River of the Flowers headwaters, Macaé de Cima, Municipality of Nova Friburgo (22.391378ºS, 42.477525ºW, 935 m elev., datum: Córrego Alegre). 20 April 1989. S. Lucena Mendes. Zoology Collection, Museu de Biologia Mello Leitão, Espírito Santo (MBML 212). Verified by J. P. Pombal Jr. and C. A. Gonçalves da Cruz. Previously known only from the type locality, Municipality of Santa Teresa, Espírito Santo, Brazil (Heyer 1984. Smithson. Contrib. Zool. 402:1–42). First state record and first record outside of the type locality, extending range ca. 335 km NW from Santa Teresa Municipality, Espírito Santo.

Submitted by **THIAGO SILVA-SOARES**, Universidade Federal do Rio de Janeiro, Departamento de Zoologia, Lab. de Anfíbios e Répteis, Caixa postal 68.044, CEP 21944-970, Cidade Universitária, Rio de Janeiro, Brazil (e-mail: thiagossoares@ufrj.br); **RODRIGO BARBOSA FERREIRA**, Museu de Biologia Mello Leitão. Av. José Ruschi, Nº 4, CEP 29.650-000, Santa Teresa – Espírito Santo, Brazil (e-mail: rodrigoecologia@yahoo.com.br); and **PAULO NOGUEIRA DAS COSTAS**, Universidade Federal do Rio de Janeiro, Departamento de Zoologia, Lab. de Anfíbios e

Répteis, Caixa postal 68.044, CEP 21944-970, Cidade Universi-tária, Rio de Janeiro, Brazil (e-mail: nogpj@yahoo.com.br).

LITHOBATES CATESBEIANUS (American Bullfrog). USA: TENNESSEE: Jefferson Co.: 12.7 km W of Jefferson City (36.1084°N, 83.6247°W). 11 July 2008. Ted M. Faust. Verified by Floyd A. Scott. Austin Peay State University Museum of Zoology (APSU 18933 [color photo]). This individual was found in a small pool of standing water in a culvert. The air temp was 30.3°C at 1625 h. Four more individuals were found nearby. All individuals were juveniles. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 09 September 2008] including links to data on amphibians in Tennessee that have appeared since 1996.

Submitted by **TED M. FAUST**, 11828 Couch Mill Road, Knoxville, Tennessee 37932, USA; e-mail: tmfaust21@gmail.com.

LITHOBATES CLAMITANS MELANOTA (Northern Green Frog). USA: TENNESSEE: Jefferson Co.: 12.7 km W of Jefferson City (36.1061°N, 83.6246°W). 12 July 2008. Ted M. Faust. Verified by Floyd A. Scott. Austin Peay State University Museum of Zoology (APSU 18932 [color photo]). Three individuals were found at 1110 h in a small stream that was not flowing. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 09 September 2008] including links to data on amphibians in Tennessee that have appeared since 1996).

Submitted by **TED M. FAUST**, 11828 Couch Mill Road, Knoxville, Tennessee 37932, USA; e-mail: tmfaust21@gmail.com.

OLLOTIS NEBULIFER (Gulf Coast Toad). USA: TEXAS: Tom Green Co.: Private residence along USH87 (31.4178333°N, 100.4388333°W). 1838 ft elev. 25 September 2007. M. S. Price and N. M. Price. Verified by Travis LaDuc. Texas Natural History Collection (TNHC 68557, photo voucher). New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.)

Submitted by **MICHAEL S. PRICE,** San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

PSEUDACRIS FOUQUETTEI (Cajun Chorus Frog). USA: ARKANSAS: Howard Co.: roadside ditch off US 278 in Umpire (34.192672°N, 94.064072°N; NAD83). 20 March 1987. W. Cox. Verified by S. E. Trauth. Arkansas State University Herpetological Museum (ASUMZ 31275). New county record completely filling a distributional gap in southwestern Arkansas between Sevier and Pike counties (Trauth et al. 2004. Amphibians and Reptiles of Arkansas. Univ. Arkansas Press, Fayetteville. 421 pp.). We follow the recent taxonomic suggestions of Lemmon et al. (2008. Zootaxa 1675:1–30) for Arkansas chorus frogs (formerly *P. feriarum*).

Submitted by **CHRIS T. McALLISTER**, RapidWrite, 102 Brown Street, Hot Springs National Park, Arkansas 71913, USA (e-mail: drctmcallister@aol.com); and **HENRY W. ROBISON**, Department of Biology, Southern Arkansas University, Magnolia, Arkansas 71754, USA (e-mail: hwrobison@suddenlink.net).

PRISTIMANTIS ASHKAPARA (NCN). BOLIVIA: DEPARTMENT SANTA CRUZ: Manuel Maria Caballero Province: Abra de la Cruz (17.8566°S, 64.3616°W; 2360 m elev.), Amboró National Park. 12 December 2007. D. Ramos. Threatened species, observed and photographed climbing 2 m high at a rocky wall almost completely covered by moss, adjacent to a small stream, around midnight, at 13.5°C air temperature; photograph deposited in Museo de Historia Natural Noel Kempff Mercado (MNKA-F 120), Santa Cruz, Bolivia. Verified by J. Köhler. Previously known only from the type locality, Department Cochabamba, Chapare Province, ca. 47 km on the "old" road from Paractito via El Palmar to Cochabamba, 17.1327778°S, 65.615°W; 2100 m elev. (Köhler 2000. Copeia 2000:516–520). First department record extends known distribution 155 km SE from the known locality in Parque Nacional Carrasco; also extends maximum known elevational distribution for 200 m.

Submitted by **DANIEL RAMOS GUTIERREZ** (e-mail: daniel_ramosg@yahoo.com) and **LUCINDO GONZALES ALVAREZ** (e-mail: bichos10@hotmail.com), Museo de Historia Natural Noel Kempff Mercado, Casilla postal 2489, Santa Cruz-Bolivia.

SCAPHIOPUS HOLBROOKII (Eastern Spadefoot). USA: INDIANA: Gibson Co.: White River Township: ca. 0.5 km W of Highway 41 on County Road 350 (38.40626°N, 87.60250°W; NAD 83, Zone 16). 31 March 2008. Nathan Engbrecht. Illinois Natural History Survey (INHS 2008.b photo voucher). New county record for the state of Indiana. Female found on road at night. Males were heard chorusing in a nearby field. Pike Co.: Madison Township: ca. 0.6 km E of Bowman (38.49646°N, 87.34070°W; NAD 83, Zone 16). 01 April 2008. Nathan Engbrecht. INHS 2008.c photo voucher. Adult male found on road at night. Specimens verified by Chris Phillips. Both are new county records that partially fill a gap in the known distribution of this species in southwest Indiana (Minton 2001. Amphibians and Reptiles of Indiana. 2nd ed., revised. Indiana Acad. Sci. 404 pp.).

Submitted by **NATHAN ENGBRECHT** (e-mail: nengbrecht@dnr.in.gov), **ANGIE GARCIA**, **BETHANY GEBOY,** and **ZACK WALKER**, Wildlife Diversity Section, Indiana Department of Natural Resources Division of Fish and Wildlife, 553 E. Miller Drive, Bloomington, Indiana 47401, USA.

SCAPHIOPUS HOLBROOKII (Eastern Spadefoot). USA: TENNESSEE: Hamilton Co.: Back yard of 8308 Pine Ridge Road, Ooltewah, Tennessee. (35.0396833°N, 85.0948°W; WGS84). 05 November 2003. David Hedrick. Austin Peay State University Museum of Zoology (APSU 18941, color photo). Verified by A. Floyd Scott. Individual found alive, submerged in a water dish. New county record (Redmond and Scott 1996. Atlas of Amphibians in Tennessee. Misc. Publ. No. 12, The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. 94 pp. Hard copy and Internet versions, the latter [http://www.apsu.edu/amatlas/ accessed 03 November 2008] including links to data on amphibians in Tennessee having appeared since 1996).

Submitted by **DAVID HEDRICK**, 207 Hillcrest Avenue, Chattanooga, Tennessee 37411, USA; e-mail: d.hedrick@hotmail.com.

SCINAX FUSCOMARGINATUS (Brown-bordered Snouted Tree-frog). BRAZIL: PIAUÍ: Piracuruca (03.978ºS, 41.556ºW; datum SAD69). April 2007. B. B. Annunziata, I. S. Castro, and W. M. Fontenele. Verified by D. Silvano and P. Valdujo. Herpetological Collection of Universidade Estadual do Piauí, Parnaíba (UESPI 0040, 0063, 0064, 0069, 0077). This species occurs in southern, central, and eastern Brazil, eastern Bolivia, Paraguay, and north-western Argentina (Frost 2008 Amphibian Species of the World. http://research.amnh.org/herpetology/amphibia/index.php). First state record, extends distribution ca. 881 km S from the city of Mateiros, Tocantins state (Vitt et al. 2002. Sam Noble Oklahoma Museum of Natural History 1:1–17), ca. 651 km SW from the city of Açailândia, Maranhão state (Brasileiro et al. 2008. Check List 4[2]:185–197), and ca. 920 km SE from Chapada Diamantina, Bahia state (Juncá 2005. Biodiversidade da Chapada Diamantina, BA. 1ª ed. 436 pp.).

Submitted by **BRUNO B. ANNUNZIATA**, Departamento de Zoologia, Coleção Herpetológica, Universidade de Brasília (UnB), CEP 70.855-160, Brasília, Distrito Federal, Brazil; **IRISMAR S. CASTRO**, Departamento de Biologia, Universidade Estadual do Piauí (UESPI), CEP 64.202-220, Parnaíba, Piauí, Brazil; and **WOLNEY M. FONTENELE**, Departamento de Biologia, Universidade Estadual do Piauí (UESPI), CEP 64.202-220, Parnaíba, Piauí, Brazil (e-mail: barcellos.ba@gmail.com).

SPEA MULTIPLICATA (Mexican Spadefoot). USA: TEXAS: Irion Co.: 0.1 rd mi E jct of TX SH 163 on TX SH 67 (31.1293167ºN, 101.16945ºW). 2562 ft elev. 20 September 2007. M. S. Price, N. M. Price, S. G. Price, and N. R. Price. Verified by Travis J. LaDuc. Texas Natural History Collection (TNHC 66566). New county record, filling distributional gap (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL S. PRICE,** San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

CROCODILIA – CROCODILIANS

ALLIGATOR MISSISSIPIENSIS (American Alligator). USA: TEXAS: Tarrant Co.: Fort Worth Nature Center. Near secondary spillway for Eagle Mountain Lake. 32.869535ºN, 97.496719ºW. 185 m elev. 21 June 2008. Verified by Jeff Streicher. Amphibian and Reptile Diversity Research Center at the University of Texas Arlington (UTADC 2062, photo voucher). New county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press. 421 pp.).

Submitted by **CARL J. FRANKLIN (**e-mail: Franklin@uta.edu) and **ERICK A. P. CATALÁN**, Amphibian and Reptile Diversity Research Center at the University of Texas Arlington, 501 S. Nedderman, Arlington, Texas 76019, USA.

TESTUDINES – TURTLES

APALONE SPINIFERA ASPERA (Gulf Coast Spiny Softshell). USA: GEORGIA: Miller Co.: Spring Creek, 0.4 km S of White's Bridge Rd. (31.0776893ºN, 84.71716945ºW; NAD83). 24 June and 17 July, 2008. Sean C. Sterrett and Andrew M. Grosse. Verified by John Jensen. (UF 153971). New county record (Buhlmann 2008. *In* Jensen et al. [eds.], Amphibians and Reptiles of Georgia, pp. 520–522. University of Georgia Press, Athens, Georgia). Five turtles (1 male, 4 females) were captured by hoop trapping. One additional juvenile was also found dead on this stretch likely due to stress of low flows.

Submitted by **SEAN C. STERRETT,** Joseph W. Jones Ecological Research Center, Route 2, Box 2324, Newton, Georgia, USA (e-mail: ssterret@jonesctr.org); and **ANDREW M. GROSSE,** D. B. Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia 30602, USA (e-mail: frog14@uga.edu).

GRAPTEMYS BARBOURI (Barbour's Map Turtle). USA: GEORGIA: Miller Co.: Spring Creek, 0.4 km S of White's Bridge Rd. (31.1558503ºN, 85.433684ºW; NAD83). 24 June, 16 July, and 6 October, 2008. Sean C. Sterrett and Andrew M. Grosse. Verified by John Jensen. (UF 153970). New county record (Moulis 2008. *In* Jensen et al. [eds.], Amphibians and Reptiles of Georgia, pp. 478–480. University of Georgia Press, Athens, Georgia). Four turtles (1 male, 1 female, 2 juveniles) were captured by hoop trapping and snorkeling in a highly agriculturally affected portion of Spring Creek during low flow periods. One additional male was observed during the summer of 2008.

Submitted by **SEAN C. STERRETT,** Joseph W. Jones Ecological Research Center, Route 2, Box 2324, Newton, Georgia, USA (e-mail: ssterret@jonesctr.org); and **ANDREW M. GROSSE,** D. B. Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia 30602, USA (e-mail: frog14@uga.edu).

GRAPTEMYS GEOGRAPHICA (Common Map Turtle). USA: ARKANSAS: Izard Co.: Twin Creek, off Co. Rd. 1, 4 km E of St. Hwy 9 (35.5804ºN, 92.0202ºW; WGS84). 6 May 2007. M. B. Connior, I. Guenther. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ photographic voucher 31266). Adult female observed digging nest. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MATTHEW B. CONNIOR** (e-mail: matthew.connior@smail.astate.edu), **IDUN GUENTHER**, and **THOMAS S. RISCH**, Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467, USA.

MACROCHELYS TEMMINICKII (Alligator Snapping Turtle). USA: TEXAS: Franklin Co.: North of Mt. Vernon in White Oak Creek near state highway 37. 16 May 1986. Verified by Jonathan A. Campbell. Amphibian and Reptile Diversity Research Center at the University of Texas Arlington. UTA R-16661. New county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University press. 421 pp.).

