

the VIVARIUM

Journal of the American Federation of Herpetoculturists

Vol. 7 No. 3



How to Establish Ornate Uromastyx • Emerald Tree Boa, *Corallus caninus* • General Ecology of *Cryptosporidium*
Argentine Black and White Tegu, *Tupinambis teguixin* • Tropical Wet Forests of Costa Rica
Profile: Edward Drinker Cope • Big Snake Bites, part II



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Manufactured and Printed
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THE VIVARIUM, (ISSN 10472665) is published six times a year: January/February, March/April, May/June, July/August, September/October and November/December issues. Subscription price is \$26 for U.S. and \$32 for all foreign countries per year. Published by American Federation of Herpetoculturists, 120 W. Grand, Ste. 106, Escondido, CA 92025 Tel# (619) 747-4948. Second-Class Postage Paid at Escondido, CA and additional mailing offices. **POSTMASTER: Send address changes to THE VIVARIUM, P.O. Box 300067, Escondido, CA 92030-0067.**

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On the cover: This wonderfully composed photograph of a blunt-headed tree snake, *Imantodes inornatus*, was taken by David T. Roberts at La Selva Biological Station, Heredia Province, Costa Rica. © Nature's Images Inc.

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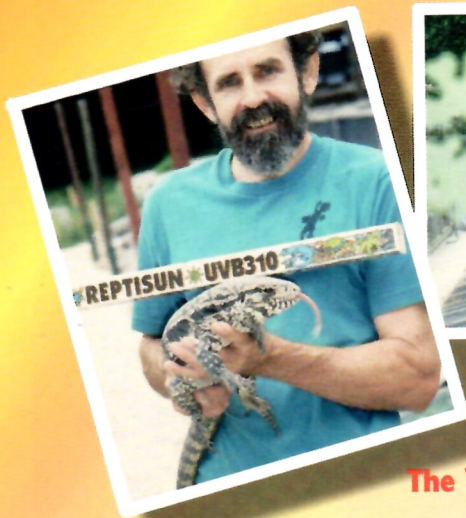
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Mission Statement of the American Federation of Herpetoculturists

The American Federation of Herpetoculturists (AFH) is a nonprofit national organization whose purpose is to represent the interests of herpetoculturists, those involved in the captive husbandry and propagation of amphibians and reptiles, through the dissemination of essential information to individuals, societies and institutions; to document the accomplishments in herpetoculture through our official publication, *The Vivarium*; to promote responsible herpetoculture through education and legislative action; and to establish a general philosophy of herpetocultural education that could contribute to the conservation of biological diversity.

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From the Editor

In my last editorial I encouraged readers to write and express their opinions on our new cover design and format. I received numerous letters, and I'm pleased to say that everyone who responded very much liked the new design. We at the AFH will constantly strive to serve our readers and produce a better product.

Along those lines, this issue of *The Vivarium* introduces a new column on "How to Establish." Recent studies estimate that over 1 million reptiles and amphibians are imported into the U.S. annually, and many of these animals die within the first few weeks. As such, we believe this column will serve our fellow herpers and their charges well.

In response to many recent letters requesting that we publish articles on insects and arachnids, volume 7(4) will introduce a new column entitled "Arachnids and Such." This column will feature articles on the ecology, husbandry, and reproduction of spiders, scorpions, centipedes, mantids, stick insects, etc. As always, I'd like to hear reader opinion on these new ideas.

In recent weeks I've attended several herp expos. The National Reptile Breeders Expo in Orlando Florida was truly amazing, with nearly 400 vendors and over 6,000 attendees. Certainly the largest gathering of herp enthusiasts I've seen under one roof!

The East Texas Herp Society's 5th Annual Conference, Breeder Expo and Educational Exhibit was a great success thanks to the hard work of Dave Doherty, Russ Walker and others. Dr. Walter Auffenberg delivered the keynote presentation on Culture and Herpetology in Pakistan. Made me want to go there.

