6-1999

Does the Water Dragon, Physignathus lesueurii (Gray 1831), Occur in New Guinea?

Gregory J. Watkins-Colwell

Greg Johnston

Herpetological Review

Volume 30, Number 2 — June 1999

HERPETOLOGICAL REVIEW

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

SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

WWW: http://falcon.cc.ukans.edu/~gpisani/SSAR.html

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 1999 in the Society for the Study of Amphibians and Reptiles are as follows: Individual membership US$50; Student membership $30; Family membership $60. Institutional subscription $95. $16 of the amount of a membership pays for a subscription to *Herpetological Review* for one year. $21 of the amount of a membership pays for a subscription to *Journal of Herpetology* for one year. Remaining funds help support Society activities. Additional fee for air mail postage outside USA $35 for one year. Institutional subscriptions for *Herpetological Review* are $70 and individual subscriptions may be purchased for $30. 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*. Subscription to the *Catalogue of American Amphibians and Reptiles*: Individuals $20; Institutions $25.

Payment must be made in USA funds, payable to "SSAR," or by International Money Order, or with VISA or MasterCard (account number and expiration date must be provided). Payment should be sent to: Robert D. Aldridge, SSAR Treasurer, Department of Biology, Saint Louis University, St. Louis, Missouri 63103, USA. Fax: (314) 977-3658; e-mail: ssar@sluvca.slu.edu.

Future Annual Meetings

2000 — Universidad Autónoma de Baja California Sur, La Paz, BCS, México, 14–20 June 2000 (Carlos Villavicencio, Chair).

About Our Cover: *Hoplocercus spinosus*

South and east of the great basin of the Amazon, the Central Plateau slopes gently across the face of Brazil. Among the distinctive biomes that etch its surface is a region of savannas and twisting gallery forests filled with glabrous, deep-rooted trees with names like *Curatella*, *Piptadenia*, and *Kielmeyeria* (Eiten 1972. Bot. Rev. 38:201–341; UNESCO 1981. Vegetation Map of South America. Explanatory Notes. UNESCO, Paris, 189 pp.). The canopy is low, perhaps 15 meters in height, wrapped around granitic outcrops, and studded with titanium-hard termite mounds. Dry-season fires burn away the dense grass cover brought by the rains. This is Brazil's cerrado. Second only to the Amazon Basin in extent (it covers about 2,000,000 km^2), the cerrado has, until recently, languished while research centered on the Amazon and Brazil's dwindling Atlantic forest (Vanzolini 1963, *In* Simpósio sobre ô Cerrado, Ed. Universidade, São Paulo, pp. 307–321). Perhaps owing to its ragged appearance—cerrado is a mosaic of xeric scrub, buritî palm stands, and open formations—it has been viewed as wasteland, and thus has been destroyed at an alarming rate. In the present decade, over 60% of cerrado has been eradicated or altered seriously. Not only is it fire that sculpts the cerrado, but also ferocious cycles of insolation and irradiation that can encompass as much as 45°C in 24 hours. Permeable soil has provided favorable habitat and much of the region's fauna is fossorial and nocturnal. There are even subterranean trees with only the branches exposed (Cabrera and Willink 1973. Biogeografía de América Latina. OAS, Washington, 120 pp.)!

The lizards depicted on the cover are Brazilian Spinytails, *Hoplocercus spinosus*, a species endemic to cerrado. Much like *Sauromalus* of North America, these lizards retreat into tunnels and inflate the body when threatened. The burrows, usually beneath stones, contain an enlarged terminal chamber. *Hoplocercus* emerge to bask or in the evening to forage; otherwise they tend to remain at the burrow's entrance, with just the spiny tail exposed (Nascimento et al. 1988. Bol. Mus. Pa. Emilio Goeldi, ser. 4:21–66). Spinytails are monotypic, sharing affinities with *Morunasaurus* and *Enyalioides*. Collectively, these genera comprise the Hoplocercidae. They are sexually dimorphic and the banded males display shades of rust and yellow during the breeding season. Spinytails are not known to exceed 150 mm in length, and their diet consists of a variety of arthropods (Carvalho 1949. Publ. Av. Mus. Nac. 5:7–19.). Their distribution, like that of many other cerrado lizards, is patchy (Vitt and Caldwell 1993. J. Herpetol. 27:46–52). They occur in Mato Grosso, Goiás, Maranhão, southern Pará, and Rondônia (Ávila-Pires 1995. Zool. Verh. Leiden 299:1–706; Sick 1951. Natur und Volk 81:30–35.).

The cover is a composite of three photographs, all taken at the Serra da Mesa Hydroelectric Reservoir on the upper rio Tocantins in Goiás, Brazil. The photographer, **Danté Fenolio**, used a Minolta 9xi camera, Fuji Velvia film, and a 100mm Minolta macro lens with flash (lizards), and a 24mm Minolta lens plus natural light (cerrado background). Danté, who is Director of the Amphibia Research Group, will soon begin graduate studies at the University of Oklahoma. He worked in Brazil courtesy of Dr. Nelson daSilva, with financial support provided by FURNAS - Centrais Elétricas S.A. and VBC Energia S.A.

Separation and imaging of Fenolio's photographs is the work of **Jim Bridges** of Herpeto, Inc., Hollywood, Florida.

SSAR BUSINESS

SSAR Grants-in-Herpetology Committee Annual Report (1999)

An award in the amount of $500 was made to each of the following individuals:

Field Studies.—**W. Bryan Jennings**, University of Texas. Project title: "Ecological morphology of Australian pygopodid lizards."

Laboratory Studies.—**Jonathan Q. Richmond**, San Diego State University. Project title: "Evolution of the *Eumeces skiltonianus* species group (Squamata: Scincidae), with emphasis on the phylogeography of *Eumeces gilberti*."

Conservation.—**Daniel W. Carpenter**, Brigham Young University. Project title: "Conservation genetics and preservation of the endangered Shenendoah salamander (*Plethodon shenandoah*)."

Travel.—**Wendy L. Hodges**, University of Texas. Project title: "Phylogenetic components in the evolution of ecological traits in a unique lizard genus, *Phrynosoma*."

International.—**Irena Grbac**, Croatian Natural History Museum. Project title: "Seasonal variation in thermoregulatory behavior in the lizards *Podarcis muralis* and *Podarcis melisellensis*."

Education.—**Catherine Lynch**, ZooMontana. Project title: "Amphibian surveys for Montana."

1999 Grants-in-Herpetology Committee.—Dawn Wilson, University of Nevada-Reno; Jill Wicknick, John Carroll University; Tod Reeder, San Diego State University; Richard King, Northern Illinois University; Anne Maglia, University of Kansas; David Kizirian, Los Angeles County Museum of Natural History; Michael Dorcas, Davidson College; Peter Ducey, State University of New York at Cortland; Christopher Beachy, Minot State University; Joseph Mendelson III (Chair), Utah State University.

SSAR congratulates the 1999 GIH recipients and thanks the committee members for their efforts.

NEWSNOTES

Upstate Herpetological Association Grants

The Upstate Herpetological Association is now accepting applications for a grant in the amount of US $1,000. This grant is intended to support herpetological conservation, education, or research. All proposals must be received on or before 30 September 1999. The successful applicant will be notified on or about 15 December 1999.

Successful applicants will be expected to submit a report of their work for publication in the Association's newsletter, the *Herp Beat*, and/or give a presentation to either the Albany or Syracuse Chapter of the UHA. Successful applicants are expected to acknowledge UHA's support in any publications that result in whole or in part based on funding by UHA.

Applicants should include the purposes for which the grant is requested, the uses to which the grant will be put, and enough background information on the applicant to enable the reviewers to access the applicant's ability to accomplish the grant objectives. A

letter of reference from a person familiar with the applicant's work in the field is desirable but not mandatory. All applications should include a completion date for the project. All applications should be typed, double spaced, and are not to exceed five pages.

The UHA reserves the right to reduce the grant, divide the grant between two or more individuals, or make the grant to an organization as a whole. All proposals will be considered, but preference will be given to original research, New York herpetology, and captive husbandry and propagation of reptiles. Applicants need not be members of UHA.

Questions and applications should be directed to: *Upstate Herpetological Association, c/o Robert C. Cunningham, 409 Waldorf Parkway, Syracuse, New York 13224-2241, USA; e-mail: rcunn1@twcny.rr.com; Tel. 315-446-9292.*

Brett Stearns Award for Chelonian Research at the California Academy of Sciences

The Department of Herpetology is pleased to provide limited financial aid—mostly to cover round-trip transportation and limited per diem expenses—to researchers who wish to visit our collections to support their work in chelonian biology. Preference will be given to graduate students.

Proposals should include a short, one page description of the research project and a budget. In the case of graduate students, a letter of support from the student's faculty advisor is required.

Proposals are due on 15 October 1999; notification will be made by 1 December 1999. Awardees are expected to complete their Academy visit by 15 September 2000. Please call (415) 750-7039 for further information.

Proposals should be sent to: *Herpetology Research Grants, Department of Herpetology, California Academy of Sciences, Golden Gate Park, San Francisco, California 94118-4599, USA.*

The CAS chelonian holdings are included in the Department of Herpetology database: www. calacademy.org.

Charles Stearns Grant-in-Aid for Herpetological Research at the California Academy of Sciences

The Department of Herpetology is pleased to provide limited financial aid—mostly to cover round trip transportation and limited per diem expenses—to graduate students who wish to visit our collections to support research in systematics.

Proposals should include a short—no more than one page—description of the research project, a budget, and a letter of support from the student's faculty advisor.

Proposals are due on 15 October 1999, with notification by 1 December 1999. Grantees are expected to complete their Academy visit by 15 September 2000. Please call (415) 750-7037 for further information.

Send proposals to: *Herpetology Research Grants, Department of Herpetology, California Academy of Sciences, Golden Gate Park, San Francisco, California 94118-4599, USA.*

Gopher Tortoise Council Awards

The Gopher Tortoise Council annually presents the J. Larry Landers Student Research Award to the best student research project concerning the biology of the gopher tortoise, *Gopherus polyphemus,* or any other relevant aspect of upland habitat conservation. Recent awards have been given for studies on striped newts and red cockaded woodpeckers. The amount of the award is variable, but has been limited to $1000. A proposal should consist of a maximum of four pages and should include a description of the project, a budget, and a brief resume of the student. Proposals should be sent to: *Bob Herrington, Chair, Research Advisory Committee, Department of Biology, Georgia Southwestern State University, Americus, Georgia 31709, USA.* Deadline for receipt of proposals to be considered for the 1999 award is 31 August 1999.

Literature Support Requested for Colección Boliviana de Fauna

The Colección Boliviana de Fauna (CBF) was established in 1990 under an agreement between the National Museum of Natural History (Bolivia) and the Institute of Ecology of the Universidad Mayor de San Andrés (La Paz, Bolivia). Its main goals are to develop a voucher collection of Bolivian fauna and to promote scientific research in zoology.

Currently, one of the priorities of the Herpetology Division is to improve the research library in order to offer better literature support to researchers and students at local and national levels. The CBF is seeking donations of any reprints, research reports, or other documents pertaining to Bolivian herpetology. Donations should be sent to: *James Aparicio E., Curator, Herpetology Division, Colección Boliviana de Fauna, P.O. Box 8706, La Paz, Bolivia. E-mail: herpeto.cbf@mail.megalink.com.*

Wildlife Links: Request for Proposals

The National Fish and Wildlife Foundation, through a cooperative agreement with the United States Golf Association, requests pre-proposals for projects that address wildlife conservation needs on golf courses. Areas of interest include: analysis of management and design techniques for increasing biodiversity on golf courses; research to determine if certain habitat characteristics result in wildlife corridors or barriers on golf courses; preparation of management guidelines for specific species or species suites; programs to monitor the success of wildlife habitat conservation programs on golf courses; and the effects of golfer and maintenance activities on wildlife. All projects must address issues of direct management concern to the golf industry, and should provide management recommendations applicable on at least a regional basis. In addition, proposals should indicate that golf courses have been contacted and will be formal project partners. Request should not exceed $25,000 per year, yet multi-year funding is possible. Deadline for pre-proposals is 16 July 1999. Applicants will be notified by the end of July if a full proposal is requested. Full proposals will be due by 14 September 1999, with funding available in February of 2000. For pre-proposal guidelines, please visit the National Fish and Wildlife Foundation's website: http://www.nfwf.org/nfwfusga.htm or contact Katie Distler, NFWF, via e-mail: distler@nfwf.org.

MEETINGS

Meetings Calendar

6–10 September 1999—10th Ordinary General Meeting of the Societas Europaea Herpetologica, Natural History Museum of Crete (University of Crete), Irakleio, Crete (Greece). Contact: Natural History Museum of Crete, University of Crete, Knosou Av, 71409, Irakleio, Crete. Tel./fax +30 81 324 366; e-mail: nhmc_vtb@cc.uch.gr.

2–4 October 1999—Australian Herpetological Society, 50th Anniversary Conference on Captive Husbandry and Conservation of Reptiles, Sydney, Australia. Contact: Daniel Holloway (e-mail: ozherps@zip.com.au) or visit the Society's web page (www.ozherps.zipworld.com.au).

5–9 October 1999—The Sixth Annual Conference of the Association of Reptilian and Amphibian Veterninarians, Columbus, Ohio, USA. For conference registration information contact: Wilbur Amand, VMD, PO Box 605, Chester Heights, Pennsylvania 19017, USA; fax: 610-892-4813.

8–11 October 1999—Second Symposium on the Status and Conservation of Florida Turtles, Eckerd College, St. Petersburg, Florida, USA. Contact: Gopher Tortoise Council, c/o George L. Heinrich, 1223 Alhambra Way S., St. Petersburg, Florida 33705-4620, USA; tel. (813) 865-6255; e-mail: highpine@gte.net.

15–18 October 1999—Canadian Amphibian and Reptile Conservation Network/Rèseau Canadien de Conservation des Amphibiens et des Reptiles Annual Meeting, Quèbec City, Quèbec, Canada. *(Refer to detailed information below).*

12–17 December 1999—5th Latin American Congress of Herpetology, University of Uruguay, Montivideo, Uruguay. Abstract deadline 30 June 1999. For registration and information contact: Lic. José A. Langone, Secretario Ejecutivo V CLAH, Museo Nacional de Historia Natural, CC 399, 11000 Montivideo, Uruguay (e-mail: vclah@fcien.edu.uy). Within the U.S. or Canada, contact: Dr. Rafael de Sá, Department of Biology, University of Richmond, Richmond, Virginia 23173, USA (e-mail: rdesa@richmond.edu). Web site: http://zvert.fcien.edu.uy/clh.

International Symposium on Herpetological Education: Call for Papers

As part of the 1999 annual meeting of the Canadian Amphibian and Reptile Conservation Network/Rèseau Canadien de Conservation des Amphibiens et des Reptiles, a full day has been set aside for the symposium: "Perspectives on Herpetological Education and its Relation to Conservation Biology." The CARCNet meeting will be held in Quèbec City, 15–18 October 1999, and the symposium is scheduled for 15 October.

Further information is available from the co-organizers: Stan A. Orchard, Chairman, CARCNet, 1745 Bank Street, Victoria, British Columbia, Canada V8R 4V7; Tel/Fax: 250-595-7556; e-mail: sorchard@islandnet.com; Henry R. Mushinsky, Department of Biology/Center for Urban Ecology, University of South Florida, Tampa, Florida USA, 33620-5150; Tel: 813-974-5218; Fax: 813-974-3263; e-mail: Mushinsk@chuma1.cas.usf.edu.

LEGISLATION & CONSERVATION

This column serves to update the herpetological community on the regulatory status and protection measures implemented for rare, threatened, and endangered amphibians and reptiles and their habitats. Please direct all communications to the section editor, Jeffery Demuth (postal and e-mail addresses on inside front cover).

USA: U.S. Fish and Wildlife Service: Effective May 3, 1999 the flatwoods salamander (*Ambystoma cingulatum*) will be protected as a threatened species under the Endangered Species Act. Flatwoods salamanders occur throughout the southeastern U.S. coastal plain of Florida, Georgia, and South Carolina. The following factors are listed as primary causes for threatened status.

First, habitat alterations from agriculture, urbanization, and silvicultural practices have resulted in loss of approximately 82% of the salamander's historical habitat. The losses of both terrestrial and breeding habitats are the primary cause of decline throughout the species' range. Second, there were inadequate existing regulatory mechanisms to protect critical habitats. No federal protection is currently afforded the necessary non-breeding habitats and only limited protection for breeding sites under the Clean Water Act. State regulations in Georgia and South Carolina prohibit direct take of flatwoods salamanders but do not protect habitat. Third, "other natural or manmade factors affecting its continued existence" include fire management, habitat fragmentation, and pesticide (and herbicide) use. Fire suppression is a contributor to the degradation of remaining longleaf pine forests that are primary habitat for *A. cingulatum*. Habitat fragmentation results in decreased opportunity for recolonization after local extinction and disruption of breeding migration routes. Agricultural chemicals pose a variety of threats via direct absorption through the skin and habitat degradation. Finally, overutilization for commercial, recreational, scientific, or educational purposes is listed as a potential threat.

The determination not to designate critical habitat was made on the basis that publication of breeding localities might lead to increased vulnerability to illegal collecting. The final rule lists several activities that would likely violate the Endangered Species Act by affecting *A. cingulatum* breeding sites and surrounding habitat within 450 meters. Additional information can be located in the *Federal Register* 64(62):15691–15704.

Questions regarding this listing should be directed to: *Linda LaClaire, Jackson Field Office, U.S. Fish and Wildlife Service, 6578 Dogwood View Parkway, Suite A, Jackson, Mississippi 39213, USA. Tel: 601/965-4900 ext. 26, e-mail: linda_laclaire@fws.gov.*

USA: U.S. Geological Service – Biological Resource Division: A new long-term frog and toad monitoring program has been launched by the USGS – BRD. The new program, entitled Frogwatch USA, aspires to engage the public in conservation, while helping to compile information about frog and toad population distributions, population trends at individual wetlands, and yearly calling phenologies. Volunteers and scientists from the United States, including Puerto Rico and the Virgin Islands, can contribute to the Frogwatch USA effort by periodically monitoring a convenient wetland site for the presence of calling frogs and toads. After surveying the wetland, they can directly submit their findings via the Frogwatch USA website: www.mp2-pwrc.usgs.gov/frogwatch/www.mp2-pwrc.usgs.gov/frogwatch/. At the end of each season, results will be posted on the website. Potential participants should visit the website to register and find out more information.

The Frogwatch USA initiative is independent from both the North American Amphibian Monitoring Program (www.mp1-

pwrc.usgs.gov/amphibs.htmlwww.mp1-pwrc.usgs.gov/amphibs.html) and the North American Reporting Center for Amphibian Malformations (www.npwrc.usgs.gov/narcam/). The three programs are all concerned with amphibian monitoring and conservation and are overseen by the USGS – BRD, but each program requires different data collection (see websites).

For more information on Frogwatch USA contact: *Gideon Lachman, Frogwatch Coordinator, Patuxent Wildlife Research Center, USGS-BRD, 12100 Beech Forest Road, Laurel, Maryland 20708-4038, USA. Tel: (301) 497-5819, Fax: (301) 497-5784, e-mail: FROGWATCH@usgs.gov.*

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 wide 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, Anne Maglia or Christopher Sheil; postal and e-mail addresses may be found on the inside front cover. Comments and suggestions are also welcome.

The current contents of various herpetological publications can now be found on the World Wide Web. At present, more than 20 publications are listed. The Web site address is:

http://www.herplit.com/contents

Herpetofauna as Predators of Killer Flatworm?

The terrestrial flatworm *Bipalium adventitium* was introduced to the United States from Asia earlier this century, and in the last 40 years, it has become widespread in suburban gardens and lawns. It is a fierce predator of earthworms that kills its prey by covering it with digestive enzymes, which turn the earthworm into a pink viscous mass. The invasion of this exotic predator may have severe ecological consequences, particularly if there is no native species that preys upon the flatworm. Because herpetofauna often prey upon soil invertebrates, Ducey et al. examined whether six species of salamanders and two species of snakes would eat *B. adventitium* offered to them in the laboratory. They found that none of the herpetofauna treated the flatworm as a prey item. The authors suggest that a combination of gliding movements, chemosensory clues, and distasteful secretions make the flatworms an unlikely prey item for salamanders and snakes.

Ducey, P. K., M. Messere, K. Lapoint, and S. Noce. 1999. Lumbricid prey and potential herpetofaunal predators of the invading terrestrial flatworm *Bipalium adventitum* (Turbellaria: Tricladida: Terricola). Am. Midl. Nat. 141:305–314.

Correspondence to: Peter K. Ducey, Department of Biological Sciences, State University of New York at Cortland, Cortland, New York 13045, USA.

Turtle Densities and Deadwood in Southern River Drainages

Deadwood is an important component in the ecology of river map turtles because they utilize this substrate for basking, foraging, and resting/sleeping. To determine the basking frequencies of five map turtles and the relationship between deadwood abundance and turtle abundance, Lindeman conducted spotting-scope counts of basking turtles in Missisippi, Louisiana, and Kentucky. He found that there was a correlation between low numbers of basking turtles and lack of deadwood in rivers and that some populations, such as *Graptemys flavimaculata* from the Pascagoula drainage, were spotted in much lower densities than expected. Based on these results, he suggests that the practice of "snagging" (the removal of deadwood from river channels) should be limited and that *G. flavimaculata* habitat in the Pascagoula drainage should be protected.

Lindeman, P. V. 1999. Surveys of basking map turtles *Graptemys* spp. in three river drainages and the importance of deadwood abundance. Biol. Conserv. 88:33–42.

Correspondence to: Peter Lindeman, Division of Biological Sciences and Related Technologies, Madisonville Community College, 2000 College Drive, Madisonville, Kentucky 42431, USA; e-mail: LPeter0@pop.uky.edu.

Salamanders as Keystone Species in Carolina Ponds

Keystone species are organisms that when removed from a community will result in a decline of species richness. Fauth tested for keystone species in several South Carolina ponds by trapping, dipnetting, and using call censuses. He compared the species diversity of the ponds with the presence/absence of several species and found that, although *Notophthalmus viridescens* and *Siren intermedia* were found to be keystone species in previous studies, there was no evidence of these taxa as keystones in the South Carolina ponds. He did find that *Ambystoma talpoideum* was a keystone species. He concludes that the identity of keystone species varies regionally and with pond characteristics, and several species may be functional equivalents in the role of keystone species.

Fauth, J. E. 1999. Identifying potential keystone species from field data—an example from temporary ponds. Ecology Letters 2:36–43.

Correspondence to: John E. Fauth, Department of Biology, University of Charleston, 66 George Street , Charleston, South Carolina 29424-0001, USA; e-mail: fauthj@cofc.edu.

Neural Bones Distinct in Indian Ocean Giant Tortoises

The carapase of turtles is made up of several dermal bones; of these, the neural bones, which lie over top of the vertebral column, are the most structurally significant. In an investigation of the neural bones of six species of *Dipsochelys*, Gerlach found that the anterior neurals (I–V) vary less in structure than the posterior neurals and that the different species of *Dipsochelys* can be identified by particular arrangements of these bones. He suggests the arrangement of neurals relates to carapace shape (e.g., domed, flattened) and the structures associated with functional stability in these taxa.

Gerlach, J. 1999. Distinctive neural bones in *Dipsochelys* giant tortoises: Structural and taxonomic characters. J. Morphol. 240:33–38.

Correspondence to: Justin Gerlach, 53 River Lane, Cambridge CB5 8HP, United Kingdom; e-mail: gerlach@bogo.co.uk.

Dwarf Chameleon Morphology: Evidence for Species Validity

The taxonomic status of the dwarf chameleons (*Brookesia*) of Madagascar has been the subject of several recent studies, many of which have questioned the validity of several species. Because it had been suggested that *B. tuberculata* and *B. peyrierasi* are synonyms of *B. minima,* Glaw et al. examined the external morphology, particularly the hemipenial structure, of these three taxa. They found several morphologies that differ among the taxa and suggest that each should be considered a distinct species. The authors also discuss several biogeographic considerations for these taxa.

GLAW, F., M. VENCES, T. ZIEGLER, W. BÖHME, AND J. KÖHLER. 1999. Specific distinctness and biogeography of the dwarf chameleons *Brookesia minima, B. peyrierasi* and *B. tuberculata* (Reptilia: Chamaeleonidae): Evidence from hemipenial and external morphology. J. Zool. Lond. 247:225–238.

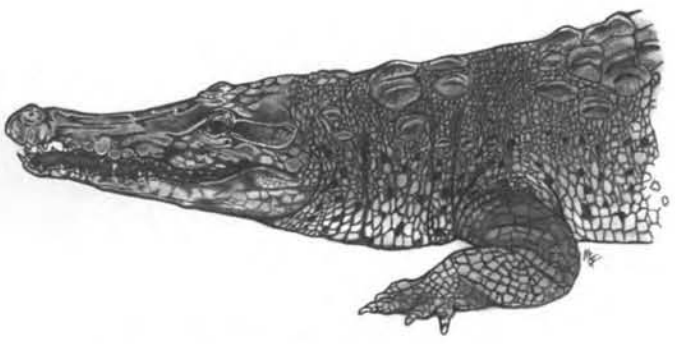
Correspondence to: Frank Glaw, Zoologische Staatssammlung, Münchhausenstrasse 21, D-81247 München, Germany; e-mail: uzs13b@uni-bonn.de.

Mass Amphibian Mortality Linked to Fungus?

Global interest in the decline of amphibian populations has sparked numerous studies geared toward identifying factors responsible for reduction in population numbers. Of particular concern are unhealthy populations that are located in protected areas, because factors causing their decline may be global in nature. Lips monitored a community of amphibians from the Reserva Forestal Fortuna, a protected forest in western Panamá. Through surveys of terrestrial amphibians conducted over a four-year period, she found declines in the number and diversity of amphibians in the area. While conducting stream surveys, she found numerous dead or dying frogs, all of which had high levels of a fungal infection. She also found that a high percentage of tadpoles living in these streams had severe developmental abnormalities. She suggests that the severe population declines of amphibians in western Panamá (and potentially around the world) are caused proximally by a highly contagious fungal infection, but that there are most likely environmental factors working in synergy to precipitate the mortality.

LIPS, K. R. 1999. Mass mortality and population declines of anurans at an upland site in western Panama. Conserv. Biol. 13:117–125.

Correspondence to: Karen R. Lips, Department of Zoology, Southern Illinois University, Carbondale, Illinois 62901-6501, USA; e-mail: klips@zoology.siu.edu.



Crocodylus acutus. Illustration by Michael Frick.

OBITUARIES

Biographical Sketch of Miguel Alvarez del Toro (Don Miguel): 1917–1996

OSCAR A. FLORES-VILLELA
Museo de Zoología, Facultad de Ciencias, UNAM
Apartado Postal 70-399, México, D.F. 04510, México
e-mail: ofv@hp.fciencias.unam.mx

and

WENDY L. HODGES
Department of Zoology, University of Texas at Austin
Austin, Texas 78712, USA

The herpetological community primarily associates the name Miguel Alvarez del Toro with the famous book "Los Reptiles de Chiapas" published in three editions (1960, 1972, and 1982), and with the zoological park of Tuxtla Gutiérrez, Chiapas, now known as ZOOMAT "Zoológico Regional Miguel Alvarez del Toro," in his honor. But "Don Miguel," as he was known to most of us who had the honor to meet him, was also dedicated to the endless battle of conservation of the wilderness of Chiapas.

Miguel Alvarez del Toro was born in the city of Colima, capital city of the state with the same name, on August 23, 1917. He was an avid collector and observer during his childhood in Colima. In 1932, his family moved to Mexico City where he finished high school and later got his first jobs in natural history. Although his formal education ended at the high school level, his self-taught natural and zoological expertise later earned him honorary doctorates from the Universidad de Chapingo (1992) and the Universidad Autónoma de Chiapas (1993).

At the age of 21, Don Miguel collected birds for the Academy of Natural Sciences of Philadelphia from areas surrounding Mexico City. From 1939 to 1940 he was a taxidermist ("Técnico preparador") for the "Museo de Flora y Fauna, dependiente del Departamento Autónomo Forestal y de Caza y Pesca" in Mexico City. He became subdirector of the same museum in 1940 and remained there until 1941.

In 1942, he moved to Chiapas and accepted the position "Zoólogo General" of the "Departmento de Viveros Tropicales y Museo de Historia Natural," currently known as the "Instituto de Historia Natural." He was appointed director two years later after the premature death of the former director, and he remained in that position until his death in 1996.

Although Alvarez del Toro began as an ornithologist, his expertise extended into other fields of zoology such as mammalogy, arachnology, and herpetology. He was also a pioneer of conservation biology, and his reputation in this field earned him worldwide recognition. He received the Alfonso L. Herrera medal for merit in ecology and conservation (1985), the Paul Getty award for conservation of nature (1989), membership on the UNEP honor roll for

environmental achievement (1992), the national forestry and wildlife merit prize from the secretary of agriculture and water resources of México (1993), and the national merit prize in ecology from the secretary of ecology and social development of México (1994), among numerous other recognitions and achievements.

Don Miguel was a prolific writer, writing for the layman as well as for the scientific community. His literary works include nine books, over 70 scientific and popular publications, and countless newspaper articles. His contributions to the herpetological literature include 15 scientific manuscripts (see Appendix 1) and three books, "Los Animales Silvestres de Chiapas" (1952), "Los Reptiles de Chiapas" (1960, 1972, and 1982), and "Los Crocodylia de México" (1974). In 1985, he wrote his memoirs, "¡Asi era Chiapas!"

In recognition of his work, six species and four subspecies bear his name:

Diaethria mixteca alvarezi (Insecta)
Dismorphia crisia alvarezi (Insecta)
Pulex alvarezi (Insecta)
Troglopedetes toroi (Insecta)
Piranga bidentata alvarezi (Aves)
Anolis alvarezdeltoroi (Reptilia)
Coniophanes alvarezi (Reptilia)
Lepidophyma alvarezi (Reptilia)
Heloderma horridum alvarezi (Reptilia)
Nototriton alvarezdeltoroi (Reptilia)

Probably his most important work was "Los Reptiles de Chiapas," a book published in three editions (a fourth edition has been in press for several years). This may be the most important work in herpetology ever published by a Mexican national and has been the standard reference on reptiles of southern México. It contains numerous observations on the natural history of species inhabiting Chiapas, the majority of them original. This book stands as a testament to his skillful and detailed observations in the field.

Alvarez del Toro also published "Los Crocodylia de México," the product of his efforts and careful studies to preserve the crocodilian fauna of México. This project was funded by the WWF and CONACyT (Consejo Nacional de Ciencia y Tecnología), and was partially conducted at the zoo in Tuxtla Gutiérrez.

The zoo at Tuxtla Gutiérrez was another example of his dedication to nature, conservation, and education. He was the director of the zoo for 52 years. His objective was to teach people about their immediate surroundings, instilling a sense of pride and value in nature that would prompt them to actively support conservation in Chiapas. In 1980, the zoo was moved to a new location, "El Zapotal," a tropical forest very close to Tuxtla Gutiérrez. In this environment, he created a zoo unique among all zoos in the world by exhibiting only native animals of Chiapas, both vertebrates and invertebrates.

Don Miguel was instrumental in the design of a system of protected areas in Chiapas, some of which are now managed by the Instituto de Historia Natural. His desire was to preserve at least a sample of all the natural habitats of the state. Thanks to his efforts, Chiapas has more protected zones with the highest cumulative protected area than any other state in México.

For all of us who had the pleasure to know Don Miguel, he was a leading figure, an example to follow, and in many respects a true mentor. When he died at the age of 79 on the second of August, 1996, in Chiapas, the world lost a superb naturalist, a great conservationist, and a generous human being. His last desire was that his ashes be dispersed in La Selva del Ocote.

Acknowledgments.—We extend our appreciation to Becky and Hebe Alvarez Rincon for providing information about their father. Alfredo Cuaron and Aldolfo Navarro sent proofs of their articles. We thank Kraig Adler for providing the photograph of Don Miguel.