Submitted by **CARL J. FRANKLIN (**e-mail: Franklin@uta.edu), and **ERICK A. P. CATALÁN**, Amphibian and Reptile Diversity Research Center at the University of Texas Arlington, 501 S. Nedderman, Arlington, Texas 76019, USA.

PELUSIOS GABONENSIS (African Forest Turtle). REPUBLIC OF CONGO: CONKOUATI DEPARTMENT: Nzambi district: Tchibenda Lake and unnamed wetland, 3 km W Conkouati Village. 27 September 2008. California Academy of Sciences photo vouchers (CAS HPV44–47). Verified by Hallie Brignall. Only known records for Republic of Congo located in central Congo along Congo River and inland within the Cuvette and Plateaux Regions, > 480 km NE of our localities (Iverson 1992. A Revised Checklist with Distribution Maps of the Turtles of the World. Privately published. Richmond, Indiana. xiii+363 pp.). Three adults captured accidentally on fish hooks by local fisherman in July 2008. Fourth specimen captured by hand in Tchibenda Lake and eaten by local family on 27 September 2008.

Submitted by **PIERRE FIDENCI**, ESI, 79 Brady St., San Francisco, California 94108, USA (e-mail: pfidenci@endangeredspeciesinternational.org); and **JEROME MARAN**, L'Association du Refuge des Tortues, 26, place du Souvenir, 31660, Bessières, France (e-mail: jerome.maran@wanadoo.fr).

TERRAPENE ORNATA ORNATA (Ornate Box Turtle). USA: TEXAS: Crockett Co.: 2.8 rd mi N jct of TX SH190 on TX SH163 (30.9515167ºN, 101.16795ºW). 2659 ft elev. 20 September 2007. M. S. Price, N. M. Price, S. G. Price, and N. R. Price. Verified by Travis J. LaDuc. Texas Natural History Collections photo voucher, TNHC 66535. New county record and fills distributional gap (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL S. PRICE**, San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

TRACHEMYS EMOLLI (Moll's Slider). EL SALVADOR: LA UNIÓN: Golfo de Fonseca: Municipio de Meanguera del Golfo: east-central shore of Pirigallo Island (13.1020°N, 87.4103°W; datum WGS 84), 0 m elev. 29 August 2007. Enrique Barraza and Ricardo Ibarra Portillo. Verified by John L. Carr. Museo de Historia Natural de El Salvador, San Salvador collection (MUHNES C-301654). Municipio de Intipucá: Playa El Icacal (13.1675°N, 88.005256 W; WGS84), 0 m elev. 11 May 2008. Carlos Funes. Verified by John L. Carr. The University of Kansas Natural History Museum Digital Archive (KUDA 002402–002405). New records for El Salvador (Köhler et al. 2006. The Amphibians and Reptiles of El Salvador. Krieger Publ. Co., Malabar, Florida. ix + 238 pp.), extending the species' range ca. 140 km NW of closest known localities in Lakes Managua and Nicaragua, in streams connecting the two lakes, and in Río San Juan near the Nicaragua-Costa Rica border (Legler 1990. *In* J. W. Gibbons [ed.], Life History and Ecology of the Slider Turtle, pp. 82–105. Smithson. Inst. Press, Washington, D.C.). The adult male from Pirigallo Island was found dead, lodged between rocks at 2 m depth in sea water. Because Pirigallo Island does not contain suitable freshwater habitat for *Trachemys*, it is likely that the specimen was blown out to sea from a nearby lagoon in the Gulf of Fonseca or from the Río Choluteca during a storm. The Playa El Icacal, male specimen was collected as it was swimming in an estuary near Río El Encantado. Legler (1990, *op. cit.*) noted the absence of *Pseudemys* (= *Trachemys*) records from suitable habitat in the lowland corridor from the Gulf of Fonseca to Lake Managua, but our records suggest that *T. emolli* occurs throughout this corridor in El Salvador, Honduras, and Nicaragua. However, we cannot eliminate the possibility that the species was introduced by the illegal wildlife trade that is rampant in the Gulf of Fonseca (O. Komar, pers. comm.).

Submitted by **RICARDO IBARRA PORTILLO**, Ministerio de Medio Ambiente y Recursos Naturales (MARN), Calle y Colonia Las Mercedes, km 5 y ½ carretera a Santa Tecla, San Salvador, El Salvador (e-mail: ribarra@marn.gob.sv); **VLADLEN HENRÍQUEZ,** Programa de Ciencias para la Conservación, SalvaNATURA, 33 Ave Sur #640, Colonia Flor Blanca, San Salvador, El Salvador (e-mail: vhenriquez@salvanatura.org); and **ELI GREENBAUM,** Department of Biological Sciences, University of Texas at El Paso, 500 West University Ave., El Paso, Texas 79968, USA (e-mail: egreenbaum2@utep.edu).

TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider). USA: FLORIDA: Gilchrist Co.: Santa Fe River, 2.5 km upstream from Suwannee River (29.9030667ºN, 82.8672583ºW, datum WGS84). 27 February 2008. Travis M. Thomas. UF 153059. Verified by Kenneth L. Krysko. New county record and 37.6 km downstream from the closest known *T. s. elgans* (UF 153056–57) in Columbia County. Adult male (carapace length 150 mm, plastron length 140 mm) captured using baited hoop trap.

Submitted by **TRAVIS M. THOMAS**, Florida Museum of Natural History, Division of Herpetology, University of Florida, Gainesville, Florida 32611, USA (e-mail: tthomas@flmnh.ufl.edu); and **GERALD R. JOHNSTON**, Department of Natural Sciences, Santa Fe Community College, Gainesville, Florida 32606, USA (e-mail: jerry.johnston@sfcc.edu).

TRACHEMYS SCRIPTA ELEGANS (Red-eared Slider). USA: FLORIDA: Suwannee Co.: Ichetucknee Springs State Park, Devil's Eye Spring, Ichetucknee River (29.9737194ºN, 82.7600556ºW; datum WGS84). 19 April 2008. Anthony Lau. Florida Museum of Natural History (UF 153060). Verified by Kenneth L. Krysko. New county record. Adult male (carapace length 140 mm, plastron length 127 mm) captured by hand while snorkeling. First known *T. s. elegans* collected in the Ichetucknee River, a tributary to the Santa Fe River, where multiple individuals of non-native *T. s. elegans* have been collected (Lau et al. 2008. Herpetol. Rev. 39:236–237).

Submitted by **ANTHONY LAU**, Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida 32611, USA (e-mail: alau0924@ufl.edu); and **GERALD R. JOHNSTON**, Department of Natural Sciences, Santa Fe Community College, Gainesville, Florida 32606, USA (e-mail: jerry.johnston@sfcc.edu).

SQUAMATA – LIZARDS

AMEIVA AMEIVA (Giant Ameiva). USA: FLORIDA: Monroe Co.: Grassy Key, jct Morton Street and Lemon Avenue (24.7629ºN, 80.9603ºW, WGS84). 21 September 2008. Renée Anderson. Two individuals observed foraging among leaves on ground. Florida Museum of Natural History photographic voucher (UF 153706). Verified by Kenneth L. Krysko. First record from the Florida Keys and a new county record. Extends range ca. 106 km SSW of the nearest known population at a reptile dealer's facility in Miami,

Miami-Dade Co. (UF 137671). Other *A. ameiva* were observed in the vicinity, suggesting an established population.

Submitted by **SCOTT HARDIN**, Florida Fish and Wildlife Conservation Commission, 620 South Meridian Street, Tallahassee, Florida 32399, USA (e-mail: scott.hardin@myfwc.com); **RENÉE ANDERSON**, Signs by Renée, 72 Coco Plum Drive, Marathon, Florida 33050, USA; and **KEVIN M. ENGE**, Florida Fish and Wildlife Conservation Commission, 1105 SW Williston Road, Gainesville, Florida 32601, USA.

ANOLIS ALLISONI (Green Anole). HONDURAS: ATLÁN-TIDA: Hotel Rotterdam, La Ceiba (15.4730°N, 86.4720°W; WGS84), near sea level. 13 May 2007. Alexander Gutsche and James R. McCranie. Verified by Steve Gotte. USNM 570550. First mainland record for this species in Honduras (McCranie et al. 2005. Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania!, Salt Lake City, Utah. xiii + 210 pp.). The specimen was captured at 1135 h on a small palm tree in the hotel garden. Observations of about ten additional specimens, including adult males and females and a subadult, indicate an established population that was likely introduced from nearby Islas de la Bahía, Honduras. Fieldwork of A. Gutsche was supported by German Research Fondation (DFG 444 HON 111/1/07).

Submitted by **JAMES R. McCRANIE,** 10770 SW 164th Street, Miami, Florida 33157-2933, USA (e-mail: jmccrani@bellsouth.net); and **ALEXANDER GUTSCHE**, Humboldt-Universität zu Berlin, Institut für Biologie, Abteilung Sinnesbiologie, Invalidenstr. 43, D-10115 Berlin, Germany (e-mail: alexander-gutsche@web.de).

ANOLIS EQUESTRIS (Knight Anole). USA: FLORIDA: HIGH-LANDS Co.: 101 Green Dragon Drive, Lake Placid (27.295233°N, 81.370525°W, WGS84; elev. 36.5 m). 27 September 2005. Florida Museum of Natural History (UF 153968). New county record and extends the range ca. 78 km NE of the closest known locality at 5207 Palm Beach Boulevard, Fort Myers, Lee County (UF 145694). POLK Co.: 3832 Avenue Q NE, Winter Haven (28.03906°N, 81.72411°W, WGS84; elev. 44 m). 15 December 2007. UF 153967. New county record and extends the range ca. 86 km north of the closest known locality in Highlands County above (Camposano et al. 2008. Iguana 15[4]:24–31). Found dead in swimming pool. Specimens collected by Daniel Parker and verified by Kevin M. Enge.

Submitted by **DANIEL J. PARKER**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA (e-mail: sunshineserpents@earthlink.net); and **KENNETH L. KRYSKO**, Division of Herpetology, Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, Florida 32611, USA (e-mail: kenneyk@flmnh.ufl.edu).

COLEONYX VARIEGATUS (Western Banded Gecko). USA: NE-VADA: ESMERALDA Co.: Cuprite Hills, northwest of U.S. Highway 95 and State Route 266 intersection (37.52292°N, 117.20111°W, WGS84), 1500 m elev. 11 March 2008. Polly Conrad. University of Nevada at Reno (UNR 7725). A second specimen (UNR 7724) was found nearby in the Palmetto Mountains. Verified by Chris R. Feldman. Northernmost record for the species. These records extend the range of *C. variegatus* by 44.2 km NNE of UNR 7002 in Nye County, Nevada and 62.8 km ENE of MVZ 227787 in Inyo County, California. Two desiccated specimens were found inside hollow mine claim marker posts. There was no evidence of predation, thus the idea of birds dropping the lizards into the posts was ruled out. Along with several hundred individuals of many other lizard species, the geckos likely accessed the plastic hollow mine claim posts through perforations slightly above ground level, turning the posts into traps.

We thank Chris Feldman for assistance with museum records.

Submitted by **PAULETTE M. CONRAD,** Nevada Department of Wildlife, Diversity Division, 4747 Vegas Drive, Las Vegas, Nevada 89108, USA (e-mail: pconrad@ndow.org); and **PETER V. BRADLEY**, Nevada Department of Wildlife, Diversity Division, 60 Youth Center Drive, Elko, Nevada 89801, USA.

CTENOSAURA PECTINATA (Mexican Spiny-tailed Iguana). USA: FLORIDA: BROWARD Co.: Hollywood, N 56th Avenue (26.03661°N, 80.2005°W; WGS84; elev. <1 m). 22 October 2008. Raymond A. Mendez. Verified by Kevin M. Enge. Florida Museum of Natural History photographic voucher (UF 153801). New county record and extends known range of this species ca. 50 km N of closest known record near Old Cutler Road along Biscayne Bay, Miami-Dade County (Townsend et al. 2003. Herpetozoa 16:67–72). Adult male found in yard at residence.

Submitted by **KENNETH L. KRYSKO**, Florida Museum of Natural History, Dickinson Hall, Division of Herpetology, University of Florida, Gainesville, Florida 32611, USA; e-mail: kenneyk@flmnh.ufl.edu.

HEMIDACTYLUS GARNOTII (Indo-Pacific Gecko). USA: FLORIDA: CLAY Co.: Keystone Heights, near Keystone Lake (29.78324°N, 82.032246°W; WGS84). 05 November 2008. B. K. Atkinson. Verified by M. A. Nickerson and K. L. Krysko. Florida Museum of Natural History (UF 153892). Juvenile gecko collected in private residence garden. New record for Clay County, extends the known range 17.3 km NE of the closest known specimen (UF 134315) in Bradford County, Florida (Krysko and Daniels 2005. Carib. J. Sci. 41[1]:28–36).

Submitted by **BENJAMIN K. ATKINSON** (e-mail: bka@ufl.edu), and **JAMES C. NIFONG (**e-mail: ncboy@ufl.edu), Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611, USA.

HEMIDACTYLUS MABOUIA (Wood Slave). HONDURAS: ISLAS DE LA BAHÍA: Isla de Guanaja, Savannah Bight (16.29078°N, 85.50300°W; WGS84), 14 m elev. 09 May 2007. Alexander Gutsche and James R. McCranie. Verified by Steve Gotte. USNM 570548–49. First record of this introduced species for Islas de la Bahía (McCranie et al. 2005. Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania!, Salt Lake City, Utah. viii + 210 pp.). The specimens were captured at night on concrete walls and a ceiling of the Savannah Hotel. The presence of subadults and adults indicate an established population. Fieldwork of A. Gutsche was supported by German Research Foundation (DFG 444 HON 111/1/07).