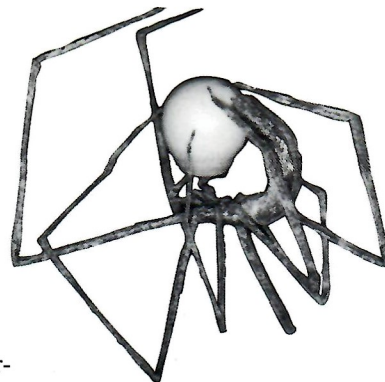
The North Texas Reptile and Exotic Pet Expo, organized by Outlander Reptiles was also a great success, as attendance increased over 100% (1,300 in '94 vs 3,400+ in '95). Members of the North Texas Herp Society co-organized this show and were able to substantially augment their scholarship fund for graduate students in herpetology.

Every year these symposia/expos are getting larger and better organized. It's encouraging to see so many people with a passion for reptiles and amphibians, and I can only imagine what the next few years will bring. As I can't possibly make every expo, I invite readers who have recently attended a show to share their thoughts. Drop me a line so that we can let the readership know what's going on.

A few closing words on expos . . . The people that sponsor, organize and attend these shows, serve as models to the many young people exploring their fascination with herps. That we can provide captive-born offspring for their enjoyment is a good thing, because animal husbandry helps teach responsibility and the finiteness of life. We, as examples, can invest in their future by using these expos as a forum for promoting responsible animal care, and to deliver conservation messages. It's critical for young people to hear about conservation issues over and over again. It would be foolish to miss the opportunity to educate so many enthusiastic young people. After all, a world with only captive herps would be a grim place indeed.



Clay M. Garrett
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HERP NEWS FROM AROUND THE WORLD

by
Ellin Beltz

QUATERNARY PARK

Entertainment megagiant developer, The Walt Disney Company, announced plans to build its (surprise!) biggest ever theme park combining rides with live animal experiences with real wildlife. Planned for 500 acres in Orange County near Orlando, Florida, the site will be landscaped to create habitats for 1000 animals, including some endangered species. Analysts propose that from \$600 to \$800 million will be needed for completion. Disney said 4000 people would be employed in construction and 3000 for permanent staff. One of the project consultants said, "We're at a time when population is growing so rapidly that the only wildlife we'll be able to save is the ones we care about." The Park is to be divided into three sections: the real, the mythical, and the extinct—including "a Jurassic Park-type trip to the dinosaur era." [*The New York Times*, June 21, 1995 from Jett] But will Kaa finally get Mickey? Stay tuned.

LET'S PUT THE MARSH HERE!

National Wildlife Magazine suggests using "Toads and frogs: Natural Pest Control . . . Toads . . . are probably the easiest of the herptiles to attract . . . you need to provide water and a shaded place for them to hide . . . the area should be devoid of pesticides . . . If you mulch, toads will hide under [it] . . . [several methods] make an elegant 'Toad Hall.'" The article describes in detail how to build a backyard pond and adds "The adage, 'if you build it they will come' applies to amphibians. Be patient and eventually you'll discover them in your yard." [April/May 1995 from David A. Webb]

NEW SCIENTIFIC EXHIBIT

"Amphibians and Reptiles of Utah" is now on display at the Monte L. Bean Life Science Museum of Brigham Young University in Provo, Utah. It shows every species and subspecies of herp in the state including gila monsters, rattlesnakes, and more obscure blind snakes. The collection is named after W. W. Tanner who helped collect and identify many of the animals. He donated a collection of nearly 30,000 preserved herps to the museum of which he was the first director. [*Deseret News*, March 28–29, 1995 from David A. Webb]

SNAKE-UP CALLS

• Tom Taylor, founder of the Arizona Herpetological Association, was quoted in the *Arizona Republic*, "We're getting 15 calls a day from people who are encountering snakes on their property." One rural fire department has rounded up 208 snakes in 1995; half were rattlesnakes. Two snakebites have also occurred. A herpetologist with the state Game and Fish Department said that he believes that snake populations have expanded in the 1990s due to mild winters and abundant rains. [March 22, 1995 from David A. Webb] Incidentally, another point of

view on the "snake problem" is that it is really a "human problem," subdivisions crowding out hibernacula, if you will.