APPENDIX 1
Publications of Miguel Alvarez del Toro

1952. Los Animales Silvestres de Chiapas. Gobierno del Estado de Chiapas. Tuxtla Gutiérrez, Chiapas. 247 pp.
1956. Notulae herpetologicae chiapasiae I. Herpetologica 12(1):3–17. (in co-authorship with H. M. Smith).
1958. Notulae herpetologicae chiapasiae II. Herpetologica 14(1):15–17. (in co-authorship with H. M. Smith).
1959. Reptiles venenosos de Chiapas (falsos y verdaderos). ICACH (2):10–22.
1960. Los Reptiles de Chiapas. Instituto Zoológico del Estado/Gobierno del Estado de Chiapas/ICACH. México. 204 pp. (1973 second edition, 1982 third edition).
1962. Notulae herpetologicae chiapasiae III. Herpetologica 18(2):101–107. (in co-authorship with H. M. Smith).
1963. Notulae herpetologicae chiapasiae IV. Herpetologica 19(2):100–105. (in co-authorship with H. M. Smith).
1969. Breeding the spectacled caiman, *Caiman crocodilus*, at Tuxtla Gutiérrez Zoo. International Zoo Yearbook 9:35–36.
1971. Centro de repoblación del cocodrilo de pantano (*Crocodylus moreletii*). Revista ICACH, Segunda Época 2/3:15–17.
1972. Trabajos para la protección de los cocodrilianos en Chiapas. *In* E. Beltrán et al. (eds.), Aspectos Internacionales de los Recursos Renovables de México. IMERNAR. 87–95.
1972. The WWF project on crocodiles in Chiapas. 37th North American Wildlife Conference. Wildlife Management Institute, pp. 81–86.
1973. Krokodile vons aussterben bedroht! UMSCHAU 73(20):629–630.
1974. Los Crocodylia de México (estudio comparativo). IMERNAR. México, D.F. 70 pp.
1975. Morelet´s crocodile. Wildlife Conservation Yearbook 1975:88–91.
1977. A new troglodytic lizard (Reptilia, Lacertilia, Xantusiidae) from Mexico. Journal of Herpetology 11(1):37–40. (in co-authorship with H. M. Smith).
1979. River turtle in danger. Oryx 15(2):170–173. (in co-authorship with R. A. Mittermeier and J. B. Iverson).
1980. A range extension for *Thecadactylus rapicaudus* (Gekkonidae) in Mexico, and notes on two snakes from Chiapas. Bulletin of the Maryland Herpetological Society. 16(2):49–51. (in co-authorship with O. Sánchez).
1983. Comparisons of pattern and color in life of the subspecies of the turtle *Pseudemys scripta* in Chiapas, Mexico. Bulletin of the Maryland Herpetological Society. 18(4):194–195. (in co-authorship with H. M. Smith).

Joseph Randle Bailey
1913–1998

ROGER CONANT
Department of Biology, University of New Mexico
Albuquerque, New Mexico 87131, USA

The death on September 18, 1998, of Joseph Randle "Joe" Bailey ended the career of a distinguished scholar and naturalist who published on all five of the principal groups of vertebrates. His major interest, however, was herpetology, a subject he pursued chiefly in North Carolina and Brazil.

Joe was born September 17, 1913, in Fairmont, West Virginia. His father's name was the same as his, his mother was Elizabeth Weston Maclaren. There was another son, Reeve Maclaren Bailey, who was two years older than Joe. The elder Joseph was killed in 1915, and Joe's mother raised the two boys at Perrysburg, Ohio, but later moved to Toledo where high school facilities were available. Both young men moved on to and graduated from the University of Michigan with Bachelor's degrees.

Joseph R. Bailey, Ann Arbor, Michigan, 1940. Photograph courtesy of Kraig Adler.

Joe's early interest in ornithology was diverted in large part to herpetology by Helen T. Gaige who was in charge of the Division of Amphibians and Reptiles at the University's Museum of Zoology. In the spring of 1936, Joe met Emmett Reid Dunn when the American Society of Ichthyologists and Herpetologists met in Ann Arbor. Dunn, in appreciation of Joe's interest and enthusiasm, invited him to pursue a Master's degree at Haverford College, for which Joe received a fellowship. Under Dunn's influence, Joe became interested in plethodontid salamanders on which he later published, and he co-authored a paper with Dunn on snakes of the Canal Zone and Darien.

After receiving his Master's, Joe returned to the University of Michigan, from which he received his Ph.D. in 1940. During the summers, in collaboration with James A. Oliver, he worked in New Hampshire on a survey of the Connecticut River Watershed, and they published reports on the amphibians and reptiles and on the fishes in two separate contributions.

Joe then decided he would like to work on snakes of the Neotropics, and he was successful in obtaining an International Exchange Fellowship to Brazil for the period of 1940–1942, the first of four sponsored sessions of work in the largest country in South America. He quickly absorbed Portuguese. Successively, he became a Guggenheim Memorial Foundation Fellow (1953–1954), a Fulbright Lecturer (1961) at the University of São Paulo where he was required to address classes in Portuguese, and a Duke Endowment Grant to South America (1966). He published several papers on Brazilian herpetology alone or with Antenor de Carvalho.

The entrance of the United States into World War II occurred while Joe was in Brazil. He asked the American Embassy what he should do, and he was told to continue his work. When he returned to the States in 1942, he was drafted into the Army Air Corps and was promptly sent back to Brazil, probably because of his familiarity with the language. He remained for a year as a member of a photo mapping squadron. After attending Officers Training School in Georgia, he was dispatched to Hawaii where he was stationed as an Aviation Physiologist until he received he discharge in June, 1946.

Joe returned to Ann Arbor to work at the University Museum. There he met Dorothy "Mike" O'Donnell, who had both a Bachelor's and Master's from Michigan. She was a skilled cartographer and illustrator. She and Joe were married on September 7, 1946, and they became a pair-bonded and inseparable couple. She never became as fluent in Portuguese as her husband, but their daughter, Patricia, even yet visits Brazil frequently in a professional capacity. A son, Robert "Mickey," is in business in North Carolina.

Joe applied for a faculty position at Duke University about the time of his marriage. He was successful, and the Baileys moved to Durham, North Carolina, which became their permanent home. Foreign travel was not over yet, however. He made his later trips to Brazil and, during 1970–1971, Joe was a Senior Scholar (Fulbright) Visiting Professor at James Cook University in Australia. Joe became a full professor at Duke in 1965 and continued in that position until he retired in 1983. He was Curator of the vertebrate collections for 20 years. He worked extensively on the wildlife of North Carolina, and for two summers he was the leader of groups that surveyed the fishes of the mountains.

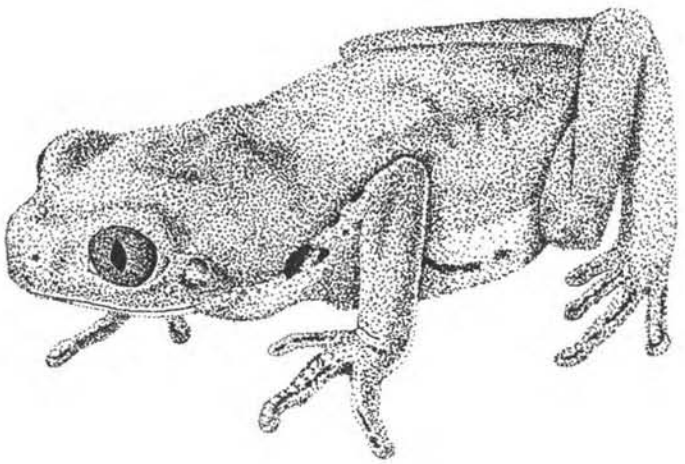
He was active in several organizations. Among them he served as president of the ASIH in 1972 and president of the southeastern division of the same organization in 1958–1959. He was also vice-president of the Highlands Biological Station during 1976–1978.

After retirement Joe kept an office and laboratory at Duke to continue his studies on South American snakes and the herpetology of his home state. He was one of a many-authored team that produced a popular work on the "Amphibians and Reptiles of the Carolinas and Virginia." His career was cut short by a debilitating stroke on November 1, 1995, that he had to endure until his death in 1998.

Joseph R. Bailey and his brother, Reeve, were the first friends I made when I, as a callow youth of 19, took my first professional job as Curator of Reptiles at the Toledo Zoo. We saw each other frequently, and they often accompanied me on field trips to various parts of Ohio as, on my days off, I sought to gather material for my "Reptiles of Ohio."

After I transferred to the Philadelphia Zoo in 1935 and Joe soon went to nearby Haverford College, we saw each other several times. Afterward our meetings were few and intermittent. I had the pleasure of nominating Joe for President of the ASIH. I fear that because of my own research on the water snakes of the Outer Banks, I may have been partially responsible for his selecting Moorehead City, North Carolina, when he served as the local chairman for the 1964 ASIH meeting. I was quite anxious to see Mullet Pond on the nearby Shackleford Banks to which he arranged for overwater transportation for several others and me. None who attended that ASIH meeting will ever forget our headquarters, the Biltmore-Moorehead City Hotel, manned by an inexperienced staff, and during which the ancient structure gradually fell apart in hilarious fashion.

With the death of Joe Bailey, I have lost an esteemed friend and one who had the great respect of his contemporaries.



Phyllomedusa hypocondrialis. Paraguay. Illustration by Dan Erickson.

ARTICLES

Use of Bomb Crater Ponds by Frogs in Laos

BRYAN L. STUART*
and
PETER DAVIDSON
Wildlife Conservation Society Lao Program
P.O. Box 6712, Vientiane, Lao PDR
e-mail: wcslao@loxinfo.co.th

**Current address: Department of Zoology, Box 7617*
North Carolina State University, Raleigh, North Carolina 27695-7617, USA
e-mail: blstuart@unity.ncsu.edu

The Ho Chi Minh Trail used by North Vietnamese and Pathet Lao forces during the Indochinese Conflict (1961–1975) passed through the limestone karst region in east-central Laos (Khammouan Province) that is presently classified as Hin Namno National Biodiversity Conservation Area (NBCA) (Timmins and Khounboline 1996). Aerial bombing of the region during the conflict has left many large craters that today hold water even into the dry season (November–April) (Fig. 1).

Amphibians are known to have colonized a wide variety of human-made sources of water, such as rain and drainage catchments, windmill wells (Burkett and Thompson 1994), rice paddies and their associated concrete ditches (Fujioka and Lane 1997), reservoirs (Boniecki 1996), irrigation canals (Schneider 1997), road-ruts (Adams and Lacki 1993), and ponds at former mine sites (Lacki et al. 1992; Turner and Fowler 1981). D. R. Karns (pers. comm.) found heavy use by both larval and adult salamanders and frogs of crater ponds created by exploded ordnance at a military test site (Jefferson Proving Ground, Indiana, USA). We report here on the use by frogs of the artificial ponds at the bottom of bomb craters formed during wartime in Laos.

Twenty-two craters along a one kilometer stretch of road (17°29.82'N 105°42.41'E to 17°30.09'N 105°42.68'E) slightly west of the Hin Namno NBCA boundary were sampled for presence of amphibians during the dry season in mid-Februrary 1998. The craters were surrounded by secondary growth and scrub, and were within 1 km of large limestone karst formations. Crater ponds were actively searched at night for post-metamorphic frogs. Ten dips were taken with a hand-net at the edge of each pond to standardize detection of amphibian larvae and other aquatic organisms.

FIG. 1. Artificial pond formed by exploded ordnance during the Indochinese Conflict (1961–1975) near the Ho Chi Minh Trail in Khammouan Province, Laos. Photograph by C. M. Francis.

The craters ranged from 20 to 40 m in diameter and from 3 to 5 m in depth, as measured from the surface of the ground. Eleven of the twenty-two craters (50%) contained standing water at the time of sampling. Cracked mud in the bottom of all the dry craters suggested they held water at wetter times of the year. The maximum depth of water in the wet craters ranged from 0.1 to 1.2 m (mean = 0.59, SE = 0.11). The estimated surface area of water in the craters varied from 2 to 250 m^2 (mean = 103.57, SE = 27.91).

No frogs were detected in any of the dry craters. However, larval or adult frogs were detected in all but one of the wet craters (90.9%). Densities of post-metamorphic frogs in the ponds ranged from 0 to 16 (mean = 4.72, SE = 1.43). Larvae were detected in two of the eleven wet craters (18.2%).

Four species of ranid frogs were found in the crater ponds. These were *Hoplobatrachus rugulosa, Rana erythraea, R. limnocharis*, and *Occidozyga martensii*. Additionally, *Bufo melanostictus* and *Microhyla ornata* were found within five meters of four of the wet craters (36.4%), and the larvae collected during sampling belonged to the former species. All of these frog species have wide geographic ranges and are typical of disturbed areas, including agricultural lands and near human habitation.

Many of the wet craters resembled permanent pond communities. Aquatic vegetation grew in nine of the craters (81.8%), sometimes quite densely. The presence of totally aquatic animal species in the ponds suggested that seasonal flooding of the Xe Bang Fai River, located approximately 0.3 km away at the nearest point from the sampling area, at least occasionally reaches these craters. Specifically, three different species of small fish and an eel were observed in seven of the wet craters (63.6%), and prawns in four of the wet craters (36.4%). Aquatic invertebrates including snails, leeches, larval odonates, heteropterans, and coleopterans were also present.

The ponds appeared to be heavily exploited for food by local people, based on the high density of people seen cast-netting the ponds during the day. This includes the collection of frogs, as two local people that were seen cast-netting a bomb crater pond for small fishes had also harvested an adult *Hoplobatrachus rugulosa*. Immigration of frogs and fish during floodings may be preventing the extirpation of these populations in the ponds, although R. Tizard (pers. comm.) reported that the ponds were sometimes stocked with fish by local people. Regardless of the harvesting, the permanence of the artificial ponds formed by exploded ordnance has provided a suitable environment in which at least six species of frogs live or reproduce.

Acknowledgments.—This work was conducted during an amphibian and reptile survey of Hin Namno NBCA, sponsored by the Wildlife Conservation Society Lao Program. We thank C. M. Francis for providing the photograph and to D. R. Karns for unpublished data.

LITERATURE CITED

ADAMS, M. D., AND M. J. LACKI. 1993. Factors affecting amphibian use of road-rut ponds in Daniel Boone National Forest. Trans. Kentucky Acad. Sci. 54:13–16.

BONIECKI, P. 1996. Biotope-related factors affecting the occurrence of amphibians in the centre of Warsaw, left of the Vistula River. Polish Ecol. Stud. 22(1–2):61–70.

BURKETT, D. W., AND B. C. THOMPSON. 1994. Wildlife association with human-altered water sources in semiarid vegetation communities. Conserv. Biol. 8(3):682–690.

FUJIOKA, M., AND S. J. LANE. 1997. The impact of changing irrigation practices in rice fields on frog populations of the Kanto Plain, central Japan. Ecol. Res. 12(1):101–108.

LACKI, M. J., J. W. HUMMER, AND H. J. WEBSTER. 1992. Mine-drainage treatment wetland as habitat for herpetofaunal wildlife. Environ. Manag. 16:513–520.

SCHNEIDER, H. 1997. Calls and reproductive behaviour of the water frogs of Damascus, Syria (Amphibia: Anura: *Rana bedriagae*, Camerano, 1882). Zool. Middle East 15:51–66.

TIMMINS, R. J., AND K. KHOUNBOLINE. 1996. A preliminary wildlife and habitat survey of Hin Namno National Biodiversity Conservation Area, Khammoune Province, Lao PDR. Wildlife Conservation Society. Final report to the Centre for Protected Areas and Watershed Management of the Department of Forestry, Ministry of Agriculture and Forestry, Lao People's Democratic Republic. 27 pp.

TURNER, L. J., AND D. K. FOWLER. 1981. Utilization of surface mine ponds in East Tennessee by breeding amphibians. Office of Biological Services 81/08, U.S. Fish and Wildlife Service, Washington, D.C., 13 pp.

Does the Water Dragon, *Physignathus lesueurii* (Gray 1831), Occur in New Guinea?

GREGORY J. WATKINS-COLWELL
Department of Biological Sciences, Sacred Heart University
Fairfield, Connecticut 06432, USA
e-mail: watkinsg@sacredheart.edu

and

GREG JOHNSTON
Mitrani Centre for Desert Ecology, Blaustein Institute for Desert Research
Ben-Gurion University of the Negev, Sede Boqer 84990, Israel
e-mail: gregj@bgumail.bgu.ac.il

The Australian water dragon, *Physignathus lesueurii* (Gray 1831), is a large acrodontan lizard which occurs in eastern Australia and has been reported from western New Guinea (Fig. 1). The species appears to be absent from eastern New Guinea (Allison 1982). This unusual disjunct distribution has been widely accepted (e.g., Allison 1982, 1996; Cogger, 1995; Harrison 1928; Moody 1980; Welch et al. 1990; Whitaker et al. 1982), and has long been the subject of comment (Covacevich et al. 1990; Harrison 1928).

The existence of *P. lesueurii* in western New Guinea was first reported by de Rooij (1915) and was based on a single specimen in the Rijksmuseum van Natuurlijke Historie in Leiden in the Netherlands (RMNH 5462). The data associated with this specimen show that it was collected from the Arfak Mountains in what is now the Indonesian state of Irian Jaya. However, there have been no further specimens of *P. lesueurii* from New Guinea reported in the literature. All published reports of *P. lesueurii* in New Guinea appear to be based on De Rooij's (1915) account of this single specimen.

We have searched for additional specimens of *Physignathus lesueurii* from New Guinea in the following institutions: Australian Museum (AM); South Australian Museum (SAM); Northern Territory Museum of Arts and Sciences (NTM); Bernice P. Bishop Museum (BPBM); National Museum and Art Gallery of Papua New Guinea (PNGM); University of Papua and New Guinea (UPNG); University of Michigan Museum of Zoology (UMMZ); Field Museum of Natural History (FMNH); Carnegie Museum of Natural History (CM); California Academy of Sciences (CAS-SU and CAS); American Museum of Natural History (AMNH); Smithsonian Museum of Natural History (USNM); University of Illinois Museum of Natural History (UIMNH); Museum of Comparative Zoology (MCZ); Rijksmuseum van Natuurlijke Historie (RMNH). Although these collections contain over 300 additional specimens of the *P. lesueurii*, none was from New Guinea.

The Leiden specimen (RMNH 5462) is correctly identified as *P. lesueurii* (Fig. 2). However, all other specimens collected from New Guinea and identified as *P. lesueurii* (N = 15) were incorrectly assigned to this species. Fourteen of these belonged to the genus *Hypsilurus* (we follow the taxonomy of Moody 1980 after Cogger 1995). The other misidentified specimen (USNM 101095) was a *Hydrosaurus amboinensis* from Idi Falls on the Mamberamo River in the Van Rees Mountains of Irian Jaya.

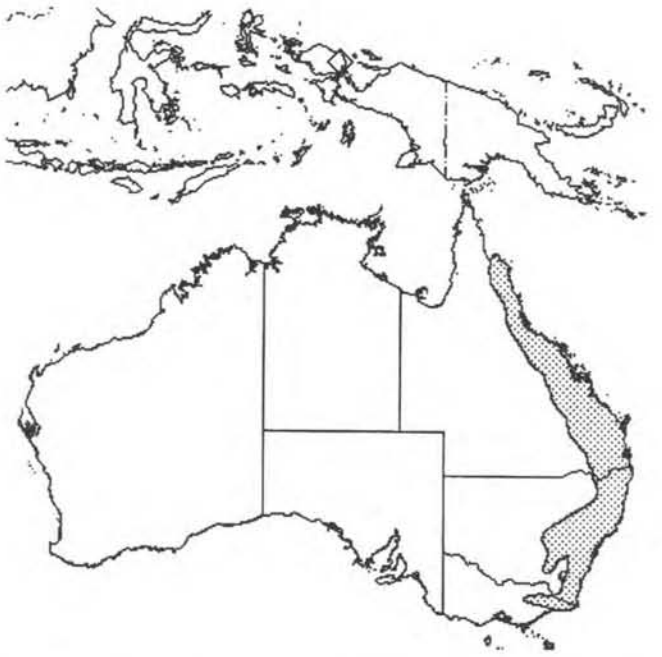


FIG. 1. The reported distribution of *Physignathus lesueurii* in Australia (following Cogger 1995) and New Guinea. The diamond indicates the location from which RMNH 5462 was reputedly collected.

Many museums had specimens of *Lophognathus temporalis* listed as *Physignathus temporalis* (following Worrell 1963; see Cogger et al. 1983 for a full synonymy of *L. temporalis*). This unfortunate artifact of taxonomic history adds confusion to the question of whether *Physignathus lesueurii* occurs in New Guinea. The two species are quite different in external morphology (see photos in Cogger 1995) and are no longer thought to be closely related (Baverstock and Donellan 1990; Cogger and Lindner 1974). The numerous specimens labeled "*Physignathus temporalis*" are not *Physignathus* at all, and provide no evidence for the existence of *P. lesueurii* in New Guinea.

Thus, the Leiden specimen of *Physignathus lesueurii* remains the only evidence we could find that this species occurs in New Guinea. Furthermore the locality data accompanying it may be suspect. RMNH 5462 was purchased from a specimen dealer called "Mulie" in 1871 (Marinus Hoogmoed, pers. comm.), and the locality data associated with the specimen may be incorrect. This specimen may actually have been collected in Australia and mislabeled prior to being purchased by the RMNH.

This issue of the occurrence of *P. leseuerii* in New Guinea is not only of academic interest. The reported occurrence of this species in New Guinea offers an opportunity for the species to be collected in Australia (where it is legally protected) and exported through New Guinea, for the exotic pet trade. This trade, although illegal, is likely of no direct consequence to the conservation status of *P. lesueurii* itself. It is abundant in large areas of eastern Australia (Fig. 1). However, the trade in *P. lesueurii* through Indonesia provides an opportunity for the illicit traffic of other, similar species (e.g., *Hypsilurus* spp. and *Hydrosaurus amboinensis*) whose conservation status is less certain, and which are commonly misidentified as *P. leseuerii*.

FIG. 2. Dorsal view of RMNH 5462. An adult male *Physignathus lesueurii*, reportedly collected in the Arfak Mountains of New Guinea. It was purchased in 1871 from a specimen dealer. The locality data may be in error. (Photograph by Mieke Van Engelen).

In conclusion, we recommend that *Physignathus lesueurii* be considered absent from the herpetofauna of New Guinea until additional specimens are collected. The locality data for the only confirmed specimen (RMNH 5462) reported as coming from New Guinea should be considered suspect as the specimen may have been collected in Australia. *Physignathus leseuerii* is a large, highly visible species. It is unusual that such an organism should not be collected in New Guinea for over a century. It is more likely that the species does not occur there, and that all unvouchered reports are actually of similar-looking species (*Hypsilurus* spp. or *Hydrosaurus amboinensis*).

Acknowledgments.—We thank the curatorial personnel associated with herpetology collections at AMS, SAMA, NTM, BPBM, PNGM, UPNG, UMMZ, FMNH, CM, CAS-SU, CAS, AMNH, USNM, UIMNH, MCZ, and RMNH for cooperation. Marinus S. Hoogmoed provided information about RMNH 5462. Thanks to Aaron M. Bauer for reviewing an earlier draft of the manuscript. This paper was written while GRJ held a Kreitman postdoctoral fellowship in the Department of Life Sciences, Ben Gurion University of the Negev. This is publication no. 264 of the Mitrani Centre for Desert Ecology.

LITERATURE CITED

ALLISON, A. 1982. Distribution and Ecology of New Guinea Lizards. *In* J. L. Gressitt (ed.), Biogeography and Ecology of New Guinea 42:803-813. Dr W. Junk, The Hague.

_____. 1996. Zoogeography of amphibians and reptiles of New Guinea and the Pacific Region. *In* A. Keast and S. E. Miller (eds), The Origin and Evolution of Pacific Island Biotas, New Guinea to Eastern Polynesia: Patterns and Processes, pp. 407–436. SPB Academic Publishing, Amsterdam.

BAVERSTOCK, P. R., AND S. C. DONELLAN. 1990. Molecular evolution in Australian dragons and skinks: A progress report. Mem. Queensland Mus. 29:323–331.

COGGER, H. G. 1995. Reptiles and Amphibians of Australia, 6th Ed. Reed, Sydney.

_____, E. E. CAMERON, AND H. M. COGGER. 1983. Zoological Catalogue of Australia. I. Amphibia and Reptilia. Australian Government Publishing service, Canberra.

_____, AND D. A. LINDNER. 1974. Frogs and reptiles in fauna survey of the Port Essington District, Cobourg Peninsula, Northern Territory of Australia. *In* H. J. Frith and J. H. Calaby (eds.), C.S.I.R.O. Div. Wildl. Res. Tech. Pap. 28:63–107.

COVACEVICH, J., P. COUPER, R. E. MOLNAR, G. WITTEN, AND W. YOUNG. 1990. Miocene dragons from Riversleigh: new data on the history of the family Agamidae (Reptilia: Squamata) in Australia. Mem. Queensland Mus. 29:339–360.

DE ROOIJ, N. 1915. The Reptiles of the Indo-Australian Archipelago. I. Lacertilia, Chelonia, Emydosauria. E. J. Brill, Leiden.

HARRISON, L. 1928. The composition and origins of the Australian fauna, with special reference to the Wegener hypothesis. Report of the eighteenth meeting of the Australasian Association for the Advancement of Science 18:332–396.

MOODY, S. M. 1980. Phylogenetic and historical biogeographical relationships of the genera in the family Agamidae (Reptilia: Lacertilia). Unpubl. Ph.D. Dissertation, University of Michigan.

WELCH K. R. G., P. S. COOKE, AND A. S. WRIGHT. 1990. Lizards of the Orient: a Checklist. Krieger Publ., Malibar, Florida.

WHITAKER, R., Z. WHITAKER, AND D. MILLS. 1982. Reptiles of Papua New Guinea 82/2. Division of Wildlife, Papua New Guinea.

WORRELL, E. 1963. Reptiles of Australia. Angus and Robertson, Sydney.

Phrynosoma hernandesi: Correct Spelling

HOBART M. SMITH
EPO Biology, University of Colorado
Boulder, Colorado 80309-0334, USA
e-mail: hsmith@spot.colorado.edu

KRAIG ADLER
Division of Biological Sciences, Seeley G. Mudd Hall
Cornell University, Ithaca, New York 14853-2702, USA

DAVID CHISZAR
Department of Psychology, University of Colorado
Boulder, Colorado 80309-0345, USA
e-mail: chiszar@clipr.colorado.edu

and
FRANK VAN BREUKELEN
EPO Biology, University of Colorado
Boulder, 80309-0334, USA
e-mail: vanbreuk@colorado.edu

Until recently the nominal species *Phrynosoma (Tapaya) hernandesi* Girard (1858:395; *Tapaya* Cuvier was explicitly adopted as a subgenus, as stated p. 394) has always been a name of little significance in herpetology, primarily because it existed throughout most of that time under a cloud of ambiguity. In a few works it was accepted as the name for a valid species, although not after

about 1917 (Stejneger and Barbour 1917). In recent years it has commonly been regarded as an invalid junior synonym of *Agama douglasii* Bell, 1828 (e.g., Hammerson 1986; Stebbins 1985; Zamudio et al. 1997; see Hammerson and Smith 1991, for spelling, often wrongly rendered *douglassii*, another original spelling). At earlier times it was often recognized as a weakly differentiated subspecies of *Phrynosoma douglasi* (e.g., Van Denburgh 1922, and Reeve 1952; the ending with a single *-i* is a permissible variant under the 1999 edition of the International Code of Zoological Nomenclature [hereinafter the "Code"], following the decision of the 1990 meeting of the International Commission on Zoological Nomenclature; see Savage 1990:56).

The mtDNA study by Zamudio et al. (1997), however, elevated Girard's name in both rank and importance by eliminating it from synonymy with *P. douglasi*, which they concluded consists only of the populations in northwestern United States and adjacent Canada that were formerly often regarded as constituting the nominotypical subspecies of the species. Girard's name is the oldest of those applied to the other populations of the species as formerly recognized, in which Zamudio et al. (1997) could find no basis for acceptance of subspecies.

Because Girard's name now appears to be firmly established for a widely distributed and frequently cited species of western United States and adjacent Mexico, the spelling of that name merits attention.

The question of spelling arises because Girard, clearly honoring Francisco Hernández (even though he did not explicitly so state), spelled the new patronym *hernandesi*. He was obviously conscious of Hernández' great work on the biota of Mexico (Hernández 1648), because he cited it in the synonymy of *P. (T.) orbiculare*, to which his description of *hernandesi* referred on the same page.

It is true that in the *P. (T.) orbiculare* synonymy Girard abbreviated all polysyllabic author names ("Bibr., Cuv., Daud., Dum., Gravenh., Grd., Griff., Hernand., Stansb., Wagl., Wiegm."), with one exception (Beechey), spelling in full only that name and those of a single syllable (Gray, Oken, Schinz, Voigt). Girard nevertheless undoubtedly knew the proper spelling of Hernández' name, even though it was not spelled out in full; he was a meticulous worker. That leaves the question of why he spelled the specific name with an "s" instead of a "z".

That the spelling *hernandesi* was a lapsus, even though it was used at least six times in Girard's (1858) thorough review of the entire genus *Phrynosoma*, was apparently immediately concluded by Baird (1859), who was the first to change it to *hernandezi* (he also added an extra terminal *-i*). Van Denburgh (1922:382) noted that Cope (1875), Yarrow (1875, 1883), McLain (1899), and Stone (1911) also used Baird's spelling, as did Smith and Smith (1976, 1993) and, upon the erroneous advice of one of us (HMS), Zamudio et al. (1997). Most others (many dozens) retained Girard's spelling, anchored by the six editions of the North American herpetological checklists beginning with Stejneger and Barbour (1917).

A strong basis for the validity of Baird's spelling is the consistency of spelling of the name Hernández, which is almost as common in Spanish-speaking countries as is Smith in English-speaking ones. For example, the National Union Catalog of Pre-1956 Imprints cites approximately 1000(!) different authors under the name Hernández, and only one under the name Hernandes (the latter appears on an 1870 publication in Paris). Similarly, the 4th, 1976 edition of the Diccionario Porrúa de Historia, Biografía y Geografía de México lists 43 persons under the name Hernández, none under Hernandes. By far the most famous of all, biologically, is of course Francisco Hernández, Mexico's first published naturalist, and still one of its most important and revered ones.

Girard's choice of spelling appears to have been deliberate and a product of a knowledge of classical Latin that was common at that time but is now rare. In classical Latin the letter "z" does not exist, nor do the letters "y" and "w". By consensus, based on commonality of sound or derivation, "s" substitutes for "z", "i" or "j" for "y", and "v" for "w", when the missing letters need to be represented. Therefore the classical Latin letters "i" (or "j"), "s" and "v" represent not only themselves per se, but under certain circumstances the foreign letters "y", "z" and "w", respectively.

On those grounds Girard chose the latinized spelling *P. hernandesi* in honoring Hernandez, and similarly Schmidt chose the spelling *Uta gadovi* to honor Gadow, and Cope *Sceloporus jarrovii* to honor Yarrow. Although it does not superficially so appear, in each case the original spelling actually was retained, but it was expressed by the customary substitute letters.

At least three nominal taxa other than Girard's were named for Hernández between 1831 and 1857: *Chamaeleopsis hernandesii* Wiegmann, 1831 (= *Corytophanes hernandesi*), *Heloderma hernandesii* Wiegmann, 1834 (= *H. h. horridum*), and *Iguana hernandesii* Jan, 1857 (a nomen nudum); in all, "s" appears instead of "z" in the original usage.

All of the examples cited appear to have been created deliberately by choice of their authors, on grounds of latinization. The Code requires maintenance of the original spellings in these cases, including Girard's, because it was obvious that the adopted spelling was deliberate, not a lapsus as required under Arts. 32 and 33 of the Code for correction of an incorrect original spelling. It is true that, at least under the current (1985) Code, eponyms do not necessarily have to be latinized, although they usually were in the past. Thus the spellings *yarrowi*, *gadowi*, *hernandezi*, etc., would be acceptable under the 1985 Code if they were proposed today, but choice of appropriate substitute letters in the past cannot be reversed, under the Code.

It is our conclusion, therefore, that under the Code the correct spelling of the name in question is *P. hernandesi*, the classical Latin equivalent of *P. hernandezi*. It should be noted also that the name *hernandesi* should be pronounced with the accent on the antepenultimate syllable, consistent with the pronunciation of Hernández' name. Written accents on scientific names are not permitted by the Code.

Literature Cited

Baird, S. F. 1859. Reptiles of the boundary, with notes by the naturalists with the survey. U.S.-Mex. Boundary Surv. (Emory) 3(2):1–35.

Bell, T. 1828. Description of a new species of *Agama*, brought from the Columbia River by Mr. Douglass. Trans. Linn. Soc.London 16:105–107, pl. 10.

Cope, E. D. 1875. Check-list of North American Batrachia and Reptilia. Bull. U. S. Natl. Mus. 1:1–104.

Girard, C. F. 1858. *In* S. F. Baird, United States Exploring Expedition During the Years 1838, 1839, 1840, 1841, 1842. Under the Command of Charles Wilkes, U.S.N. Vol. 20. Herpetology. C. Sherman & Son, Philadelphia. xv, 492 pp. [As explained in Zhao and Adler (1993:369), the official original edition here cited bears the name of Spencer F. Baird as author on the title page. However, Baird's introduction credits the work to Girard. A second version of this book, published by Lippincott in 1858, has Girard's name, instead of Baird's, on the title page.]