Submitted by **ALEXANDER GUTSCHE,** Humboldt-Universität zu Berlin, Institut für Biologie, Abteilung Sinnesbiologie,

Invalidenstr. 43, D-10115 Berlin, Germany (e-mail: alexander-gutsche@web.de); and **JAMES R. McCRANIE**, 10770 SW 164th Street, Miami, Florida 33157-2933, USA (e-mail: jmccrani@bellsouth.net).

HEMIDACTYLUS TURCICUS (Mediterranean Gecko). USA: LOUISIANA: Washington Parish: 1730 Sullivan Dr., Bogalusa, 3.5 km S of intersection of Highways 10 and 21 (30.75871ºN, 89.84551ºW; WGS 84). 17 July 2007. Beau B. Gregory and Aran C. Meyer. Verified by Jeff Boundy. LSUMZ 90434–90435. Two individuals captured on wall of building. First parish record (Dundee and Rossman 1989. The Amphibians and Reptiles of Louisiana. Louisiana St. Univ. Press, Baton Rouge. 300 pp.).

Submitted by **BEAU B. GREGORY** and **ARAN C. MEYER**, Coastal and Nongame Resources Division, Louisiana Department of Wildlife and Fisheries, P.O. Box 98000, Baton Rouge, Louisiana 70898, USA.

SCELOPORUS JARROVII (Yarrow's Spiny Lizard). USA: NEW MEXICO: Grant Co.: Gila River, 2.0 km W, 0.8 km E Gila Hot Springs (33.17675°N, 108.20131°W, WGS84). 02 August 2006. Randy D. Jennings and Jan L. Frye. Two juveniles, one collected (43 mm SVL, WNMU 14779). Found on sycamore trunk by large rock outcrop near river. Vouchers from two additional sites were also collected (WNMU 14780, 14781) in 2007. All three locations are along 2.9 km of Gila River corridor; 0.8 air km separate two distant-most sites. All verified by C. W. Painter. Deposited in Western New Mexico University, Gila Natural History Collection. First verified collections in Grant County, an extension of ca. 160 km from known localities in neighboring Hidalgo County (Degenhardt 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.).

Submitted by **RANDY D. JENNINGS**, Western New Mexico University, P.O. Box 680, Silver City, New Mexico 88062, USA (e-mail: jenningsr@wnmu.edu); **BRUCE L. CHRISTMAN,** 736 Cardenas SE, Albuquerque, New Mexico 87108, USA (e-mail: nattybrew@hotmail.com); and **JAN L. FRYE**, P.O. Box 92, Silver City, New Mexico 88062, USA (e-mail: janlf@hotmail.com).

SQUAMATA – SNAKES

ARIZONA ELEGANS ELEGANS (Kansas Glossy Snake). USA: TEXAS: Irion Co.: 1.6 rd mi E of jct of TX SH163 on RM 2469 (31.2993ºN, 101.14035ºW). 2596 ft elev. 07 July 2007. M. S. Price, and N. M. Price. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 66534 photo voucher). New county record and fills a distributional gap (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL S. PRICE**, San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

BOGERTOPHIS SUBOCULARIS (Trans-Pecos Ratsnake). USA: TEXAS: Upton Co.: 1.3 rd mi N of U.S. Hwy 67 on CR 405 (31.1586333ºN, 102.20145ºW). 2692 ft elev. 12 June 1996. M. S. Price and J. Garza. Verified by Travis LaDuc. Texas Natural History Collections (TNHC 66555). New county record (Dixon 2000.

Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL S. PRICE,** San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

CORALLUS CANINUS (Emerald Tree Boa) COLOMBIA: CALDAS: Municipio de Victoria, Vereda San Lorenzo (05.3394ºN, 74.9467ºW; WGS84), 800 m elev. 20 September 2008. J. D. Sánchez-L and A. Arias Alzate. Verifed by R. W. Henderson. Museo de Herpetología Universidad de Antioquia, Medellín, Colombia (MHUA 14625). The species has a wide distribution in the Amazon Basin occurring in Brazil, Peru, French Guiana, Suriname, Guyana, Venezuela, and Ecuador (Henderson 1993. Cat. Amer. Amp. Rept. 574:1–3). The only confirmed records for the species outside of the Amazon River basin are two documented vouchers from the Choco-Magdalena region in Colombia (Renjifo and Lundberg 1999. Anfibios y Reptiles de Urrá. Ed. Colina, Medellín, Colombia; Daza-R. and Henderson 2005. Herpetol. Rev. 36:338–339). This is first record for the Department of Caldas and extends the known distribution in the Magdalena River valley region ca. 248 km to the south.

Submitted by **JUAN DAVID SÁNCHEZ-L.**, Instituto de Biología, Universidad de Antioquia, AA. 1226, Medellín, Colombia (e-mail: jdavids21@gmail.com); **JUAN M. DAZA**, Department of Biology, University of Central Florida, Orlando, Florida 32816, USA (e-mail: jdaza@mail.ucf.edu); and **ANDRÉS ARIAS AL-ZATE.**, Instituto de Biología, Universidad de Antioquia, AA. 1226, Medellín, Colombia (e-mail: andresarias3@yahoo.es).

CROTALUS VIRIDIS (Prairie Rattlesnake). USA: TEXAS: Crockett Co.: 3.1 road miles S of junction of CR131 on CR209 (31.0743ºN, 100.9745ºW). 2497 ft elev. 24 May 2007. M. S. Price and S. G. Price. Verified by Travis LaDuc. Texas Natural History Collections (TNHC 66855 photo voucher). New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.)

Submitted by **MICHAEL S. PRICE**, San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

DIADOPHIS PUNCTATUS EDWARDSII (Northern Ring-necked Snake). USA: WISCONSIN: Monroe Co.: Fort McCoy United States Army Installation Facility, (44.121430°N, 90.723391°W). 21 June 2008. Matthew Heeter and Luke Breitenbach. Verified by Robert Hay. Illinois Natural History Survey (INHS 2008.h photo voucher). New county record. Fills gaps in range map in Wisconsin (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 87 pp.), and complements four prior unverified Monroe County records from: T16N, R2W (Fort McCoy, Eric W. Spadgenske, 1993), T18N, R3W, Sec. 35 SE ¼ (Fort McCoy, Dan Nedrelo, 1992), T19N, R2W, Sec. 1 or 2 (Rich King, 1998), and T19N, R2W, Sec. 6 SE ¼ of SW ¼ (Rich King, 1995)—data from Wisconsin Herp Atlas, Univ. Wisconsin Field Station, accessed Oct. 2008. Two individuals found under a rotting log on 21 June 2008 (MH and LB).

Submitted by **TIMOTHY T. WILDER,** Department of the Army, Directorate of Public Works, IMNE-MCY-PWEN, 2171

South 8th Avenue, Fort McCoy, Wisconsin 54656-5136, USA; **MATTHEW HEETER**, 106 ½ Clinton Street, La Crosse, Wisconsin 54603, USA; **LUKE BREITENBACH**, 2505 Elmwood Road, Hartford, Wisconsin 53027, USA; **GARY S. CASPER**, University of Wisconsin-Milwaukee Field Station, 3095 Blue Goose Rd, Saukville, Wisconsin 53080, USA; and **JOSHUA M. KAPFER**, Natural Resources Consulting, Inc., 209 Commerce Parkway, PO Box 128, Cottage Grove, Wisconsin 53527, USA.

FARANCIA ABACURA (Red-bellied Mudsnake). USA: TENNESSEE: Fayette Co.: Wolf River Wildlife Management Area (35.02909ºN, 89.26639ºW; WGS84). 18 May 2008. J. Ream and E. Johansen. Verified by A. Floyd Scott. Austin Peay State University's David H. Snyder Museum of Zoology (APSU 18940). Voucher photographs taken of specimen found at 1530 h in graveled parking lot along Beasley Drive. New county record (Scott and Redmond 2008. Atlas of Reptiles in Tennessee. The Center for Field Biology, Austin Peay State University, Clarksville, Tennessee. Available from http://apsu.edu/reptatlas/, ver. 03 October 2008, accessed 14 October 2008).

Submitted by **JOSHUA TAYLOR REAM** (e-mail: jream14@apsu.edu), and **ERIC PAUL JOHANSEN**, The Center of Excellence for Field Biology, Austin Peay State University, Clarksville, Tennessee 37044, USA.

HETERODON NASICUS (Western Hog-nosed Snake). USA: TEXAS: Schleicher Co.: 1.3 rd mi W of jct. of Crockett County line marker on TX SH190 (30.9072167ºN, 100.9415833ºW). 2514 ft elev. 19 August 2006. M. S. Price and Ben Vanecek. Verified by Travis J. LaDuc. Texas Natural History Collections (TNHC 66536, photo voucher). Sterling Co.: 5.4 rd mi W of U.S. Hwy 87 on TX SH 158. (31.8505833ºN, 101.1268833ºW). 2353 ft elev. 27 April 2007. M. S. Price and K. Conder. TNHC 66560. New county records (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL S. PRICE**, San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

LACHESIS MELANOCEPHALA (Black-headed Bushmaster). PANAMÁ: CHIRIQUÍ: Cantón Racimiento, Finca Hartmann, 20 km W of Volcán (ca. 8.51ºN, 82.54ºW, map estimation), ca. 1200 m elev. 1965 (no other information available). Ratibor Hartmann. Verified by J. A. Campbell. University of Texas at Arlington Digital Collection (UTADC 1039). First verified locality record from Panamá, although there is an old record (MVZ 27231) with inexact data that implied the species' presence in Chiriquí. The closest known locality is about 30 km W at San Vito in adjacent Puntarenas, Costa Rica (Campbell and Lamar 2004. The Venomous Reptiles of the Western Hemisphere, Vol. 1. Comstock Publ. Assoc., Cornell Univ. Press, Ithaca, New York. 476 pp.).

Submitted by **QUETZAL DWYER** and **MONICA PEREZ**, Parque Reptilandia, Platanillo, Pérez Zeledón, San José, Costa Rica; e-mail: Reptilandia_cr@racsa.co.cr.

LAMPROPELTIS CALLIGASTER CALLIGASTER (Prairie Kingsnake). USA: ARKANSAS: Searcy Co.: ca. 0.5 km W of jct. AR 14 and AR 263 (35.5925°N, 92.2458°W; NAD 83). 26 October 2008. M. B. Connior, I. Guenther. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31273). Adult found DOR on AR 14. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. University of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **MATTHEW B. CONNIOR** (e-mail: matthew.connior@smail.astate.edu), and **IDUN GUENTHER**, Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467, USA.

LAMPROPELTIS CALLIGASTER RHOMBOMACULATA (Mole Kingsnake). USA: ALABAMA: Chilton Co.: 9.0 km S of CR 25 on CR 73 (33.00685°N, 86.52074°W; WGS84). 25 May 2000. J. Burling. Verified by Joseph R. Mendelson III. University of Montevallo Collection of Vertebrates (UMCV-RS0083). Female with five eggs found dead on road. County record; fills a gap among Shelby, Bibb, and Coosa counties (Mount 1975. The Reptiles and Amphibians of Alabama. University of Alabama Press, Tuscaloosa. 347 pp.).Specimen was collected under Alabama Department of Conservation and Natural Resources collecting permit number 1044 (JWB).

Submitted by **JOHN W. BURLING[1]** and **JILL A. WICKNICK[2]**, Departments of Psychology[1] and Biology[2], University of Montevallo, Montevallo, Alabama 35115, USA (e-mail: wicknickja@montevallo.edu).

LAMPROPELTIS MEXICANA (Mexican Kingsnake). MEXICO: JALISCO: Sierra del Laurel near La Ciénega, along border with Aguascalientes (ca. 21.72970°N, 102.69890°W; WGS84), elev. 2435–2440 m. 26–27 July 2006. B. Alexander, R. W. Hansen, C. Heim, B. McGregor. Verified by David Lazcano. University of Texas at Arlington Digital Collection (UTADC 2602–2604, photo vouchers); Universidad Autónoma de Nuevo Leon (UANL, three specimens, uncatalogued). First records for Jalisco and ca. 33 km S of closest known locality from the Mesa Montoro region of Aguascalientes (Quintero-Díaz et al. 2001. Herpetol. Rev. 32:278). Snakes were collected under rocks or in crevices within rock outcrops that were surrounded by montane woodland dominated by oaks (*Quercus* spp.) and manzanita (*Arctostaphylos* sp.).

Scientific collecting permits were issued to us by SEMARNAT (OFICIO NUM.SGPA/DGVS/03382/06, OFICIO NUM.SGPA/DGVS/02100).

Submitted by **ROBERT W. HANSEN**, 16333 Deer Path Lane, Clovis, California 93619, USA (e-mail: rwh13@csufresno.edu); and **ROBERT W. BRYSON, JR**., School of Life Sciences, University of Nevada-Las Vegas, 4505 Maryland Parkway, Las Vegas, Nevada 89154-4004, USA (e-mail: brysonjr@unlv.nevada.edu).

LAMPROPELTIS MEXICANA (Mexican Kingsnake). MEXICO: DURANGO: Municipality of Canatlán, ca. 30 km (air) WNW of Canatlán (24.5814167°N, 104.9354833°W; WGS 84), 2306 m elev. Summer 2007. Ron Savage. Verified by Carl Franklin. University of Texas Arlington Digital Collection (UTADC 2599, photo voucher). New municipality record, extending range northward by ca. 70 km (LACM 107230–31; Garstka 1982. Breviora 466:1–35) and brings *L. mexicana* to within 90 km of *L. alterna* on the eastern flank of the Sierra Madre Occidental (Ingrasci et al. 2008. Herpetol. Rev. 39:371–372). The snake was found in a rock crevice surrounded by

Madrean woodland, which appears to span the range gap between *L. alterna* and *L. mexicana* in unbroken fashion.

Submitted by **RON SAVAGE**, 609 Edmonston Street, Rockville, Maryland 20851, USA (e-mail: Ronsavage@yahoo.com); and **ROBERT W. HANSEN**, 16333 Deer Path Lane, Clovis, California 93619, USA (e-mail: rwh13@csufresno.edu).