• Arkansas, too, is experiencing a rash of snake/human interactions. Six people were treated in Rogers, Arkansas for snakebite over the Memorial Day weekend. [*USA Today*, June 6, 1995 from David Webb]

A GLIMPSE OF AERIAL STOCKING

Is the seeding of wilderness lakes with trout a possible cause of amphibian decline? Some Forest Service biologists have speculated that dropping fingerlings into formerly fishless lakes may be a contributing factor in frog loss in the Eldorado National Forest and the Mokelumne Wilderness. The California department of fish and game denies that its stocking program has hurt amphibians, pointing out that they have been stocking trout for 40 years and claiming that amphibian decline is a more recent phenomenon. [*The San Francisco Examiner*, December 18, 1994 and February 5, 1995 from Matthew and Laurie Aikawa] Apologies to Noel Coward.

GOOD NEWS, BAD NEWS FOR CROCODYLIA

• The People's Republic of China has established a reserve for 190 endangered Chinese alligators on Hainan, an island in the South China Sea. The species once spread over most of the Yangtze River basin, from the Tibetan Himalayas to the East China Sea. Habitat destruction has limited the range of the 500 survivors of this species to a small area at the mouth of the river. [*The Daily Herald*, Provo, UT, November 28, 1994 from David A. Webb]

• Salt-water crocodiles are being hunted again in Australia. Protected by law since 1971, the species has become common in the Northern Territories where large individuals have taken residence in backyards, pools, and suburbs. A two-year test hunt will be implemented about 100 miles east of Darwin. [*The Toronto Star*, February 18, 1995 from K & W Herp Haven]

• A crocodile kept in captivity since a czar ruled Russia has died in Ekaterinburg. Believed to have been the oldest of his kind in the world, the long-term captive was acquired by the zoo between 1913 and 1915 when he was already adult. He was believed to be from 110 to 115 years old when he died. [*The Globe and Mail*, February 16, 1995 from Capt. Wes von Papineau]

• *The Cancun News Daily* reports: "Cancun's oldest inhabitant, a 30-year-old crocodile that was famous for crossing [Kukulcan] Avenue at least once a month was in trouble. His left leg was severely injured after a boat hit him . . . the poor reptile had to wait nine days to be rescued . . . because the authorities didn't lift a finger . . . [A local activist said] 'What do you think all the tourists who saw the animal laying hurt for nine days will say about Mexico?' . . . Finally, the municipality provided a truck in which the crocodile was transported to Crocoun, a crocodile farm near Puerto Morelos, to receive proper attention. . . . The Elder, as Cancun people know the crocodile . . . is now recovering." [March 23, 1995 from Vinny Lupi]

• Windsurfers and visitors of Astbury Water Park Lake, near the northern English town of Congleton, have been warned to be on the lookout for a loose crocodile. It was first spotted by a couple visiting the lake. Authorities believe it may have been a pet which was released when it got "too big to handle." Keith Brown, reptile curator at the Chester Zoo said, "It is the goldfish-down-the-toilet syndrome." [*The Globe and Mail*, Toronto, June 6, 1995 from Wes von Papineau and Kimberley Heaphy]

• The first leucistic alligators confirmed by science have been sent out on display loans from the Audubon Zoo in New Orleans. One of the white alligators is on display at Chicago's Shedd Aquarium until mid-September. All 17 white alligators were found by a fisherman in 1987 right after they had hatched in a remote Louisiana swamp. The zoo has been raising them since that time. "Being a snowy white infant devoid of cryptic coloration and left otherwise defenseless in a swamp, is tantamount to hanging a sandwich board on the animal with a simple message to all predators: 'Here I am. Eat me.'" according to William Mullen of the *Chicago Tribune*. The white alligators are also prone to sunburn, turning a vivid pink if unprotected. [*The Daily Herald*, Provo, UT, May 25, 1995 from David Webb]