Hammerson, G. A. 1986. Amphibians and Reptiles in Colorado. Colorado Division of Wildlife, Denver. vii, 130 pp.

_____, and H. M. Smith. 1991. The correct spelling of the name for the short-horned lizards of North America. Bull. Maryland Herpetol. Soc. 27:121–127.

Hernández, F. 1648. Rerum Medicarum Novae Hispaniae Thesaurus seu Plantarum Animalium Mineralium Mexicanorum Historia. Mascardi, Rome. 950, 90 pp.

McLain, R. B. 1899. Contributions to North American Herpetology. Critical Notes on a Collection of Reptiles from the Western Coast of the United States. Privately Printed, Wheeling, West Virginia. 13 pp.
Reeve, W. L. 1952. Taxonomy and distribution of the horned lizards, genus *Phrynosoma*. Kansas Univ. Sci. Bull. 34:817–960.
Savage, J. M. 1990. Meetings of the International Commission on Zoological Nomenclature. Herpetol. Rev. 21:55–57.
Smith, H. M., and R. B. Smith. 1976. Synopsis of the Herpetofauna of Mexico. Volume III. John Johnson, North Bennington, Vermont. 995 pp.
_____, and _____. 1993. Synopsis of the Herpetofauna of Mexico. Volume VII. University Press of Colorado, Niwot. ix, 1082 pp.
Stebbins, R. C. 1985. A Field Guide to Western Reptiles and Amphibians. Second edition, revised. Houghton Mifflin, Boston, Massachusetts. xvi, 336 pp.
Stejneger, L. H., and T. Barbour. 1917. A Check List of North American Amphibians and Reptiles. Harvard Univ. Press, Cambridge. iv, 5–125 pp.
Stone, W. 1911. On some collections of reptiles and batrachians from the western United States. Proc. Acad. Nat. Sci. Philadelphia 63:222–232.
Van Denburgh, J. 1922. The Reptiles of Western North America. Part I. Lizards. Occ. Pap. California Acad. Sci. 10:1–611.
Yarrow, H. C. 1875. Report upon the collections of batrachians and reptiles made in portions of Nevada, Utah, California, Colorado, New Mexico, and Arizona, during the years 1871, 1872, 1873 and 1874. Rept. Geog. Geol. Expl. Surv. W. 100 Mer. Wheeler 5(4):509–584.
_____. 1883. Check list of North American Reptilia and Batrachia, with catalogue of specimens in the United States National Museum. Bull. U.S. Natl. Mus. (24):i–1v, 1–249 (1882).
Zamudio, K. R., K. B. Jones, and R. H. Ward. 1997. Molecular systematics of short-horned lizards: biogeography and taxonomy of a widespread species complex. Syst. Biol. 46:284–305.
Zhao, E., and K. Adler. 1993. Herpetology of China. Soc. Study Amph. Rept., Oxford, Ohio. 522 pp.

Life History Attributes of a Rare Neotropical Salamander, *Nototriton picadoi* (Plethodontidae: Bolitoglossini)

RICHARD C. BRUCE
Department of Biology, Western Carolina University
Cullowhee, North Carolina 28723, USA
e-mail: bruce@wcu.edu

Nototriton picadoi is a diminutive, arboreal lungless salamander of Costa Rican rain forests. Its taxonomic history is complex; populations currently recognized as *N. picadoi* are known from a few localities at the northwestern end of the Cordillera de Talamanca (Good and Wake 1993). The species is a habitat specialist in moss; most specimens have been taken in clumps of moss on tree trunks and limbs, and moss also serves as nesting sites (Bruce 1998; Good and Wake 1993). These authors noted that egg clutches are unattended by the female parent, as is probably the case in other species of *Nototriton* (Good and Wake 1993; Jockusch and García-París 1998; McCranie and Wilson 1992). This is an unusual feature in plethodontids, where the ancestral condition is female parental attendance at egg clutches (Jockusch and Mahoney 1997).

The current study was undertaken to further define the life history of *Nototriton picadoi*, for comparison with other species of *Nototriton* and other neotropical bolitoglossine salamanders. The field work was conducted in Parque Nacional Tapantí, in the watershed of the Rio Orosi, on the Caribbean slope of the Cordillera de Talamanca, Cartago Province, Costa Rica. Tapantí is an area of premontane rain forest featuring a relatively open canopy with medium to tall trees, dense understory, nearly continuous ground layer, and a profusion of epiphytic bromeliads, orchids, ferns, and mosses (Sawyer and Lindsey 1971). Mosses are especially abundant, often covering extensive areas of the surfaces of trees, shrubs, and lianas. Rainfall is about 3300 mm annually at the official weather station at 1200 m elevation, but exceeds 6000 mm in the higher reaches of the watershed (Coen 1983). Although there is a modest dry season from January through April, rainfall is relatively high (≥ 100 mm) even in the driest month (March). The heavy rainfall and steep slopes result in unstable soil conditions; frequent treefalls create openings that quickly fill with dense tangles of large herbs, vines, and saplings. The lush vegetation and high rainfall would seem to favor large salamander populations, but the several species of *Bolitoglossa, Nototriton*, and *Oedipina* that occur in Tapantí are in fact quite rare (Wake 1987).

I visited Tapantí for periods of several days on each of nine occasions between September 1994 and January 1999, in various months, except for the drier period between mid-January and May. Approximately 270 person-hours were spent searching for *N. picadoi* at Tapantí. Searches were made in daytime, mainly by opening clumps and mats of mosses growing on the ground and on the surfaces of trees, shrubs, and lianas, as high as a person could reach, and occasionally pulling smaller dead trees to the ground to inspect mosses occurring at greater heights. In addition to finding egg clutches, as described herein and elsewhere (Bruce 1998), I located 38 individuals only of *N. picadoi* during the course of the lengthy sampling period. Three were found in moss mats on the ground, and the remaining 35 were taken above ground, to about 2.5 m. All but one of the latter were taken in clumps of moss; the exception was found in the root mass and soil at the base of a bromeliad. Salamanders were found on trunks of trees of various sizes, on horizontal logs, and frequently on small vertical and horizontal branches, and on dead sticks. Several kinds of mosses were used as habitat, but were not identified.

The specimens were preserved by anesthetization in MS-222, fixation in 10% formalin, and eventual transfer to 70% ethyl alcohol. Following preservation, each specimen was measured for snout-vent length (SVL) from the tip of the snout to the posterior end of the cloacal slit to the nearest 0.1 mm. Specimens > 15 mm SVL were then dissected to determine sex and reproductive status. In males, the absence or presence of a mental gland was noted, and the size and condition of the vasa deferentia and testes were determined. Squashes of the vasa deferentia and testes were examined at 100X for the presence of sperm. In females, the diameters and degree of convolution of the oviducts were recorded, the ovaries were examined for the presence of yolked follicles, and the number and sizes of the latter were determined.

Of eight individuals ≤ 15 mm SVL, three (8–10 mm) were similar in size to hatchlings obtained in the laboratory from field-collected egg clutches (Bruce 1998). They were collected in August and January, within the hatching period estimated in the earlier study. Five larger unsexed juveniles (13–15 mm) were collected in June and January. The low frequency of small salamanders in the total sample may reflect the greater difficulty of locating smaller *Nototriton* in the rhizoid tangles of the moss mats.

For males, three individuals 18–22 mm were scored as immature based on the absence of a mental gland, thin and straight vasa deferentia, small testes, and the absence of sperm in the vasa and testes. Ten other males, 20–29 mm, were considered mature. Thus it appears that males mature at 20–22 mm SVL. In mature males the testes were large, white, either club-shaped or elongate, and had prominent ampullae. The vasa were white or gray, with a scattering of brown pigment, and usually showed some degree of

coiling. None of the three smallest mature individuals (20–22 mm), collected in June (1) and August (2), had an obvious mental gland; in each the vasa deferentia were empty, but the posterior ampullae of the testes contained numerous bundles of sperm. I concluded that all three were undergoing spermatogenesis for the first time. In seven larger males (24–29 mm) a mental gland was present, though not prominent, as a darker, shield-shaped area on the throat just behind the lower jaw. Four of these males (26–29 mm), collected in July (1), September (1), and January (2) were in obvious breeding condition, having swollen, coiled vasa deferentia packed with sperm. The other three, taken in September (2) and January (1), had empty vasa. Although these data shed little light on whether males reproduce on a seasonal basis in *N. picadoi*, they do suggest that courtship and mating occur over an extended period of the annual cycle.

Among females, four individuals 17–21 mm were obviously immature, having thin, straight oviducts less than 0.1 mm in diameter, and ovaries with small, whitish, translucent follicles no greater than 0.3 mm diameter. The remaining 13 females, 23–33 mm, were all scored as mature on the basis of having swollen, convoluted oviducts (≥ 0.5 mm) and ovaries with enlarged, yolky follicles. In only two females did the follicles approach the sizes of eggs seen in natural clutches; one such female, 27 mm, collected in mid August, had six yolked follicles enlarged to 1.7–2.3 mm diameter. Her ovarian complement fell within the range of clutch sizes (1–11) observed in the field (see below). In the other individual, the largest in the sample at nearly 33 mm, taken in early January, the 12 yolked follicles were smaller (1.1–1.6 mm), but formed a discrete class separate from the tiny, non-yolked follicles. In other females the yolked follicles were more variable in size, and thus were difficult to assign to the class of follicles destined for the next clutch. However, in none of these females could more than 11 yolked follicles be counted. A number of females had several orange bodies in the ovaries, which presumably represented atretic follicles. These data suggest that females deposit most of their yolked follicles at one time in a single nest, with the remainder undergoing atresia in the ovaries. It is not known whether oviposition occurs on an annual cycle in this species.

TABLE 1. Body sizes of sexually mature *Nototriton picadoi* from Tapantí.

		Snout-vent length (mm)			
Sex	N	Size at maturation	Range	Mean	SD
Male	10	20–22	20.3–29.0	25.3	3.11
Female	13	≈ 23	23.1–32.6	28.3	3.36

The results suggest that females mature at slightly larger sizes, grow to larger sizes, and average larger than males (Table 1). Six of 13 mature females exceeded the largest male in SVL. The difference in mean size between the sexes was marginally significant at $\alpha = 0.05$ ($t = 2.184$, $df = 21$, $P = 0.040$). Thus, the trend is in the direction of female-biased sexual size dimorphism, which is the general pattern in neotropical bolitoglossine salamanders (Bruce 1999).

In the latter part of the field study, additional data on egg laying and nests were collected which supplemented and reinforced earlier observations (Bruce 1998). Two clutches containing late embryos taken on 27 and 28 July 1998 had 4 and 11 eggs, respectively. Both were taken in moss, and in neither case was an attending female present. The clutches were returned to the laboratory, and maintained in the moss in which they were found at temperatures similar to those recorded in the field (≈ 20°C). The four embryos of the first clutch hatched on 13–14 August (SVL: mean = 7.9 mm, SD = 0.24), while 10 of 11 embryos of the second clutch survived, to hatch on 18–20 August (SVL: mean = 7.6 mm, SD = 0.24). On 6 January 1999 I found a cluster of six empty egg capsules of *N. picadoi* in a clump of moss on a stump about 0.5 m above the forest floor. A juvenile (13 mm) was found in moss within 10–15 cm of the egg capsules. These newer data confirm the pattern reported earlier (Bruce 1998) of (1) oviposition, embryonic development, and hatching throughout much of the wet season, (2) the presence of discarded egg capsules in the latter part of the wet season (August–early January), and (3) non-attendance of clutches by the female parent.

Nototriton is one of only three or four genera of plethodontid salamanders in which females do not attend their egg clutches (Jockusch and Mahoney 1997). Within *Nototriton* this behavior is best documented in *N. picadoi* (Bruce 1998). In North American genera where parental care is lacking or reduced, namely in *Batrachoseps* and *Hemidactylium*, the loss of parental care is sometimes associated with communal nesting (Breitenbach 1982; Harris et al. 1995; Jockusch and Mahoney 1997). In *Nototriton* this may also be true of *N. barbouri* in Honduras (McCranie and Wilson 1992). However, there is no evidence of communal nesting in Costa Rican species of *Nototriton* (Good and Wake 1993). In the present study, numbers of yolked ovarian follicles could not be used to reliably estimate clutch size, because most of the few mature females exhibited partial vitellogenesis only. Nevertheless, counts of yolked follicles were similar to numbers observed in field clutches of eggs and in clusters of empty capsules of recently-hatched eggs, as reported herein and earlier (Bruce 1998), indicating that *N. picadoi* probably does not engage in communal nesting.

The data on egg clutches in this and the previous study (Bruce 1998) suggest that oviposition may be seasonal in *N. picadoi*, beginning early in the wet season (May), continuing for several months, followed by hatching of the eggs from August through December. The dissection data on adult females are too limited to either reinforce or refute this conclusion. McDiarmid and Worthington (1970) postulated that in neotropical bolitoglossines, in species living in areas having pronounced wet-dry seasonality, oviposition occurs in the dry season, with hatching following at the start of the wet season several months later; whereas in species occurring in regions lacking a dry season, oviposition may occur in any month. Given the generally wet climate of Tapantí and the brevity of the dry season, it appears that environmental conditions could support year-round reproduction by *N. picadoi* and other salamanders.

Acknowledgments.—I thank Elizabeth Bruce especially for participating in all aspects of the field work. Wayne Van Devender and Steve Mentor also provided valuable help in the field. David Wake was generous in sharing his vast knowledge of *Nototriton* and other neotropical salamanders. The Dirección General de Vida Silvestre, Ministerio del Ambiente y Energia de Costa Rica, issued collecting permits. The staff of the Parque Nacional Tapantí was helpful in facilitating the research. Climatological data were provided by the Instituto Meteorologico Nacional de Costa Rica. I thank the Organización para Estudios Tropicales for assistance in securing collecting permits and for numerous other courtesies. The field studies were supported by grants 5510-95 and 5811-96 from the National Geographic Society and by institutional funds from Western Carolina University.

LITERATURE CITED

BREITENBACH, G. L. 1982. The frequency of communal nesting and solitary brooding in the salamander, *Hemidactylium scutatum*. J. Herpetol. 16:341–346.

BRUCE, R. C. 1998. Nesting habits, eggs, and hatchlings of the salamander *Nototriton picadoi* (Plethodontidae: Bolitoglossini). Herpetologica 54:13–18.

_____. 1999. Sexual size dimorphism in the Plethodontidae. *In* R. C. Bruce, R. G. Jaeger, and L. D. Houck (eds.), The Biology of Plethodontid Salamanders, in press. Plenum Publishing Corp., New York, New York.

COEN, E. 1983. Climate. *In* D. H. Janzen (ed.), Costa Rican Natural History, pp. 35–46. The University of Chicago Press, Chicago, Illinois.

GOOD, D. A., AND D. B. WAKE. 1993. Systematic studies of the Costa Rican moss salamanders, genus *Nototriton*, with descriptions of three new species. Herpetol. Monogr. 7:131–159.

HARRIS, R. N., W. W. HAMES, I. T. KNIGHT, C. A. CARRENO, AND T. J. VESS. 1995. An experimental analysis of joint nesting in the salamander *Hemidactylium scutatum* (Caudata: Plethodontidae): the effects of population density. Anim. Behav. 50:1309–1316.

JOCKUSCH, E. L., AND M. GARCÍA-PARÍS. 1998. *Nototriton abscondens* (Cordilleran Moss Salamander). Reproduction. Herpetol. Rev. 29:38.

_____, AND M. J. MAHONEY. 1997. Communal oviposition and lack of parental care in *Batrachoseps nigriventris* (Caudata: Plethodontidae) with a discussion of the evolution of breeding behavior in plethodontid salamanders. Copeia 1997:697–705.

MCCRANIE, J. R., AND L. D. WILSON. 1992. *Nototriton barbouri* (NCN). Reproduction. Herpetol. Rev. 23:115–116.

MCDIARMID, R. W., AND R. D. WORTHINGTON. 1970. Concerning the reproductive habits of tropical plethodontid salamanders. Herpetologica 26:57–70.

SAWYER, J. O., AND A. A. LINDSEY. 1971. Vegetation of the life zones in Costa Rica. Indiana Acad. Sci., Monogr. 2:1–214.

WAKE, D. B. 1987. Adaptive radiation of salamanders in Middle American cloud forests. Ann. Missouri Bot. Gard. 74:242–264.

RECENT POPULATION CHANGES

Conservation Status of the Northern Cricket Frog (*Acris crepitans*) in Colorado and Adjacent Areas at the Northwestern Extent of the Range

GEOFFREY A. HAMMERSON
The Nature Conservancy, 201 Devonshire Street
Boston, Massachusetts 02110, USA
email: ghammerson@aol.com

and

LAUREN J. LIVO
EPO Biology, University of Colorado
Boulder, CO 80309-0334, USA
email: ljlivo@aol.com

The northern cricket frog (*Acris crepitans*) is a small hylid with an historical range extending as far west as eastern New Mexico (Degenhardt et al. 1996) and eastern Colorado (Hammerson 1982). Its presence in Colorado was first documented by Ellis and Henderson (1913), who reported the collection of two juveniles (UCM 195) from the North Fork Republican River drainage at Wray, Yuma County, on 26 October 1912. The next Yuma County record comprised nine individuals collected 3.2 km E Wray on 10 July 1948 (UCM 3235–3243). The known range in that area was enlarged slightly by a specimen collected 8 km E Wray on 9 July 1955 (UCM 10233). A specimen collected in the South Fork Republican River drainage at Bonny Reservoir on 17 May 1958 (UCM 10875) and 12 specimens collected from 3.2 km E Wray on the following day (UCM 10861–10874) provided further documentation of the range in Yuma County. *Acris crepitans* evidently remained fairly widespread in this area through the 1960s, evidenced by a specimen from Wray on 23 July 1965 (KU 98094), two from downstream from Bonny Reservoir, eight from west of Stalker Lake (North Fork Republican River), and two from 8.8 km E Eckley (North Fork Republican River), all collected on 8 October 1967 (KU 125062–125071, 125073–125074).

The 1967 specimens include the last known *A. crepitans* observed from the South Fork Republican River drainage in Colorado. However, the species persisted in the North Fork Republican River in Yuma County through the late 1970s, based on records from our field notes: 4 km E Wray, 10 observed, 7 September 1975; 6.4 km E Wray, 4 June 1977; 5.8 km E Wray, 10 June 1977; 3.2 km W Wray, Stalker Lake, one calling, 18 June 1978; 6.4 km E Wray, five adults observed on 15 July 1979 and 10 adults and juveniles observed on 20 September 1979. A single specimen (UNSM 7792) was collected 4.8 km E Wray on 8 July 1977.

Occurrences in the South Platte River drainage in Colorado are few and questionable. Burnett (1926) reported that a specimen was found at the entrance of a prairie dog burrow near Briggsdale, Weld County, on 27 May 1922; the specimen (number 4843), no longer in existence, was deposited in the collection of the Colorado Agriculture College (now the University of Northern Colorado). This record may be based on a misidentified *Pseudacris triseriata*, which the senior author has observed in exactly the same circumstances in the same area, but Burnett's report included records of *Pseudacris*, suggesting that he was able to distinguish the two species. A record from the southern half of Weld County, mapped by Hammerson (1982), is based on an unpublished species list by an experienced herpetologist, but no documentation of the occurrence is available, and our searches in the area at the time of the report and later yielded no observations of this species. A record of *A. crepitans* from Morgan County (Fitzgerald 1978; Hammerson 1982) is based on specimens we examined in the collection of the University of Northern Colorado in Greeley around 1980. One container included a mixed collection of several *Pseudacris triseriata* with several *Acris crepitans*, plus a label with the data, "Narrows Reservoir site, 21 June 1971." None of the specimens was individually tagged with collection data. One additional specimen in the South Platte River drainage, from Varsity Lake on the University of Colorado campus in Boulder (25 July 1957, UCM 10232), was obtained from a short-lived introduced population that subsequently was extirpated when the lake was drained (T. P. Maslin, pers. comm., 1978; Livo et al. 1998).

Several field surveys by us at the historical localities in Colorado and in other areas of apparently suitable habitat in Yuma County in the 1980s and 1990s (at least one field survey in 10 of 18 years) yielded no additional observations of *A. crepitans*. In Weld and Morgan counties, we made incidental surveys from the late 1970s through 1997. Several searches along Crow Creek near Briggsdale from the 1970s to the 1990s yielded no observations of *A. crepitans*. Recent amphibian surveys in the Pawnee National Grassland (the vicinity of the Briggsdale record), conducted by the Colorado Division of Wildlife, also failed to reveal any extant populations (Ken Kehmeier, Colorado Division of Wildlife, pers. comm.). Our recent surveys along the South Platte River in southern Weld and Morgan counties also yielded no observations of this frog.

Little is known of the current status of *A. crepitans* in other areas in the northwestern portion of its range. In western Nebraska, Lynch (1985) mapped this anuran along the North Fork Republican River contiguous with Colorado. John Iverson collected nine specimens about 30 km east of the Colorado border along the North Fork Re-

publican River near Parks in Dundy County, Nebraska, in 1977 (UNSM 7793–7801), but all other records of *A. crepitans* in the University of Nebraska State Museum from the lower 200 km of the Republican River system in Nebraska are from 1938, 1947, 1973, and 1974. In the South Platte River drainage, Ballinger et al. (1979) found *A. crepitans* no farther west than North Platte, Lincoln County, during their 1975–1978 field surveys. Jones et al. (1981) did not encounter *A. crepitans* at Mormon Island Preserve along the Platte River in central Nebraska but reported that previously the species rarely had been found near that area. Corn et al. (1995) observed a population of *A. crepitans* next to the Niobrara River near Valentine in north-central Nebraska in 1991 (also mapped there by Hudson 1942 and Lynch 1985).

Acris crepitans was common in extreme western Kansas in Wallace County between 1978 and 1980 at about 39°N latitude in 1979 and 1980 when Gorman (1986) collected 91 from three localities. Most KU records for Kansas localities west of 100 degrees longitude are from before 1980. Two individuals were observed at separate localities in Morton County in extreme southwest Kansas in 1978 (Collins and Collins 1991). However, more recent records, each based on single individuals, exist for Greeley (1991, KU 218847), Wichita (1991, KU 218848), and Grant (1992, KU 220758) counties. *Acris crepitans* was observed along the South Fork Republican River in Cheyenne County in 1996 and Smoky Hill River drainage in Sherman County in 1997 (Stan Roth, pers. comm.). This anuran remains common in central and eastern Kansas (Busby and Parmelee 1996; Busby et al. 1996; Collins 1993).

The distribution and status of *A. crepitans* in western Oklahoma are not well known, although *Acris* appears to remain abundant in the central part of the state (J. Caldwell, pers. comm.). Recent vertebrate surveys in the panhandle region of western Oklahoma did not result in any observations of this species (Mark Lomolino, pers. comm.); however, these surveys did not concentrate on amphibian habitats. The only *Acris* records from the Oklahoma panhandle in the Oklahoma Museum of Natural History date from 1933 and are more the 150 km east of the Colorado border.

In summary, *A. crepitans* was fairly common in the Republican River drainage in Colorado through at least the late 1970s, and it may have occurred in the Platte River drainage in Weld and Morgan counties through at least the early 1970s. Subsequent surveys indicate that the species has declined in distribution in Colorado. Conspicuous breeding calls make this species easy to locate, so it is unlikely that the frog still occurs in the recently surveyed locations within the historical range. It is notable that, since 1995, we have observed in Colorado all of the state's other species of amphibians, including species with erratic activity and restricted distributions in the state such as the Great Plains narrowmouth toad (*Gastrophryne olivacea*) and Couch's spadefoot (*Scaphiopus couchii*) and others (e.g., *Bufo boreas* and *Rana pipiens*) that have experienced declines in distribution and abundance in mountainous areas of the state (Corn et al. 1989). In eastern Colorado, suitable habitat for *A. crepitans* exists primarily or exclusively along major streams, and we were able to access these areas by public roads in several locations. Hence existing data indicate that *A. crepitans* is extirpated or extremely localized at best in Colorado. Existing information for the contiguous portions of adjacent states suggests that the species is scarce there as well but extant in at least a few locations in western Kansas.

What accounts for the decline of *A. crepitans* in Colorado? Its continued presence within a few kilometers of the Colorado border in Cheyenne County, Kansas, suggests the possibility of a temporary contraction in the range. Regan (1972) suggested "general aridity, especially in the southwestern part of the study area; wave action around man-made reservoirs; and winterkill due to frost penetration" as potential limiting factors for *A. crepitans* in the western margins of the range. However, we know of no particular climatological events that we can associate with the decline of *Acris* in western Colorado. For example, *A. crepitans* remained common near Wray, Colorado, after the exceptionally cold winter of 1978–1979 when the average temperature in January in northeastern Colorado was 6.8°C below the median—the coldest January during the period 1961–1996 (NOAA-CIRES Climate Diagnostics Center). Exceptional drought conditions did not occur in northeastern Colorado after 1979.

Among anthropogenic factors that may have reduced or eliminated *A. crepitans* populations, habitat change, establishment of exotic species, and chemical contaminants warrant consideration. Over the past two decades some changes in the habitat of *A. crepitans* have occurred in Colorado, such as the lining of some irrigation ditches with concrete, but the extent of primary breeding habitat (ponds with shallow, marshy edges) seems not to have changed much. One Yuma County pond formerly inhabited by *Acris* appeared to have an increased amount of tall, thick vegetation where previously it was open and sunny at the pond edge, but an adequate evaluation of habitat changes in relation to the frog decline is not possible. Land use within the historical range apparently has remained relatively stable in recent decades.

The non-native bullfrog (*Rana catesbeiana*) is a well-known predator on small frogs (Bury and Whelan 1984), including *A. crepitans* (Lewis 1962; Perrill and Magier 1988; Tyler 1978). *Rana catesbeiana* is now abundant within the historical range of *Acris* in Colorado, but it was present at least as early as the 1940s and 1950s (UCM specimens) and may have been abundant in the vicinity of Bonny Reservoir by the early 1950s (Anonymous 1954), so it is difficult to attribute the decline of *A. crepitans* after the 1970s to the impact of *R. catesbeiana*. Also, the two species coexist over much of their ranges in central and eastern North America.

Chemicals associated with agricultural activity in the historical range of *Acris* in Colorado could have caused a decline through excessive mortality in adults and/or embryos, but again lack of sufficient information prevents an adequate evaluation of this possibility. At present, the decline is inexplicable but parallels a similar puzzling decline observed in the Midwest, where the species has largely disappeared from the northern portion of its range in the southern Great Lakes region (e.g., Harding 1997; Jung 1993; Lannoo 1998; Lannoo et al. 1994; Ludwig et al. 1992; Oldham and Campbell 1990; Weller and Green 1997; Vogt 1981). Factors responsible for the decline in the Midwest remain speculative, but the authors just cited mentioned pollution of water by pesticides and/or other chemicals deriving from agricultural sources, vegetation succession, climatic fluctuations (e.g., drought), predation by exotic and native species, and/or competition from other frog species, coupled with the frog's short life span and associated vulnerability to short-term phenomena, as possibly significant. However, further study is needed before any reliable conclusions can be reached on the cause(s) of the decline of *A. crepitans* in the northern and northwestern margins of its range. The species remains common in much of the southcentral and southeastern United States.

Acknowledgments.—We thank Janalee Caldwell, Joseph T. Collins, P. Stephen Corn, Thomas E. Labedz, Mark Lomolino, John D. Lynch, and Stan Roth for providing museum records or information on the occurrence of *A. crepitans* in states adjacent to eastern Colorado. The University of Colorado Museum (UCM), University of Kansas Museum of Natural History (KU), and the Division of Zoology of the University of Nebraska State Museum (UNSM) curate the specimens discussed here. Three anonymous reviewers helped us improve the manuscript.

LITERATURE CITED

ANONYMOUS. 1954. Bonny bullfrogs. Colorado Conservation 3(2):16–17.

BALLINGER, R. E., J. D. LYNCH, AND P. H. COLE. 1979. Distribution and natural history of amphibians and reptiles in western Nebraska with ecological notes on the herpetiles of Arapaho Prairie. Prairie Nat. 11(3):65–74.

BURNETT, W. L. 1926. Notes on Colorado herpetology. Occasional Papers of the Museum of Zoology and Entomology, Colorado State Agricultural College 1(1):1–3.

BURY, R. B., AND J. A. WHELAN. 1984. Ecology and management of the bullfrog. U.S. Fish and Wildlife Service Resource Publication 155. ii + 23 pp.

BUSBY, W. H., J. T. COLLINS, AND J. R. PARMELEE. 1996. The reptiles and amphibians of Fort Riley and vicinity. Kansas Biological Survey. 72 pp.

_____, AND J. R. PARMELEE. 1996. Historical changes in a herpetofaunal assemblage in the Flint Hills of Kansas. Am. Midl. Nat. 135(1):81–91.

COLLINS, J. T. 1993. Amphibians and Reptiles in Kansas. Third edition, revised. University of Kansas Museum of Natural History, Public Education Series (13):i–xx, 1–397.

_____, AND S. L. COLLINS. 1991. Reptiles and Amphibians of the Cimarron National Grasslands, Morton County, Kansas. U.S. Forest Service. 60 pp.

CORN, P. S., M. L. JENNINGS, AND R. B. BURY. 1995. Amphibians and reptiles. *In* M. A. Bogan (ed.), A Biological Survey of Fort Niobrara and Valentine National Wildlife Refuges, pp. 32–59. Final report. National Biological Service, Midcontinent Ecological Science Center, Fort Collins, Colorado.

_____, W. STOLZENBURG, AND R. B. BURY. 1989. Acid precipitation studies in Colorado and Wyoming: interim report of surveys of montane amphibians and water chemistry. U.S. Fish Wildlife Service Biological Report 80(40.26). 56 pp.

DEGENHARDT, W. G., C. W. PAINTER, AND A. H. PRICE. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque. xix + 431 pp.

ELLIS, M. M., AND J. HENDERSON. 1913. The Amphibia and Reptilia of Colorado, Part I. University of Colorado Studies 10:39–129.

FITZGERALD, J. P. 1978. Vertebrate associations in plant communities along the South Platte River in northeastern Colorado. *In* W. D. Graul and S. J. Bissell (tech. coord.), Lowland River and Stream Habitat in Colorado: A Symposium (Greeley, Colorado, Oct. 4–5, 1978), pp. 73–88. Colorado Chapter of the Wildlife Society and Colorado Audubon Council.

GORMAN, W. L. 1986. Patterns of color polymorphism in the cricket frog, *Acris crepitans*, in Kansas. Copeia 1986:995–999.

HAMMERSON, G. A. 1982. Amphibians and Reptiles in Colorado. Colorado Division of Wildlife, Denver. vii + 131 pp.

HARDING, J. H. 1997. Amphibians and Reptiles of the Great Lakes Region. University of Michigan Press, Ann Arbor. xvi + 378 pp.

HUDSON, G. E. 1942. The Amphibians and Reptiles of Nebraska. Nebraska Conservation Bull. (24):1–146.

JONES, S. M., R. E. BALLINGER, AND J. W. NIETFELDT. 1981. Herpetofauna of Mormon Island Preserve, Hall County, Nebraska. Prairie Nat. 13(2):33–41.

JUNG, R. E. 1993. Blanchard's cricket frogs (*Acris crepitans blanchardi*) in southwest Wisconsin. Trans.Wisconsin Acad. Sci., Arts, Letters 81:79–87.

LANNOO, M. J., ED. 1998. Status and Conservation of Midwestern Amphibians. Univ. Iowa Press, Iowa City. 507 pp.

_____, K. LANG, T. WALTZ, AND G. S. PHILLIPS. 1994. An altered amphibian assemblage: Dickinson County, Iowa, 70 years after Frank Blanchard's survey. Am. Midl. Nat. 131:311–319.

LEWIS, W. M. 1962. Stomach contents of bullfrogs (*Rana catesbeiana*) taken from a minnow hatchery. Trans. Illinois State Acad. Sci. 55:80–83.

LIVO, L. J., G. A. HAMMERSON, AND H. M. SMITH. 1998. Summary of amphibians and reptiles introduced into Colorado. Northwestern Nat. 79:1–11.

LUDWIG, D. R., M. REDMER, R. DOMAZLICKY, S. KOBAL, AND B. CONKLIN. 1992. Current status of amphibians and reptiles in DuPage County, Illinois. Trans. Illinois State Acad. Sci. 85:187–199.

LYNCH, J. D. 1985. Annotated checklist of the amphibians and reptiles of Nebraska. Trans. Nebraska Acad. Sci. 13:33–57.

OLDHAM, M. J., AND C. A. CAMPBELL. 1990. Status report on the cricket frog *Acris crepitans* in Canada. Unpublished report, Committee on the Status of Endangered Wildlife in Canada. 31 pp.

PERRILL, S. A., AND M. MAGIER. 1988. Male mating behavior in *Acris crepitans*. Copeia 1988:245–248.