LAMPROPELTIS TRIANGULUM TRIANGULUM (Eastern Milksnake). USA: GEORGIA: White Co.: Wildcat Mountain, 9.7 km WNW Helen (34.7270°N, 83.8419°W), 1064 m elev. 13 September 2008. Bryan Hudson and Carlos D. Camp. Verified by Kenney Krysko. Florida Museum of Natural History (UF 153761, photo voucher). Hatchling. New county record (Jensen et al. 2008. Amphibians and Reptiles of Georgia. Univ. Georgia Press, Athens. 575 pp.).

Submitted by **BRYAN HUDSON**, 101 Nancy Trail, Roswell, Georgia 30075, USA (e-mail: Yoitsbry142@aol.com); **CARLOS D. CAMP**, Department of Biology Piedmont College, PO Box 10, Demorest, Georgia 30535, USA (e-mail: ccamp@piedmont.edu); and **JOHN B. JENSEN**, Georgia Department of Natural Resources, Nongame-Endangered Species Wildlife Program, 116 Rum Creek Drive, Forsyth, Georgia 31029, USA (e-mail: John_Jensen@dnr.state.ga.us).

LIOPELTIS FRENATUS (Günther's Stripe-necked Snake). VIETNAM: THUA THIEN-HUE: Bach Ma. Collected before August 1998. Hoang Xuan Quang and students. Verified by Wolfgang Böhme. Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany (ZFMK 83105). *Liopeltis frenatus* was previously reported in Vietnam from Lao Cai Province in the north and from the provinces of Quang Binh, Da Nang, and Gia Lai in central and southern Vietnam (Nguyen et al. 2005. A Checklist of Amphibians and Reptiles of Vietnam. Nha xuat ban nong nghiep, Hanoi, 180 pp.; Szyndlar and Nguyen 1996. The Snake 27:91–98; Orlov et al. 2003. Russian J. Herpetol. 10:217–240; Ziegler et al. 2007. Zootaxa 1493:1–40). Our finding represents the first record for Thua Thien-Hue Province, which borders Da Nang Province in the south. Besides coloration and pattern, the specimen has 15 smooth scale rows around midbody, 141 ventrals, 72 divided subcaudals, divided anal scale, seven supralabials (third and fourth in contact with eye), eight infralabials, single loreal, one preocular, and two postoculars that are characteristic of *L. frenatus*. The specimen is a female (SVL 340 mm; tail 128 mm) that contained four eggs of 25–28 mm length and 7–9 mm width.

Submitted by **THOMAS ZIEGLER**, Cologne Zoo, Riehler Str. 173, D-50735 Köln, Germany (e-mail: ziegler@koelnerzoo.de), and **HOANG XUAN QUANG**, University of Vinh, Nguyen Du Str., Vinh - Nghe An, S. R. Vietnam.

MICRURUS TENER (Texas Coralsnake). USA: TEXAS: Schleicher Co.: Eldorado, 7.0 rd mi SW (30.8270167°N, 100.7056833°W). 2433 ft elev. 07 April 2007. M. S. Price and N. M. Price. Verified by Travis J. LaDuc. Texas Natural History Collection (TNHC 66564). New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL S. PRICE,** San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

NERODIA SIPEDON (Northern Watersnake). USA: TEXAS: Dallas Co.: Dallas, White Rock Creek near northeast quadrant of Forest Lane and Hillcrest Road. 32.916482°N, 96.776481°W, 151 m. 28 April 2008. Specimens were collected from White Rock Creek from 1200–1545 h. Verified by Corey E. Roelke. Amphibian and Reptile Diversity Research Center at the University of Texas Arlington (UTA R- 55906–913). New county record (Dixon 2000. Amphibians and Reptiles of Texas. Texas A&M University Press. 421 pp.).

Submitted by **CARL J. FRANKLIN** (e-mail: Franklin@uta.edu), and **ERICK A. P. CATALÁN**, Amphibian and Reptile Diversity Research Center at the University of Texas Arlington, 501 S. Nedderman, Arlington, Texas 76019, USA.

PITUOPHIS CATENIFER SAYI (Bullsnake). USA: ILLINOIS: Kane Co.: Collected on property of a private residence in Geneva (41.900090°N, 88.315087°W; WGS84). 26 June 2008. Jace Robinson. Verified by Chris Phillips. Illinois Natural History Survey (INHS 2008.20, photo voucher). New county record (Phillips et al. 1999. Field Guide to Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Surv. Manual 8, 300 pp.).

Submitted by **JACE W. ROBINSON**, Department of Biology, Harper College, Palatine, IL, 60067, USA; Department of Biological Sciences, Northern Illinois University, DeKalb, IL, 60115, USA; e-mail: jrobinso@harpercollege.edu.

PROTOBOTHROPS CORNUTUS (Smith's Horned Pit Viper). VIETNAM: HA GIANG: Khau Ca area (22.49°–22.51°N, 105.05°–105.09°E). October to November 2002. Photographed by Le Khac Quyet. Verified by Wolfgang Böhme. Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany (ZFMK color slides 0210–11). Previously known from type locality "Fan-si-pan Mts., Tong-king" (Lai Chau/Lao Cai provinces) in northern Vietnam, as well as from localities in central Vietnam (Nghe An, Ha Tinh, Quang Binh, and possibly Thua Thien-Hue provinces: Ziegler and Herrmann 2002. Mitt. Zool. Ges. f. Arten u. Populationsschutz e.V. 18:24–26; Herrmann et al. 2004. Herpetologica 60:211–221; Orlov et al. 2003. Russian J. Herpetol. 10:217–240). New photographic reports from Ha Giang Province in northern Vietnam, close to border with Yunnan and Guangxi Zhuang Autonomous provinces (China), represent northernmost records in Vietnam, extending known distribution in northern Vietnam by ca. 200 km airline distance to NE. Besides coloration and pattern (brownish-black pattern on light brownish-gray head and body, reddish-brown tail tip), its distinctly raised, horn-like, enlarged supraocular scales are characteristic of *P. cornutus*. Both specimens were found between 1200–1500 h in sunny weather on tree trunk and in branches in limestone forest. Most recently, the species was recorded from China (Nanling Mountains), ca. 980 airline km distance from type locality (David et al. 2008. Asiatic Herpetol. Res. 11:17–23).

Submitted by **LE KHAC QUYET**, Fauna & Flora International—Vietnam Programme, IPO Box 78, 55 To Hien Thanh, Hanoi, S. R. Vietnam; and **THOMAS ZIEGLER**, Cologne Zoo, Riehler Str. 173, D-50735 Köln, Germany (e-mail: ziegler@koelnerzoo.de).

REGINA SEPTEMVITTATA (Queen Snake). USA: WIS-CONSIN: Rᴏᴄᴋ Cᴏ.: Turtle Creek Watershed (42.59376821°N, 88.79786439°W; WGS84). Verified by Robert Hay. Illinois Natural History Survey (INHS 2008.i, photo voucher). New county record. Extends confirmed Wisconsin range ca. 6.4 km downstream from nearest confirmed Turtle Creek records (Casper 1996. Geographic Distributions of the Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 87 pp.; Wisconsin Herp Atlas, Univ. Wisc. Field Station, accessed Oct. 2008). One gravid female captured and photographed on 25 July 2008 (JMK and WPM). Complements two other unverified Rock County records: Carver's Rock Park off Turtle Creek, T2N, R14E, Sec. 27 (George Bachay, 1960) and Turtle Creek, T2N, R14E, Sec. 32 NE ¼ (Robert Parker Hodge, 1956) (Wisconsin Herp Atlas, *op. cit.*). Although this species prefers clear streams with rocky shores and substrates (e.g., Vogt 1981. Natural History of Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, 205 pp.), this individual was found in a wet meadow, ca. 30 m from flowing water. The nearby stream was turbid, with muddy banks and likely a silt substrate. It is possible that the significant flooding that occurred in this area the month prior carried this individual downstream from known Walworth County sites into a habitat-type that was not normally preferred. The snake regurgitated a molted crayfish (species unidentifiable) while it was being manipulated for photographs.

Submitted by **JOSHUA M. KAPFER**, **WILLIAM P. MUEL-LER**, and **MEGHAN M. PORZKY**, Natural Resources Consulting, Inc., 209 Commerce Parkway, PO Box 128, Cottage Grove, Wisconsin 53527, USA; and **GARY S. CASPER**, University of Wisconsin-Milwaukee Field Station, 3095 Blue Goose Rd, Saukville, Wisconsin 53080, USA.

RAMPHOTYPHLOPS BRAMINUS (Brahminy Blindsnake). HONDURAS: ISLAS DE BAHÍA: Utila, near Iguana Station (16.619°N, 86.5393°W; WGS84), 30 m elev. Collecting dates and collector name unavailable. Verified by Konrad Klemmer. SMF 79882, 82718. First records for Honduras and Islas de Bahía (McCranie et al. 2005. Amphibians and Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania, Salt Lake City, Utah. 210 pp.), and first record of this introduced species on the Atlantic versant of Central America (Köhler 2003. Reptiles of Central America. Herpeton, Verlag E. Köhler, Offenbach, Germany. 368 pp.).

Submitted by **MILAN VESELY**, Department of Zoology, Faculty of Natural Sciences, Palacký University, tř. Svobody 26, 77146 Olomouc, Czech Republic (e-mail:veselym@prfnw.upol. cz); and **GUNTHER KÖHLER**, Forschungsinstitut und Naturmuseum Senckenberg, Senckenberganlage 25, 60325 Frankfurt a.M., Germany.

RHADINOPHIS PRASINUS (Green Bush Ratsnake). VIET-NAM: QUANG NAM: Dong Giang District, Macoih Commune, Axo Village. March 2004. Vu Ngoc Thanh. Zoological Museum, Vietnam National University Hanoi (VNUH 12.3.04–1). Verified by Wolfgang Böhme. *R. prasinus* (see Burbrink and Lawson 2007. Mol. Phyl. Evol. 43:173–189 for generic assignment) was previously known from a few provinces in northern Vietnam (Cao Bang, Lao Cai, Bac Kan, Thai Nguyen, and Vinh Phuc: Nguyen and Ho 1996. Danh luc bo sat va ech nhai Viet Nam. Ha Noi; Nguyen et al. 2005. A Checklist of Amphibians and Reptiles of Vietnam. Nha xuat ban nong nghiep, Hanoi, 180 pp.), as well as from Quang Binh and Gia Lai provinces in central and southern Vietnam (Orlov et al. 2003. Russian J. Herpetol. 10:217–240; Ziegler et al. 2007. Zootaxa 1493:1–40). In addition, Schulz 1996 (A Monograph of the Colubrid Snakes of the Genus *Elaphe* Fitzinger. Koeltz Scientific Books, Havlickuv Brod, 439 pp.) mentions two records for southern Vietnam "in the coastal buttresses of the northern Annam Highlands (Annam) and Plateau du Kontum." Thus, our finding represents the first record for Quang Nam Province in southern Vietnam. Specimen caught resting at noon on primary forest path at ca. 600 m elev. Besides coloration and pattern, 19 (dorsally keeled) scales across midbody, 209 ventrals, 107 divided subcaudals, undivided anal scale, nine supralabials (IV–VI in contact with eye), single loreal and preocular scale, and two postoculars are characteristic of *R. prasinus*. Specimen is female (SVL 800 mm; tail 275 mm), containing nine eggs of dimensions 31–39 mm x 16–19 mm.

Submitted by **VU NGOC THANH**, Vietnam National University, Hanoi, University of Science, Faculty of Biology, Department of Vertebrate Zoology, Zoological Museum, 334 Nguyen Trai Str., Thanh Xuan, Hanoi, S. R. Vietnam; and **THOMAS ZIEGLER**, Cologne Zoo, Riehler Str. 173, D-50735 Köln, Germany (e-mail: ziegler@koelnerzoo.de).

SISTRURUS MILIARIUS STRECKERI (Western Pigmy Rattlesnake). USA: ARKANSAS: Nᴇᴡᴛᴏɴ Cᴏ.: Found on County Road 78, E of AR 7. 28 September 2008. I. Guenther. Verified by S. E. Trauth. Arkansas State University Museum of Zoology Herpetology Collection (ASUMZ 31262). DOR. First county record (Trauth et al. 2004. The Amphibians and Reptiles of Arkansas. Univeristy of Arkansas Press, Fayetteville. 421 pp.).

Submitted by **IDUN GUENTHER** and **MATTHEW B. CONNIOR** (e-mail: matthew.connior@smail.astate.edu), Department of Biological Sciences, Arkansas State University, P.O. Box 599, State University, Arkansas 72467, USA.

SISTRURUS MILIARIUS STRECKERI (Western Pigmy Rattlesnake). USA: OKLAHOMA: Lᴏᴠᴇ Cᴏ.: Hickory Creek Wildlife Management Area (34.00464°N, 97.06274°W; WGS84). Collected by C. E. Roelke and C. L. Cox. Verified by C. J. Franklin. The University of Texas at Arlington Amphibian and Reptile Diversity Research Center (UTA R 56342). New county record (Webb 1970. Reptiles of Oklahoma. Univ. Oklahoma Press, Norman, Oklahoma. 370 pp; Distribution of Oklahoma Amphibians and Reptiles by Recorded Sightings [http://www.biosurvey.ou.edu/dokadesc.html], Accessed on 10/15/2008.) The specimen was found dead on main road leading through Wildlife Management Area. This record extends the known range of the species westward in Oklahoma, even though it is found slightly further west in Montague and Wise counties, Texas (Dixon 2000. Amphibians and Reptiles of Texas. Univ. Texas A&M, Univ. Press College Station. 421 pp.: Werler and Dixon 2000. Texas Snakes: Identification, Distribution, and Natural History. Univ. Texas Press, Austin. 437 pp.).