• Efforts to change public opinion about crocodiles in the Philippines have been underway by the government-run Crocodile Farming Institute since 1987. It's been slow going. The second part of their task, the actual breeding of crocodiles, has been going much better. The institute's headquarters on Palawan Island, southwest of Manila, is home to about 2500 crocs, 80% of which were born in captivity. Officials hope to create crocodile sanctuaries on remote islands and release the crocs in the wild. However, local residents are not enthusiastic about the potential release of animals bigger than they are. [*Deseret News*, April 15, 1995 from David Webb]

MIXED NEWS FOR TURTLES

Visitor sightings on Mustang Island and the Padre Island National Seashore led to the discovery of Kemp's ridley turtles nesting. A park ranger found another turtle while she was laying eggs. Biologists removed 231 eggs for protected incubation and hatching. James Pinkerton of *The Houston Chronicle*, reports: "Optimism spurred by the three nests is tempered by concern over mounting losses of sea turtles along the Gulf of Mexico, with Texas reporting 527 dead turtles last year (1994). Of those, 254 were the Kemp's ridley. At the end of April, mounting turtle deaths prompted the National Marine Fisheries Service to order shrimp fleets in parts of Texas and Louisiana to install the most efficient type of turtle-excluding devices in their nets. . . . [Even so] during April, 52 Kemp's ridleys were among the 88 turtles found on Texas beaches. In May, 34 turtles were found, 17 of which were Kemp's ridleys. . . . the peak of [their] nesting season is the last week of May and the first week of June." [*The Denver Post*, June 3, 1995 from David Webb]

GOOD NEWS FOR TURTLES

• Happy birthday to four olive ridley sea turtles hatched at the Dallas Zoo! The eggs were among 30 seized by federal agents at the Dallas-Fort Worth Airport. [*The Salt Lake Tribune*, February 9, 1995 from David A. Webb]

• Reuter News Agency reports that Sri Lanka has been criticized for its trade in endangered turtles. The United Kingdom is a large source of tourists for the island nation south of India. "Sri Lankan newspapers said activists from [an environmental group] were organizing demonstrations in London outside the tourist board office, Ceylon Tea Center and Airlanka office." Turtle shells are freely sold in tourist areas of Colombo and along the Indian Ocean Beaches. Concerned about the adverse publicity, the Sri Lankan tourist board met to establish a task force with three jobs: tackle child prostitution, trade in endangered turtles, and drugs. They recommended prosecution of individuals in the turtle trade. [*The Globe and Mail*, Toronto, June 10, 1995 from Wes von Papineau and Kimberley Heaphy]

• Also from the Indian Ocean, the islands of the Maldives banned the trade in turtles for 10 years after being criticized by environmental groups. A moratorium on catching, selling, importing, and exporting turtle products has been implemented. It was announced by the President's office and the ministry of fisheries. [*The Gazette*, Montreal, June 27, 1995 from Wes von Papineau and Kimberley Heaphy]

• Twenty-six Pacific nations have begun a campaign to save marine turtles from extinction by calling for a ban on commercial sales. Turtles are protected under CITES but experts in Wellington, New Zealand said that this has not prevented the sale of turtle meat, oils, and shells. [*The Seattle Times*, March 6, 1995 from Lee W. Roof]

• "On June 19, 1995, the National Turtle Farmers and Shippers Association was fined \$25,000 in U.S. District Court for conspiracy to suppress trade by fixing prices on red-eared slider turtles for the pet trade." [Associated Press from Gene Buck of the Congressional Research Service via Internet]

WATCH OUT FOR THE END WITH TEETH . . .