REGAN, G. T. 1972. Natural and man-made conditions determining the range of *Acris crepitans* in the Missouri River Basin. Dissertation Abstracts 33/06-B:2564–2565.

TYLER, J. D. 1978. Bullfrog observed eating Blanchard's cricket frog. Bull. Oklahoma Herpetol. Soc. 3(4):68–69.

VOGT, R. C. 1981. Natural History of Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum, Milwaukee, Wisconsin. 205 pp.

WELLER, W. F., AND D. M. GREEN. 1997. Checklist and current status of Canadian amphibians. *In* D. M. Green (ed.), Amphibians in Decline: Canadian Studies of a Global Problem, pp. 309–328. Herpetological Conservation (1):xiii + 338 pp.

TECHNIQUES

Laundry Detergent Effectively Preserves Amphibian and Reptile Blood and Tissue for DNA Isolation

ULRICH KUCH*
Zentrum der Rechtsmedizin, Johann Wolfgang Goethe-Universität
Kennedyallee 104, 60596 Frankfurt am Main, FRG
e-mail: kuch@stud.uni-frankfurt.de

MARKUS PFENNINGER
Abteilung Ökologie und Evolution
Zoologisches Institut der Johann Wolfgang Goethe-Universität
Siesmayerstr. 70, 60054 Frankfurt am Main, FRG

and

ANDREAS BAHL
Abteilung Ökologie und Evolution
Zoologisches Institut der Johann Wolfgang Goethe-Universität
Siesmayerstr. 70, 60054 Frankfurt am Main, FRG

** Author to whom correspondence should be sent.*

Molecular techniques have become invaluable tools in numerous fields of herpetology. The fact that only very small quantities of blood or tissue are needed for these analyses usually allows researchers to continue studies of the live animals after sample collection, and is of special importance if rare or endangered species are involved. Several methods of collecting and storing samples for DNA analysis are currently employed in the field (Dessauer and Hafner 1984; Dessauer et al. 1990). If refrigeration is not possible, blood and tissue samples are usually stored in ethanol, lysis buffers containing sodium dodecyl sulfate, a saturated salt solution, or anticoagulant preservative solution (Arctander 1988).

Using different commercially available laundry detergents (Persil Megaperls®, Persil Supra® Liquid, Frosch®) we previously extracted high molecular weight DNA from several types of tissue (human, lizard, snail, tobacco plant), and obtained a quality and yield of isolated DNA equal to that from conventional DNA isolation methods (Bahl and Pfenninger 1996). The extracted DNA was suitable as template for Polymerase Chain Reaction (PCR) and digestible with restriction enzymes. Furthermore, high molecular weight DNA could be isolated from Wall Lizard (*Podarcis muralis*) tissue after 14 d of incubation (37°C) with the laundry detergent-

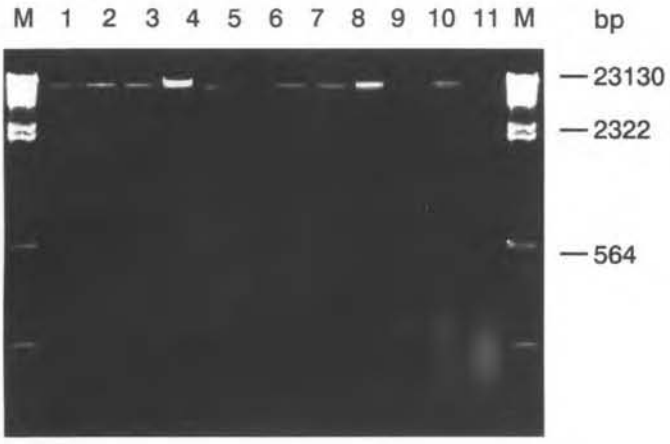


FIG. 1. DNA isolated after different storage procedures. Lane assignment: 1–4, from snake blood after 4 weeks incubation in laundry detergent; 5, from snake blood extracted with laundry detergent after 4 weeks incubation in 90% ethanol; 6–7, from snake tail tip tissue treated with laundry detergent and Hom II buffer, respectively; 8–9, same as 6-7, isolated after 14 d incubation; 10–11, from toad toe-clips extracted with laundry detergent, after 14 d incubation in laundry detergent (10) and 70% ethanol (11); M, l/Hind III marker (MBI Fermentas).

mixture, but not after incubation with a conventionally used DNA extraction buffer (Bahl and Pfenninger 1996). Considering the potential value that this method may have for workers in the field, we were interested to find out whether these results could be reproduced using a wider variety of amphibian and reptile samples, and if the new method could effectively preserve samples collected for DNA analysis and kept at ambient temperatures during field work in a tropical country. Storage of blood and tissue samples in ethanol and a conventional buffer was tested under the same conditions.

Blood samples were taken by cardiac puncture from a euthanized Java Krait, *Bungarus javanicus*. Reptile tissue samples were collected from the tail tip of a captive Many-Banded Krait, *Bungarus m. multicinctus*. This specimen died of multiple parasitoses and sepsis and had been frozen at –20°C immediately after death. Forty-nine millimeters of the total 99 mm tail were cut and nine cross-cut pieces of 42–57 mg were produced. Amphibian toe-clips were obtained from a previously frozen (–20°C) Common Toad, *Bufo b. bufo*.

The conventional DNA extraction buffer herein named Hom II was prepared according to a standard protocol (Sambrook et al. 1989). The commercially available laundry detergent Persil Megaperls® (Henkel Waschmittel KGaA, Düsseldorf, Germany) was suspended to 10% (w/v) in deionized water. Blood samples (0.1–0.5 ml) were transferred to screw top cryovials containing 2 ml of the laundry detergent suspension. Equal blood volumes were stored in 2 ml 90% ethanol. After manually shaking the samples for 30 sec to mix the blood and the laundry detergent suspension, they were kept at ambient temperatures (26–32°C) during four weeks of field work. After this period the samples were frozen at –20°C. Snake tail tissue, in 42–57 mg sections, was transferred to screw top cryovials containing either 2 ml laundry detergent suspension or 2 ml Hom II buffer. Some snake tail tissue samples were frozen immediately at –20°C until DNA isolation, whereas the rest was incubated 14 d at 37°C. Fifty milligrams of amphibian tissue per sample were incubated 14 d at 37°C in 2 ml laundry detergent suspension or 70% ethanol. All fresh tissue (previously frozen in laundry detergent or the conventional buffer) was crude homogenized manually for 30–60 sec with a micropestle 1–2 h before extraction. Twenty microliters proteinase K (10 mg/ml) was then added to the samples to be extracted with Hom II buffer, followed by 2 h incubation at 37°C. Prior to DNA extraction, proteinase K was also added to the samples that had been stored 14 d in Hom II buffer, followed by 12 h incubation at 37°C. To process the ethanol samples the supernatant ethanol was removed and the samples were air dried for 30–60 min at room temperature. Two milliliters laundry detergent suspension or Hom II buffer was added and the samples were processed as above. The DNA was isolated using a standard phenol/chloroform-isoamyl alcohol method (Sambrook et al. 1989). Ethidium bromide fluorescence after gel electrophoresis was used to estimate the integrity and yield of the isolated DNA. The degree of purity of the isolated DNA samples was calculated using the ratio of their spectrophotometric absorptions at 260 and 280 nm, which indicate concentrations of nucleic acids and proteins, respectively.

High molecular weight DNA could be isolated from all samples (Fig. 1, Table 1). No low molecular weight degradation products were observed in DNA samples from snake blood that had been preserved in laundry detergent over a period of four weeks at 26–32°C (Fig. 1, lanes 1–4). All samples preserved in 70% or 90% ethanol contained some degradation products, as did tissue samples under all preservation methods. Fresh snake tail tip tissue yielded more DNA if treated with laundry detergent, but a higher $A_{260/280}$ ratio was achieved by the conventional (Hom II buffer and proteinase K) extraction (Table 1). This might be due to adjuvants contained in the laundry detergent. Incubation of amphibian toe-clips in laundry detergent resulted in fewer degradation products than ethanol storage (Fig. 1, lanes 10–11). No DNA could be detected in the negative controls (extraction from laundry detergent without blood or tissue; data not shown). The DNA isolated from samples which had been incubated (26–37°C) in Persil Megaperls® laundry detergent for two to four weeks was digestible by a restriction enzyme (data not shown), and suitable as a template for PCR (Fig. 2).

Although DNA could be isolated from all samples, differences in quantity and quality were obvious. The best results (high quantity of high molecular weight DNA and no visible amount of degradation products) were obtained from snake blood that had been preserved in laundry detergent. Most commercial washing powders contain a mixture of detergents designed for removal of organic

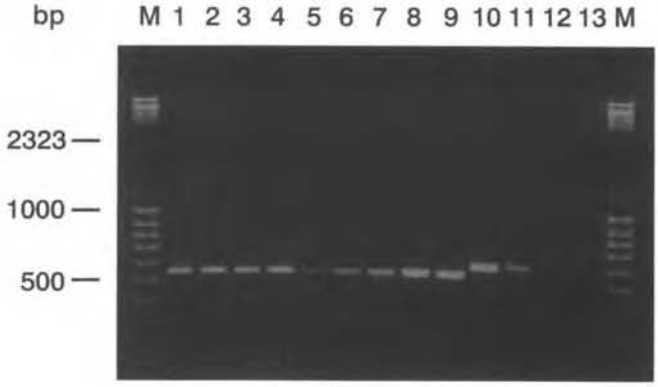


FIG. 2. A 1.4% agarose gel showing PCR amplification products of a 550 base pair fragment of the mitochondrial 16S gene using 3 ng DNA from the samples in Fig. 1. See Fig. 1 for assignment of lanes 1–11, 12–13, water; M, mix of 100 base pair ladder and l/Bst II marker (MBI Fermentas).

TABLE 1. DNA isolation protocols and spectrophotometrically estimated purity and yield.

Species	Material	Incubation	Extraction	Mean DNA Yield ± SD	Range	N	A_{260}/A_{280} Ratio
Bungarus javanicus	Blood	4 weeks, laundry detergent, 26–32°C	Laundry detergent	125 ± 89 µg from 0.1–0.5 ml	43–294 µg	5	1.60–1.87
		4 weeks, 90% ethanol, 26–32°C	Laundry detergent	149 ± 84 µg from 0.1–0.5 ml	65–233 µg	2	1.62–1.81
Bungarus multicinctus	Tail tip	— (fresh)	Laundry detergent	1.3 ± 0.1 µg/mg	1.2–1.4 µg/mg	2	1.38–1.47
		— (fresh)	Hom II buffer	0.5 ± 0.1 µg/mg	0.4-0.6 µg/mg	2	1.80–2.00
		14 d, laundry detergent, 37°C	Laundry detergent	1.1 ± 0.4 µg/mg	0.8-1.5 µg/mg	2	1.31–2.06
		14 d, Hom II buffer, 37°C	Hom II buffer	1.0 ± 0.1 µg/mg	1.0-1.1 µg/mg	2	1.32–1.87
		14 d, 70% ethanol, 37°C	Hom II buffer	0.5 ± 0.3 µg/mg	0.2–0.7 µg/mg	2	1.87–2.50
Bufo bufo	Toe clips	14 d, laundry detergent, 37°C	Laundry detergent	2.7 ± 1.1 µg/mg	1.5–3.8 µg/mg	2	1.41–1.51
		14 d, 70% ethanol, 37°C	Laundry detergent	3.5 ± 0.1 µg/mg	3.5–3.6 µg/mg	2	1.28–1.31

material, enzymes (e.g., proteases, lipases), and chelating complexes (e.g., EDTA), just like most of the conventional buffers for the isolation of genomic DNA. Being a single-cell suspension, blood is quickly and easily digested by the laundry detergent while the digestion of tissue samples appears to be slower. Similarly, passive ethanol diffusion into tissue appears to require more time. Although all tissue preservation techniques we tested yielded amounts of high molecular DNA that are sufficient for analysis, autolytic processes as evinced by DNase activity and resulting degradation products occurred in every tissue sample. Furthermore, the sampling of blood is less harmful for most studied animals than the collection of tissue, and guarantees the availability of undamaged specimens for morphological studies.

In studies of amphibian populations toe-clipping is a frequently used, semi-permanent marking method (ASIH et al. 1987; Donnelly et al. 1994; Ferner 1979). Usually, the toes are discarded after amputation. Gonser and Collura (1996) presented evidence that this tissue is a readily available source of genetic material, and urged that toe-clips should therefore be collected rather than wasted. Our observations on *Bufo bufo* toe-clips confirm their findings, and show that high molecular DNA can be isolated from amphibian tissue by laundry detergent too, even after prolonged incubation at high temperatures.

In a laboratory setting, laundry detergent has proven a rapid and uncomplicated storage method for recovering large quantities of genomic DNA. For applications which require a very high purity an additional extraction with phenol or conventional extraction methods may be needed.

With respect to field work in remote areas, laundry detergent has several advantages over freezing, ethanol, and the conventional buffer systems. Laundry detergent has a low dry weight, can be suspended with clean drinking water, is not flammable, and is not subject to legal restrictions. Unlike many conventional buffer systems, laundry detergent is inexpensive and widely available. Due to these characteristics and its ability to preserve blood and tissue samples under field conditions while providing the first steps of DNA extraction at the same time, it may be of interest not only for laboratory use but especially for herpetologists in the field.

Acknowledgments.—We are grateful to Claudia I. Czimczik for assistance during field work, and to Frank Bambang Yuwono for logistical support in Indonesia. We thank Brian Bowen, Brian I. Crother, Richard A. Seigel, Mary E. White, and an anonymous reviewer for helpful comments and suggestions on the manuscript. Funding of the laboratory work was provided by Henkel Waschmittel KGaA.

LITERATURE CITED

ARCTANDER, P. 1988. Comparative studies of avian DNA by restriction fragment length polymorphism analysis: Convenient procedures based on blood samples from live birds. J. Ornithologie 129:205-216.

ASIH, HL, AND SSAR. 1987. Guidelines for Use of Live Amphibians and Reptiles in Field Research. (Available from Robert D. Aldridge, SSAR Publications Secretary, Dept. Biology, St. Louis University, St. Louis, Missouri 63130, USA)

BAHL, A., AND M. PFENNINGER. 1996. A rapid method of DNA isolation using laundry detergent. Nucleic Acids Research 24:1587-1588.

DESSAUER, H. C., AND M. S. HAFNER (EDS.). 1984. Collections of frozen tissues: value, management, field and laboratory procedures, and directory of existing collections. Association of Systematics Collections, Univ. Kansas Press, Lawrence.

_____, C. J. COLE, AND M. S. HAFNER. 1990. Collection and storage of tissues. *In* D. M. Hillis and C. Moritz (eds.), Molecular Systematics, pp. 25-41. Sinauer, Sunderland.

DONNELLY, M. A., C. GUYER, J. E. JUTERBOCK, AND R. A. ALFORD. 1994. Techniques for marking amphibians. *In* W. R. Heyer, M. A. Donnelly, R. W. McDiarmid, L. A. C. Hayek, and M. S. Forster (eds.), Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians, pp. 277–284. Smithsonian Institution Press, Washington, D.C.

FERNER, J. W. 1979. A review of marking techniques for amphibians and reptiles. SSAR Herpetol. Circ. 9:1-41.

GONSER, R. A., AND R. V. COLLURA. 1996. Waste not, want not: toe-clips as a source of DNA. J. Herpetol. 30:445–447.

SAMBROOK, J., E. F. FRITSCH, AND T. MANIATIS. 1989. Molecular Cloning: A Laboratory Manual. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.

A Method to Study the Development of the Dentition in Pleurodont Reptiles

SERGIO R. P. LINE
Department of Morphology
Faculdade de Odontologia de Piracicaba-UNICAMP
13414-018 Piracicaba, São Paulo, Brazil
e-mail: serglin@fop.unicamp.br

Studies regarding the development of the dentition in reptiles are usually performed in decalcified tissue sections (Slavkin et al. 1984; Weill and Tassin 1970; Westergaard and Ferguson 1990). These studies are limited to the observation of few sections in a tooth, and are mainly focused on the cellular aspects of development, as enamel matrix is lost during decalcification procedure. In this paper we describe a simple procedure using scanning electron microscopy (SEM) and histochemistry to study the dentition development in whole mounts of tooth germs.

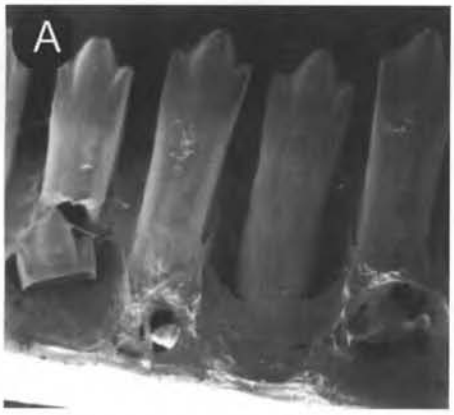


FIG. 1a. SEM image of macerated jaw. Note the presence of three small tooth germs which are inducing the resorption of the functional tooth. X 50.

Three specimens of the iguanid lizard *Tropidurus torquatus* (Vanzolini et al. 1980) were captured and killed by ether inhalation. After decapitation, the heads were macerated for 30 days in a 4% $CaCO_3$ solution at room temperature. After maceration, specimens were boiled in distilled water for 30 min, and the soft tissue was carefully removed under a binocular microscope. To prepare specimens for SEM, tooth germ-bearing bones were air dried and mounted intact on metal stubs. The material was coated with gold using a Balzers MED 010 sputter coater and examined in a Zeiss DSM 900 scanning microscope. For the histochemical analysis, tooth germs were stained with 0.05% Coomassie Brilliant Blue R-250 (Sigma Chemical Corporation, USA) diluted in a 50% methanol, 5% acetic acid solution (Pearse 1985).

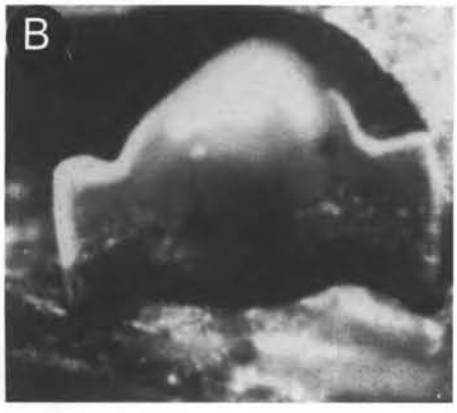


FIG. 1b. Enlarged SEM of a tooth germ. The corrugated surface of the tooth germ reflects large amounts of water loss from the organic matrix (Robinson et al. 1978). Details of the numerous resorption lacunae in the dentin of the functional teeth are also observed. X 140.

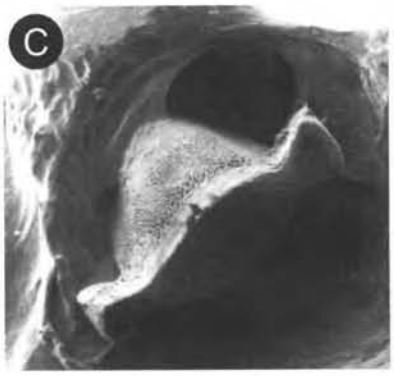


FIG 1c. Coomassie Brilliant Blue staining of a tooth germ. Note that the tip of the tooth germ is not stained, indicating that in this region the organic matrix was already replaced by a mineralized enamel. X 170.

Like in most reptiles, the teeth of the *T. torquatus* are continuously replaced throughout life. This is evidenced by the presence of multiple tooth germs in distinct stages of development (Fig. 1a). This lizard has a pleurodont type of tooth attachment, in which the tooth is attached to the inner margin of the bone jaw (Gaengler and Metzler 1991).

The maceration procedure preserves much of the organic matrix and allows the histochemical staining of the iguanid lizard tooth germs (Fig. 1b). The method described in this paper allows us to directly observe morphological details of odontogenesis (Fig. 1c), as well as the sequence and pattern of tooth formation in pleurodont reptiles and amphibians, and possibly in animals with other type of tooth attachment. This methodology can be used in carcasses of animals that have been dead for several weeks, and is especially useful for the observation of the tooth development in tiny animals, whose tooth germs can have a transverse diameter smaller than 0.1 mm.

Acknowledgment.—Thanks are due to Dr. E. Kitajima from the NAP/MEPA-ESALQ-USP for the use of the scanning electron microscope.

LITERATURE CITED

GAENGLER, P., AND E. METZLER. 1991. The periodontal differentiation in the phylogeny of teeth—an overview. J. Per. Res. 27:214–225.

PEARSE, A. G. E. 1985. Histochemistry. Theoretical and Applied. 4th ed., vol 2. Churchill Livingstone, Edinburg. 449 pp.

ROBINSON, C., P. FUCHS, D. DEUTSCH, AND J. A. WEATHERELL. 1978. Four chemically distinct stages in developing enamel from bovine incisor teeth. Caries Res. 12:1–11.

SLAVKIN, H. C., M. ZEICHNER-DAVID, M. L. SNEAD, E. E. GRAHAM, N. SAMUEL, AND M. W. J. FERGUSON. 1984. Amelogenesis in Reptilia: Evolutionary aspects of enamel gene product. Symp. Zool. Soc. Lond. 52:275–304.

VANZOLINI, P. E., A. M. M. RAMOS-COSTA, AND L. J. VITT. 1980. Répteis das Caatingas. Academia Brasileira de Ciências, Rio de Janeiro.

WEILL, R., AND M-T. TASSIN. 1970. Étude de l'adamantogenèse chez certains reptiles. Arch. Anat. Microsc. 59:427–434.

WESTERGAARD, B., AND M. W. J. FERGUSON. 1990. Development of the dentition in *Alligator mississipiensis*: Upper jaw dental and craniofacial development in embryos, hatching, and young juveniles, with a comparison to lower jaw development. Am. J. Anat. 187:393–421.

The Harmonic Direction Finder: A New Method for Tracking Movements of Small Snakes

CHRISTIAN ENGELSTOFT
Department of Biology, University of Victoria
Victoria, British Columbia, Canada V8W 3N5
e-mail: alula@islandnet.com

KRISTIINA OVASKA
Department of Forest Sciences, University of British Columbia
Vancouver, British Columbia, Canada V6T 1Z4
e-mail (KO): kovaska@jdmicro.com

and
NEIL HONKANEN
Department of Physics and Astronomy, University of Victoria
Victoria, British Columbia, Canada V8W 3P6
e-mail (NH): honkanen@uvic.ca

The harmonic radar (Riley et al. 1996, 1998) and harmonic direction finder techniques (Lövei et al. 1997; Mascanzoni and Wallin 1986, Roland et al. 1996; Wallin and Ekbom 1988) provide new possibilities for tracking small animals. The techniques are based on the principle that a tag (diode and antenna) attached to an animal converts incoming radio signals to a harmonic frequency of the original, broadcast wavelength, and re-radiates at this harmonic frequency. Thus, the returned signal differs from reflections from other objects and vegetation, and the tag can be detected. Because the tag does not need a power source, it can be exceedingly small, weighing as little as 0.4 mg (Roland et al. 1996). High-power scanning harmonic radars (which provide information on both the direction and range) are suitable for recording the dynamic trajectories of low-flying animals (particularly insects) over ranges of hundreds of meters, whereas the hand-held harmonic direction finders (which provide information on only direction) are more suited to the location of stationary or slowly moving targets that can be followed on foot.

The harmonic direction finder has been previously used to follow the movements of carabid beetles (Hockmann et al. 1989, Lövei et al. 1997, Mascanzoni and Wallin 1986, Wallin and Ekbom 1988), snails (Lövei et al. 1997), and a variety of flying insects (Roland et. al 1996). We are aware of only one published report on its use on vertebrates. As part of a study of spatial ecology of the Broad-headed Snake, *Hoplocephalus bungaroides*, in Australia, Webb and Shine (1997) augmented their radio-telemetry data by using the harmonic direction finder to follow movements of juvenile snakes with snout-vent length (SVL) < 35 cm. However, they did not specifically address the harmonic direction finder methodology, including its efficacy for use on snakes. The tags we describe are considerable lighter than those used by Webb and Shine (0.004 g versus 0.25-0.41g) and therefore have potential for tracking smaller animals. Here we present our adaptation of the technique for use on the Sharp-tailed Snake, *Contia tenuis*, including tag assembly, tag implantation, and field trials on tracking a small number of snakes. We also discuss problems that we encountered in our field trials. Our hope is that this information will stimulate others into further developing the method for use on vertebrates that are too small for conventional radio-tracking.

Due to the cryptic habits of *C. tenuis*, very little is known of its life history, behavior, and habitat use. In British Columbia, *C. tenuis* is extremely rare and on the provincial Red List of species at risk. Thus, information on its natural history, including movement patterns, is highly desirable for management and conservation purposes. The small size and slender body form of the snakes preclude the use of conventional radio-telemetry (SVL of adults typically < 30 cm, weight < 8 g, body diameter < 0.5 cm).

Tags and their assembly.—For tags, we used a high-frequency Schottky diode (Hewlett-Packard HP5316; detection frequency range: 1 to 26 GHz, capacitance: 0.10pF at 0V, voltage sensitivity: 6.6mV/μW) mounted in the center of a filamentous antenna (Roland et al. 1996). Characteristics necessary for a diode to function with a harmonic direction finder transceiver unit include an ability to operate in the GHz range of frequencies, a high sensitivity to detect weak signals, and a very low noise figure. To increase the strength of the tag suitable for use on snakes, we first soldered the two leads of the diode onto a small (0.1 x 0.4 mm) substrate made of a flexible, printed circuit board material (Kapton™, a polymide-based dielectric film, which is copper-clad and then etched). A copper plate (or lead) is imbedded to each end of the substrate. The substrate provided support for the diode and its fragile gold leads. We then soldered an antenna (0.079 mm or 40 gauge, enameled copper wire) onto each end of the substrate (Fig. 1).

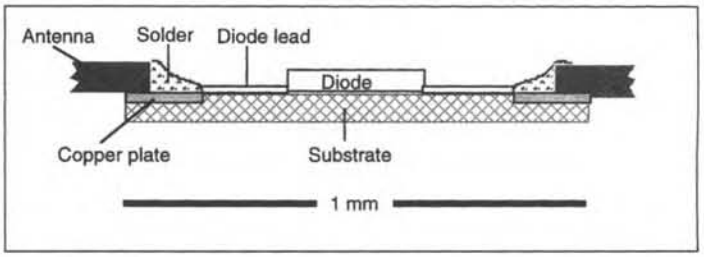


FIG. 1. Diagram of the tag implanted in *Contia tenuis*.

We assembled the tags under a dissecting microscope using a commercially available soldering station (Pace Sensa Temp®) and a 0.4 mm (1/64") diameter soldering bit. As the detection distance increases with antenna length, we used the longest antenna that could be implanted in the snakes (ca. 7 cm in total length). We dipped the tag (diode and antenna) into a presumably inert commercial plastic

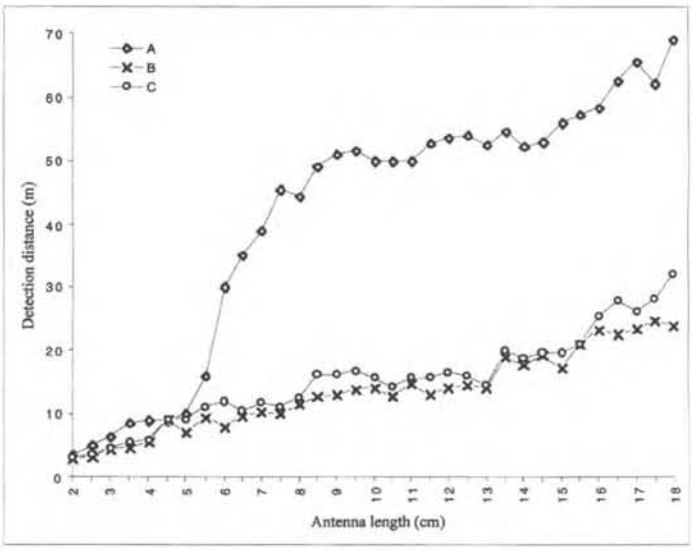


FIG. 2. Maximum detection range of a tag in relation to antenna length. A) Tag 80 cm above ground, transceiver at chest height (100 cm above ground; ◊). B) tag on ground, transceiver at chest height (100 cm above ground; O). C) tag on ground, transceiver above the observer's head (220 cm above ground; X).

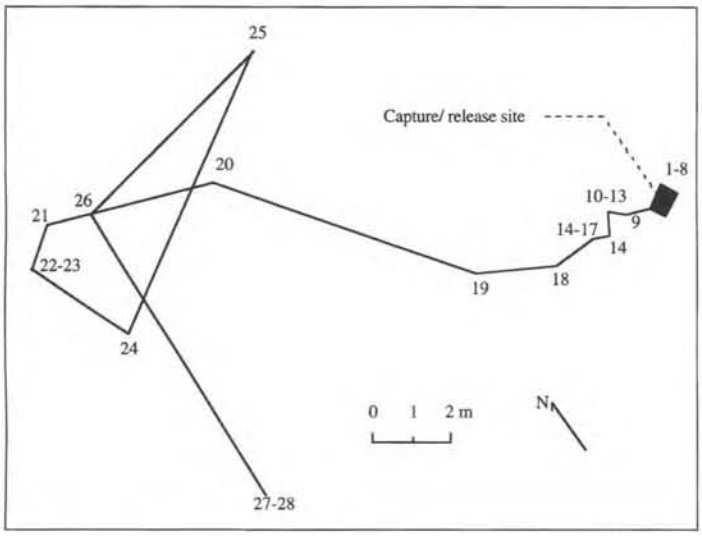


FIG. 3. Movements of an individual *C. tenuis* (# 3) during the night of its release on 11 September 1997. Numbers indicate detection locations.

mixture used for coating tool handles (Plasti Dip®, PDI, Inc. P.O. Box 130, Circle Pines, Minnesota 55014, USA); this potting material has been previously used for coating implanted radio-transmitters used for frogs and snakes (Jansen 1982, Macartney 1985). The total weight of the plastic-coated tag was ca. 4 mg. Webb and Shine (1997) placed tags used for *H. bungaroides* inside flexible, medical-grade silicon tubes.

Detection range.—To determine the relationship between antenna length and detection range, we incrementally shortened an antenna that was initially 18 cm in total length to 2 cm by snipping off 0.5 cm at a time from alternating ends of the tag. After each cut, we measured the maximum detection distance with a portable transceiver unit (RECCO4). The unit transmits a continuous signal at 917 MHz at 4–5 W and receives at 1834 MHz. The incoming wavelengths are translated into an auditory signal to permit tag detection. A Yagi antenna is built into the transceiver unit. We measured the detection distance (A) when the tag was 80 cm above the ground and the transceiver unit was held at chest height (100 cm above the ground), (B) when the tag was on the ground and the transceiver at chest height, and (C) when the tag was on the ground and the transceiver was held above the observer's head (at ca. 220 cm above the ground). In all trials the antenna was horizontal and perpendicular to the line of sight between the tag and transceiver; an antenna end-on to the transceiver cannot be detected (Lövei et al. 1997). We carried out the experiment in an open field where the path between the transceiver and the tag was unobstructed by vegetation.

For antenna lengths greater than 5 cm, the maximum detection distance of a tag raised above the ground was dramatically greater than that of a tag on the ground (Fig. 2). For a tag on the ground, the detection distance decreased steadily with decreasing antenna length. The maximum, unobstructed detection distance of a tag with a 7 cm long antenna, which we used on the snakes, was ca. 12 m when the tag was on the ground. The position of the transceiver unit (at chest height or above the observer's head) had little effect on the detection distance.

Attaching tags to snakes.—Initially, we attempted to attach the tag externally on the dorsum of the snakes by glueing it with SkinBond®, a surgical glue that remains flexible when dry. While tags glued onto four juvenile *Thamnophis ordinoides* (20–25 cm in SVL) remained in place for 7–20 days in captivity, the glue did not adhere properly to *C. tenuis*, presumably due to its smoother, unkeeled scales. Because of the failure of the glue, we decided to attempt subcutaneous attachment. Webb and Shine (1997) implanted tags used on *H. bungaroides* into the body cavity with methods used for radio-transmitter implantation. Our smaller tags allowed subcutaneous implantation.

We first anaesthetized a snake with Metophane® (2% Lidocaine was used for the first two *T. ordinoides*), and then inserted a catheter (11 cm long, gauge 22 [0.85 mm], Monoject® 220, 22 x 3.5) for the length of the tag (7 cm) under the skin. After removing the center rod of the catheter, we inserted a stiff lead wire attached to the tag through the catheter and then slowly removed the catheter while holding onto the lead wire. By pulling the lead wire, we placed the tag in the desired position under the skin. We then removed the lead wire, cut the antenna to appropriate length, and closed the two incisions with SkinBond®.