Submitted by **COREY E. ROELKE** (e-mail: croelke@uta. edu), and **CHRISTIAN L. COX,** University of Texas at Arlington, Department of Biology, 501 S. Nedderman Dr., Arlington, Texas 76019, USA.

STORERIA OCCIPITOMACULATA OCCIPITOMACULATA (Northern Red-bellied Snake). USA: IOWA: Chickasaw Co.: Newell Road 0.2 km N of State Hwy 24 (43.0616°N, 92.2797°W; WGS84). 04 October 2007. Terry J. VanDeWalle. Verified by James L. Christiansen. DOR specimen deposited in the Drake University Research Collection (DRUC 7298). New county record. Although species is known from a number of adjacent counties, this specimen fills a gap in the distributional data in this portion of the state (J. L. Christiansen, pers. comm.; http://www.herpnet.net/Iowa-Herpetology/). The closest record for this species found in the DRUC is from Bremer County 32.3 km to the south.

Submitted by **TERRY J. VANDEWALLE** (e-mail: tvandewalle@nrc-inc.net), and **STACEY J. CARLSON,** Natural Resources Consulting, Inc., 2300 Swan Lake Blvd., Suite 200, Independence, Iowa 50644, USA.

TANTILLA HOBARTSMITHI (Smith's Black-headed Snake). USA: TEXAS: Irion Co.: 2.2 air miles SW of Barnhart on CR311 (31.1134667°N, 101.2040667°W). 2600 ft elev. 03 April 2007. M. S. Price and J. T. Fisher. Verified by Travis LaDuc. Texas Natural History Collections (TNHC 68556, photo voucher). New county record (Dixon 2000. Amphibians and Reptiles of Texas, 2nd ed. Texas A&M University Press, College Station, Texas. 421 pp.).

Submitted by **MICHAEL S. PRICE,** San Angelo Nature Center, 7409 Knickerbocker Road, San Angelo, Texas 76904, USA; e-mail: michael.price@sanangelotexas.us.

XENOPHOLIS UNDULATUS (Jensen's Ground Snake). BRAZIL: CEARÁ: Municipality of Ubajara, Ubajara National Park (03.840278°S, 40.907500°W; WGS84), 896 m elev. 09 September 2008. Coleção Instituto Butantan, São Paulo, Brazil (IBSP 76832). Municipality of Ubajara, Ubajara National Park (03.838346°S, 40.911467°W; WGS84), 829 m elev. 07 November 2008. IBSP 77110. Both specimens were collected by D. N. Lima, and verified by F. L. Franco. The species was recorded for Paraguay and Brazilian states of Goiás, Maranhão, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, São Paulo, and Tocantins (Cunha and Nascimento 1993. Bol. Mus. Para. Emílio Goeldi, sér. Zool. 9[1]: 1–191; França et al. 2006. SNOMNH Occas. Pap. [17]:1–13). These new records represent an isolated population in the rainforests of Ibiapaba's plateau and also are the first report for the genus in Ceará state and from the Caatinga biome. Extends distribution ca. 770 km NE from Porto Franco municipality, Maranhão state, Brazil, and ca. 1220 km E from Carajás municipality, Pará state, Brazil (Cunha et al. 1985. Publ. Avul. Mus. Para. Emílio Goeldi 40:9–85).

Submitted by **DANIEL LOEBMANN**, Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista, Rio Claro, São Paulo, Brazil, Caixa Postal 199, CEP 13506-970; e-mail: contato@danielloebmann.com.

New State Records for Amphibians and Reptiles from Colima, Mexico

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The herpetofauna of Colima, México, has not been thoroughly sampled. There have been only two published inventories for the state, but both appeared during the middle of the last century. Oliver (1937) reported on a collection from Colima and recorded 61 species of amphibians and reptiles from the state. Later, Duellman (1958) reported 85 non-marine species, and of those, 80 are still considered valid, although many have experienced taxonomic name changes. Since 1958, another 21 species were added to the state's list from a variety of publications revising specific groups, describing new taxa, or reporting new discoveries due to expanded field work. Therefore, 101 species of non-marine reptiles and amphibians were known to occur in Colima prior to the survey reported on herein.

Between January 2004 and October 2006, we surveyed the mainland herpetofauna from every municipality in the state of Colima and documented 94 of the 101 terrestrial species previously recorded. We did not sample marine species and three of the terrestrial forms are endemic to islands that were not visited. We also discovered 21 species that had never been reported from the state, including two salamanders, one caecilian, four anurans, five lizards, and nine snakes. Although we sampled every major habitat present on mainland Colima, our efforts were primarily focused in four areas: 1) tropical deciduous forest and tropical thorn scrub in the Municipality of Ixtlahuacán; 2) tropical thorn scrub, tropical deciduous forest, tropical semi-deciduous forest, and mixed tropical deciduous/oak woodland along México Hwy. 98 between the cities of Colima and Manzanillo, in the Municipalities of Comala, Manzanillo, Minatitlán, and Villa de Álvarez; 3) pine-oak woodland and cloud forest in the Sierra de Manantlán, Municipality of Minatitlán; and 4) tropical thorn scrub and mixed mesquite grassland/tropical thorn scrub at higher elevations above the city of Colima in the Municipalities of Colima, Comala, Cuauhtemoc, and Villa de Álvarez. See Fig.

1 for a map depicting collecting localities for individuals listed in the species accounts. Those accounts may include only one voucher for a larger series observed within a given locality. All four authors were involved in collecting voucher specimens and taking digital photographs. Preserved specimens were deposited in the Museo de Zoología, Facultad de Cinecias (MZFC) and verifying photographs were placed in the Digital Collection, University of Texas at Arlington (UTADC). Vouchers deposited in MZFC were verified by Edmundo Perez-Ramos and those placed in UTADC by Fernando Mendoza-Quijano. Coordinates and elevations were taken with a GPS device using map datum WGS84. New state records for the 21 species of amphibians and reptiles from Colima are as follows.

Anura

Dendropsophus sartori (Taylor's Yellow Treefrog). Municipality of Colima: 1.6 km E of México Hwy. 110 on road to Tepames (19.105727°N, 103.405559°W), 476 m elev. 6 July 2004. UTADC 1020. Municipality of Manzanillo: 3 km NE Tepehuajes on México Hwy. 98 446 m elev. (19.153846°N, 104.101999°W),

446 m elev. 28 June 2004. UTADC 1021. These records fill a significant gap in the known distribution of this species between the Chamela-Cuixmala region of southwestern Jalisco and the coast of central Guerrero (Duellman 2001). Both samples were males found calling in flooded agricultural fields surrounded by tropical deciduous forest.

Hyla arenicolor (Canyon Treefrog). Municipality of Colima: 5 km (by air) SW of Tepames (19.0816°N, 103.666°W) 870 m elev. 7 January 2005. UTADC 1018. This record is a range extension of ca. 90 km S of the two nearest published records, 4 km NE Ciudad Guzman, Jalisco, and 14.4 km NE Union de Tula, Jalisco (Duellman 2001). Numerous males were found calling from rocks next to an intermittent stream in tropical deciduous forest.

Hyla eximia (Mountain Treefrog). Municipality of Villa de Alvarez: El Naranjal (19.243741°N, 103.392046°W), 1443 m elev. 23 September 2006. UTADC 1019. The record represents a range extension of 40 km SW of the closest known locality in southern Jalisco (Duellman 2001). Frogs were found calling in a flooded field within an ecotone between tropical thorn scrub and mesquite grassland.
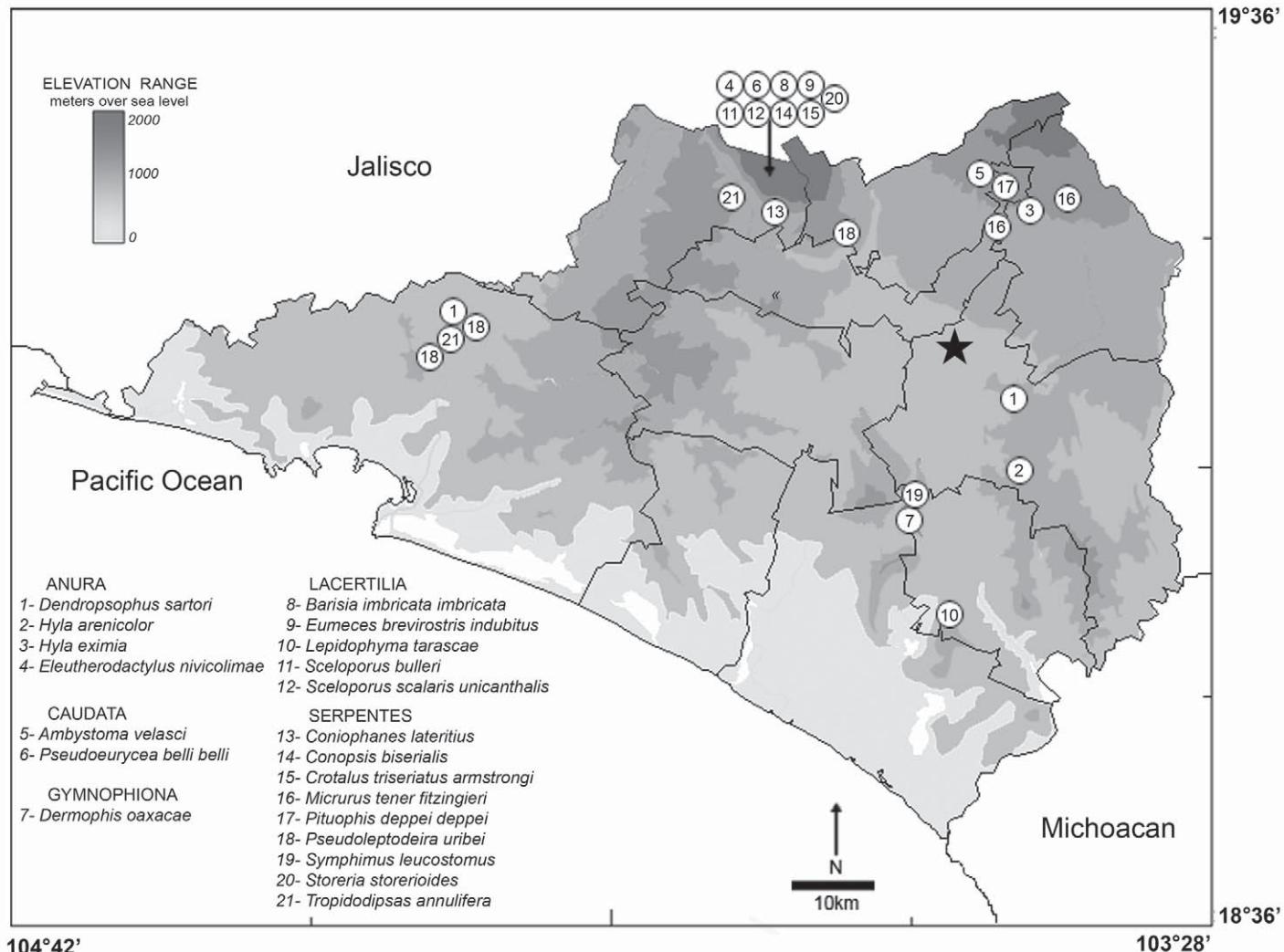
Fig. 1. Map of Colima, México showing collection localities reported in the text and a list of species collected from those localities. The star indicates the city of Colima.

Eleutherodactylus nivicolimae (Nevado de Colima Chirping Frog). Municipality of Minatitlán: Sierra Manantlán: 2.3 km SW (by road) of El Terrero (19.261686°N, 103.573144°W), 2040 m elev. 11 July 2004. UTADC 1033. This record represents a range extension of approximately 46 Km SW of the closest known localities on Nevado de Colima, in Jalisco (Dixon and Webb 1966). The frog was calling at 2200 h from the base of a tree in oak forest.

Caudata

Ambystoma velasci (Plateau Tiger Salamander). Municipality of Comala: 13 km NNE of Comala (19.251511°N, 103.405721°W), 1520 m elev. 9 February 2007. UTADC 1037. This record is a range extension of 60 km S from the closest known locality 2.68 km E Tapalpa, Jalisco (McKnight and Shaffer 1997). The series is composed of larvae captured in a flooded grassy field, two of which were kept in captivity until metamorphosis to facilitate identification, and then released. Surrounding vegetation was a mix of tropical thorn scrub and mesquite grassland.

Pseudoeurycea bellii bellii (Bell's False Brook Salamander). Municipality of Minatitlán: 2.5 km SE of El Terrero (19.25528°N, 103.54510°W), 2164 m elev. 11 July 2004. MZFC19769. This locality is a range extension of ca. 8 km SE of El Tepeixtle, Tolimán, Jalisco, which was initially recorded erroneously from Colima by Mendoza-Quijano et al. (1995) The salamander was found under a log in cloud forest. It is noteworthy that the species is presently abundant at this site.

Gymnophiona

Dermophis oaxacae (Oaxacan Caecilian). Municipality of Ixtlahuacan: 2.8 km (by road) SW of La Salada (19.01816°N, 103.47446°W), 297 m elev. 24 June 2006. UTADC 1016. This record represents a range extension of ca. 150 km S from the closest reported locality, 50 NE Autlan, Jalisco (Savage & Wake 2001). The specimen was found AOR on a rainy night in tropical deciduous forest.

Lacertilia

Barisia imbricata imbricata (Imbricate Alligator Lizard). Municipality of Minatitlán: Sierra de Manantlán: 2.5 km SE of El Terrero (19.255454°N, 103.56444°W), 2200 m elev. 15 August 2004. UTADC 1012. This record represents a range extension of ca. 37 km ESE from the nearest reported locality on the Sierra de Manantlán in adjacent Jalisco (Guillette and Smith 1982). Several juveniles and the reported adult were seen crawling in leaf litter on a hillside covered by oak woodland.