• A 15-inch Savannah monitor lizard tried to swallow a 3-year-old human's finger in Quarryville, Pennsylvania. The rescue squad was called. The police chief said, "I couldn't even see the child's finger. It was in the lizard's mouth up to his hand. The lizard was gnawing on the child's hand, while the mother clutched the lizard with both hands." The chief pried open the lizard's mouth with a butter knife. An ambulance was called because the boy's finger was mangled and bloody. The family plans to give the animal away. [*The Lancaster, PA Sunday News*, April 23, 1995] On June 4, the same publication reported that "Rescue 911" planned to film a segment provisionally titled "Lizard Finger Lock," featuring the police chief who gave such good quote to reporters of the actual event. The family will be interviewed in their home, and a casting agent is searching for actors to take the place of the mother and child for a re-enactment of the actual finger grab and swallow. Filming was planned for mid-June. After the film crew came to town, a third article reported "Quarryville still reeling from visit by 'Rescue 911' crew . . . perhaps the lead role in the drama, however, goes to a lizard named Homer . . . less than two months ago . . . Homer was just another obscure reptile in a cage . . . the [film] crew filmed [the police chief]—over and over and over—as he re-enacted to the moment he received the dispatcher's call." Filming of the one-hour event took five days. [June 15, 1995—all from Michael J. Shrom]

• A Georgia man died at home following a rattlesnake bite he sustained while holding the serpent in church. "If he had gone to the hospital, it would've all been different," said the local sheriff. Witnesses reported the man had brought the snake to church in a box and was bitten when he tried to take the animal out. [*Seattle Times*, January 18, 1995 from Jett]

• The Australian tiger snake eats other venomous snakes. Researchers have found that it has an antivenin in its blood which neutralizes the fatal effects of its own venom and that of a wide variety of other snakes, including cobras, moccasins and rattlesnakes. Researchers are now trying to work out the structure of the tiger snake blood protein in an effort to synthesize it for use as an antivenin. [*Discover*, May, 1995 from David Webb]

• A 51-year-old owner of Reptile World in Orlando, FL was bitten by a 12-foot king cobra during daily milking at his facility near St. Cloud. As soon as he was bitten, he injected himself with epinephrine to counteract the bite, took 10 vials of antivenin and left for the hospital with his assistant. George Van Horn was unconscious when he reached Orlando Regional Medical Center. An additional number of vials of antivenin were obtained from around the country; nearly 50 were administered. [*Seattle Times*, June 23, 1995 from Jett] Several days later he was conscious and determined to go back to work as soon as possible.

YOU MEAN SNAKES CLIMB?

Two employees of the Utah power company plucked a python from a tree. They had been planning to trim the tree out of the power wires, but were informed by the resident that a python was curled up high in the tree. At first, the workers thought the object was a ball, but when they got closer, they saw it was a snake. They called for a backup. The man climbed up, the snake climbed higher. Eventually, a rope was tied around the branch, a limb was cut, and branch, snake and all was lowered to the ground. The snake's owner said he was really grateful to the workers. The snake had escaped when placed in a crook of the same tree early in the week to take some sun. [*The Ogden, UT Standard-Examiner*, June 3, 1995 front page from David Webb]

"AND MY NEIGHBORS THINK I'M WEIRD . . ."

wrote David Webb, the greatly appreciated super-clipper who sends so much for this column. The item thus engraved read: "Princess of Snakes" remains unrattled by writhing horde—Seventeen-year-old Shahzadi Zarqua drapes a writhing bundle of snakes around her neck, letting them wriggle across her face and body . . . pops their heads in her mouth." Later she encourages another to draw blood from her finger. Zarqua's snake show is performed nightly in a town 250 miles south of Islamabad in Pakistan. Of her 30 snakes, a few are reported to be "highly poisonous. But Zarqua has lived with snakes all her life and does not mind their bites." She said, "snakes are harmless animals. They do not bother anyone unless disturbed. What harm could an animal bring which has no eyelids or ears? It is a very innocent being." [*Deseret News*, June 2, 1995]