We implanted tags in four *Contia tenuis* (155–253 mm SVL) and five juvenile *Thamnophis ordinoides* (200–250 mm SVL). Apart from one fatality (the first *T. ordinoides* treated), which probably resulted from holding the snake too tight during the procedure, all snakes recovered and their movements appeared normal 4–6 days after the operation. We kept all four *T. ordinoides* in captivity to investigate signal retention. During the first three months, one *T. ordinoides* died in captivity, apparently from unrelated causes. The remaining three snakes retained functional tags for at least three months. We noted no obvious effects of the tags on feeding, shedding, or growth. We held the four tagged *C. tenuis* in the laboratory for 5–8 days after the procedure to allow for recuperation. We then released the snakes, one at a time, at their original capture locations as part of field trials.

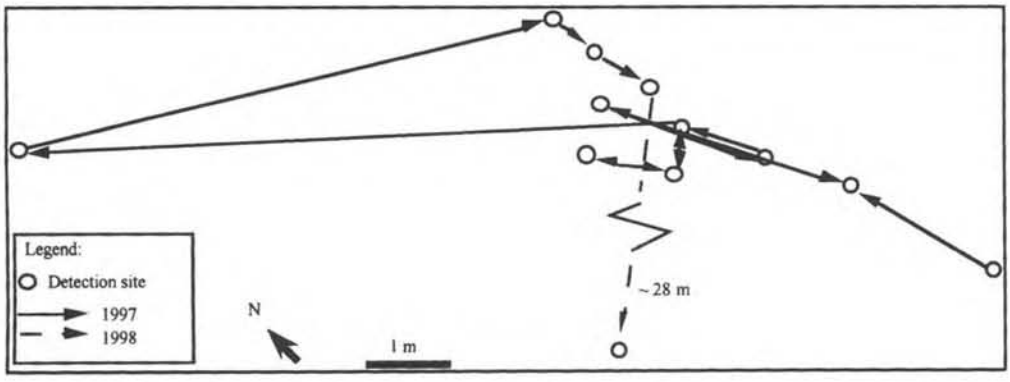


FIG. 4. Movements of an individual *C. tenuis* (# 3) from 12 September 1997 to 20 April 1998. The snake was found a total of 57 times during this period (52 times in fall and 5 times in spring) at the indicated locations. Double-headed arrows indicate movements back and forth between same locations.

Field trials.—We released three *C. tenuis* on North Pender Island (26 August 1997, 11 September 1997, 19 March 1998) and one on Saltspring Island (30 September 1997), British Columbia. The study site on Saltspring was ca. 0.15 ha and that on North Pender ca. 0.75 ha. To examine the feasibility of tracking tagged snakes, we followed the snakes throughout the night of their release, recording locations hourly or more often. For example, Snake #3 (a female) was

released at 1632 h and began to move at 2002 h. We located the snake 28 times during the first night, when it moved a total distance of 44 m (Fig. 3). During each check, we were able to pinpoint the position of the signal to within ca. 15 cm, but only once (at 0219 h) did we visually locate the snake; it traveled mostly under the surface.

After the first night, we were unable to relocate two of the four released snakes. The snakes presumably moved out of the study areas. However, we were able to track the remaining two tagged snakes for several months. From 11 September to 11 November 1997, we located Snake #3 52 times (excluding locations during the first night of release; Fig. 4). The snake spent five days (6 detections) within a log and an adjacent stump, which were in advanced stages of decay. It spent three days (11 detections) under a rock. The remaining 34 detections were at underground locations not associated with surface rocks or logs. During the two-month period, we searched for the snake an additional 17 times without success. In winter, the snake presumably hibernated underground at depths beyond signal detection (i.e., deeper than 20–30 cm). We located this snake again on 21 March 1998, and visually confirmed its identity. We located the snake five times in the same location in the following three weeks using the harmonic direction finder (until 7 April). The distance between two farthest locations was 39 m between September 1997 and April 1998. On 20 October 1998 (about 13 months after tagging), the snake was captured but emitted no signal; most likely, the connection between the antenna and the diode had become detached.

We located Snake #21 three times between 13 March and 20 April 1998 with the harmonic direction finder (excluding locations during the night after its release). One location was under a rock and two were under a downed log. The distance between two farthest captures was 93 m.

The most desirable features of the harmonic direction finder are the small size and relatively long functional life of the tag. In theory, a tagged animal is marked for life, but mechanical wear and tear can shorten tag life, as we documented for one snake. One of our tags lasted at least 208 days in the field, considerably longer than the 8–21 days of battery life for the smallest available radio-transmitters.

Limitations of the technique included short detection range, false signals, and lack of individual recognition. Because the tagged snakes spent most of their time underground, the detection range in the field was < 5 m and often only 1–2 m, a distance considerably shorter than the maximum, unobstructed detection distance of 12 m that we recorded for a tag with a 7 cm long antenna in an open field. Thus, it was necessary to search for snakes by thoroughly scanning the study sites from different directions and with the transceiver close to the ground. The coiling behavior of the snakes and the sigmoidal shape assumed by the antenna of at least one snake, presumably due to muscular activity, probably also contributed to a decrease in the detection distance. A transmitter unit with a stronger, pulsed signal would be desirable, but we are aware of no commercially available sources for such units. Because of its short detection distance, the harmonic direction finder is best suited for detecting relatively short movements. Webb and Shine (1997) obtained movement data for four juvenile *H. bungaroides* in the field. Most movements were < 110 m, but movements up to 250 m were detected.

At our disturbed study sites, various human-made objects, such as metal fencing, concrete with embedded wire mesh, and discarded cans and aluminum wrapping, as well as some iron-bearing rocks, generated false signals (see Lövei et al. 1997 for other sources of false signals). Therefore, before releasing tagged snakes, we examined the study areas with the transceiver and either removed objects emitting false signals or marked them with flags. To identify individual snakes, we tagged only a few snakes per site and verified their identity during visual encounters whenever possible; often, however, digging up the snakes would have resulted in considerable damage to the microhabitats, for example, when the snakes were inside decaying logs. Because known sites with *C. tenuis* are few and restricted in area in British Columbia, the number of individuals that can be potentially tracked without confusion is limited.

Regardless of its short-comings, the field trials showed that the harmonic direction finder can be used to obtain data on movements and habitat use of *C. tenuis*, information that otherwise would not be possible to obtain. With further development of both tags and the transceiver unit, the method holds promise for tracking movements of a variety of small animals.

Costs and permits.—The transceiver unit costs US $6,400 (from RECCO AB, Box 4028, S-181 04 Lidingö, Sweden; e-mail: Recco@recco.se). The diodes cost about US $4.00 each (from Penstock RF/Microwave Distribution Penstock, now AtNet, 520 Mercury Drive, Sunnyvale, California 94086-4060, USA).

Because of its novelty, regulations for the operation of the harmonic direction finder were not well defined in British Columbia at the time of our study and were dealt with on a case by case basis. We suggest that potential users check with their regional regulatory agencies for possible rules and regulations governing the operation of the device.

Criteria for using the harmonic direction finder.—The following questions should be considered before embarking on the use of the harmonic direction finder: (1) Does the target animal move within a relatively small area (e.g., within < 1 ha)? The method is not suitable for detecting long movements. Flying or climbing animals, however, can be detected farther away than animals that are underground or submerged in water. (2) Are there funds available for tag development and assembly? At present, tags are not commercially available and need to be assembled by researchers. Different tag configurations and attachment methods might need to be developed for particular species. (3) Are there objects in the study area that result in false signals? Whereas isolated signal-emitting objects can be identified, widely dispersed contaminants, such as certain metal-bearing rocks, may render the method unsuitable in particular areas. (4) Is individual recognition required? At present, the tags do not allow for individual recognition, and individuals must be identified visually or through other means when located. Passive interrogative transponders (pit tags) might allow individual identification without handling snakes once they have been located using the harmonic direction finder. Alternatively, tracking can be carried out either sequentially or at widely spaced locations.

Acknowledgments.—This work was conducted as part of an ecological study of *Contia tenuis*, for the Ministry of Environment, Lands and Parks, Vancouver Island Regional Office, with funding from Forest Renewal British Columbia. We thank Trudy Chatwin and Susan Holroyd for encouraging us to pursue testing the harmonic direction finder. Malcolm Macartney helped us in developing tag implantation procedures. John Crawford tirelessly assisted us with locating tagged snakes in the field. Sylvia and Kevin O'Reilly, Don Williams, John Crawford, Fred Franke, and Vince and Sandra Knight generously allowed us to track snakes on their properties. We thank Megan O'Shea for sharing ideas on the harmonic direction finder and Joe Riley for his extremely useful comments on an earlier version of this paper. We also thank Daryl Karns, Steve Beaupré, and Howard K. Reinert for their comments that greatly improved this paper.

Literature Cited

Jansen, D. K. 1982. A new potting material for radio-telemetry packages. Copeia 1982:189.

HOCKMANN, P., P. SCHLOMBERG, H. WALLIN, AND F. WEBER. 1989. Bewegungsmuster und Orientierung des Laufkäfers *Carabus auronitens* in einem westfälischen Eichen-Hainbuchen-Wald (Radarbeobachtungen und Rückfangexperimente). Abhandlungen aus dem Westfälischen Museum für Naturkunde 51:1–71. Landschaftsverband Westfalen-Lippe, Münster, Germany.

LÖVEI, L. G., I. A. N. STRINGER, C. D. DEVINE, AND M. CARTELLIERI. 1997. Harmonic radar: A method using inexpensive tags to study invertebrate movement on land. New Zealand J. Ecol. 21:187–193.

MACARTNEY, J. M. 1985. The ecology of the northern Pacific Rattlesnake, *Crotalus viridis oreganus*, in British Columbia. M.Sc. thesis, Univ. Victoria, Victoria, British Columbia, Canada.

MASCANZONI, D., AND H. WALLIN. 1986. The harmonic radar: a new method for tracking insects in the field. Ecol. Entomol. 11:387–390.

RILEY, J. R., SMITH, A. D., REYNOLDS, D. R., EDWARDS, A. S., OSBORN, J. L., WILLIAMS, I. H., CARRECK, N. L., AND G. M. POPPY. 1996. Tracking bees with harmonic radar. Nature (London) 379:29–30.

_____, VALEUR, P., SMITH, A. D., REYNOLDS, D. R., POPPY, G., AND C. LÖFSTEDT. 1998. Harmonic radar as means of tracking the pheromone-finding and pheromone-following flight of male moths. J. Ins. Behav. 11:287–296.

ROLAND, J., G. MCKINNON, C. BACKHOUSE, AND P. D. TAYLOR. 1996. Even smaller radar tags on insects. Nature (London) 381:120.

WALLIN, H., AND B. S. EKBOM. 1988. Movements of carabid beetles (Coleoptera: Carabidae) inhabiting cereal fields: a field tracking study. Oecologia 77:39–43.

WEBB, J. K., AND R. SHINE. 1997. A field study of spatial ecology and movement of a threatened snake species, *Hoplocephalus bungaroides*. Biol. Conserv. 82:203–217.

HERPETOLOGICAL HUSBANDRY

Cage Design for "Hard to Handle" Venomous Snakes

R. MARK WATERS
Department of Ecology and Evolutionary Biology
The University of Tennessee, Knoxville, Tennessee 37919, USA
e-mail: rmwaters@utk.edu

DONNA G. LAYNE*
and
GORDON M. BURGHARDT
Department of Psychology
The University of Tennessee, Knoxville, Tennessee 37919, USA
e-mail (GMB): gburghar@utk.edu

**Present address: Department of Biological Sciences*
Kent State University, Kent, Ohio 44242, USA
e-mail:dlayne1@kent.edu

Venomous snakes present unique husbandry problems to the researcher keeping them in the laboratory. In addition to providing a suitable environment for the snakes, the keepers must ensure the safety of those persons who study and care for the snakes. Researchers may also be required by their institutions to follow established guidelines for animal care and welfare (e.g., UFAW 1987; National Research Council 1996), despite the fact that such guidelines focus mainly on avian and mammalian species and provide little guidance for keeping snakes (Greene et al. 1997). Many institutions are also voluntary members of regulatory bodies, such as the American Association for the Accreditation of Laboratory Animal Care (AAALAC), which carry out compliance inspections. Thus, laboratory caging must meet both safety and animal care requirements. In recent years, the number of commercial cage designs for reptiles has proliferated. These vary from simple, modified aquaria to elaborate polycarbonate (e.g., Plexiglas®) vivaria. However, most of these cages are intended for non-venomous reptiles. Cages designed specifically for housing venomous snakes are generally lacking, so the keeper usually has to modify an existing cage.

In 1993 we began behavioral studies in the laboratory with neonate and juvenile habu (*Trimeresurus flavoviridis*: Crotalinae). Initially, we housed the snakes individually in modified 57 L glass aquaria with sliding, lockable tops, and manipulated the snakes using a standard snake hook. Although our initial research on young snakes was productive (Waters et al. 1996), we found that, as the snakes grew, our caging and method of animal transfer became unsuitable and potentially dangerous. We found that many specimens did not sit on the hook passively, but instead used the hook as a branch, and climbed toward the handler. Efforts to prevent this behavior agitated the snakes and made them difficult to control safely. Therefore we looked for a new cage system that: a) limited the need to handle snakes using a hook, b) provided an environment that reduced stress on the snakes and allowed normal behavior to be observed, c) met the standards for animal care required by AAALAC, and d) maximized the limited space available in our laboratory.

Of the existing caging options we examined, none provided a design that would accommodate all of our needs. Zoos provide examples of well-designed housing for venomous snakes (e.g., Frye 1991, Fig. 2-21). Unfortunately such housing is frequently very large and not easily adapted for laboratory use. Two published accounts describe well-designed cages. Mason et al. (1991) described a cage design for arboreal snakes (specifically *Boiga irregularis*) that met all animal care and welfare requirements. Unfortunately it does not easily accommodate snakes that seek seclusion in a visually isolated retreat. Coote's (1985) design for housing colubrid snakes provided a shelter by using a drawer beneath the main cage. The drawer had a fixed open top making it unsuitable for venomous snakes. In addition, the cage was constructed of wood, which if not completely sealed, does not meet AAALAC guidelines. With these and other designs in mind, we developed a cage that met all of our requirements. We have outlined the design in broad terms, and discuss the features of the design rather than merely providing a blueprint. Interested persons may wish to apply these features when constructing cages for their specific study animal.

Materials.—All elements of the cage are constructed from materials that meet AAALAC guidelines. The main body of the cage is constructed from clear Lexan® polycarbonate panels (6.35 mm thick) and stainless steel hardware. Panels are held together with steel screws. We chose screws, rather than a commercial bonding agent, to facilitate replacement of individual panels if they are damaged. The Lexan® panels tolerate an industrial cage washer that cleans at high temperatures. The hide boxes are not constructed from Lexan® because it was not available in the colors that we wanted. Instead we used acrylic of the same thickness. A complete list of materials is available on request.

Main Cage.—The cage is a 61 x 61 x 40.5 cm box divided into three permanent spaces: a large, upper living space, and two smaller, lower retreats. A hide box is inserted into each of the lower retreats. The living space can be divided into halves by a removable opaque divider (Fig. 1, Element A; Fig. 2). We find this flexibility useful when dealing with different sizes of snakes. Snakes are able to move freely between the living space and hide box via a round, 6.4 cm opening in the floor (Fig. 1, Element G). The openings in the hide box and living space can be independently closed using stainless steel plates that slide under (Fig. 1, Element H) or over (Fig. 1, Element I) the holes, respectively. The plates are secured in place with plastic thumbscrews.

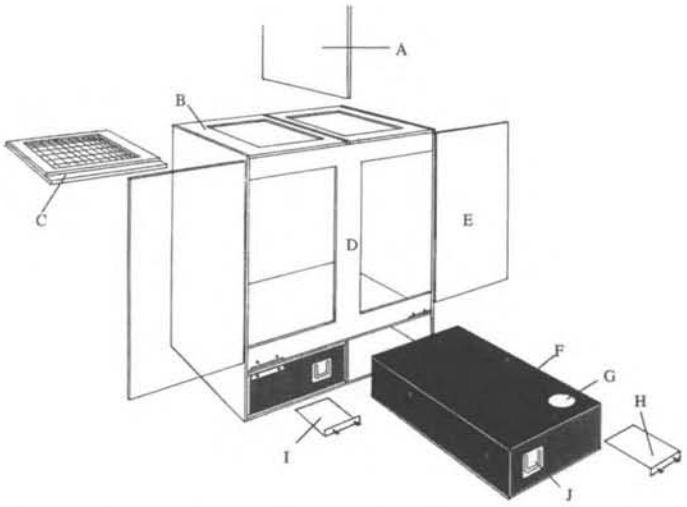


FIG. 1. Schematic diagram of venomous snake cage. A) opaque divider; B) protective top panels; C) lid; D) protective front panel; E) front door; F) hide box; G) opening for snakes to exit box; H) stainless steel sliding plate for hide box; I) stainless steel sliding plate for main cage; J) handle for removing hide box from main cage.

The front of the living space is an **I**-shaped panel (Fig. 1, Element D). This feature serves two purposes: it provides structural support while leaving openings for front access, and it forms a modest vertical barrier (5.1 cm high) to snakes moving forward along the ground. Similarly, the top panels (Fig. 1, Element B) form a lip around the top of the cage to restrict vertical exits when the lids are open.

The front doors (Fig. 1, Element E) are hung with stainless steel piano hinges and close over the **I**-shaped panel. When closed, the doors are secured using padlock hardware that is screwed to the doors and the **I**-shaped panel. In addition, each door has two nylon thumbscrews (top and bottom of distal end of door) that are threaded into the **I**-shaped panel (Fig. 2) to prevent the door from bowing out at the edges.

Each cage lid is constructed from two Lexan® frames with 3.2 mm stainless steel mesh sandwiched between them (Fig. 1, Element C). The mesh ensures adequate ventilation, but can be replaced with a solid panel for those species having high humidity requirements. The cage lids are also hung using stainless steel hinges (Fig. 2). When closed the left and right lids are secured together with a padlock. As with the doors, each lid has two nylon thumb screws which secure the lid to the underlying panel.

Hide Boxes.—The hide boxes are the most important feature of this design because they enable the keeper to avoid direct contact with the snakes. With sliding gates closed, each box may be moved into any other cage and can be weighed with the snake in it.

Each hide box (Fig. 1, Element F) is 39.4 x 58.4 x 8.6 cm. The top, bottom, and sides are constructed of black opaque acrylic to provide a dark retreat. The front and back panels are constructed of dark red transparent acrylic. The red tinted panels provide a measure of visual isolation while permitting the keeper to check the condition and behavior of the snakes in the hide box. An opening (Fig. 1, Element G) allows the snake to exit the hide box and enter the living space. In the face of the front panel there is a recessed handle (Fig. 1, Element J). The rear panel is removable and secured in place with thumbscrews. Snakes readily enter the hide box when disturbed.

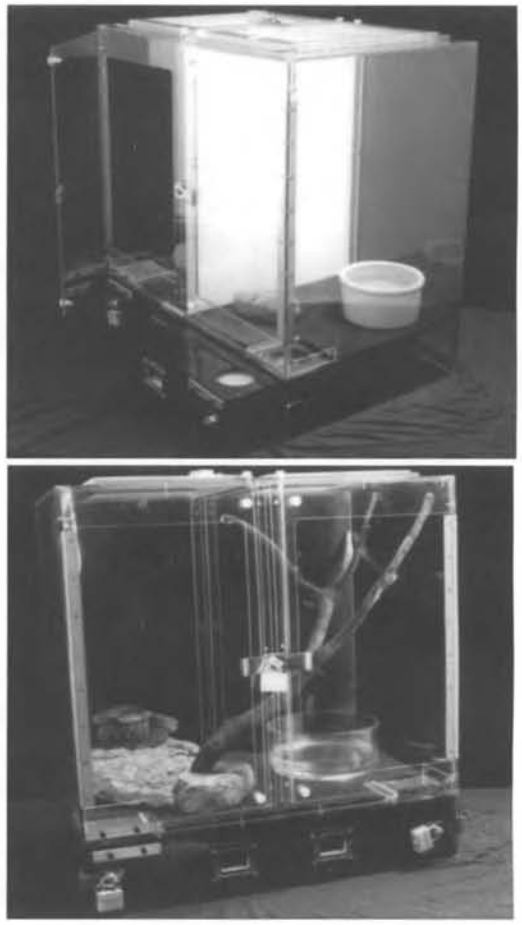


FIG. 2. Photographs of the cage with (a) partition in place; (b) without partition and habu in living space.

We have used this design for three years to house all our venomous snakes (*Trimeresurus flavoviridis, T. elegans*, and *Agkistrodon contortrix*) and have needed to use a snake hook (direct contact) rarely. The hook is occasionally used to encourage snakes to go into their hide box when the living space needs cleaning. If a snake needs to be removed from the hide box, the back panel of the box can be opened and the snake gently lifted out and into the upper living space. We find that the snakes adapt well to the cage and make use of both the living space and hide box. The habu is primarily nocturnal (Koba 1971) and therefore makes greatest use of the living space when the room is dark (Waters et al. 1998). We shifted the light/dark cycle so that the room becomes dark at noon. The mornings can then be used for servicing the cage while the snakes are secured in their hide boxes.

We are in the process of adapting the hide box so veterinarians may use it when treating snakes that become ill. This is usually the only time when the snakes need to be handled directly. One design will incorporate a squeeze box apparatus, while another will be adapted as an induction chamber for anesthesia with inhalation anesthetics.

Acknowledgments.—We thank Dr. M. Nishimura of the Habu section, Okinawa Prefectural Institute of Public Health, Ozato, Okinawa, Japan for his support and providing the habu. We also thank David Pratt and Gary Branson of Biological Services, University of Tennessee, for comments on the design and constructing the cage. We thank Paul Andreadis, Mark Krause, L. Ardell Mitchell, and two anonymous reviewers for comments and suggestions on the manuscript.

LITERATURE CITED

COOTE, J. 1985. Breeding colubrid snakes, mainly *Lampropeltis*. *In* S. Townson and K. Lawrence (eds.), Reptiles: Breeding, Behaviour and Veterinary Aspects, pp. 5–17. British Herpetological Society, London.

FRYE, F. L. 1991. Biomedical and Surgical Aspects of Captive Reptile Husbandry. Krieger Publishing Company, Malabar, Florida. 637 pp.

GREENE, M. J., D. K. NICHOLS, R. F. HOYT, JR., AND R. MASON. 1997. The brown tree snake (*Boiga irregularis*) as a laboratory animal. Lab Animal 26(7):28–31.

KOBA, K. 1971. Natural history of the habu, *Trimeresurus flavoviridis* (Hallowell). Snake 3:75–96.

MASON, R. T., R. F. HOYT, JR., L. K. PANNEL, E. F. WELLNER, AND B. DEMETER. 1991. Cage design and configuration for arboreal reptiles. Lab. Anim. Sci. 41:84–86.

NATIONAL RESEARCH COUNCIL. 1996. Guide for the Care and Use of Laboratory Animals. U.S. Department of Health and Human Services. National Academy Press, Washington, D.C. 140 pp.

UFAW. 1987. The UFAW Handbook on the Care and Management of Laboratory Animals. 6th Edition. Longman Scientific and Technical Group, Longman Group UK Limited, Essex England. 933 pp.

WATERS, R. M., G. M. BURGHARDT, AND K. A. MACLEAN. 1998. A comparative study of microhabitat use and activity patterns in captive *Trimeresurus elegans* and *Trimeresurus flavoviridis*: Preliminary observations. Reports of Ecological Researches to Diminish Bites of Habu (*Trimeresurus flavoviridis*) in Okinawa Prefecture 21:131–137

_____, D. CHISZAR, AND G. M. BURGHARDT. 1996. Strike-induced chemosensory searching in the habu (*Trimeresurus flavoviridis*), an Asian pit viper. J. Herpetol. 30:147–151.

NATURAL HISTORY NOTES

Instructions for contributors to Natural History Notes appear in Volume 30, Number 1 (March 1999).

CAUDATA

NOTOPHTHALMUS PERSTRIATUS (Striped Newt). **COLORATION**. Occurrence of albinos has been reported for numerous species of salamanders (Dyrkacz 1981. SSAR Herp. Circ. 11. 31 pp.). Here we report observations of four albino striped newts encountered over a three-year period at One Shot Pond, a seasonally-ponded isolated wetland located on the Katharine Ordway Preserve-Carl Swisher Memorial Sanctuary, Putnam Co. Florida, USA. This is the first published account of albinism for *Notophthalmus perstriatus* and apparently the first for the genus *Notophthalmus*.

The first albino observed was a larva captured by dip net on 11 July 1995. This animal lacked normal integumentary pigmentation (Fig. 1) but had a yellowish cast throughout its body. Shiny bluish flecks were present along the dorsal and ventral margins of the tail fin (these appear as white spots in Fig. 1). The eyes appeared to be normally pigmented. Using the terminology of Dyrkacz (*op. cit.*), this animal is described as leucistic with xanthophores. The larva was maintained in captivity until its death on 6 August 1995 at which time it measured 23 mm SVL. We were unable to determine its sex. Although its tail fin and gills had atrophied considerably, it failed to complete metamorphosis. The specimen and a color slide of it in life were deposited in the Florida Museum of Natural History, University of Florida (UF102170). A second larva closely resembling the above was collected by dip net on 17 August 1996 (UF111290, sex unknown, SVL = 21 mm, TL = 43 mm).

FIG. 1. Albino (leucistic with xanthophores) *Notophthalmus perstriatus* larva from One Shot Pond, Putnam Co., Florida. Photo by Barry Mansell.

Two leucistic efts were also captured at One Shot Pond. The first was caught on 8 November 1996 in a bucket trap at a drift fence 60 m from the pond (UF111291, sex unknown, SVL = 20 mm). The second eft (UF 111292, female, SVL = 22 mm, 0.2 g) was captured on 2 December 1997 in a bucket trap on the inside of a drift fence that encircled the pond. Based on the presence of gill buds, it had recently metamorphosed and was moving into the uplands. Both efts lacked integumentary pigmentation although the eyes appeared normal. The stripes, which are characteristic in transformed individuals of *N. perstriatus*, were visible as distinct light lines. Both efts are described as leucistic with xanthophores (Dyrkacz, *op. cit.*).

We have conducted regular sampling in One Shot Pond since July 1995, usually examining about 50 individuals each month. Since October 1996, we individually marked more than 4000 striped newts caught in pitfalls at the drift fence that encircled the pond. We also have observed hundreds of striped newts at numerous breeding ponds throughout the geographic range of the species; however, these four individuals are the only *N. perstriatus* we have encountered with abnormal pigmentation. Additionally, in over 2500 captures at a breeding in north-central Florida, as well as numerous individuals observed throughout the species range in Georgia, USA, Dodd never encountered an albino striped newt (C. K. Dodd, Jr., pers. comm.).

We thank C. Kenneth Dodd, Jr., Richard D. "Bubba" Owen, and Dale A. Johnson for reviewing earlier drafts of this note. Barry Mansell took the photograph in Fig. 1.

Submitted by **STEVE A. JOHNSON**, Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida 32611, USA, and **RICHARD FRANZ**, Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611, USA.

PLETHODON DUNNI (Dunn's Salamander). **REPRODUCTION**. Only a single nest of *Plethodon dunni* has been reported (Dumas 1955. Copeia 1955:65). On 27 May 1997, a second nest was discovered at Keel Mountain, Linn County, Oregon, USA (T12N R1E Sec 13). The nest contained an adult coiled around 12 eggs and was located in a cavity in a decay class 5 log (Maser et al. 1979. *In* Thomas (ed.), Wildlife Habitats in Managed Forests: the Blue Mountains of Oregon and Washington, pp. 78–95. USDA For. Serv. Agric. Hndbk. 553.) near the upper surface of the log under loose wood. The log was on a 0.5 m high cut-bank ca. 0.2 m from a small, first-order perennial stream. Habitat at the site was characterized by ca. 40 yr old Douglas fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*), naturally regenerated after logging, with an understory of sword fern (*Polystichium minutum*), Oregon grape (*Berberis nervosa*), and huckleberry (*Vaccinium parvifolium*). Large decayed downed wood was

abundant due to apparent "high-grading" and/or snag-felling during previous timber management activities; log decay classes 4 and 5 were the most abundant at the site (S. Chan, USFS pers. comm.). A thick layer of bryophytes covered a large portion of the downed wood and forest floor.

Funding was provided to DHO by the USDA Forest Service, National Forest System and the Pacific Northwest Research Station. For assistance in study implementation and coordination, we are grateful to Charley Thompson (Portland, BLM), John Tappeiner (Biological Resources Division, U.S. Geological Survey), and Kerry Murphy (Salem District, BLM).

Submitted by **RICHARD S. NAUMAN, DEANNA H. OLSON, LORETTA L. ELLENBURG**, and **BRUCE P. HANSEN**. Aquatic-Land Interactions Research Program, USDA Forest Service, Pacific Northwest Research Station, 3200 SW Jefferson Way, Corvallis, Oregon 97331, USA.

ANURA

ACRIS CREPITANS (Northern Cricket Frog). **DEATH FEIGNING**. During October 1990, 89 juvenile *Acris crepitans* (20–27 mm SVL) were collected in southwest Normal, Illinois, USA. They were housed in plastic shoeboxes, filled with ca. 1 cm water and tilted to provide an aquatic and terrestrial environment. In captivity, 17 of these frogs displayed death feigning when they were roughly handled or restrained, although this behavior was not displayed as frequently when captured in the wild (pers. obs.). The apparent higher display frequency may be a result of stress levels experienced in captivity, as they were held captive for 2–3 weeks prior to release. When displaying this behavior, a frog would position all limbs in their normal resting position but raised from the substrate so the frog was resting on its venter. The medial digits of the forelimbs were positioned against the tympanum. The hind legs were similarly raised with the femoral portions of the limbs held against the lateral flanks of the abdomen. If released, a frog displaying this behavior would remain in this position for a few seconds, even when turned on its back. Afterwards it would right itself and quickly leap away from the observer. This behavior somewhat resembles the unken reflex displayed by highly toxic frogs such as *Bombina orientalis*. In the unken reflex, a toxic frog will raise its pectoral and pelvic regions from the ground and balance on its ventral surface. In the death feigning behavior, *A. crepitans* only positions its limbs, the pectoral and pelvic regions remain in their usual position, thus causing the chin to rest on the ground as if the frog were crouching. This appears to be the first report of death feigning in *A. crepitans*.

Submitted by **MALCOLM L. McCALLUM**, Department of Biology, Health, and Physical Education, Belleville Area College, 2500 Carlyle Avenue, Belleville, Illinois 62223, USA.

BUFO ALVARIUS (Colorado River Toad). **HABITAT**. *Bufo alvarius* has been reported to occur from elevations of 1250–1387 m in New Mexico (Degenhardt et al. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. 431 pp.). Range-wide elevation has been reported between 0–1610 m (Stebbins 1985. A Field Guide to Western Amphibians and Reptiles. 2nd ed. Houghton Mifflin Co., Boston, Massachusetts. 336 pp.) and 0–1615 m (Cole 1962. Herpetologica 18:172–175; Fouquette 1970. Cat. Am. Amphib. Rept. 93:1–4). Degenhardt et al. (*op. cit.*) described the habitat as "desert shrub characterized by broad flat expanses of creosotebrush and mesquite, in rocky riparian zones grown to cottonwood and sycamore, in muddy stock ponds". Stebbins (*op. cit.*) described range-wide habitat as "arid mesquite-creosotebush lowlands and arid grasslands into the oak-sycamore-walnut groves (plant community) in mountain canyons" and noted that the species "enters tropical thorn forest in Mexico." Fouquette (*op. cit.*) described the occurrence "in desert, but also in grassland and lower oak-woodland" of the Lower and Upper Sonoran life zones. Cole (*op. cit.*) listed 13 specimens collected in San Simon and San Bernardino Valleys as well as a specimen from the Peloncillo Mountains "200 yards E of the Arizona-New Mexico State Line on Geronimo Trail" in "an open meadow surrounded by pine-oak-juniper forest" (R.W. Axtell, pers. comm.). Presently, this site in Cottonwood Canyon is a mosaic of encinal woodland and savanna, with Mexican pinyon (*Pinus cembroides*) and alligator bark juniper (*Juniperus deppeana*) occurring throughout.

During the summers of 1997 and 1998, we observed six *B. alvarius* at elevations above 1685 m in Clanton Draw (NM) of the Peloncillo Mountains. These specimens were found in pine-oak woodlands characterized by high densities of Chihuahua pine (*Pinus leiophylla*), Mexican pinyon, alligator bark juniper, and various oaks (*Quercus* spp.). On 9 August 1998 a single specimen (Arizona State University ASU 30937) was collected at 1763 m in Cottonwood Canyon (NM) on a steep (>30°) rocky slope dominated by native grasses. Our observation of multiple individuals over two years, in addition to Cole's (*op. cit.*) 1961 specimen, indicate an adult population of *B. alvarius* occupies this rugged Madrean community bounded by grasslands and Chihuahuan desert scrub.