Eumeces bevirostris indubitus (Mexican Shortnose Skink). Municipality of Minatitlán: Sierra de Manantlán: El Terrero, 2183 m elev. (19.2540°N, 103.9388889°W). 11 July 2004. UTADC 1017. This record represents a 43 km SW range extension from the nearest reported locality near Atenquique, Jalisco (Dixon 1969). Individuals of the species were commonly observed at the site in pine-oak woodland under rocks and in leaf litter.

Lepidophyma tarascae (Tarascan Tropical Night Lizard). Municipality of Ixtlahuacán: 1 km NW of San Gabriel (18.55339°N, 103.44016°W), 538 m elev. 3 July 2005. UTADC 1022. This record extends known distribution 95 km WNW from closest reported locality in the Municipality of Aguililla, Michoacán (Guzmán-Villa et al. 1998). The specimen was found at dusk in a crack of a limestone wall in tropical deciduous forest, which is the same plant formation reported by Bezy et. al. (1982) at the type locality. Guzmán-Villa et al. (1998) erroneously suggested that the species is restricted to pine-oak woodland.

Sceloporus bulleri (Buller's Spiny Lizard). Municipality of Minatitlán: Sierra de Manantlán: 1.7 km SW of El Terrero (19.2604°N, 103.5740°W), 2098 m elev. 11 July 2004. UTADC 1029. This record represents a range extension of ca. 65 km SE of the closest know locality in SW Jalisco (Webb 1967). The species was commonly observed on dead trees and under rocks at this site, which is situated in pine-oak woodland.

Sceloporus scalaris unicanthalis (Smith's Bunch Grass Lizard). Municipality of Minatitlán: Sierra de Manantlán: 3.5 km SE El Terrero (19.252494°N, 103.543354°W), 2160 m elev. UTADC 1030. 3 August 2005. This record represents a range extension of ca. 40 Km SW of other known localities in Jalisco on Nevado de Colima and vicinity of Ciudad Guzmán (Smith et. al. 1997). The lizard was found among bunch grass in an open mountain meadow surrounded by pine-oak woodland.

Serpentes

Coniophanes lateritius (Cope's Stripeless Snake). Municipality of Minatitlán: 6.4 km W of junction of México Hwy. 98 and road to El Sauz (19.225443°N, 103.57704°W), 750 m elev. 9 August 2005. UTADC 1013. This record represents a SE range extension of 110 km from the nearest reported locality in Jalisco (Ponce-Campos & Smith 2001). The specimen was found AOR at ca. 1500 h in tropical deciduous forest.

Conopsis biserialis (Two-lined Mexican Earth Snake). Municipality of Minatitlán: 2.5 km SE of El Terrero (19.135838°N, 104.12384°W), 2200 m elev. 15 August 2004. UTADC 1014. This record represents a SW range extension of 40 km from the nearest locality on Nevado de Colima in Jalisco (Goyenechea & Flores-Villela 2006). Numerous other samples were found under rocks in pine-oak forest.

Crotalus triseriatus armstrongi (Armstrong's Dusky Rattlesnake). Municipality of Minatitlán: Sierra de Manantlán: 1.7 km SW El Terrero (19.2604°N, 103.5740°W), 2098 m elev. 15 August 2004. UTADC 1015. This expected record extends the known range ca. 12 km N of other localities on the Serra de Manantlán in adjacent Jalisco (Campbell and Lamar 2004). The snake was found crossing a dirt road at 1900 h in oak forest. It is noteworthy to mention that the species was locally abundant in the vicinity of this site, as over 30 individuals have been found there during the past three years.

Micrurus tener fitzingeri (Fitzinger's Coral Snake). Municipality of Cuauhtémoc: vicinity of Montitlán, 30 km (airline) NNW of Colima, (19.244323°N, 103.361477°W), 1480 m elev. 13 February 2004. MZFC 19743. Municipality of Villa de Alvarez: vicinity of El Carrizal, 17.5 km (airline) N of Colima (19.233248°N, 103.402168°W), 1291 m elev. 23 November 2005. MZFC 19746. These records represent a 350 km range extension W of the closest known localities in western Queretaro (Campbell and Lamar 2004). Both snakes were found in tropical thorn scrub.

Pituophis deppei deppei (Mexican Bullsnake). Municipality of Comala: Laguna Carrizalillos: 19.5 km N of Colima (19.244553°N, 103.402534°W), 1492 m elev. 3 August 2005. UTADC 1026. This record represents a range extension of 60 km S from the nearest known locality at Tapalpa, Jalisco (Campbell 1979). The area is in an ecotone between tropical thorn scrub and oak forest.

Pseudoleptodeira uribei (Uribe's False Cat-eyed Snake). Municipality of Comala: 4 km SW of Juluapan, on México Hwy. 98 (19.182966°N, 103.511855°W), 494 m elev. 14 May 2004. MZFC 19752. Municipality of Manzanillo: 2 km SW Tepehuajes, on México Hwy. 98 (19.181829°N, 103.513089°W), 482 m elev. 8 May 2004. MZFC 19775. 3 km NE Tepehuajes, on México Hwy. 98 (19.152967°N, 104.101939°W), 453 m elev. 29 June 2004. UTADC 1028. These records help fill a 190 km distributional gap between Estación de Biologia Chamela, Jalisco, the type locality (Ramirez-Bautista and Smith 1992), and Ejido Maquili, Michoacán (Mijangos et al. 2007). All three specimens were found DOR in tropical deciduous forest.

Storeria storerioides (Mexican Brown Snake). Municipality of Minatitlán: Sierra de Manantlán: 2.5 km SE of El Terrero (19.255454°N, 103.56444°W), 2200 m elev. 11 June 2004. UTADC 1031. This record fills a distributional gap between localities at Chinicuila, Michoacán (Ponce-Campos et al. 2003) and Tapalpa, Jalisco (Campbell 1979). The snake was found under leaf litter in oak forest.

Symphimus leucostomus (Isthmian White-lipped Snake). Municipality of Ixtlahuacán: 1.7 km NE of La Salada (19.0653306°N, 103.7819833°W), 448 m elev. 11 October 2004. UTADC 1032. This record fills a distributional gap between 14.2 km S of La Huerta, Jalisco (Rossman and Shaefer 1974) and 23 km NW of Punta San Telmo, Michoacán (Alvarez and Diaz-Pardo 1982). The snake was found DOR in tropical deciduous forest.

Tropidodipsas annulifera (Western Snailsucker). Municipality of Minatitlán: 1.5 km W of exit to El Sauz on México Hwy. 98 (19.251908°N, 103.594542°W), 1042 m elev. 28 May 2004. UTADC 1034. Municipality of Manzanillo: 1 km SW Tepeguajes (Puertecito de Lajas) on México Hwy. 98 (19.135838°N, 104.12384°W), 430 m elev. 11 September 2006. UTADC 1035. These records fill a large distributional gap between SW Jalisco and central Guerrero (Kofron 1988). Both specimens were found DOR in tropical deciduous forest.

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BOOK REVIEWS

Malformed Frogs, the Collapse of Aquatic Ecosystems, by Michael Lannoo. 2008. University of California Press, Berkeley (www.ucpress.edu). Hardcover. xvi + 270 pp. US $65.00. ISBN 978-0-520-25588-3.

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I remember the phone call from an official at the regional EPA research lab in Duluth, Minnesota. A group of students from a charter school had found some abnormal frogs during a field trip to a local wetland. The frogs exhibited mainly hind limb deformities, including twisted, missing, or even duplicated hind limbs. The teacher immediately realized that this was a great opportunity to get her students involved in a genuine scientific puzzle, and they reported their discovery to the Minnesota Pollution Control Agency (MPCA). The MPCA helped the kids put together a web page concerning deformed amphibians and what it possibly signified. The web page mentioned something about chemical pollution (who wouldn't think of that?), which generated a firestorm in the media. Soon stories began appearing in major newspapers about a "froggy love canal" with the implication that there might be some contaminant in Minnesota ground water causing thalidomide-like limb "malformations" and worse. I can easily imagine a Minnesota farmer sitting down to breakfast, picking up the newspaper and spitting out his coffee as he reads the headlines: Minnesota ground water may cause birth defects. Soon, state authorities were distributing bottled water to all who asked for it. Inevitably, the US Environmental Protection Agency would become involved. The EPA official called me because I had published a paper on deformed amphibians five years earlier providing an "explanation" for the deformities, and he invited me to an emergency deformed frog workshop at the EPA lab in Duluth.

The Duluth workshop was infused with a sense of urgency and excitement. I watched with amazement as slide after slide of frogs with astonishing deformities elicited audible gasps from the audience. Multilegged frogs drew the most attention as the oddest deformities, and soon became the "poster child" for deformed frogs. My presentation focused on the research I had done with colleague Steve Ruth in California on populations of deformed Pacific Treefrogs and Long-toed Salamanders, most of which had hind limb duplications but a wide range of other deformities as well, including missing limbs (Sessions and Ruth 1990). We showed that the deformities were caused by a parasitic flatworm (trematode) that disrupts limb development in young tadpoles. My intention was to present "the parasite hypothesis" as the one to exclude before searching for more elusive and (in my view) less likely causes such as chemical pollution. In fact, chemical pollution seemed very unlikely as a cause for multi-limbed frogs in particular, since toxic chemicals are far more likely to kill cells and halt limb development than to induce cells to build extra structures. To my amazement, my presentation seemed to help divide the group of researchers into two opposing camps, setting the stage for a decade of controversy: those who favored the chemical pollution hypothesis, and those who favored the parasite hypothesis.

It was at the meeting in Duluth that I first met Mike Lannoo, a well-known and highly respected herpetologist from the Indiana University School of Medicine. A somewhat reserved man, Lannoo played the role of a sort of deformed frog diplomat. Impressed with the strength of the parasite evidence (in fact, he was responsible for my being invited to the workshop), he also saw merit in other hypotheses, including chemical pollution, UV-B radiation, and even predation. In the ensuing controversy and associated media craziness and follow-up workshops and conferences, Mike continued to keep a relatively low profile, focusing his energies on editing multi-authored compendia on declining and deformed amphibians. His "behind the scenes" role is described in William Souder's book "A Plague of Frogs" (Souder 2000). Lannoo patiently waited 10 years for all the fuss to die down before coming out with his own definitive statement about deformed amphibians: *Malformed Frogs, the Collapse of Aquatic Ecosystems*.

Lannoo's book is a solid, handsome little volume, 23.5 cm tall, 16 cm wide, and 2 cm thick, with excellent quality paper, narrow margins, and an attractive, easy-to-read font. Most of the illustrations are black and white and of excellent quality, as are the few pages of beautiful color plates. Physically, it is a high quality book, as expected from the University of California Press (even if, at US $65.00, a bit on the expensive side). After a brief introduction, personal preface and acknowledgment sections, the contents of the book are sorted into seven chapters. The first chapter addresses the issue of what is an amphibian "malformation." Beginning with a quote about symmetry (as a sign of health), Lannoo defines malformation as "bad form" and "unintended" lack of symmetry that arises through one of three mechanisms: genetic flaws, epigenetic perturbation of gene expression, and trauma due to injury or disease. After a brief discussion of each of these mechanisms, Lannoo concludes that the most likely cause is "epigenetic disturbance of gene expression." Lannoo then presents evidence that most malformations involve anurans rather than urodeles. This chapter also presents important background information including a primer on frog skeletal anatomy and limb development, with some brief comments on jaw and eye development, and ends with some comments about when in development certain malformations are likely to arise.

The second chapter covers "malformed frog types" and presents the main kinds of malformations seen including high quality x-ray photographs of over 50 specimens representing the different types. A handy-dandy table provides a description of each of the types, most of which are designated by medical terminology; for example, *microphthalmia* (small eye), *amelia* (missing limb),

taumelia (bent bone), *polymelia* (complete extra limb), and so forth. Some malformations do not have a Latinized medicinal moniker (e.g. "bloated body"). Some of these main types can be broken down into subtypes, for example *unilateral amelia* (too few hind limbs) or *unilateral hemimelia* (short limb on one side). Most of the examples are *Rana pipiens*, but a few other species are included, such as *Acris crepitans* and *Bufo americanus*. The examples are meticulously assembled and presented along with collection locality, collectors, and sometimes a Field Museum specimen number.

Chapter Three focuses on "hotspot" localities, mostly in Minnesota and nearby regions in the Midwest that have yielded a large number, and especially percentage, of malformed amphibians. Here we are presented with a map, showing the overall distribution of the hotspots in Minnesota, and then each hotspot locality (designated with an abbreviation for convenient cross-referencing) is described with an accompanying photograph of the site. The entries include a brief description of the physical aspects, some of the major vegetation present, what types of deformities were found at each one, and how many animals were sampled. In most cases, brief mention is made of any other obvious organisms encountered at the locality, including insects, snails, crustaceans, fishes, and other species of amphibians.

Chapter Four ("Causes") reviews the main causes of amphibian malformations that have been proposed or confirmed over the years. Here Lannoo first divides the causes into two broad categories (following Ouellet 2000): Natural causes and Manmade causes. Natural causes include wounding (failed predation attempts), fish excrement (involving the mysterious "*anomalie P*"; you'll have to read the book and/or Ouellet 2000), crowding, sweet pea extracts (lathyrogens), nutritional deficiencies, UV-B radiation, disease, temperature extremes, genetics, and parasitic cysts. Manmade causes include acidification, radioactive contamination, ozone depletion (UV-B radiation), heavy metals, retinoids, agricultural chemicals (e.g., pesticides), and other chemicals (especially xenobiotics). The brief (four page) descriptive list of causes in Chapter Four is followed by two of the most interesting sections in the book: "synergisms and neutralizations," discussing the possible (probable) interaction of multiple factors in the generation of malformations, and especially "determining cause from malformation type: the search for morphological signatures" in which we are assured that there are, as yet, no morphological signatures in the deformities that point to a particular cause.