Submitted by **ANDREW T. HOLYCROSS** and **BRIAN G. FEDORKO**, Biology Department, Arizona State University, Tempe, Arizona 85287-1501, USA, and **OCKERT FOURIE**, University of Toronto, Department of Medical Biophysics, 1 King's College Circle, Toronto, Ontario M5S 1A8, Canada.

BUFO AMERICANUS (American Toad). **DEPTH RECORD**. On 19 June 1997 while SCUBA diving in the Connecticut River we captured two *Bufo americanus* tadpoles at a depth of 8 m. The dive site was near the confluence of Pine Meadow Brook and the Connecticut River, ca. 42°42'34"N, 72°26'14"W in the town of Northfield, Franklin County, Massachusetts, USA. The river bottom dropped steeply to 1 m and then gently to a maximum of 10 m. The bottom was a continuous bed of live mussels overlaying dead mussel shell and fist-sized rocks. The flow regime is variable on a diel basis due to an upstream power plant pumping station, with the current ranging from 0–2.5 knots. The two tadpoles, which had not started to transform, were found at a depth of 8 m while we were turning rocks and shells. We identified the tadpoles as *Bufo* sp. because of their distinctive coloration and size. The species, *B. americanus*, was inferred because the only other toad occurring in the area, *B. woodhousii fowleri*, breeds later in the year (Degraaf and Rudis 1983. Amphibians and Reptiles of New England: Habitats and Natural History. Univ. Massachusetts Press. Amherst. 85 pp.). In 1997, due to a cool and prolonged spring season, local *B. americanus* did not breed until mid-May with *B. woodhousii fowleri* delaying reproduction until June (TFT, pers. obs.). Typically, *B. americanus* breed in ponds and still, shallow water (Klemmens 1993. Amphibians and Reptiles of Connecticut and Adjacent Regions. State Geological and Natural History Survey of Connecticut. Bull. 112 xii+318 pp.). They also breed in local streams and rivers. This is the first report of a toad tadpole in deep and relatively fast flowing water. It is probable that eggs or tadpoles were washed into the river and settled in this vicinity as *B. americanus* have not been reported to breed in the river itself. The shells and rocks provide a still water microhabitat until transformation.

Submitted by **ALAN M. RICHMOND, THOMAS F. TYNING**, and **ADAM P. SUMMERS**, Organismic and Evolutionary Biology, University of Massachusetts at Amherst, Amherst, Massachusetts 01003-5810, USA.

BUFO BOREAS (Boreal Toad). **PREDATION**. Numerous predators of *Bufo boreas* adults and tadpoles have been reported in the literature. In 1994 and 1995, one of us (JPG) examined the stomach contents of 154 brook trout (*Salvelinus fontinalis*) from a boreal toad breeding site containing numerous tadpoles in Chaffee County, Colorado, USA. Most guts contained chironomid pupae and larvae, but none contained any tadpoles. Ten 150-mm greenback cutthroat trout (*Oncorhynchus clarki*) coexisted in a 3.7-m long hatchery trough with eight *B. boreas* tadpoles for 48 days and did not consume or injure any tadpoles. These observations suggest that these salmonids do not routinely consume boreal toad tadpoles.

When offered 200 boreal toad tadpoles, four captive mallards (*Anas platyrhynchos*) consumed the tadpoles in less than one minute. In Chaffee County, mallards have been observed at boreal toad breeding sites apparently consuming tadpoles (C. Fetkavich, pers. comm.). Medium and large odonate larvae consumed boreal toad tadpoles in laboratory trials, but we did not observe predation by odonate larvae at boreal toad breeding sites. We frequently observed spotted sandpipers (*Actitis macularia*) consuming toadlets in the Woods Creek drainage, Clear Creek County. Most predation occurred in August, when the toadlets were metamorphosing. During one observation on 9 August 1995, a spotted sandpiper ate 21 newly metamorphosed toadlets in approximately 30 seconds. Most of the toadlets were on the shore, but a few were in shallow water. At one site where dropping water levels exposed >1 m of unvegetated shore, the sandpipers walked parallel to the shoreline, picking up toadlets as they progressed. Also in August, American robins (*Turdus migratorius*) were observed eating tadpoles from the shallow portions of a boreal toad breeding pool. One robin ate six tadpoles in a one-minute period.

We also observed predation on adult boreal toads by red fox (*Vulpes vulpes*) and raccoon (*Procyon lotor*). Beginning in late June 1998, and continuing through July, raccoon tracks were found at three breeding ponds at or near the stripped-off skins of at least six adult toads, including three toads that had been equipped with radio transmitters. The skins were discarded in shallow water. A toad carcass was found near fox tracks, with no other mammal or bird tracks in the vicinity. In contrast to raccoon predation, the body parts appeared chewed rather than peeled away and were on the ground rather than underwater. In 1998, late June and early July were particularly dry, which may have concentrated both the toads and these mammalian predators, as we observed no such predation in the previous years (1995–1997) at this site. In addition, in 1998 a domestic dog tore the abdomen of an adult female toad, which died from the wound.

Funding for this work was provided by Great Outdoors Colorado through the Colorado Division of Wildlife. We thank Anne Beierle, Environmental Coordinator, and the Climax Molybdenum Company for facilitating research activities. Bud Stiles assisted with the field work.

Submitted by **MARK S. JONES** and **JOHN P. GOETTL**, Colorado Division of Wildlife, 317 West Prospect, Fort Collins, Colorado 80526, USA, and **LAUREN J. LIVO**, Colorado Division of Wildlife, 317 West Prospect, Fort Collins, Colorado 80526, USA, and EPO Biology, University of Colorado, Boulder, Colorado 80309-0334, USA.

DENDROBATES AURATUS (Green Poison Frog). **PREDATION**. Predation on members of the genus *Dendrobates* is apparently rare, perhaps due to the presence of highly toxic alkaloids in their skin (Myers and Daly 1983. Sci. Am. 248:120–133). Here, I report observations of predation on *Dendrobates auratus* by the tarantula *Sericopelma rubronitens* on Toboga Island, Panama.

On 5 June 1985, I observed an adult *S. rubronitens* rush out of its burrow, capture a passing female *D. auratus* in its mandibles, and retreat back into its burrow. Apparently this spider was not hungry or was repelled by the frog's toxins as the frog left the burrow after ca. two minutes. The frog left the burrow slowly, hopping at a normal pace. Presumably the tarantula could have retrieved the frog if it had simply escaped. Examination revealed the frog was unscathed except for two parallel scratches in the skin on the right side, apparently from the fangs of the tarantula.

On 20 June 1985, I observed a courting male and female *D. auratus* as they passed by a rock under which a tarantula had a burrow. The spider rushed out, captured the male, and returned into its burrow. After one hour the spider was captured, examined, and found to be clutching the frog in its mandibles The frog was dead although the cause of death was not obvious, and it was not apparent that the tarantula had been attempting to consume the frog.

At a later date, I captured a *D. auratus*, tied a length of fishing line around its waist, and presented it to a foraging tarantula I had observed earlier. The spider immediately grabbed the frog in its mandibles and retreated under a rock. I allowed the spider to remain in this position for 2.5 h and then retrieved the frog. Examination of the corpse revealed two puncture marks in the upper venter, near the left foreleg. The frog's body on the left side was deformed and the internal tissues were dissolved and partially removed. Hence, it appeared the tarantula had injected the frog with digestive fluids and was in the process of removing the liquefied tissues.

The tarantula was kept in a terrarium for two days and showed no obvious ill effects from partially consuming the poison frog. Apparently *S. rubronitens* does prey on *D. auratus*, although the first observation of capture and subsequent release of a female suggests *D. auratus* may not be a preferred prey item.

I thank A. S. Rand and the administrative staff of the Smithsonian Tropical Research Institute for advice and assistance.

Submitted by **KYLE SUMMERS**, Department of Biology, East Carolina University, Greenville, North Carolina 27858, USA.

GASTROPHRYNE OLIVACEA (Great Plains Narrowmouth Toad). **AGGREGATION WITH TARANTULA**. Blair (Copeia 1936:115) was the first to call attention to the tarantula *Aphonopelma hentzii* sharing its burrows with *Gastrophryne olivacea*, citing that up to nine of the toads were found in an individual burrow. In a presentation at the 1991 SSAR meeting I elaborated on the nature of this association, offering evidence that the tarantulas indeed would not attack *G. olivacea* or *G. carolinensis* but would attack and eat the frog, *Acris crepitans*.

On 14 April 1998 at a site in Wagoner County, Oklahoma, USA, I found several tarantulas under flat stones, some sharing the burrow with toads, others not. Under one stone I found 22 *G. olivacea* with a female tarantula. When uncovered, all of the animals attempted to rush into the burrow, the crush being so great that the animals literally plugged the burrow and could not force their way through the entrance. Because the toads must journey up to several hundred meters to reach their breeding sites, experiments are in progress to determine if individual toads return to the same burrows after the mating season.

Submitted by **HAROLD A. DUNDEE,** Tulane University Museum of Natural History, Belle Chasse, Louisiana 70037-3098, USA; e-mail: dundee@museum.tulane.edu.

LEPTODACTYLUS CHAQUENSIS (NCN). **DIET.** *Leptodactylus chaquensis* is a common frog in the Chacoan region of Argentina, where it is found in the eastern foothills of the Andean system (Jujuy, Salta, and Tucuman) up to the central marshes of Corrientes (Ibera swamps), the Entre Rios, and Santa Fe Province (Cei 1980. Amphibians of Argentina. Monitore Zoologico Italiano (NS). Monogr 2, 609 pp.). Nine individuals were collected during the following periods: April–June 1996 (one male 74.5 mm SVL; two females 52.1 and 52.3 mm SVL), October 1996 (two females 54.4 and 75.8 mm SVL), and January 1997 (two males 68.1 and 47.6mm SVL; two females 61.5 and 64.7 mm SVL). All specimens were collected 15 km northeast of Corrientes (27°28'S, 58°50'W) Corrientes, Argentina. *Leptodactylus chaquensis* is a nocturnal, active forager. Table 1 summarizes data collected during this study.

I thank Arturo I. Kehr for suggestions on field and laboratory methods and for reviewing a draft of this manuscript.

TABLE 1. Prey consumed by *Leptodactylus chaquensis* (N = 9) from Corrientes, Argentina.

Items	N	% Total	Vol (cm^3)	% Vol.	Freq.
ARACHNIDA					
Araneae	1	1.9	0.006	0.1	1
INSECTA					
Coleoptera	13	25.0	1.95	38.6	6
Orthropoda	5	9.6	2.16	42.7	5
Diptera	2	3.8	0.0003	0.1	1
Homoptera	2	3.8	0.039	0.8	1
Hemiptera	1	1.9	0.19	3.8	2
Hymenoptera (ants)	14	26.9	0.032	0.6	1
Hymenoptera (excl. ants)	2	3.8	0.37	7.3	2
Isoptera	9	17.3	0.03	0.6	3
Larva	1	1.9	0.001	0.2	1
MOLLUSCA					
Hirudineae	1	1.9	0.12	2.4	1
VERTEBRATA					
Amphibia	1	1.9	0.15	3.0	1
TOTAL	52	100	5.05	100	

Submitted by **MARTA I. DURE**, Centro de Ecología Aplicada del Litoral (CECOAL-CONICET), C.C. 291, (3400) Corrientes, Argentina.

LITHODYTES LINEATUS (Ant Frog). **COLORATION.** The leptodactylid frog *Lithodytes lineatus* occurs in eastern Peru, Ecuador, Colombia, Bolivia, Brazil, southern Venezuela to the Guianas, and on the island of Trinidad (Frost 1985. Amphibian Species of the World. Allen Press, Inc. and Assoc. Systematics Collections. Lawrence, Kansas. v + 732 pp.; Cochran and Goin 1970. Frogs of Colombia. Smithsonian Inst. Press. 655 pp.; Murphy 1997. Amphibians and Reptiles of Trinidad and Tobago. Krieger Publishing, Malabar, Florida. 245 pp.).

Normal coloration for *L. lineatus* consists of a black dorsum and a pair of wide yellow to golden tan dorsolateral stripes extending from the snout to nearly the groin. The dorsal surface of the limbs is black to brown with black or dark brown bars; red spots are present in the groin. The flanks are black and the venter is normally grayish brown (Duellman 1978. The Biology of an Equatorial Herpetofauna. Univ. Kansas Mus. Nat. Hist. Misc. Publ. 65. 352 pp.; Rodriguez and Duellman. 1994. Guide to the Frogs of the Iquitos Region, Amazonian Peru. Univ. Kansas Mus. Nat. Hist. Spec. Publ. 22. 106 pp.).

On 6 July 1998, an aberrant adult *L. lineatus* (ca. 35 mm SVL; Univ. Texas at Arlington (UTA) Slide 24363) was photographed and released in the riparian forest at Quebrada Ungurawe in the vicinity of Monteverde, Rió Tigre, Loreto, Peru (W. Lamar, pers. comm.). The specimen lacked all black pigment and was a uniform pale brown (flesh color by night). The dorsolateral stripes on the back were a weaker yellow, but the red markings in the groin appeared normal. The bars occurring on the dorsal surface of the limbs were yellow, and the ventral surface was pale gray to white.

Hypomelanism has been documented in anurans (Bechtel 1995. Reptile and Amphibian Variants: Colors, Patterns, and Scales. Krieger Publishing, Malabar, Florida. 206 pp.); however, this is the first report of hypomelanism in *L.lineatus*.

Submitted by **MATTHEW J. RUSSELL**, Department of Biology, University of Texas at Arlington, Box 19498, Arlington, Texas 76019, USA.

PHYLLOMEDUSA HYPOCONDRIALIS (NCN). **DIET.** Although many aspects of the ecology of *Phyllomedusa hypocondrialis* were discussed by Cei (1980. Amphibians of Argentina. Monitore Zoologico Italiano (NS). Monogr. 2, 609 pp.), the diet has not been investigated. Nine individuals were collected during the following periods: 7 February 1996 (two males; 28.2 and 31.0 mm SVL), October–November 1996 (five males; mean = 31.2 ± 0.06 mm SVL), and January 1997 (two males; 29.9 and 32.0 mm SVL). All specimens were collected 15 km northeast of Corrientes (27°28'S, 58°50'W), Corrientes, Argentina. *Phyllomedusa hypocondrialis* is a sit-and-wait predator. Table 1 summarizes data collected during this study.

I thank Arturo I. Kehr for suggestions on field and laboratory methods and for reviewing a draft of this manuscript.

TABLE 1. Prey consumed by *Phyllomedusa hypocondrialis* (N = 9) from Corrientes, Argentina.

Items	N	% Total	Vol (cm^3)	% Vol.	Freq.
ARACHNIDA					
Araneae	1	2.6	0.003	1	1
INSECTA					
Hymenoptera (ants)	1	2.6	0.0005	0.2	1
Hymenoptera (excl. ants)	2	5.3	0.078	26.1	2
Diptera	29	76.3	0.18	58.1	7
Homoptera	4	10.5	0.051	16.4	1
Orthoptera	1	2.6	0.003	1	1
TOTAL	38	100	0.31	100	

Submitted by **MARTA I. DURE**, Centro de Ecología Aplicada del Litoral (CECOAL-CONICET), C.C. 291, (3400) Corrientes, Argentina.

PHYSALAEMUS PUSTULOSUS (Túngara Frog). **PREDATION.** Although primarily nocturnal, *Physalaemus pustulosus* are active during the day on Toboga Island, Republic of Panama. *Physalaemus pustulosus* were heard calling, observed mating, and seen moving about the forest throughout the day (0700–1800 h, May–June 1998). On 15 June 1998 at 1030 h, we observed an adult *P. pustulosus* being attacked and dragged into a crevice under a boulder by an adult female tarantula, *Sericopelma rubronitens*. Toboga Island has a large population of tarantulas, with adult females (>100 mm in body length) encountered frequently (diurnal censusing yielded approximately 1 spider per 2 m^2).

To examine if *P. pustulosus* were being consumed by *S. rubronitens*, a thread was tied around a live frog's waist and the frog was placed on the leaf litter near a foraging tarantula. The spider pounced on the frog as soon it tried to hop away. The tarantula briefly handled the frog before inserting its fangs, and then carried the frog under a rock overhang. After 3 h, the tarantula was seen moving away from the overhang. The *P. pustulosus* was retrieved for examination and found to be flaccid with most of its tissues digested and removed. The frog's skin was intact except for the area under the left forelimb where the tarantula's fangs had been inserted. The carcass was surrounded by a thin veil of spider silk.

Unlike the majority of *P. pustulosus* predators, which locate the frogs through orientation to calls (Ryan 1985. The Túngara Frog. The University of Chicago Press, Chicago, Illinois. 230 pp.), these tarantulas use vibrational cues to locate prey. The spiders therefore present a threat to *P. pustulosus* during movement to and from breeding ponds. As both these spiders and frogs are more active at night, the incidence of tarantula predation on *P. pustulosus* is probably frequent on Toboga.

Submitted by **HEATHER M. GRAY**, and **DAVID M. GREEN** Redpath Museum, McGill University, 859 Sherbrooke Street West, Montreal, Quebec H3A 2K6, Canada, and **M. JASON PETERS**, Department of Biology, La Sierra University, Riverside, California 92515, USA.

RANA CASCADAE (Cascade Frog). **PREDATION**. On 11 September 1996, we released a male *Rana cascadae* (35 mm SVL) in Long Lake, Klamath County, Oregon, USA (T35S R5E Sec 27). It was immediately seized by a large (38 mm TL) giant water bug (*Lethocerus* sp.) which was concealed in the silty lake bottom. The frog was retrieved within 30 s from the water bug and was suffering paralysis throughout its body. The frog was breathing but all limbs were limp and no response to touch was observed. After ca. 10 min. the frog began to regain use of its limbs and was released. Giant water bugs are known predators of anuran larvae (Duellman and Trueb 1986. Biology of Amphibians. McGraw-Hill Book Co., New York. 670 pp.) and in laboratory experiments giant water bugs readily fed on *R. cascadae* tadpoles (Peterson and Blaustein 1992. Copeia 1992:577–584). We know of no previously published records of giant water bugs preying on adult frogs.

Submitted by **RICHARD S. NAUMAN**[1] and **YVONNE DETTLAFF**[2], Chiloquin Ranger District, Winema National Forest, 38500 Hwy 97 North, Chiloquin, Oregon 97624, USA. [1]Present Address: PNW Research Station, USDA Forest Service, 3200 SW Jefferson Way, Corvallis, Oregon 97331, USA. [2]Present Address: USDA Forest Service, 2020 Toketee Ranger Station, Idelyld Park, Oregon 97447, USA.

RANA LUTEIVENTRIS (Columbia Spotted Frog). **CANNIBALISM**. Intraspecific predation is well documented in ranid frogs (Crump 1992. *In* Elgar and Crespi [eds.], Cannibalism: Ecology and Evolution Among Diverse Taxa, pp. 256–276. Oxford Univ. Press, New York), but is infrequently reported among ranid species in western North America. Despite several dietary studies of *R. luteiventris* (Turner 1959. Am. Midl. Nat. 61:403–413; Miller 1978. Northwest Sci. 52:243–249; Whitaker et al. 1983. Northwest Sci. 57:147–154), cannibalism has not been documented. However, intraspecific predation has been observed in Oregon spotted frogs (*R. pretiosa*) (M. P. Hayes, pers. comm.) and may be more prevalent than generally recognized. Herein, I report intraspecific predation of a metamorphosing juvenile by an adult *R. luteiventris*.

During a 5 September 1997 amphibian survey in a high-elevation (2484 m) lake, I observed an adult female *R. luteiventris* (ca. 75 mm SVL) consuming a metamorphosing conspecific (ca. 25 mm SVL; Gosner stage 42–43). The adult female was captured, with the metamorphosing frog in her mouth, along the marshy shoreline of a small (0.2 ha), unnamed lake (UTM Zone 11, E688900, N4998200) in the Bighorn Crags of the Frank Church-River of No Return Wilderness, Lemhi County, Idaho, USA.

Adult anurans do not appear to distinguish conspecifics from other prey (Duellman and Trueb 1986. Biology of Amphibians, John Hopkins University Press, Baltimore, p. 246). Therefore, cannibalism on juveniles by adults may simply represent utilization of an available food source. In the short, ice-free season of oligotrophic, high-elevation lakes, the consumption of abundant metamorphosing juvenile frogs by conspecific adults may be an important nutrient-rich food source for *R. luteiventris*. Intraspecific predation has been shown to increase nutrition and growth compared to other food sources (Crump 1990. Copeia 1990:560–564; Lannoo 1989. Can. J. Zool. 67:1911–1914; Wildy et al. 1998. J. Herpetol. 32:286–289). This may be particularly important in high-elevation lakes that typically have low productivity.

I thank Marc P. Hayes, John Lee, Charles R. Peterson, Dave Ross, and Elena Velasquez for commenting on an earlier version of this note, and Peter Ritson for his assistance with this observation.

Submitted by **DAVID S. PILLIOD**, Herpetology Laboratory, Department of Biological Sciences, Idaho State University, Pocatello, Idaho 83209-8007, USA.

RANA SPHENOCEPHALA (Southern Leopard Frog). **REPRODUCTION (FALL BREEDING).** In the southern portion of its range, *Rana sphenocephala* is known to breed during every month of the year (Mount 1975. The Reptiles and Amphibians of Alabama. Auburn Univ. Agri. Exp. Station. Auburn, Alabama. 347 pp.; Dundee and Rossman 1991. The Amphibians and Reptiles of Louisiana. Louisiana State University Press. Baton Rouge, Louisiana. 300 pp.). Caldwell (1986. Copeia 1986:249–253), however, reported that even in these areas, breeding occurred in two primary time periods; early fall and winter. Smith (1961. The Amphibians and Reptiles of Illinois. Illinois Nat. Hist. Sur. Bull., 28[1]. Illinois Natural History Survey Division, Urbana, Illinois. 298 pp.) reported that the breeding season for *R. sphenocephala* in Illinois is March and April and that transforming frogs can be found in June and July. Wright and Wright (1949. Handbook of Frogs and Toads, 3rd ed. Comstock Publ., Ithaca, New York. 640 pp.) observed ten *R. sphenocephala* egg complements south of Olney, Richland County, Illinois on 11 September 1929.

This note supports the Wrights' observation of fall breeding in *R. sphenocephala* in Illinois. Newly hatched tadpoles and egg masses were observed on 30 September 1996 in a recently filled, rainwater pond located 5.5 km E Ullin, 0.5 km S Cache River, E side Cache Chapel Road, Pulaski County, Illinois, USA (T14S R1E NW 1/4 Sec. 21; UTM Zone 16: N4127970m, E312475m).

Tadpoles were brought back to the laboratory and raised through metamorphosis to verify identification. In March 1997, 18 tadpoles successfully metamorphosed and positive identifications were made. Six metamorphs were vouchered in April (Illinois Natural History Survey 12981–12986); the remainder were released on 4 July 1997 at the site of capture. At the time of release, hundreds of *R. sphenocephala* tadpoles and metamorphs were observed. Because the hydrology of the pond is unknown from October 1996 to July 1997, we do not know if these tadpoles and metamorphs represent progeny of Fall 1996, Spring 1997, or both.

The range of the southern leopard frog in Illinois extends into the northern third of the state. The Wrights' Richland County and our Pulaski County observations fall within the southern third of the state. It is not known if fall breeding occurs near the northernmost edge of the range of *R. sphenocephala* in Illinois.

Submitted by **JOHN E. PETZING** and **CHRISTOPHER A. PHILLIPS**, Illinois Natural History Survey, Center for Biodiversity, 172 Natural Resources Building, 607 East Peabody Drive, Champaign, Illinois 61820, USA.

RANA SYLVATICA (Wood Frog). **COLORATION**. An albino *Rana sylvatica* tadpole was collected in St. Croix County, Wisconsin, USA, during Spring 1996. Several albino tadpoles were also observed in the area. The tadpole was raised in captivity and has reached 50 mm SVL as an adult. The specimen is being kept alive at the J. F. Bell Museum of Natural History and will be added to the vertebrate collection upon its death. The frog is ivory yellow with a pinkish mask. This is the first report of albinism in *R. sylvatica*.

Submitted by **DON LUCE**, J. F. Bell Museum of Natural History, 10 Church Street SE, Minneapolis, Minnesota 55455, USA, and **JOHN J. MORIARTY**, Hennepin Parks, 3800 County Road 24, Maple Plain, Minnesota 55359, USA.

RANA SYLVATICA (Wood Frog). **PREDATION**. On 26 May 1998 while electrofishing along the north shoreline of Pigeon Lake at the Pigeon Lake Field Station, Bayfield County, Wisconsin, USA (T45N R8W Sec 26), I collected a juvenile largemouth bass (*Micropterus salmoides*), 112 mm TL, that had captured a *Rana sylvatica* (29 mm SUL). The frog had been swallowed hind feet first up to the insertion of the forelimbs, and was still alive (largemouth bass often capture prey that are too large to swallow in one gulp and swim with them partially swallowed as digestion proceeds). Although largemouth bass are well known to prey on frogs (e.g., Cochran 1982. Herpetol. Rev. 13:45–46), fish were not included among the predators of wood frogs listed in recent field guides to the herpetofauna of the upper Midwest (Vogt 1981. Natural History of Amphibians and Reptiles of Wisconsin. Milwaukee Public Museum. 205 pp.; Oldfield and Moriarty 1994. Amphibians and Reptiles Native to Minnesota. Univ. Minnesota Press. 237 pp.; Harding 1997. Amphibians and Reptiles of the Great Lakes Region. Univ. Michigan Press. 378 pp.). Presumably this reflects the wood frog's tendency to inhabit terrestrial environments and to breed in temporary fishless ponds. Relatively high water levels in Pigeon Lake in 1998 may have brought wood frogs and largemouth bass into closer proximity that usual by flooding areas of woody shoreline vegetation.

Submitted by **PHILIP A. COCHRAN**, Division of Natural Sciences, St. Norbert College, DePere, Wisconsin 54115, USA.

SCAPHIOPUS HOLBROOKI HURTERII (Hurter's Spadefoot). **PREDATION**. Recently metamorphosed Hurter's spadefoots were found in 25 samples during a crop analysis of 1767 northern bobwhites (*Colinus virginianus*) harvested between December 1995 and February 1996 from near Encino, Brooks County, Texas, USA. Three specimens (mean SVL = 16.6 mm) were deposited in the Texas Cooperative Wildlife Collection, Texas A&M University, College Station (TCWC 80162–164).

Although *Scaphiopus* spp. have been described as producing odors that are disagreeable to humans (Conant and Collins 1991. A Field Guide to Reptiles and Amphibians. Eastern and Central North America. Houghton Mifflin Co., Boston, Massachusetts. 450 pp.), there are no experimental data on the effects of these odors or secretions on potential predators (Duellman and Trueb 1986. Biology of Amphibians. McGraw-Hill Book Co., New York. 670 pp.).

Scaphiopus spp. migrate en masse at metamorphosis (Neill 1957. Herpetologica 13:185–187). Neill (*op. cit.*) observed mockingbirds and jays in the vicinity of a *Scaphiopus* mass migration but did not observe any predation by these birds. We suspect that predation by northern bobwhite on spadefoots is rare and limited to those times when coveys of quail fortuitously encounter mass migrations of metamorphosing spadefoots. However, because northern bobwhite coveys can contain as many as 16 adults (Lehmann 1984. Bobwhites in the Rio Grande Plain of Texas. Texas A&M Univ. Press, College Station. 371 pp.) and consume as many as 10 toadlets per individual (this study), these rare predation events may be locally important in spadefoot population dynamics.

Submitted by **MICHAEL J. McCOID**[1], **FRED S. GUTHERY**[2], **STEVE KOPP**[3], Caesar Kleberg Wildlife Research Institute, Campus Box 218, Texas A&M University, Kingsville, Texas 78363, USA, and **RONNIE HOWARD**, San Tomas Hunting Club, Box 94, Encino, Texas 78353, USA. [1]Present Address: Department of Biology, Campus Box 158, Texas A&M University, Kingsville, Texas 78363, USA. [2]Present Address: Department of Forestry, Oklahoma State University, Stillwater, Oklahoma 74078, USA. [3]Present Address: 25100 Hwy. 441 North, Okeechobee, Florida 34972, USA.

TESTUDINES

CHRYSEMYS PICTA BELLII (Western Painted Turtle). **EARLY EMERGENCE**. On 7 April 1997, a hatchling *Chrysemys picta bellii* (James Ford Bell Museum of Natural History 13513) was found dead on a road in Shoreview, Ramsey County, Minnesota, USA. This was within a week of snowmelt. The winter of 1996–97 was one of early and heavy snow. This snow kept the ground from freezing. Once the snow melted the soil warmed up quickly, but was still not above 10°C when the hatchling was found. The temperature for the week of 1–7 April 1997 averaged 10°C with a high of 21°C, which was 5°C above normal. The month as a whole was 2°C below normal. Overwintering *C. picta bellii* hatchlings normally emerge in late May to early June. This is the earliest known emergence for this species at this latitude (Oldfield and Moriarty 1994. Amphibians and Reptiles Native to Minnesota. University of Minnesota Press, Minneapolis, Minnesota. 237 pp.).

Submitted by **JOHN J. MORIARTY**, Hennepin Parks, 3800 County Road 24, Maple Plain, Minnesota 55359, USA.

CHRYSEMYS PICTA BELLII (Western Painted Turtle). **HATCHLING EMERGENCE.** *Chrysemys picta bellii* in British

Columbia is at the extreme northwestern edge of its range. Females are known to lay multiple clutches of eggs at more southerly locations, but produce at most one clutch per year in British Columbia (Gregory and Campbell 1984. The Reptiles of British Columbia. British Columbia Provincial Museum, Victoria, British Columbia. 102 pp.). In northern populations, eggs hatch in late summer, hatchlings overwinter in the nest and emerge the following spring (St. Clair and Gregory 1990. Copeia 1990:1083–1089). Hatchlings have well-developed freeze tolerance, and can endure periods of freezing temperatures in the nest (Rubinsky et al. 1994. Am. J. Physiol. 267:R1078–R1088). There have been no previously published reports of viable hatchlings emerging from the nest in the fall in British Columbia, although St. Clair and Gregory (*op. cit.*) found a dead hatchling on the ground by a nest in September 1988.

On 18 September 1998, in the Creston Valley Wildlife Management Area, British Columbia, Canada (49°12'N, 116°38'W) we found the opening of a turtle nest. It was a small hole (ca. 5 cm across) in a dirt road leading down to the Kootenay River on a southwest-facing slope, about 20 m from the water. The opening to the nest did not appear to have been dug out by a predator. There were pieces of shell and two partly opened eggs with dried yolk in them on top of the rocks inside the hole; when these were removed, we could see a small turtle inside the hole, partly buried in the dirt and pebbles. It had been raining off and on all day, the first significant rain in over a week, and the air temperature was 20°C. As the rain began again, the turtle started to move around in the hole, and eventually dug itself out and climbed out of the hole. It had an egg tooth, and its carapace was about 3 cm long. The turtle immediately moved to the nearest vegetation at the side of the road. Meanwhile, a second hatchling appeared at the opening, moved uphill a short distance, then turned and went into the vegetation. Turtle breeding in Creston was about two weeks early in 1998 (pers. obs.); the fall hatchling found by St. Clair and Gregory (*op. cit.*) was from the first nest observed the previous mating season. Therefore, it is possible that an atypically long growing season may allow hatchlings to leave the nest before winter.

Submitted by **HEATHER L. WAYE**, 2927 Cedar Hill Road, Victoria, British Columbia, Canada V8T 3H8 (e-mail: hlwaye@islandnet.com), and **CAMERON GILLIES**, Box 245 Windermere, British Columbia, Canada V0B 2L0.

PSEUDEMYS FLORIDANA PENINSULARIS (Peninsula Cooter) and ***P. NELSONI*** (Florida Redbelly Turtle). **MUTUALISM**. For turtles that ambush their prey, an algae-covered carapace may provide camouflage from predators and prey (Neill and Allen 1954. Ecology 35:581–584). However, algal growth on the carapace could be pathological if, for example, the algae spread to the skin (Neill and Allen, *op. cit.*). Turtles can remove algae from their carapace by basking and shedding (Neill and Allen, *op. cit.*), biting algae off of their own shells (Reilly 1983. Herpetol. Rev. 14:76), and by biting algae off of conspecifics (Meshaka 1988. Herpetol. Rev. 19:88). Here, we report individuals of two different species of turtles removing algae from each other, an interaction that approaches interspecific mutual grooming.