Finally we come to probably the most important (or, at 65 pages, at least the largest) chapter of the whole book: Chapter Five, which is devoted to resolutions. The chapter begins with a brief and somewhat scolding diatribe about "bitter personality clashes" that warped the scientific process of discovery into one of competition and simplification, thereby interfering in a resolution of the problem, and warnings about falling into the trap of adaptationist ("just so") thinking (I get a slap on the hand here). Most of the rest of the chapter is devoted to a "deconstruction" of the major hypotheses presented to explain amphibian malformations, and ends with an overall summary of where we stand, in the form of Lannoo's answers to Frequently Asked Questions about amphibian malformations.

Chapter Six covers human malformations and causes (which I mostly skipped), and then we come to the last chapter, Chapter Seven: "Solutions." If Chapter Five was the pièce de résistance of the book, Chapter Seven appears to be the raison d'etre. After another brief diatribe, scolding fellow researchers for tending to reduce the problem to one or two main causes, Lannoo comes, finally, to his shocker conclusion (presented as a kind of unfunny joke): The solution to the malformed frog phenomenon is largely independent of specific cause. Here is the reasoning: After all is said and done, given the complexity of wetland ecology and environmental science, including parasites, predators, UV-B radiation, and various kinds of chemical pollution, it is obviously unlikely that there is a single cause for all malformations in natural populations of amphibians. Instead, the malformed frog problem largely consists of local, site-specific issues. The important thing, according to Lannoo, is that we identify the correct *solution*, and luckily we already know what that is! All vectors point towards one gigantic ultimate problem: general environmental degradation, in this case, collapse of wetland ecosystems. Thus the solution is obvious: ecosystem remediation.

In terms of overall organization of the book, I like it with one exception: Lannoo references his comments with notes that are listed numerically at the end of the book. Thus, to look up a footnote or citation, you must flip to the back of the book and search around for the correct chapter and then find the corresponding number. Because some of the entries contain a large number of references, this is more difficult that it sounds. I found this to be a nuisance. Many will appreciate a section at the end of the book called "species affected," which lists all known species of amphibians with those involved in reported deformities indicated in bold.

My overall take of this book is that it is a very useful summary of the most important issues and research involved in the problem of deformed amphibians. It should be on every herpetologist's bookshelf, and is also of use to anyone who is interested in environmental issues and controversies, and even how science works in the context of such human foibles as competition for attention and grants. Having said that, and being intimately involved in some of the controversy and privy to some of the fascinating stories that have emerged (see Souder's book, *A Plague of Frogs*, for a taste), I do take issue with some of Lannoo's conclusions. Here I will give just a few main examples.

The very first chapter should have served as a warning for me that working my way through the rest of the book was going to involve a struggle with semantics and specific terminology. Definitions are important, and anyone who has kept track of the deformed frog controversy has noticed that some people refer to the abnormalities as "malformations" while others refer to them as "deformities." In the world of medical terminology, the difference in meaning between these two terms is highly significant. Malformation implies an *intrinsic* developmental defect of developing tissues (Winter et al. 1988; MedicineNet.com 2008) whereas deformity refers to *extrinsic* (environmental) factors disrupting the development of *otherwise normal* tissues. Because all of the suggested and known causes of morphological abnormalities in amphibians involve extrinsic factors (e.g., parasites) disrupting the development of otherwise normal tissues, the more precise term for these abnormalities is "deformity."

The question is why does Lannoo use the term malformation rather than deformity? My opinion is that in the world of deformed amphibian research, these terms have become ideological, or

politicized, and the term malformation is usually used to imply disruption of biochemical processes in developing systems, such as endocrine disruption. In this sense, malformation implies disruption of biochemical signaling pathways, for example in the developing limb. Scary stuff indeed! So much is now known about the biochemistry and developmental genetics of limb development that it is easy to construct a detailed scenario by which small biochemical perturbations (via retinoids, for example) could generate monstrocities. One problem here is that I think Lannoo has a very simplistic (deterministic) view of limb development, as exemplified by his statement that "…developmental biology is largely a chemical phenomenon" (p. 193). In actuality, developmental biology is largely a *cellular* phenomenon, and this is critical in understanding how various kinds of deformities are generated. For example, it is only by understanding limb pattern formation as the outcome of interacting cells in an undifferentiated limb bud that you can fully appreciate how parasites can generate massive limb deformities using nothing but mechanical perturbation (Stopper et al. 2002).

Likewise, Lannoo does not seem to understand *amphibian* limb development, specifically in anurans, and this colors his assessment of various cause hypotheses. A dirty little secret (just emerging in recent years) of the deformed frog controversy is that multilegged frogs, the oddest-looking deformities which (understandably) became the poster child of the deformed frog issue (featured in several articles and on the covers of several books) actually represent a small minority of reported cases of deformed amphibians, at least in number of reported hotspots. By far the most common deformities are frogs with *missing* hind limbs and missing hind limb segments and, while less dramatic looking than multilegged frogs, these have turned out to be far more difficult to explain. Anyone who picks up a limbless frog should first think of predation as the most likely explanation. This is Ocam's razor at work. However, Lannoo spends a considerable amount of book space debunking the role of predation, based mainly (as far as I can tell) on assumptions and logical inferences derived from various anatomical and morphological characteristics of deformed frog specimens (ironic given his previous debunking of "morphological signatures"). For example, he sees no obvious signs of wounding or wound repair, he sees pigment malformations in most of the specimens, he sees damaged limb girdles as well as limbs, he finds no evidence of likely predators, etc. Most of these objections are invalidated by one key characteristic of anuran limb development of which Lannoo appears to be unaware: Regenerative decline (Muneoka et al. 1986). Young tadpoles with early limb buds can completely regenerate their limbs, but this ability gradually diminishes to zero as they approach metamorphosis and the limbs complete their development. At intermediate stages, amputation of a limb results in a range of incomplete limb development represented by a panoply of idiosyncratic abnormalities including bent bones, cellular accumulations, cartilaginous spikes, and pigment abnormalities. I feel that this is a major omission in the book and a serious flaw in Lannoo's overall analysis of the most common types of deformed amphibians.

To understand how limb development works you need to think like a developmental biologist, who is used to contemplating the cellular basis of pattern formation and morphogenesis in four dimensions, and small things early on having big final ramifications. Developmental thinking is necessary to appreciate how trematode cysts, located at the base of fully developed limbs, could be responsible for massive deformities located distally. I found the lack of developmental thinking in the book frustrating, because it is so necessary for understanding how various deformities can arise from disparate causes, but not from others. I feel that this is how Lannoo could assert the absence of "morphological signatures" that would point to particular causes. For example, over a century of research in limb development has shown, via simple grafting experiments, that mechanical disruption of the spatial organization of cells in a developing or regenerating amphibian limb is all that parasite cysts need to do to cause the outgrowth of different kinds of mirror-image limb duplications (French et al. 1971). Retinoids can cause a subset of these, but not all of them (Sessions et al. 1999). On the other hand, a true signature of retinoids is a proximal-distal duplication (e.g., two elbows; Bryant and Gardiner 1992). Likewise, the presence of a cartilaginous bump or spike on the end of a limb stump indicates traumatic amputation near the end of regenerative decline (late tadpole stages; Muneoka et al. 1986). Thus, in Chapter 2 where deformed frog types are described and illustrated, I was able to identify the *most likely* causes of the deformities in over 80% of the cases. Out of a total of 63 specimens, 23 were almost certainly parasite-induced and 28 were almost certainly trauma-induced. Nine of the remainder appeared to be trauma, one appeared to be parasite-induced, and only two of them seemed completely ambiguous. Of course, the most important morphological signature of all is the fact that the vast majority of deformities involve the hind limbs, with the rest of the frog (including the front limbs) appearing perfectly normal.

Finally, I cannot agree with Lannoo's conclusion that wetland ecosystem remediation is the solution to the problem of deformed amphibians regardless of the specific causes. What if it turns out (as seems likely to me) that parasites and predation together account for the vast majority of deformities (or "malformations") in natural populations of amphibians? As Lannoo's parasitologist friend, the late Dan Sutherland (to whom the book is dedicated), pointed out to him (and to me), parasites are even more sensitive to environmental pollution than amphibians….. so we should worry when the parasites disappear! Likewise, predator diversity is, if anything, negatively affected by habitat degradation. So if we follow Lannoo's advice (which seems like good advice under any circumstances), ignoring the causes of amphibian deformities and focusing on *the solution* (wetland remediation), we might actually expect an *increase* in the incidence of amphibian deformities! I call this the "perverse hypothesis."

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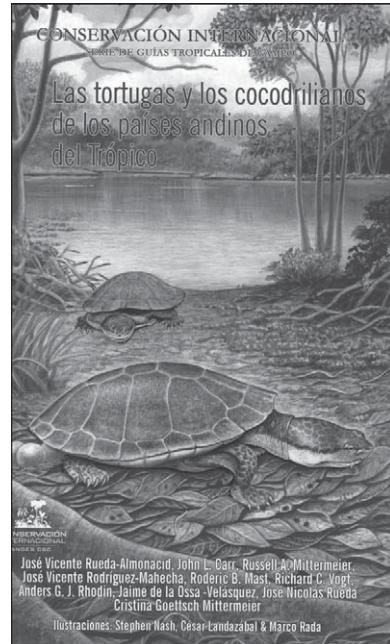
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CÉSAR L. BARRIO-AMORÓS
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Lovers of Neotropical turtles and crocodilians are lucky. This new book fills the enormous vacuum of information that exists with respect to these two orders, gathering information that was previously scattered in many publications, some with quite limited circulation. Until now, the most comprehensive books that treated these animals were Pritchard and Trebbau's (1984) masterpiece, *The Turtles of Venezuela*, (required reading for anyone interested in any aspect of South American turtles, not just Venezuelan ones) and Federico Medem's two classics (1981, 1983) about Colombian and South American crocodilians, respectively. Those interested in the last quarter century of new data, however, have had to search through mountains of diverse primary sources and regional and national publications.

The work of the multiple authors of this book, supported by three formidable illustrators (Stephen Nash, César Landazábal, and Marco Rada), and an endless list of collaborators, has yielded an extraordinary result that will certainly become a herpetological classic both because of the quality of information presented and because of its fine illustrations. The text is entirely in Spanish but, as I have previously argued (Barrio-Amorós 2006a, b), anyone with a serious interest in working with Neotropical species should master Spanish, at least to the level of competent reading comprehension.

The book, of small size (20 x 12 cm) and ideally suited for the field, is unusually beautiful, showing on its front cover an illustration of the rare species *Mesoclemmys dahli*, and on its back the threatened Orinoco Crocodile, along with the logos of sponsoring institutions. Two maps of South America, one physiographic, another showing major vegetation types, are on the inside covers. The book is dedicated to the Latvian herpetologist Federico Medem, who arrived in Colombia after the Second World War and became the most important investigator on turtles and crocodiles of that country. He died in 1984, leaving the most comprehensive information to date on the Colombian species of these two orders. Reminiscences by Russell Mittermeier (current president of Conservation International) and Anders Rhodin (president of the group of the IUCN Terrestrial and Freshwater Turtle Specialist Group), both of whom were influenced by Medem in their youth, provide a suitable tribute. This is followed by a foreword, brief resumés of the authors and illustrators, acknowledgments, and a table of contents.

The introduction highlights aspects of the conservation of chelonians and crocodilians in the region. A guide for handling marine turtles injured by fishing hooks, which has also been published as a separate pamphlet, is included in this section. The introduction to the general characteristics of chelonians is extremely complete and well-illustrated. There is also a section on how to record field data (valid for all types of vertebrates), how to mark shells, how to take different measurements, how to capture turtles using different methods, etc. There are very well illustrated keys at both the family and species level. The text for each species account is complete and accompanied by color photos and/or illustrations of the animal and very accurate distribution maps. In some cases, however, the origin of the photographed specimen is not noted.

The comparable section dealing with the Crocodylia is equally valuable, with extensive and informative text, high quality photos and illustrations, useful keys (including one for eye shines and another for skins), and many other features.

Following the main text a further 70 plates with multiple photos and illustrations each are provided. These show, amongst other things, sexual, ontogenetic, and geographic variation of the included species. It would have seemed preferable to have these illustrations placed in the relevant sections of text, particularly since the book has color throughout anyway, but clustered as they are they do permit easy visual comparisons of similar or related species.

A glossary with the most important terms, a bibliography, and an index to species complete the book. The bibliography, although useful, is not as complete as it might be and some references are lacking although, based on the updated information presented in the text, it seems they were consulted (e.g., Barrio 2001; Barrio-Amorós and Manrique 2006).

There are a number of seeming inconsistencies in the book, but these do not detract significantly from the work as a whole. The title, although correct, may surprise readers not familiar with the Neotropics, since it may seems that the species are restricted to the countries usually understood as Andean. These, for most of the people, are only Bolivia, Peru and Ecuador. The word "Andean" may also be surprising, since no turtle or crocodile species live in the Andes proper (the highest are found in the Andean foothills at no more than 1000 m). However, the tropical Andean countries also include Venezuela and Colombia (but exclude Argentina and Chile, which are Andean but not tropical). So the context is that of the species inhabiting these five countries, and extending the information to other countries where the same species also occur — although these are not Andean (Brazil, Paraguay, the Guianas, Trinidad and Tobago). The presence, for example, of *Mesoclemmys vanderhaegei* in the book is due to the possibility that it may occur in Bolivia. The treatment of Galapagos tortoises in a book with this title may also seem out of place, but of course, the islands belong to Ecuador. The map for *Chelus fimbriatus* is actually correct, but a spot in the southern part of Lake Maracaibo in Venezuela, represents a reported, but unconfirmed record that might have been more appropriately designated with a question mark. Another point to highlight is that the section of common and indigenous names, which is often incomplete, gives the common names in use Colombia, since the book was originally going to be dedicated only to that country. In any case, it is difficult to come to an agreement on the appropriate common name of a species that goes by several names in each country or region. It is even more confusing that the general name in Colombia and Venezuela for the two species of *Crocodylus* (*C. acutus* and *C. intermedius*) is "caiman," while the true caimans of the genus *Caiman* are called "babos" or "babillas" in these countries.