On 11 May 1996 at 1445 h we watched a male *Pseudemys nelsoni* eating algae from the carapace of a female *P. floridana peninsularis* in Taylor Slough at Anhinga Trail, Everglades National Park, Dade County, Florida, USA. For six minutes, we observed the male removing algae from the rear of the female's carapace. During this time, the female's head was above water and she moved only passively from the actions of the male. Our observations ended when the actions of the male moved both turtles behind vegetation. We do not know how long this interaction had been taking place; however, there was a mosaic of freshly cleared patches on the pleurals of the female's carapace, suggesting that the male had been foraging for some time prior to our arrival.

On 27 May 1996 from 1010 to 1100 h, also at Anhinga Trail, WEM watched a female *P. f. peninsularis* feeding on the algae from the carapace of a female *P. nelsoni*. With each bite, the *P. f. peninsularis* would use her forefeet to push herself from the other turtle, removing algae in the process. The *P. nelsoni* made no attempt to avoid the *P. f. peninsularis*. At 1100 h, a second female *P. nelsoni* arrived along with a male *P. nelsoni*. The shells of both of these turtles were covered with algae. The *P. f. peninsularis* and male *P. nelsoni* foraged on the carapace of the second *P. nelsoni* female until 1105 h, after which the second female *P. nelsoni* swam away. At 1115 h, the original *P. nelsoni* female swam 0.5 m from shore, where she had been feeding on aquatic plants, to the female *P. f. peninsularis* and each fed from the other's carapace. From 1117 to 1123 h the male *P. nelsoni*, having found and swam around both turtles, positioned himself on top of the female *P. nelsoni*, vibrating his forefeet over her head in courtship. Throughout courtship attempts, the *P. f. peninsularis* alternately foraged on the rear of both turtles, often pulling the male from the female *P. nelsoni*. The male repeatedly moved above the female after these disruptions. At 1123 h, the *P. f. peninsularis* swam away from the courting pair of *P. nelsoni*.

As suggested for intraspecific algal grazing (Meshaka, *op. cit.*), this interspecific grazing behavior is suggestive of mutualism, whereby one individual receives nutrition and the other is relieved of a potential burden. Although basking sites were plentiful at this site, the carapaces of turtles of both species were covered with algae, perhaps because of the high pH, temperature, and eutrophication of the slough. Because of these conditions, the rate of algal growth on turtle carapaces might exceed that which can be removed during normal basking or shedding. Thus, it is possible that mutual algal grazing in these two species is adaptive. We thank James L. Dobie for commenting on this manuscript.

Submitted by **WALTER E. MESHAKA, JR.**, Everglades Regional Collections Center, Everglades National Park, 40001 SR-9336, Homestead, Florida 33034-6733, USA (e-mail: walter_meshaka@nps.gov), and **MARK DEYRUP**, Archbold Biological Station, P.O. Box 2057, Lake Placid, Florida 33862, USA.

TERRAPENE CAROLINA CAROLINA (Eastern Box Turtle). **DIET**. *Terrapene carolina* is regarded as omnivorous, eating a wide variety of plant and animal foods. Reptiles documented as food items, typically as carrion, include lizards (*Phrynosoma*), turtle eggs (*Chelydra*), and snakes (*Carphophis*, *Coluber*, *Storeria*, *Thamnophis*) (Ernst et al. 1994. Turtles of the United States and Canada. Smithsonian Institutional Press, Washington, D.C. 578 pp). On 20 August 1998, in Monroe County, Georgia, USA, I observed an adult male *T. carolina carolina* eating the entrails of a road-killed juvenile *Agkistrodon contortrix*. As I approached, rather than retracting its head into its shell, the turtle bit down firmly on the snake and carried it off the road and away from me. I know of no other reported observations of box turtles consuming road-killed venomous snakes.

Submitted by **JOHN B. JENSEN**, Georgia Department of Natural Resources, Nongame-Endangered Wildlife Program, 116 Rum Creek Drive, Forsyth, Georgia 31029, USA (e-mail: john_jensen@mail.dnr.state.ga.us).

TERRAPENE ORNATA LUTEOLA (Desert Box Turtle). **HOMING BEHAVIOR.** Many turtle species seem to exhibit homing behavior and can return to their home range after being displaced up to several km away (Cagle 1944. Misc. Publ., Mus. Zool., Univ. Michigan 61:1–37; Gibbons and Smith 1968. Herpetologica 24:331–333). Box turtles (*Terrapene* spp.) have shown some tendency to exhibit homing behavior when experimentally moved. Eastern box turtles (*T. carolina*) have been able to return to their home range when displaced up to 1.2 km (Nichols 1939. Copeia 1939:125–127; Posey 1979. Bull. Maryland Herpetol. Soc. 15:139–140), but did not return when displaced greater than 1.6 km (Nichols 1939, *op. cit.*; Posey 1979, *op. cit.*; Schwartz and Schwartz 1974. Missouri Dept. Conserv. Terr. Ser. 5:1–28). Ornate box turtles (*T. o. ornata*) have shown the ability to return to their home range from up to 2.8 km away (Metcalf and Metcalf 1970. Trans. Kansas Acad. Sci. 73:96–117; Metcalf and Metcalf 1978. J. Herpetol. 12:411–412). We found a desert box turtle (*T. ornata luteola*) that appears to have returned over 9 km to its home range after accidentally being displaced.

We have been studying a population of *Terrapene ornata luteola* at the Sevilleta National Wildlife Refuge, 85 km south of Albuquerque, New Mexico, USA, since 1986. Turtles have been found while driving dirt roads (Nieuwolt 1996. Herpetologica 52:487–495). When encountered, turtles were marked by filing scutes (Cagle 1939. Copeia 1939:170–173) and most were put into a container for transport back to facilities where additional data were recorded. Turtles were returned to the site of capture and released within 1–7 d. Besides turtles that we found, we occasionally received unmarked turtles from others working in the area. Location data always accompanied these turtles. However, field notes and data sheets indicate that one turtle probably was not returned to its point of capture. On 20 September 1986, we received an adult female (116 mm CL, 373 g). After processing, we returned her the next day to what we understood to be her capture location near the northern end of our study site. We did not capture her again until 14 July 1988, when we found her 9.15 km south of the site where she had been released. This turtle was recaptured 18 times during 1990–1992. Each capture was within a well-defined area 8.10–8.75 km from her original release site. Because this adult female made one long-distance move and then settled into a fixed area, we feel certain that she returned to her original home range after accidentally being displaced in 1986.

Submitted by **DAVID J. GERMANO**, Department of Biology, California State University, Bakersfield, California, 93311, USA (e-mail: Dgermano@csubak.edu), and **PIMMY M. NIEUWOLT-DACANAY**, Department of Biology/314, University of Nevada, Reno, 89557, USA.

LACERTILIA

ABRONIA MIXTECA (NCN). **REPRODUCTION.** The anguid lizard *Abronia mixteca* is known only from seven pine-oak forested localities in the Sierra Madre Occidental of the Mexican states of Guerrero and Oaxaca (Bogert and Porter 1967. Amer. Mus. Novitates 2279:1–21; Campbell and Frost 1993. Bull. Amer. Mus. Nat. Hist. 216:1–121). Little is known about its reproduction. Herein we report observations of reproduction in captive individuals.

On 29 July 1995 at 1100 h an adult male (WSB 716-1, 115 mm SVL, 130 mm TL) was collected near the type locality at El Tejocote, Oaxaca (17°56'14"N, 97°33'03"W), elev. 2286–2400 m. The next day an adult female (WSB 716-2, 100 mm SVL, 125 mm TL) was collected in a disturbed oak forest at km 156.5 on the Tehuacán-Oaxaca Federal Hwy. 135 (17°36'83"N, 97°19'58"W), elev. 2287 m.

In the laboratory the specimens were housed together in a glass terrarium (70 x 50 x 50 cm). On 1 August 1998 at 0800 h the pair was found mating, the male grasping the female on the temporal region, and their tails loosely intertwined, as described by Campbell and Frost (*op. cit.*) for *Abronia lythrochila*. The lizards did not disengage until about 1600 h. Afterwards, the pair continued to be housed together. On 26 February 1996, seven months (210 days) after copulation, the female gave birth to seven live young (mean SVL 35.57 mm, SD 0.53, range 35–36 mm; mean TL 42 mm, SD 1.29, range 40–44 mm; mean mass 0.81 g, SD 0.069, range 0.7–0.9 g). The neonates were pale golden yellow with 5–6 black bands on the body, which were not continuous, but formed by a series of irregular black spots. There were 12–14 black rings on the tail, and the head had some black markings. The color pattern of the young differed from that of adults, which were bright light green dorsally with some irregular, black blotches on the body and tail.

The litter size is within the range for that of other anguids (range 1–12 young). Our observations suggest that *A. mixteca* mates during the summer and the offspring are born in the spring.

We thank Mario Mancilla and W. C. Sherbrooke for assistance in the field. W. C. Sherbrooke also provided financial support for the field work. We thank Ubaldo Guzmán for assistance in the lab.

Submitted by **WALTER SCHMIDT BALLARDO**, Museo de Zoología, Facultad de Ciencias, UNAM, Apdo. Postal 70-399, México D.F. 04510, México, and **FERNANDO MENDOZA-QUIJANO**, Instituto Tecnológico Agropecuario No. 6, Km. 5.5 Carr. Huejutla-Chalahuiyapa, Apdo. Postal 94 C.P. 43000, Huejutla, Hidalgo, México.

ANOLIS CASILDAE (NCN). **FORAGING.** *Anolis casildae* is a large anoline species recently described from Panama (Arosemena et al. 1991. Rev. Biol. Trop. 39:255–262), and for which nothing is known of its natural history. On 23 November 1997, while collecting this species in western Panama, Provincia de Chiriquí, I observed a large (108 mm SVL, 23.0 g mass, CRE 7665, University of Miami) male *A. casildae* leap from the ground to a sapling (2 cm diam) and perch ca. 0.5 m above the ground. While perching head-up on this sapling, the lizard began to consume a large green katydid (Orthoptera). Subsequently, the lizard was captured and found to be missing its left forearm. The distal portion of the remaining arm fragment was scarred but well healed, with a tiny bone fragment protruding from the tip. The injury may have been the result of a predation attempt. The missing forelimb appeared to have little effect on locomotion, as the anole captured the katydid with little difficulty, moved easily to the sapling to feed, and even managed to escape and evade capture for several minutes in the dorm room of the field station.

I thank the Smithsonian Tropical Research Institute for help with all aspects of collecting in Panama. I also thank Stan Rand, Roberto Ibañez, and the Herpetological Circle for encouragment and help while in Panama. This work was supported by a Tropical Biology Fellowship from the Department of Biology, University of Miami.

Submitted by **KIRSTEN E. NICHOLSON**, Department of Biology, University of Miami, Coral Gables, Florida 33124, USA.

CNEMIDOPHORUS SEXLINEATUS (Six-lined Racerunner). **ACTIVITY.** As is typical for *Cnemidophorus* species, *C. sexlineatus* is a highly active heliotherm that narrowly maintains a relatively high body temperature during a restricted activity period (Bogert 1949. Evolution 3:195–211; Fitch 1958. Univ. Kansas Publ. Mus.

Nat. Hist. 11:11–62; Hardy 1962. Univ. Kansas Sci. Bull. 43:1–73; Paulissen 1988. J. Herpetol. 22:473–476). Although *C. sexlineatus* has a wide geographic distribution in North America extending from New Jersey to Florida west to southern North Dakota and eastern New Mexico (Conant and Collins 1991. A Field Guide to Reptiles and Amphibians. Houghton Mifflin Co., Boston, Massachusetts, 450 pp.), activity periods and field body temperatures have been reported for relatively few populations (Florida, Bogert, *op. cit.*; Kansas, Fitch, *op. cit.*, Hardy, *op. cit.*; Oklahoma, Carpenter 1960. Proc. Oklahoma Acad. Sci. 41:72–77.; Paulissen, *op. cit.*). Here we document diel activity and body temperatures of *C. sexlineatus* from a population occupying a 400 m stretch of active railway trackbed in Searcy, White Co., Arkansas, USA.

On each of seven days between 28 July and 8 September 1985, one of us (RER) censused the active lizards on the study area every two hours from 0600 to 2000 h by slowly walking its length one time and recording all active *C. sexlineatus* observed by sex and age class (juvenile vs. adult). In addition, lizards were captured using a fishing pole with an attached 0.5 m length of monofilament line and a small hook baited with a cricket. We immediately measured each captured lizard's cloacal temperature with a Schulteis thermometer, and then sexed, measured (SVL), and released it at the site of capture. Air and soil surface temperatures were recorded at the onset of each census.

A total of only three lizards was observed on two overcast, rainy days when maximum soil surface temperatures reached only 26.4° and 29.2°C, respectively. On five cloudy or clear days, when maximum soil temperatures reached 41.2–52.0°C, a total of 203 lizard observations was made. Over these five days, no lizards were observed at either 0600 or 2000 h and only two lizards were observed at 0800 h and 10 lizards at 1800 h. Most lizards (94.1%) were active between 1000 and 1600 h when an average of 47.8 (SD = 13.0) lizards were observed at each census time (data pooled over five days). Mean activity temperature (Pough and Gans 1982. *In* C. Gans, ed., Biology of the Reptilia, Physiology C, Vol. 12, pp. 17–23. Academic Press, New York), calculated from body temperatures of 53 active lizards, was 40.7°C (SD = 0.20, range 36.9–42.8). Mean activity temperatures did not differ among juveniles (mean = 40.6°C, SE = 1.03), males (mean = 40.7°C, SE = 0.30) or females (mean = 40.7°C, SE = 0.28) (ANOVA, $F_{2, 50} = 0.006$, $P>0.99$).

Diel activity of *C. sexlineatus* at this locality was unimodal and restricted to the warmer parts of clear or partly cloudy days. Body temperature during activity was characterized by a relatively high mean and low variance (CV = 0.49%). These results are similar to those documented for the thermophilic *C. sexlineatus* in other parts of its range and reflect adaptations resulting in restricted activity times for *Cnemidophorus* spp. in general (Lowe 1991. *In* J. W. Wright and L. J. Vitt [eds.], Biology of Whiptail Lizards [Genus *Cnemidophorus*], pp. 1–25. Oklahoma Mus. Nat. Hist. Norman).

Submitted by **RANDY E. RANSOM** and **MICHAEL V. PLUMMER**, Department of Biology, Box 12251, Harding University, Searcy, Arkansas 72149, USA. Current address (RER): 1402 North Pierce E6, Little Rock, Arkansas 72207, USA.

EUMECES LATICEPS (Broad-headed Skink). **FORAGING BEHAVIOR.** On 22 May 1995 at 1200 h, two adult *Eumeces laticeps* were observed in a tree at the Village Creek Historical Park in Arlington, Texas, USA. Both were chasing hackberry butterflies (*Asterocampa celtis*), which were feeding on resins from an American elm (*Ulmus americanus*). The skinks were about 2.5 m above the ground. They made numerous attempts to capture the butterflies as they landed on the tree. After several failed attempts, one of the lizards waited until a butterfly flew past. The skink then leaped from its perch and narrowly missed a mid-flight capture of the butterfly. The lizard returned to its original perch site and made a second attempt to capture its prey in the same manner. *Eumeces laticeps* has been described as the most arboreal skink in North America (Conant and Collins 1991. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin Co., Boston, Massachusetts. 450 pp.).

Submitted by **CARL J. FRANKLIN**, Department of Herpetology, Dallas Zoo, 635 South R. L. Thornton Freeway (I-35), Dallas, Texas 75203, USA.

LEIOSAURUS BELLI (NCN). **CLUTCH.** Data on the natural history of *Leiosaurus belli* (Polychridae) are scarce (Cei 1986. Reptiles del Centro, Centro Oeste y Sur de la Argentina, Mon. IV, 527 pp.). On 15 January 1993 two female *L. belli* were collected by FD'H in maritime sand dunes near Las Grutas beach, 18 km SW San Antonio Oeste (40°44'S, 64°57'W, San Antonio Department, Río Negro Province, southeastern Argentina. The lizards were maintained in a glass terrarium with sand substrate. On 18 January 1993, one female (102 mm SVL, 210 mm TL, not weighed) oviposited 15 white eggs (mean = 15.3 mm x 8.8 mm) in 30 minutes. Four days later, the other female (96 mm SVL, 195 mm TL, not weighed) oviposited 11 white eggs (mean = 14.2 mm x 8.8 mm) in 30 minutes. Both clutches were placed in a small container with sand and moist humus until their arrival in the laboratory. Upon arrival the eggs were discarded, as they appeared to be in bad condition. This is the first report on clutch size in *L. belli*. Nothing is known of the reproductive behavior of this species in the wild.

Submitted by **LUCIANO JAVIER AVILA**, CRILAR-CONICET, Mendoza y Entre Ríos s/n, 5301, Anillaco, La Rioja, Argentina, and **FEDERICO D'HERVÉ,** Instituto Superior de Formación Docente de Villa Regina, Alem 250, 3816, Villa Regina, Río Negro, Argentina.

LEPIDOPHYMA LOWEI (Lowe's Tropical Night Lizard). **REPRODUCTION**. No previously published reproductive data are available for *Lepidophyma lowei* (Bezy and Camarillo 1997. Contrib. Sci. 465:1–8). A female *L. lowei* collected at the type locality on 7 April 1991 was maintained in captivity and gave birth to four offspring on 27–29 April 1991: 27 April at 1500 h; 28 April at 1200–1400 h and at 2030–2120 h; and 29 April (time unknown). The extraembryonic membranes were not present and may have been eaten by the mother. No dead newborns or undeveloped eggs were observed. The female had a SVL of 60 mm, and weighed 5.50 g before and 3.32 g after parturition. The newborns weighed 0.29 g, 0.32 g, 0.33 g, and 0.31 g in order of birth.

These observations document viviparity in an additional species of xantusiid lizard and indicate that *Lepidophyma lowei* has a smaller litter size than most other members of the genus (Aguilar Cortes et al. 1990. Southwest. Nat. 35:373–374). The specimens were deposited in the Colección Herpetológica, Escuela Nacional de Estudios Profesionales Iztacala (ENEPI 3804-07).

Submitted by **JOSÉ L. CAMARILLO R.**, Herpetología, Proyecto Conservación y Mejoramiento del Ambiente, Escuela Nacional de Estudios Profesionales Iztacala, UNAM, A.P. 314, Tlalnepantla, Estado de México, México.

PHYMATURUS PATAGONICUS (Argentine Chuckwalla). **FACULTATIVE PARTHENOGENESIS.** In April 1991, BG purchased an adult *P. patagonicus,* which, although not measured at the time of purchase, measured 17 cm total length on 20 June 1998. It was kept alone in captivity from the time it was purchased. On or about 5 May 1998, the lizard produced a single, female offspring, which is still alive, and measured 9.5 cm total length on 20 June 1998 (Fig. 1). On 27 May 1998 a stillborn female (ca. 7 cm total length, 57 mm SVL) was assist-delivered, apparently fully-developed. It expired, however, presumably from the inability of the mother to extrude it. Sex of both neonates was determined by the absence of well-defined preanal pores.

The dead neonate was referred to the *Phymaturus patagonicus* complex of viviparous, herbivorous lizards from Argentina, by Richard Etheridge, who also recalled that Lamborot and Navarro-Suárez (1984. Herpetologica 40:258–264) karyotyped the congeneric *P. palluma*. That study revealed that males are the heterogametic sex, with 32+3 chromosomes (autosomes + genosomes), including a Y chromosome; females have 32+4 chromosomes, and lack a Y chromosome. Assuming that *P. patagonicus* is similar to *P. palluma*, we suggest that, in the absence of cytological proof, the two offspring, both being female, could have been produced by facultative parthenogenesis. The only alternative explanation is sperm retention (amphigonia retardata), which is unlikely for a period of seven years; the longest record of sperm retention in reptiles was reported by Haines (1940. Copeia 116–118), who observed fertile eggs (none of which hatched) laid by a *Leptodeira septentrionalis polysticta* after five years of isolation.

Facultative parthenogenesis has been shown to occur in snakes by Schuett et al. (1998. Herpetol. Nat. Hist. 5:1–10), who also note evidence of occurrence in lizards of the genera *Basiliscus* and *Iguana*. Herein we add another genus and family (Tropiduridae) to the list of probabilities.

Thanks to Richard Etheridge for identification and assistance with the literature.

FIG. 1. Mother and daughter *Phymaturus patagonicus*.

Submitted by **DAVID CHISZAR**, Department of Psychology, University of Colorado, Boulder, Colorado 80309-0345, USA, **TILLIE GINGERY**, P.O. Box 225, Granby, Colorado 80446, USA, **BRETT GINGERY**, P.O. Box 780, Tabernash, Colorado 80478, USA, and **HOBART M. SMITH**, Department of EPO Biology, University of Colorado, Boulder, Colorado 80309-0334, USA.

SCELOPORUS UNDULATUS ELONGATUS (Northern Plateau Lizard). **EGG LAYING**. Very little is known about the life history and ecology of *Sceloporus undulatus elongatus* in Wyoming, the northern distribution limit for the subspecies (Baxter and Stone 1980. Amphibians and Reptiles of Wyoming. Wyoming Game and Fish Department). Previously I have reported mating behavior (Ashton 1998. Herpetol. Rev. 29:102) of this subspecies in Wyoming. Here I describe egg laying behavior, observed ca. 70 km (by air) SW of Rock Springs, Flaming Gorge National Recreation Area, Sweetwater Co., Wyoming, USA.

On 12 June 1998, from 1145 h to 1200 h, I observed an adult female *S. u. elongatus* (76.0 mm SVL, 96.0 mm tail length, 10.0 g mass post-partum). At 1145 h her anterior body was exposed while her posterior was under a small rock. She was not making any movements at this time. Then at 1150 h she moved most of her body out from under the rock and began digging with her hind limbs, pushing dirt over the eggs that she had just laid. She finished covering the eggs with dirt at 1200 h, at which time I captured her. She had distinct lateral folds, verifying that she had just laid eggs. I palpated her and did not detect any more eggs within her body cavity.

Submitted by **KYLE G. ASHTON**, Department of EPO Biology, Campus Box 334, University of Colorado, Boulder, Colorado 80309, USA.

UROSAURUS MICROSCUTATUS (Small-scaled Lizard). **ENDOPARASITES**. *Urosaurus microscutatus* occurs from Imperial and San Diego Counties, California south to the vicinity of El Medaño, Baja California (Stebbins 1985. A Field Guide to Western Reptiles and Amphibians. 2nd ed., Houghton Mifflin Co., Boston, Massachusetts. 336 pp.). There are no reports of endoparasites from this species. This note reports helminths from *U. microscutatus* from southern California.

Ten male *U. microscutatus* (mean SVL = 45.0 mm ± 2.5 SD, range 41–48) collected in 1953, 1956–57, 1966, 1972–1973, and 1997, were borrowed from the Natural History Museum of Los Angeles County (LACM 97828–97830, 97832, 97834, 122066, 123398–12399) and San Diego State University (SDSU 3772–3773). Nine were from San Diego County; one was from Imperial County. The lizards had been fixed in 10% formalin and preserved in 70% ethanol (LACM) or 55% isopropanol (SDSU). The body cavity was opened by a longitudinal incision. The esophagus, stomach, small and large intestine were removed and examined with a dissecting microscope. The body cavity and liver were also examined. One ten-segment strobila of a cestode was found in the small intestine. It was stained with hematoxylin, mounted in balsam and identified as *Oochoristica* sp. The immaturity of the specimen prevented assignment to a species. Two species of nematodes were found in the large intestine and identified using a glycerol wet mount: *Spauligodon giganticus* and *Strongyluris rubra*. *Urosaurus microscutatus* is a new host record for these helminths.

Prevalence (number infected individuals divided by number of indiviuals examined) was 10% for *Oochoristica* sp.; 20% for *Spauligodon giganticus* (11 and 5 nematodes in 2 lizards); 10% for *Strongyluris rubra* (9 nematodes in 1izard). Helminths were deposited in the U.S. National Parasite Collection, Beltsville, Maryland: *Oochoristica* sp. USNPC 87999; *Spauligodon giganticus* USNPC 88000; *Strongyluris rubra* USNPC 88001. The related species *Urosaurus graciosus* from Los Angeles County, California (Goldberg et al. 1993. Bull. South. California Acad. Sci. 92:43–51) was found to harbor *Oochoristica* sp. and a single third stage larva, *Physaloptera* sp. *Urosaurus ornatus* from New Mexico harbored the cestodes, *Mesocestoides* sp. and *Oochoristica* sp., the nematodes *Spauligodon giganticus* and *Physaloptera* sp. (third stage larvae); *U. ornatus* from Arizona harbored *S. giganticus* (Goldberg et al. 1993. J. Helm. Soc. Washington 60:118–121.

We thank Robert L. Bezy (Natural History Museum of Los Angeles County) and Tod Reeder (San Diego State University) for permission to examine *U. microscutatus*.

Submitted by **STEPHEN R. GOLDBERG,** Department of Biology, Whittier College, Whittier, California 90608, USA, **CHARLES R. BURSEY**, Department of Biology, Pennsylvania State University, Shenango Campus, Sharon, Pennsylvania 16146, USA, and **HAY CHEAM**, Department of Biology, Whittier College, Whittier, California 90608, USA.

SERPENTES

BITIS NASICORNIS (Rhinoceros Viper). **DERMATOPHAGY.** Dermatophagy by captive snakes is well documented (Weldon et al. 1993. J. Herpetol. 27:219–228, and references therein). Although I was unable to locate any literature regarding this behavior in rhinoceros vipers (*Bitis nasicornis*), I did find one account of shed skin consumption in another viperid, *Bitis arietans* (Haagner 1991. The Naturalist 35:32–33). It has been suggested that this behavior may be coincidental or related to reptile-eating in snakes (Groves and Groves 1972, Herpetologica 28:45–46). Other authors have speculated that dermatophagy in snakes may be used to eliminate evidence of the animal's location (Weldon et. al. 1993, *op. cit.*).

On 6 April 1998, I observed a three year old captive-born *Bitis nasicornis* (SVL = 737 mm; TL = 876 mm) in ecdysis at 0945 h. Approximately four minutes lapsed until the snake completed half of the shedding process. At this point, the animal removed the dead skin from its body and began consuming it. The snake then completed ecdysis, but it did not consume the remaining skin.

This specimen was housed in a plastic enclosure (90.8 x 44.5 x 44.5 cm) with a hide box, water bowl, and slabs of cork bark. It was misted twice weekly and fed a diet of adult mice (*Mus musculus*) once a week. No subsequent observations of this behavior have been made.

I thank members of the Dallas Zoo's Department of Herpetology for help with the preparation of this note.

Submitted by **MATTHEW J. RUSSELL**, Department of Reptiles and Amphibians, Dallas Zoo, 650 South R.L. Thornton Freeway, Dallas, Texas 75203, USA; e-mail: porthidium@aol.com. Present address: Department of Biology, University of Texas at Arlington, Box 19498, Arlington, Texas 76019-0498, USA.

CHIRONIUS FLAVOLINEATUS (NCN)**. COURTSHIP**. The reproductive behavior of Neotropical snakes in the wild is poorly documented. Here, we report courtship involving one adult female *Chironius flavolineatus* (SVL 875 mm, Museu de Zoologia João Moojen de Oliveira, Universidade Federal de Viçosa, MZUFV 943), and six adult males (SVL 700–790 mm, MZUFV 944–946 and Museu Nacional, Universidade Federal do Rio de Janeiro, MNRJ 6453–6455). The animals were found on the ground, at 1800 h on 8 October 1997 in gallery forest (15°09'S, 44°08'W) close to the Mocambinho River, Jaíba, Minas Gerais, Brazil. The snakes were found during the tactile-chase phase of courtship (Gillingham 1986. *In* Seigel et al. [eds.], Snakes: Ecology and Evolutionary Biology, pp. 184–209. McGraw Hill, New York). At any time, two males were in close contact with the female; the remaining males were perched on the ground or in low bushes nearby (Fig. 1). From time to time, males would trade places, so that each male spent time in direct contact with the female and perched nearby. Typically, a male in direct contact with the female would be interrupted by another male that would pull the former out of position. Despite these displacements, males did not engage in combat or any other aggressive behavior. After 30 minutes of observation, we interrupted this behavior because the female appeared stressed and tried to escape. During the observation, we noted the following behaviors: dorsal body looping, chin rubbing, and dorsal advance (Gillingham, *op. cit.*). The latter phases of the courtship act (tactile-alignment, intromission, and coitus) were not observed.

We thank U. Caramaschi and J. P. Pombal, Jr. for commenting on the manuscript and CODEVASF, SYTEC 3, CNPq, FAPERJ, and FUJB for providing financial support.

FIG. 1. Courtship in *Chironius flavolineatus*, showing two males in direct contact with the female, while two other males wait in the background.

Submitted by **RENATO N. FEIO**, **PATRÍCIA S. SANTOS**, Museu de Zoologia, Departamento de Biologia Animal, Universidade Federal de Viçosa, 36571000 Viçosa, Minas Gerais, Brazil, **RONALDO FERNANDES**, and **THAIS S. DE FREITAS,** Departamento de Vertebrados, Museu Nacional, 20940.040, Rio de Janeiro, RJ, Brazil.

CHIRONIUS MULTIVENTRIS FOVEATUS (NCN). **PREY.** Existing data on the diet of the colubrid *Chironius multiventris* suggest that, like other members of the genus, it feeds mainly on anurans (especially hylids and leptodactylids; e.g., Cunha and Nascimento 1993. Bol. Mus. Paraense Emílio Goeldi 9:1–191; Dixon et al. 1993. Revision of the Neotropical Snake Genus *Chironius* Fitzinger. Monografie XII, Museo Regionale di Scienze Naturali Torino. 279 pp.). The Atlantic Rainforest subspecies, *C. m. foveatus*, has been reported to prey on the hylids *Osteocephalus langsdorffi* and *Hyla* cf. *hylax* (Marques 1998. Composição Faunística, História Natural e Ecologia de Serpentes da Mata Atlântica, na Região da Estação Ecológica Juréia-Itatins, São Paulo, SP. Ph.D. Dissertation. Univ. de São Paulo. 135 pp.). Hylids of the genera *Hyla* and *Phrynohyas* and leptodactylids of the genera *Leptodactylus* and *Eleutherodactylus*, as well as lizards (genera *Ameiva*, *Anolis* and *Polychrus*) have also been reported as prey of other subspecies of *C. multiventris* (Cunha and Nascimento 1993, *op. cit.*; Dixon et al. 1993, *op. cit.*). Here we report the stomach contents of a specimen of *C. m. foveatus*, a subspecies whose natural history is still largely unknown (Dixon et al. 1993, *op. cit.*).

On 8 December 1996 at 0948 h, on an overcast rainy day, an adult male *C. m. foveatus* (129 cm SVL) was captured by CFDR in an undisturbed Atlantic Rainforest area (ca. 240 m elevation) on the coastal island of Ilha Grande (23°15'S; 44°15'W), near Vila Dios

Rios. The snake, which was moving over large boulders near a subterranean stream (width ca. 5 m), had a slight bulge in its abdomen. Upon dissection and examination of the snake's stomach contents, we found a partially digested, egg-laden female *Hyla circumdata* (Hylidae), the partially digested right hind foot of an adult *Proceratophrys appendiculata* (Leptodactylidae), and numerous insect remains (almost certainly secondary ingestions, originally in the frogs' stomachs). The *H. circumdata* (75 mm SVL) had been ingested head first and the head and trunk were already much digested, though the hind legs were almost intact.

This report confirms the tendency of *C. multiventris* to prey mainly on hylids and leptodactylids and adds a new anuran genus (*Proceratophrys*) and two new species to its diet. The snake (along with stomach contents) was deposited at the Museu Nacional do Rio de Janeiro (MNRJ 6717).

We thank José P. Pombal, Jr., Renato N. Feio, and Marcelo F. Nápoli for identifying the frog remains, and Thais S. de Freitas for confirming the identification of the snake and for her help in taking the measurements. CFDR (Process # 300819/94-3), DV (Process # 143607/98-7), and MVS (Process # 301117/95-0) benefitted from research grants from the Conselho Nacional do Desesnvolvimento Científico e Tecnológico (CNPq).

Submitted by **CARLOS FREDERICO DUARTE ROCHA, DAVOR VRCIBRADIC*,** and **MONIQUE VAN SLUYS**, Setor de Ecologia, Departamento de Biologia Animal e Vegetal, Instituto de Biologia, Universidade do Estado do Rio de Janeiro, Rua São Francisco Xavier, 524, Maracanã, 20550-019, Rio de Janeiro, RJ, Brazil (e-mail [CFDR]: cfdrocha@uerj.br). *Present address: Post-Graduation Program in Ecology, Universidade Estadual de Campinas, C.P. 6109, 13083-970, Campinas, SP, Brazil.