Lastly, I consider that with only a little more effort, it would have been possible to include the rest of the species that occur in South America (those of the southern cone: *Hydromedusa maximiliani, H. tectifera, Platemys pallidipectoris, P. macrocephala, P. radiolata, P. spixii, Mesoclemmys hogei, M. perplexa, M. tuberculata, M. nasuta, Phrynops hilarii, P. williamsi, Trachemys dorbigni*), thereby making the work truly comprehensive.

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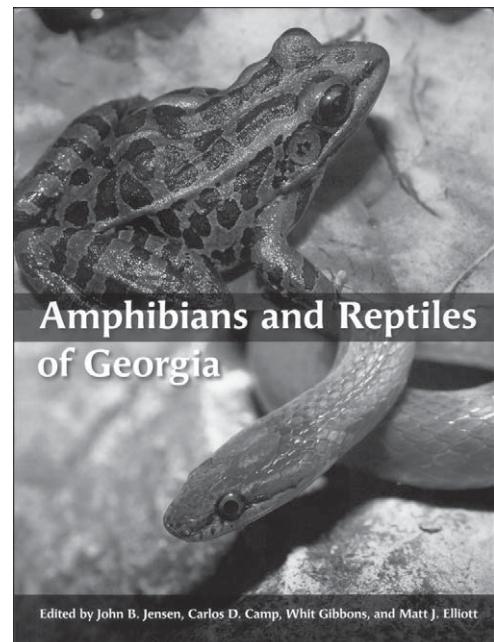
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The Amphibians and Reptiles of Georgia has been long awaited and is much needed. Georgia as a diverse herpetofauna of 170 species and there has been no state-wide treatment of its amphibians and reptiles since Martof's (1956) key and checklist.

The Introduction starts with a detailed explanation of the physiography, climate, and habitats of Georgia. The various maps showing changes in temperature and moisture from the northwest to the southeast are very helpful in explaining the variation in herp diversity across the state.

The taxonomy section is a basic primer on scientific names and Linnaean nomenclature. There is no discussion of the recent name changes in many genera and the associated publications (Frost et al. 2006; Crother 2008; Collins and Taggart 2008) are not even listed. The numerous new names for genera listed in Crother (2008) are problematic to some. I wish the authors had either provided a better explanation for or against the name changes or not included them at all. The way they are presented adds to the ongoing confusion. This will surely be a recurrent issue with other state and regional publications over the next several years as the dust settles.

The editors brought together 54 regional experts and the Georgia Herp Atlas Project to write the species accounts, which comprise the majority of the book. The accounts provide detailed descriptions of adult and larval stages. A taxonomy and nomenclature section provides useful information on relationships to other species and subspecies, although as noted above, newer scientific names are used without discussion. The distribution and habitat, reproduction and development, and habitats sections provide good information on each species. It would have been nice to have more details in these sections, but I understand that with 170 species there has to be a limit. The conservation section is nice to see for even for the

more widespread and abundant species. The county distribution maps show the most recent data collected by the Georgia Herp Atlas. In addition, the map shading shows the expected range within each county when habitat requirements are added. The color photos of the adults and larval stages with each species account are an important feature. The selection of photos, of which all but a few very rare species are of Georgia specimens, is excellent. Photos are of high quality and appropriately sized and the inclusion of images showing pattern variety and color phases provides valuable information.

The Amphibians and Reptiles of Georgia omits a dichotomous key to the species. While this is a common feature in many state works, the lack of a key is probably not a significant drawback as most general users tend to flip through the photos and do not use keys when they are provided.

The inclusion of a county map in the introduction and back inside cover is very handy for those of us not from Georgia. It would be a task to remember all 159 counties.

The references are arranged by topic and species. I find it cumbersome, but a more general reader looking for info on one species would probably find it convenient.

The listings of amphibian and reptile (frogs and alligators) calls on the University of Georgia Press website is an innovative way of accessing acoustic information. I have never used the CDs that are found in the back of some state books, but I have already visited the web to listen to the calls. My one concern is the University of Georgia Press's ability to maintain the website for years to come.

The Amphibians and Reptiles of Georgia is a tremendous resource to herpetologists and naturalists working in Georgia and throughout the southeastern United States and should be on every bookshelf. The flexible cover makes it suitable to use in the field, even though the size may limit some people from putting it in their pack.

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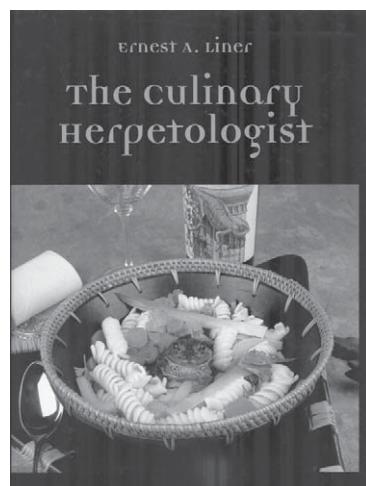
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Gastronomy and herpetology being two of my main Epicurean passions, I have to confess that I was awaiting my copy of Ernie Liner's book with much impatience and salivation. One of my favorite hobbies, certainly shared with millions of people, is to look at the pictures in cookbooks. The satisfaction is often not as great as eating the illustrated dishes, but the principle is the same as visiting an art gallery. Seeing Liner's book for the first time, I examined its front cover, illustrated by a photograph of a live frog bathing in an Italian noodle soup, which I found of dubious humor, and its back cover, showing *Leiolepis* lizards being prepared, which reminded me some marvellous meals I had in northern Thailand. My disappointment was great when I opened the book and realized that these are the only photographs that the book includes.

This reasonably priced, well-bound book is printed on a good quality glossy paper, and is of a large size (8.5 x 11 inches) that is practical for culinary use, with characters big enough to be read while busy cooking. It includes a brief introduction (4 pages), followed by 952 recipes arranged in successive chapters (with 103 additional auxiliary recipes, especially for accompanying sauces and marinades), respectively on salamanders (26 recipes), frogs and toads (193), crocodiles (379), turtles (281), lizards (9), snakes (34), and recipes of indigenous people (30). The book closes after a glossary, an index, and a short biography of the author, who is a renowned specialist on the herpetofauna of Mexico. A few references to published works are made in the main text, but there is no literature cited section. 'Deep fried brandied Amphiuma,' 'Seafood stuffed frog legs,' 'Crumbed toad legs,' 'Alligator cabbage rolls,' 'Snapping Turtle in a pot,' 'Florida Green Turtle soup,' 'Cayenne Iguana stew,' and 'Baked snake with berries' are a few randomly-selected examples of the proposed recipes.

The recipes are generally short, and the ingredients are often not very specific ('frog,' 'mushroom,' 'beer,' 'white wine,' etc., without mentioning the species, the variety or the brand). This gives much space for improvisation and is actually an encouragement to apply the recipes to what ingredients are available and create personal and local versions of the recipes. The recipes are designed for a

variable number of persons, sometimes one, sometimes many more (I noted that the 'Wild game sauce piquant,' proposed for use with alligator or turtle meat, was designed for 60 persons, and that the 'Bayou Alligator sauce piquant' recipe was intended for 100+ persons). The units of measurement used and brands cited make the book practical mostly for the American public.
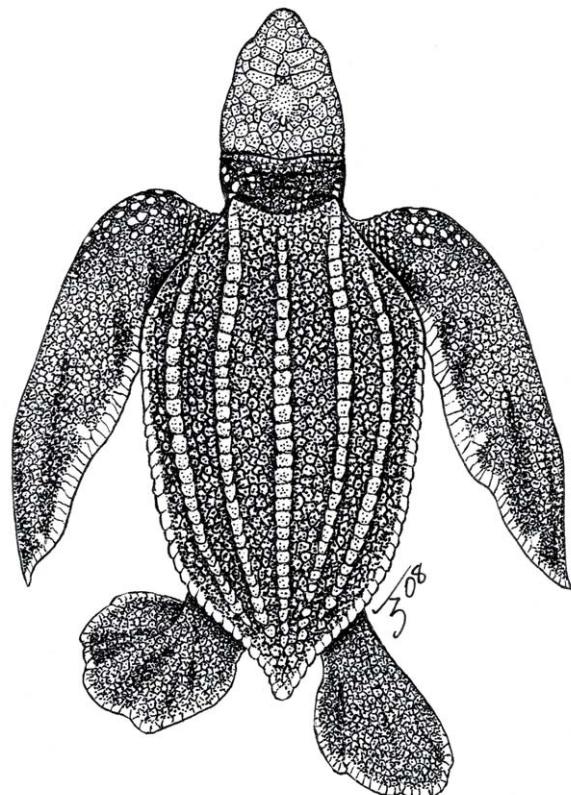
The publisher's note at the beginning of the book stresses the contradiction between herp conservation and the publication of a reptile and amphibian cookbook, with a hope that readers will replace the proposed herps in the various recipes with chicken. I disagree. First, many herp species are not endangered, especially those easily farmed (such as some crocodiles, softshell turtles, etc.), and their controlled consumption as food does not endanger them. Second, you do not replace a recipe's main ingredient by another without dramatically altering the result. By experience, I know for example that a ranid and a pipid do not taste the same, and that a ranid and a chicken do not taste the same at all. The recipes in the book most often do not specify which exact herp species has to be used, except in a few cases, where even highly endangered species are proposed, such as Leatherback Turtle, etc. (the Index does not list the scientific names used in the book, and only some of them are in the Glossary). It is a question of common sense and civic responsibility on the part of readers to use taxa that are currently not endangered or protected in their area, and the author is right to mention all species used in the original recipes he collected without obscuring the use of currently endangered species. In several cases the author stresses the fact that one species or another is protected.

Besides the absence of photographs, my main disappointment was that there is only rarely an indication of the geographical or cultural origin of the recipes. Gastronomy is in my opinion one way to discover other peoples' cultures, and a way to mentally travel while comfortably sitting at one's home dinner table. Even the section on indigenous people's recipes most often does not specify the country or ethnic group of origin. Moreover, I do not understand what the author meant by 'indigenous' and 'native,' and what were the criteria for putting these recipes in a distinct section. Outside this indigenous section, a series of 15 recipes are given in Spanish, i.e. the original language in which the author received them, 'to add to their historical value' says the author, but without mentioning from which country they originate! The author explains in the introduction that he gathered the recipes over decades, from various sources including anonymous ones, with no intention to be exhaustive. Whether the given recipes were born in the imaginative mind of a single person or are part of the gastronomy of a whole cultural or ethnic group is not specified. The recipes in the present book are thus a compilation of recipes the author heard of or encountered about preparing herps, with no scientific nor cultural pretention.
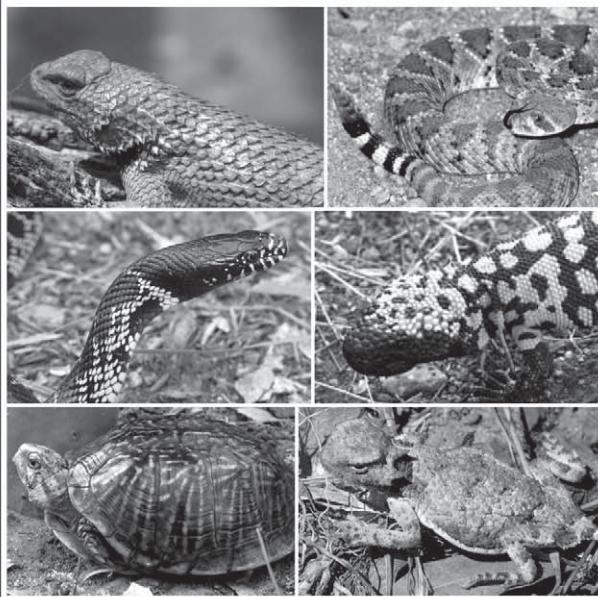
The author mentions (page 347) that 'only the larger species of lizards are of any value as food,' and the only lacertilians in the recipes he provides are *Iguana*, *Ctenosaura* and *Varanus* (there is one recipe using *Tiliqua* in the indigenous section). The back cover however shows the preparation of *Leiolepis*, a genus lizards of modest size, but there is no mention of that genus inside the book. But the author clearly specifies that there are many cookbooks and published recipes that he did not consult, especially from Asian, Australian, European, and South American sources.

Reading the text it is obvious that the author has a wide experience in herp cooking, and knows his subject very well. He provides useful tips for the best ways to cut meat and the most savory parts in turtles and crocodiles. Besides the cover photographs, the book contains a single figure (page 92), very schematic, showing Alligator meat cuts. Given the author's experience, one would have hoped to get such drawings for the other kinds of animals treated in the book, at least at the level of order.

Due to the general lack of information on the species used and the countries where they are used, the book provides a too limited an ethnoherpetological content to belong to a strictly herpetological library. It is, however, an excellent addition to any kitchen bookshelf. I recommend it not only for the numerous delicious recipes presented, but also for a number of other sakes. For instance, it should be shown to your neighbor, whose pet turtles are growing too big and who envisages releasing them in the wild. Or, it may be of special value if you live in an area where many herps are found dead on the road. Or it can help to creatively combat exotic invasive species, as the author himself suggests (the book contains nice recipes to cook *Bufo marinus*, *Rana catesbeiana*, etc.); this answers, in part, the publisher's worries regarding conservation. Many recipes, some of them very appetizing, are proposed for preparing rattlesnakes, which can in some aspects pose real safety issues. The book gives ideas for the use of alternative, cheaper, protein resources that are often neglected, even in periods of economic crisis. This book is, in general, an invitation to remind to the omnivorous species we are that there is more to eat than the few hormone-grown, warm-blooded animal species on sale at the corner supermarket.

Dermochelys coriacea (Leatherback Sea Turtle). Illustration by Jackson Shedd (www.jacksonshedd.com).

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