CROTALUS WILLARDI (Ridgenose Rattlesnake). **MAXIMUM LENGTH**. Stebbins (1985. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin, Boston, Massachusetts. 336 pp.) reported *Crotalus willardi* reaches 640 mm total length (TL). Lowe et al. (1986. The Venomous Reptiles of Arizona. Arizona Game and Fish Department, Phoenix, Arizona. 115 pp.) reported an upper adult size of ca. 610 mm TL (reported as "exceptionally 24 inches"). Boundy (1995. Bull. Chicago Herpetol. Soc. 306:109–122) reported the maximum length as 641 mm TL based on a specimen of *C. w. obscurus* at the University of New Mexico (MSB 13715) originally reported by Harris and Simmons (1976. Bull. Maryland Herpetol. Soc. 12:1–22). In captivity, *C. willardi* has reached 670 mm TL (Campbell and Lamar 1989. The Venomous Reptiles of Latin America. Comstock Publishing Associates, Ithaca, New York. 425 pp.).

On 23 Sept 1994, we collected an adult male *C. w. obscurus* near the summit of Indian Peak (2585 m) in the Animas Mountains, Hidalgo County, New Mexico. The specimen's mass was 218 g (209 g after defecating) and it measured 668 mm TL (601 mm SVL). This is the largest wild-caught *C. willardi* reported. Since 1994, three additional males exceeding 640 mm TL have been observed on Animas Mountain including: 645 mm on 16 July 1997, 649 mm on 8 October 1996, and 649 mm 7 October 1998.

Submitted by **KIRK A. KEEGAN**, Department of Radiology, University of California, San Francisco, 350 Parnassus, Suite 908, San Francisco, California 94117, USA, **ROBERT N. REED**, Department of Zoology, Auburn University, Auburn, Alabama 36849-5414, USA, **ANDREW T. HOLYCROSS**, Biology Department, Arizona State University, Tempe, Arizona 85287-1501, USA (e-mail: holycow@asu.edu), and **CHARLES W. PAINTER**, Endangered Species Program, New Mexico Department of Game and Fish, P.O. Box 25112, Santa Fe, New Mexico 87504, USA.

ELAPHE GUTTATA GUTTATA (Corn Snake). **AGONISTIC INTERACTIONS WITH POTENTIAL PREY.** Maternal aggression towards conspecifics functions to prevent infanticide in *Peromyscus leucopus* (Wolff 1985. J. Mammal. 33:117–123). I have observed this aggression to also be directed towards neonate corn snakes (*Elaphe guttata*) that pose a similar threat to a mother mouse's offspring. In October 1995, the carcass of a captive neonate corn snake that had escaped from its container was found in an adjacent room in the Bowling Green State University Animal Care Facility in a laboratory mouse container housing a female *P. leucopus* and her young. The body of the snake was badly mangled and had numerous bite marks along its length. This incident demonstrated that lactating white-footed mice will react aggressively towards smaller snakes, and indeed are capable of killing them.

To further examine the agonistic interactions between corn snakes and white-footed mice, I conducted controlled arena studies individually pairing six neonate corn snakes (SVL 220–252 mm) with either a lactating *P. leucopus* and her young (two trials), an adult male *P. leucopus* (two trials), or adult female *P. leucopus* (two trials). All of the snakes had been purchased from a supplier, and the mice were wild-caught near Bowling Green, Ohio. The snake and mouse were placed together in a laboratory mouse container (30 x 21 x 13 cm) covered with clear plexiglas, and the container placed on the floor beneath a video camera. A gap between the plexiglas and the container allowed the snake to escape the arena at any point during the trial. Three of the four snakes paired with adult male or female mice attempted to strike the mouse, even though it was far too large to be successfully ingested by the snake. In all instances, the mouse dodged the strike, fled to the opposite side of the container, and never retaliated against the snake. In one of the two trials pairing a neonate snake and a lactating mouse and her young, the snake attempted to strike at the mother and her offspring, but was quickly attacked and bitten by the mother. The trial was immediately terminated, but even in this short exchange the snake suffered a bleeding cut on its ventral side. The snakes and mice used in these tests suffered no permanent harm, and all were healthy afterwards.

It is not known if lactating white-footed mice will react similarly to smaller, foraging corn snakes in the wild, but these observations suggest maternal aggression may influence prey choice in small corn snakes. Although neonate corn snakes will readily eat baby mice in captivity, the diet of wild snakes of the same size consists primarily of lizards and caterpillars, with a shift to predominantly rodent prey with increasing snake size (Hamilton and Pollack 1956. Ecology 37:519–526). If maternal aggression functions to prevent neonate snakes from preying upon baby *P. leucopus* mice in the wild, then ontogenetic diet shifts in snakes may not only be a function of increasing gape size (Mushinsky et al. 1982. Ecology 63:1624–1629), but could also be due to agonistic interactions with potential prey.

Submitted by **MATTHEW M. LAPOSATA**, Department of Biological Sciences, Bowling Green State University, Bowling Green, Ohio 43403, USA. Present address: Department of Biology, The Pennsylvania State University, University Park, Pennsylvania 16802, USA (e-mail: mml146@psu.edu).

ELAPHE OBSOLETA SPILOIDES (Gray Rat Snake). **REPRODUCTION**. Female *Elaphe obsoleta obsoleta* have

clutches of 6–44 eggs, but clutches exceeding 24 eggs are rare (Fitch 1963. Copeia 1963:649–658; Wright and Wright 1957. Handbook of Snakes of the United States and Canada. Cornell Univ. Press, Ithaca, New York. 561 pp.). Although information concerning clutch size and husbandry is available for captive *E. o. spiloides* (Merker and Merker 1995. Reptiles 3:56–75; Staszko and Walls 1994. Rat Snakes. TFH Publications, Neptune City, New Jersey. 208 pp), little is known about the reproductive biology of wild individuals of this subspecies. I report the clutch size of *E. o. spiloides* in Shelby County, Tennessee, USA, at the northwestern extreme of their range (Conant and Collins 1991. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. 3rd ed. Houghton Mifflin Co., Boston, Massachusetts. 450 pp.). During 1994–1997, two clutches were obtained from females that were gravid when collected in the field, and one clutch was discovered in a rotting tree stump. Mass (± 0.5 g) and SVL (± 0.5 cm) were recorded for each female at the time of collection. One female (772.7 g, 124.5 cm) laid 19 eggs and weighed 523.2 g following oviposition. The other female (716.5 g, 122.0 cm) laid eight eggs and weighed 583.4 g following oviposition. Eggs were weighed within 5 h of oviposition; individual egg mass ranged from 10.12–21.74 g (mean ± SE = 13.51 ± 0.68). Relative clutch mass (Shine 1980. Oecologia 46:92–100) averaged 33.42 ± 8.37%.

The clutch found in the tree stump contained eight eggs positioned ca. 75 cm above ground level in a tree stump measuring 25 cm in basal diameter. Activity by a colony of carpenter ants (*Camponotus* sp.) higher in the stump had encased the snake eggs in a layer of decaying wood grains.

Following either collection or oviposition, eggs were incubated at 26–28°C in plastic boxes containing a 1:2 water:vermiculite (by mass) substrate. Eggs hatched between 30 August and 24 September following an incubation period of 60–62 days. Eleven of the 41 eggs (26.8%) failed to hatch or produced still-born embryos following pipping. The sex ratio of the surviving neonates was 1:1.22 female:male.

I thank Tom Norman, Jr. and Dave Frederick for assistance in the field, and Bill Gutzke for comments on the manuscript.

Submitted by **STEPHEN J. MULLIN**, Department of Biology, University of Memphis, Memphis, Tennessee 38152-6080, USA. Present address: Department of Biology, University of Central Arkansas, Conway, Arkansas 72035, USA; (e-mail: smullin@mail.uca.edu).

EUNECTES MURINUS (Green Anaconda). **CAIMAN PREDATION**. The green anaconda (*Eunectes murinus*) and the spectacled caiman (*Caiman crocodilus*) are two large predators that use very similar habitats in the seasonally flooded savannas of South America. Predation of caimans by anacondas has been reported (Wehekind 1955. Brit. J. Herpetol. 2:9–13) and appears to occur often in the llanos (Rivas, unpubl. data). Predation by *Caiman sclerops* on *Eunectes notaeus* has been reported (Medem 1983. Los Crocodylia de Suramerica II. Editorial Carrera, Bogota, Colombia. 270 pp.); however, there are no reports of predation by caiman on the larger *E. murinus*. During a seven-year study of the behavioral ecology of the anaconda in the Venezuelan Llanos, we observed spectacled caimans preying on *E. murinus* on three occasions.

On 25 May 1996 we discovered a large caiman (SVL >90 cm) firmly gripping the head of a radio-implanted female anaconda (494 cm total length, 29 kg), who in turn had wrapped herself around the caiman's head and neck. After ca. 15 min. the snake relaxed her coils, apparently losing the struggle with the caiman. When the snake stopped struggling, we interrupted the event to recover the transmitter. Because this snake had been found severely wounded two months before this observation, it is likely that she was not in top physical shape, and this may have played some role in the attack.

Another observation took place on 29 April 1996 in a roadside channel covered partially by water hyacinth (*Eichhornia*). A caiman (SVL >90 cm) was on the left side of the anaconda, gripping it by the anterior 1/5 of its body. The snake had thrown a loop over the dorsal surface of the caiman and wrapped its posterior body and tail around the caiman's left hind leg. The snake, although much smaller than the caiman, was wrapped so tightly around the hind leg that the head of the caiman was pulled towards its hindquarters. The snake periodically tightened its loop, causing the caiman to flip over to the right and under the water. The caiman repeatedly attempted to drag the snake out of the water, but each time the anaconda managed to flip the caiman and pull it back under water. The wrestling match continued for five hours, often punctuated by both animals submerging for periods of 10–15 min. Finally, as the light faded (1900 h), we saw an unidentified caiman of similar size leaving the area with no snake in its mouth. Five days later we found a dead male anaconda (247 cm total length, 5.5 kg), with wounds from a caiman bite on the anterior 1/5 of its body. The wounds suggest a caiman with estimated measurements of 121 cm SVL, 43 kg mass, and 29.5 cm skull length (Thorbjarnarson, unpubl. data). The snake showed no signs of decomposition, indicating a recent death. We surmise that the snake escaped from the caiman but subsequently died from its wounds. Judging by the relationship of masses, we believe that it was the caiman trying to eat the snake and not vice-versa.

The last observation (19 March 1997) also involved a large caiman (SVL >90 cm) attacking a small female anaconda (152 cm total length, 1.7 kg). The caiman was in a small roadside pool with the snake in its mouth. Upon our approach, the caiman dropped the seriously wounded female anaconda. Although the snake survived, we consider this a predation event because the snake was not struggling when we arrived and thus would not have survived without our intervention.

In total, we have found twelve dead anacondas (six males and six females) during the study. Based on our observations and examination of the anacondas (presence of deep circular bite marks matching the size and position of caiman teeth), we determined that all six males and two of the females were killed by spectacled caimans. Interactions between these two sympatric reptiles seem to be quite common.

We are in debt to M. Quero and P Azuaje for their cooperation with the project. W. Holmstrom helped in the data collection and P. Calle was great help in the implantation of the transmitters. We also thank P. Andreadis and G. M. Burghardt for editorial comments on early versions of the manuscript. This research was possible thanks to grants from The Wildlife Conservation Society, The National Geographic Society, CITES, and the Venezuela Fish and Wildlife Service (Profauna). We thank COVEGAN for allowing us to work on their ranch and for all their cooperation with this project.

Submitted by **JESUS A. RIVAS**, Department of Ecology and Evolutionary Biology, University of Tennessee, Knoxville Tennessee 37996-0900, USA (e-mail: jrivas@utk.edu), **JOHN B. THORBJARNARSON**, Wildlife Conservation Society, 2300 Southern Boulevard, Bronx, New York 10460-1099, USA, **MARÍA C. MUÑOZ**, Graduate Program in Ecology, Departamento de Biología de Organismos, Universidad Simón Bolívar, Caracas, Venezuela, and **RENÉE Y. OWENS**, World Society for the Protection of Animals, 29 Perkins Street, P.O. Box 190, Boston Massachusetts 02130, USA.

IMANTODES CENCHOA (Chunk-headed Toad Snake). **AGGREGATION.** Aggregation is a poorly known behavior in snakes. Here we report an aggregation of *Imantodes cenchoa* in the southeastern Peruvian rainforest (Zona Reservada Tambopata-Candamo, Madre de Dios, Perú, 12°51'10"S, 69°21'57"W). On 21 May 1998 at ca. 2000 h, six individual *I. cenchoa* (4 male, 2 female) were observed actively moving in a single plant 1.5–2.5 m above the ground. All individuals were captured by hand, weighed, and measured. The females measured 63.0 cm SVL, 13.5 g; and 71.1 cm SVL, 16.5 g. The males measured 79.2 cm SVL, 20.5 g; 70.2 cm SVL, 16.0 g; 70.9 cm SVL, 20.0 g; and 78.0 cm SVL, 18.0 g. All individuals were adults and neither of the females was gravid. The snakes were subsequently released at the point of capture. We found no obvious purpose for this aggregation.

We thank Chris Kirkby, Huw Lloyd, Arturo Cornejo F., Arturo Palomino M., James I. Watling, and all of our field assistants.

Submitted by **TIFFANY M. DOAN*** and **WILFREDO ARIZABAL ARRIAGA***, TReeS-RAMOS, Casilla 28, Puerto Maldonado, Madre de Dios, Perú. *Present address: Urb. Los Angeles E-1, Cusco, Perú (e-mail: tiffperu@yahoo.com).

LEPTODEIRA ANNULATA (Culebra Desteñida, Banded Cat-eyed Snake). **DIET**. Colubrids are known to take a wide range of food items, including carrion such as fish (Norton 1993. Herpetol. Rev. 29:34) and frogs (Bedford 1991. Herpetofauna 21:35–36).

Leptodeira annulata is a medium-sized, nocturnal, colubrid snake with a maximum recorded total length of 870 mm (Wilson and Meyer 1985. The Snakes of Honduras. 2nd. ed. Milwaukee Publ. Mus. Publ., Biol. & Geol. No. 6, 159 pp.). This snake feeds on lizards, salamanders, and frogs (Alvarez del Toro 1982. Los Reptiles de Chiapas. 3d ed. Instituto Zoológico del Estado, Tuxtla Gutiérrez, México. 178 pp.). On 11 November 1997 (2250 h) we observed a *L. annulata* (SVL 459 mm) eating a road-killed frog from the gravel road surface in Palo Verde National Park, Guanacaste Province, NW Costa Rica (10°21'N, 85°2'W). The snake was deposited in the Museo de Zoología Universidad de Costa Rica (MZUCR 13629). The frog was in an advanced stage of decomposition, with a strong rotten smell. The snake was peeling the squashed frog from the mud, and subsequent dissection of the snake showed that it had consumed some of the remains. It had rained from 2130 h to 2200 h, and frog activity was high in the area where we found the snake. All the frogs we observed (at least 10 individuals) on the road during the 15 min. prior to the observation were *Rana vaillanti*. Because of similarities in size, we infer that the dead frog may have been another *R. vaillanti.*

These observations were conducted during a field trip of the Zoology II course of the School of Biology, University of Costa Rica. I acknowledge the enthusiasm of my students on this field trip. I thank Gerardo Chaves for the verification of the identification of the snake and frogs, and M. I. Di Mare and W. Eberhard for their suggestions on the ms.

Submitted by **JOSE M. MORA**, Escuela de Biología, Universidad de Costa Rica, San José, Costa Rica (e-mail: jmmora@cariari.ucr.ac.cr).

MORELIA AMETHISTINA (Australian Scrub Python). **MALE-MALE COMBAT**. There is considerable diversity among snake species in terms of whether or not males engage in physical combat during the breeding season; and if they do, whether or not the combat bouts involve biting as well as "wrestling" (Shine 1994. Copeia 1994:326–346). Australian pythons of the genus *Morelia* are of particular interest because they include the only recorded case of intraspecific variation in the occurrence of male-male combat. Males display vigorous combat in some populations of *M. spilota*, but not in others (Shine and Fitzgerald 1995. Oecologia 103:490–498). Because the same phenomenon might occur in other *Morelia*, we need records of snake behavior from throughout the range of all species. Combat has been reported in captive specimens of *M. amethistina* (Ross and Marzec 1990. The Reproductive Biology of Pythons and Boas. Institute for Herpetological Research, Stanford, California. 270 pp.), but without detail. Khorzov et al (1995. Russian J. Herpetol. 2:69–70) noted that males of the Indonesian subspecies (*M. a. amethistina*) may bite each other and cause severe injury. Scars on adult male *M. amethistina* in the field in northern Queensland have been interpreted as evidence of male-male combat (Anonymous 1993. Chondro 1:11–12).

One of us (LS) observed and photographed combat between two large scrub pythons one morning (1015 h) in early July 1997, in tropical Queensland (on the outskirts of the town of Gordonvale, near the Mulgrave River). Scrub pythons (*M. a. kinghorni*) regularly inhabit the ceilings of a farmhouse and adjacent shed, especially during winter. Alerted by the sound of items falling from the rafters of the shed, LS found two large (ca. 4.5 m) scrub pythons intertwined, having fallen from the rafters above. The snakes wrestled with each other for ca. 30 min., moving out of the shed and across the adjacent garden area. The posture adopted was similar to that depicted in photographs of male *M. spilota* in combat (see Shine and Fitzgerald, *op. cit.*; and Greer 1998. The Biology and Evolution of Australian Snakes. Surrey-Beatty, Sydney, New South Wales. 358 pp.); the posterior bodies were entwined and the heads of both snakes raised up to 1 m above the ground. One snake repeatedly bit the forebody of the other animal, leaving deep lacerations. The snakes were very similar in size; we infer that both were males. One of the snakes eventually moved away into thick bush; the other (with open wounds from the bites it had received) climbed to the roof of the house, and then to the rafters of the shed where the bout had commenced. Another scrub python (4 m long, without scars, and thus inferred to be female) was coiled among these rafters throughout the combat episode.

This appears to be the first report of male-male combat in free-ranging scrub pythons. Our observations suggest that combat takes the same form in these giant snakes as in other large python species, including other *Morelia* (for a review, see Shine 1994, *op. cit.*). However, our report also provides another example of a puzzling phenomenon first reported for populations of *M. spilota* from northeastern New South Wales (Shine and Fitzgerald, *op. cit.*): the co-occurrence of male-male combat and large mating aggregations within single taxa. Scrub pythons gather in considerable numbers in open areas during the winter mating season in northeastern Queensland, and male-male tolerance rather than aggression has been reported under these circumstances (see page 72 in Shine 1991. Australian Snakes. Reed Books, Sydney, New South Wales. 223 pp. for a photograph of multiple snakes in close proximity). The fact that males tolerate each other sometimes, but battle vigorously at other times, suggests that the reproductive "tactics" of male pythons may be more flexible than has hitherto been assumed.

Submitted by **LYN SUES**, P.O. Box 38, Gordonvale, Queensland 4865, Australia, and **RICHARD SHINE**, Biological Sciences A08, University of Sydney, NSW 2006, Australia (e-mail: rics@bio.usyd.edu.au).

MORELIA SPILOTA (Australian Carpet Python) **CAUDAL LURING**. Snakes of several phylogenetic lineages utilize caudal

luring to attract prey. Caudal luring involves a snake waving its tail tip such that it resembles a live worm or insect, inducing the potential prey item to approach the snake (Heatwole and Davidson 1976. Herpetologica 32:332–336). Caudal luring appears to be most common in "ambush" predators, such as viperids, boids, and pythonids (Strimple 1995. Litteratura Serpentium 15:74–77). Caudal luring seems to be elicited more easily in juveniles than in conspecific adult snakes (Allen 1949. Copeia 1949:225–226; Rabatsky and Farrell 1996. J. Herpetol. 30:558–561).

Among pythons, caudal luring has been reported in two Australian species: the highly arboreal *Morelia viridis* (Greene and Campbell 1982. Herpetologica 28:32–34) and the semifossorial *Aspidites ramsayi* (Wilson and Knowles 1988. Australia's Reptiles: A Photographic Reference to the Terrestrial Reptiles of Australia. Collins, Sydney. 447 pp.). We can now add another species to this list. We observed and filmed caudal luring in a young (49-day-old) *Morelia spilota mcdowelli* (coastal carpet python) hatched in captivity. The snake's parents were collected near the town of Bellingen on the northern coast of New South Wales, in eastern Australia. While filming for a documentary on python biology on 2 March 1996, one of us (PS) placed a green tree frog (*Litoria caerulea*) in a hexagonal cage (90 cm across) that contained two hatchling pythons. One snake that was loosely coiled on branches several cm above the ground immediately oriented towards the frog and began twitching its tail-tip rapidly. The tail-tip was vibrated a total of 23 times over the course of the next several hours. The first 17 of these vibrations occurred with the tail held >2 cm above the head. The snake then raised its tail above the head and completed six more vibrations.

We used frame-by-frame analysis of the film to quantify several attributes of the tail-flicks exhibited. All of the tail-flicks initiated from beneath the snake's head were horizontal, whereas the tail-tip moved vertically in four of the six "above-head" tail-flicks. These proportions differed significantly ($c^2 = 9.47$, 1 df, $P < 0.003$ with Yate's correction). "Above-head" versus "below-head" flicks did not differ significantly in terms of the arc over which the tail-tip travelled on each tail-flick (respective means ± SD = 91.3 ± 62.5° vs. 77.9 ± 33.4°, ANOVA $F_{1,21} = 0.39$, $P = 0.54$), the total duration of the flick (1.09 ± 0.32 s vs. 0.78 ± 0.34 s, ANOVA $F_{1,21} = 2.90$, $P = 0.10$) or the delay between successive flicks (2.08 ± 2.32 s vs. 1.48 ± 0.64 s, ANOVA $F_{1,21} = 0.87$, $P = 0.37$). However, above-head flicks involved a much greater proportion of the total tail length (27.5 ± 2.9% versus 15.3 ± 8.1%, ANOVA $F_{1,21} = 8.24$, $P < 0.01$). The frog showed no overt response to the snake's behavior, but was later seized and consumed by the snake. Part of this film sequence was included in the completed film ("Python, The Sly Strangler." Roger Whittaker Films Pty Ltd.).

The caudal luring exhibited by this young carpet python was very similar to that seen in other snakes that exhibit caudal luring, including elapids (Carpenter et al. 1978. J. Herpetol. 12:574–577) and viperids (Heatwole and Davidson, *op. cit.*) as well as other pythonids (Rabatsky and Farrell, *op. cit.*). The potential selective advantage of this behavior to cryptic "sit-and-wait" predators is obvious: it may substantially increase the number of potential prey items that approach the snake closely enough to be seized. Juvenile carpet pythons have a diverse diet, although anurans appear to be taken only rarely (Shine and Slip 1990. Herpetologica 46:283–290; Shine and Fitzgerald 1996. Biol. Conserv. 76:113–122). The most surprising aspect of our report is that this distinctive behavior has not been reported previously, because the species involved is abundant, widely-distributed, well-studied in the field and commonly maintained and bred in captivity (Barker and Barker 1994. Pythons of the World. Volume 1, Australia. Advanced Vivarium Systems, Lakeside, California. 171 pp.).

Submitted by **PHIL SIMON**, RMB Darkwood Road, Thora, NSW 2454 Australia, **ROGER WHITTAKER**, The Stonehouse, Clavering Road, Seaforth, Sydney NSW 2092 Australia, and **RICHARD SHINE**, Biological Sciences A08, The University of Sydney, NSW 2006 Australia (e-mail: rics@bio.usyd.edu.au).

NERODIA TAXISPILOTA (Brown Water Snake). **FEEDING BEHAVIOR**. *Nerodia taxispilota* is known to feed on a variety of fish species that collectively occupy all levels of the water column (Camp et al. 1980. J. Herpetol. 14:301–304; Mills and Hudson 1995. Herpetol. Rev. 26:149). Carr (1940. Univ. Florida Publ. Biol. Sci. Ser. 3:1–118) regarded *N. taxispilota* as probably the fastest swimmer among Florida water snakes, and Camp et al. (1980, *op. cit.*) proposed that speed may allow *N. taxispilota* to capture fish more easily than other *Nerodia*. Here we report an individual *N. taxispilota* hunting fast-swimming, open-water fishes in a ambush fashion.

On 22 April 1998 at 1530 h, a *Nerodia taxispilota*, ca. 1 m total length, was observed for 15 min as it attempted to ambush fish in the Hillsborough River, Hillsborough County, Florida, USA. The snake's tail was anchored to a mat of aquatic vegetation, while its anterior half was extended horizontally from the vegetation. The surface of the water was ca. 10 cm above the snake and the overall depth of the water was 1.5 m. The snake was 5 m from the shoreline and within 2 m of several cypress trees.

Twenty-two fish of the genus *Lepomis* (sunfish) were swimming near and around the snake's head, in some cases within 2–3 cm. The snake's underwater tongue flicks occurred at a rate of 10–12 per minute during five minutes of counting. The snake surfaced for air twice during the observation. On three separate occasions, when the fish swam within 1 cm of the snake's head, the snake struck open-mouthed and made three swift side swipes at the fish. Although no captures were observed, an object approximately the size of a sunfish could be seen moving posteriorly inside the snake's neck, probably indicating recently ingested prey.

Our observation suggests that *N. taxispilota* need not be a fast swimmer to capture fish, and that *N. taxispilota* sometimes hunts fast-swimming, open-water fishes using an ambush strategy.

We thank Ardell Mitchell for reviewing this note.

Submitted by **RICHARD D. REAMS**, Department of Herpetology, Dallas Zoo, 650 South R.L. Thornton Freeway, Dallas, Texas 75203, USA (e-mail: hylareams@aol.com), and **ANN M. STEVENS**, Department of Mammalogy, Dallas Zoo, 650 South R.L. Thornton Freeway, Dallas, Texas 75203, USA.

PSEUSTES SULPHUREUS SULPHUREUS (Papa-Ovo). **DIET**. On 5 September 1998, a specimen of *Pseustes sulphureus sulphureus* was collected in the National Forest of Caxiuanã, Melgaço, Pará State, Brazil. The specimen was captured on the roof of a house after it had eaten a bat, ca. 0300 h. This snake was deposited in the Museu Paraense Emílio Goeldi, Brazil (MPEG 19408). When we examined the stomach of the snake, we found the bat, an adult male *Molossus mollosus* (MPEG 26338). The literature suggests that *P. sulphureus* eats mainly rodents, wild birds, and young domestic animals (Beebe 1946. Zoologica, Chicago, 31[1-3]:11–52; Cunha and Nascimento 1993. Bol. Mus. Para. Emílio Goeldi 9:92–93). We believe that this is the first record of *P. sulphureus* eating a bat.

We thank N. Saldanha for identifying the bat and F. Diniz for suggestions on the manuscript.

Submitted by **NELSON RUFINO**, Fundação Centro de Referência em Educação Ambiental Escola Bosque Professor

Eidorfe Moreira, Av. Nossa Senhora da Conceição s/n, Outeiro, Belem, Para, Brazil (e-mail: rufino@interconect.com.br), and **JOSÉ A. R. BERNARDI**, Museu Paraense Emílio Goeldi, Caixa Postal 399, CEP: 66040-170, Belem, Para, Brazil.

SPILOTES PULLATUS (Tiger Ratsnake). **PREY**. Few data are available on the feeding habits of *Spilotes pullatus* (Colubridae) in the wild. On 10 February 1998 (1100 h) at Volcán Mombacho (ca. 1 km SW of Cutirre, 11°49.67'N, 85°56.37'W, 390 m elevation), Departamento de Granada, Nicaragua, we discovered an adult male *S. pullatus* trying to swallow a juvenile Mexican porcupine (*Sphiggerus mexicanus*) (Fig. 1). The locality is at the edge of a coffee plantation close to a forest. Immediately after we found the snake, it started to regurgitate its prey. Both the snake and the porcupine were preserved and deposited in the collection of the Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt, Germany (SMF). The snake (SMF 78370) had a SVL of 160 cm and a tail length (TL) of 57.5 cm. The porcupine (SMF 86959) measured 165 mm SVL, 177 TL and 40 mm hind foot length. The oral cavity as well as parts of body and tail of the snake were spiked with numerous porcupine spines.

We thank Milton G. Camacho, Mauricio Fonseca Cuevas, Carlos Peres-Román, and Sandra Tijerino, Ministerio del Ambiente y los Recursos Naturales (MARENA), Managua, Nicaragua, for granting collecting and export permits, and Gerhard Storch, Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt, Germany, for the identification of the mammal.

FIG. 1. *Spilotes pullatus* trying to swallow a juvenile *Sphiggerus mexicanus* (Volcán Mombacho, Nicaragua).

Submitted by **GUNTHER KöHLER** and **ROBERT SEIPP**, Forschungsinstitut und Naturmuseum Senckenberg, Sektion Herpetologie, Senckenberganlage 25, D-60325 Frankfurt, Germany (e-mail [GK]): gkoehler@sng.uni-frankfurt.de).

THAMNOPHIS ELEGANS VAGRANS (Wandering Garter Snake). **MATING**. The timing of mating in garter snakes is often linked to spring emergence from hibernacula, which may facilitate scramble competition among males for mates (Rossman et al. 1996. The Garter Snakes: Evolution and Ecology. University of Oklahoma Press, Norman, Oklahoma. 332 pp.). Here I report observations of spring mating behavior in *Thamnophis elegans vagrans* from a denning area 32 km N of Craig, Moffat Co., Colorado, USA.

On 10 May 1998 at 1400 h I found two *T. e. vagrans* courting in the dirt between sagebrush ca. 10 m from the denning area. The female was 53.5 cm SVL, 69.5 cm total length; the male was 47.5 cm SVL, 63.0 cm total length. Then, at 1600 h I observed three *T. e. vagrans* intertwined at the denning area. I was unable to capture the three snakes to verify sex; however, this behavior is similar to the scramble competition involving one female and multiple males that has been noted at den sites in spring for other populations of *Thamnophis* (Rossman et al., *op. cit.*).

Submitted by **KYLE G. ASHTON**, Department of E.P.O. Biology, Campus Box 334, University of Colorado, Boulder, Colorado 80309, USA (e-mail: ashtonk@colorado.edu).

THAMNOPHIS SAURITUS SAURITUS (Eastern Ribbon Snake). **HIBERNACULUM**. Although information regarding common garter snake (*Thamnophis sirtalis*) hibernacula is relatively abundant (Aleksiuk 1977. Herpetologica 33:98–101; Carpenter 1953. Ecology 34:74–80), such data for the congeneric eastern ribbon snake (*T. sauritus sauritus*) are relatively scarce. Most data available on hibernaculum use by *T. sauritus* are summarized in Ernst and Barbour (1989. Snakes of Eastern North America. George Mason Univ. Press, Fairfax, Virginia, 282 pp.), who reported use of vole tunnels, crayfish burrows, ant mounds, and possibly muskrat (*Ondatra zibethica*) lodges and bank burrows.

On 5 January 1998 amidst a week of unseasonably warm weather, five *T. s. sauritus* were observed at 1245 h on and around a large fallen beech tree (*Fagus grandifolia*) at Mason Neck National Wildlife Refuge, Fairfax County, Virginia, USA. The upturned root base of the tree was situated on a south-facing bank at the northern edge of a permanent tidal marsh with the trunk extending into the marsh. The fallen tree measured ca. 24 m in length and 86 cm in diameter at breast height. The mass of roots and attached soil at the base was 3.5 m in diameter and 98 cm thick. Electronic data loggers placed in the general area to record air temperature at 30 min. intervals indicated that air temperatures had not dipped below freezing the previous two nights, daytime highs had exceeded 16.5°C the previous two days, and mean daily temperatures had exceeded freezing the previous three days. The area surrounding the tree was scrutinized for other possible hibernation sites. None were found, and no snakes other than those around the tree base were found on 5 January.

Of the five *T. s. sauritus* seen on that day, two males were captured. The first (SVL 47.0 cm, mass 37.5 g) had a cloacal temperature of 29.0°C. The second (SVL 43.0 cm, mass 26.0 g) had a cloacal temperature of 26.0°C. The air temperature at the time of the captures was 22.0°C. Two other individuals were entwined on the sunlit bank near the base of the tree, with one exhibiting stimulatory courtship undulations.

We concluded that the ribbon snakes had been overwintering in tunnels, probably created by small mammals, within the tree's upturned root/soil base. The thickness of the root/soil base seemed sufficient to insulate snakes near its center from freezing temperatures. Additionally, the position and southern orientation of the tree base permitted exposure to sunlight at low angles of incidence during most of the winter daylight hours, providing further thermal buffering from frost. This condition is also likely to raise the body temperatures of snakes hibernating within the tree base to the activity threshold more quickly than those hibernating in adjacent soil, resulting in earlier emergence and providing them with an advance choice of amphibian prey.

Submitted by **KERRY A. HANSKNECHT**, **TERRY R. CREQUE**, and **CARL H. ERNST**, Department of Biology, George Mason University, Fairfax, Virginia 22020-4444, USA; e-mail (CHE): cernst@gmu.edu.