Thanks to several contributors for their concern about my family, myself and our critters in our recent record heat wave. Chicago posted several days over 100° F. Over 500 people in Chicago died from the record heat/humidity in early July; the late July heat wave was not so disastrous. I was out of town when the wave first hit, but prompt action by my husband saved everything except the fruit flies. I was really gratified to receive several messages from AFH-ers worried about us in that disaster. I'd also like to thank David A. Webb, Robert Innes, Alan W. Rigerman, Jett, Michael J. Shrom, Marty Marcus, and Andy Viasmith for sending in articles,

cards, letters, and photos which I've enjoyed greatly but haven't summarized for this column. You can contribute, too! Send clippings with date/publication slug firmly attached (return address labels are really super!) or written directly on the clipping to "Ellin Beltz, c/o AFH, P.O. Box 300067, Escondido, CA 92030-0067." You can e-mail me at "uebeltz@uxa.ecn.bgu.edu"—so far, I can respond personally to all Internet requests.



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Ask the Expert

by Winston Card



Q. I have four large spectacled caimans in my collection which I have been raising for several years. I believe my animals are nearing sexual maturity, but I do not know what sex my animals are. Is there a simple way to sex crocodilians?

Fort Worth, TX

A. There is a fairly simple method of sexing adult crocodilians. With the help of a partner, safely restrain your animal. Insert an index finger into the animal's cloaca an inch or two. In males, you should be able to palpate a single recurved penis just inside the cloaca.

Q. I have been a member of the American Federation of Herpetoculturists (AFH) for a number of years and have enjoyed reading the various articles presented in your journal. While reading *The Vivarium* I came across references to a number of other publications that appear to contain her-

petological papers of a more technical nature. Can you give me any information about these publications and how I might subscribe to them?

Tulsa, OK

A. There are three national herpetological societies in the USA that publish technical herpetological journals, The American Society of Ichthyologists and Herpetologists (ASIH), The Herpetologists' League, and the Society for the Study of Amphibians and Reptiles (SSAR).

The ASIH was founded in 1913 and is the oldest of the above-mentioned societies. The official publication of the ASIH is *Copeia*. This journal is published quarterly and contains articles pertaining to both ichthyology (the branch of zoology dealing with fishes) and herpetology. Membership information can be obtained by writing to American Society of Ichthyologists and Herpetologists Business Office, Department of Zoology, Southern

Illinois University, Carbondale, Illinois 62901-6501.

The Herpetologists' League was established in 1936 and publishes the quarterly journal, *Herpetologica*. For more information write to The Herpetologists' League, Inc., Department of Biological Sciences, Box 70726, East Tennessee State University, Johnson City, Tennessee 37614-0726.

The third and largest national herpetological society in the USA is the SSAR. This society was actually established as the Ohio Herpetological Society; in 1967 its name was changed to the Society for the Study of Amphibians and Reptiles to provide a more international identity. The SSAR not only publishes the *Journal of Herpetology*, but also publishes a separate quarterly news-journal called *Herpetological Review*. This publication contains articles concerning various biological issues, as well as sections on husbandry, natural history, and geographical distribution. Additional information concerning this society can be obtained by writing to SSAR Treasurer, P.O. Box 626, Hays, Kansas 67601-0626.

All of the journals mentioned above publish peer-reviewed manuscripts of a technical nature dealing with the behavior, conservation, ecology, morphology, physiology, and systematics of amphibians and reptiles.

There are also a number of noteworthy herpetological societies in Europe and Asia, but I can't list them all here in this single column. However, if any readers express an interest in joining a particular international society, other than those mentioned herein, I would be happy to provide information about those organizations in a future column.

Q. Recently, my veterinarian had to amputate about four inches of my green basilisk's (*Basiliscus plumifrons*) tail. Just before having the tail amputated it turned black and crusty. My veterinarian ran a series of diagnostic tests to determine the general health of my animal. Other than the problem with the tail, the lizard was healthy. Any ideas as to what might have caused this?

Canton, OH

A. While it's difficult to know exactly what occurred without having more information about your animal's captive environment, I have seen this condition in several species of tropical lizards and have

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a pretty good idea of what the problem might be.

Often, when lizards shed, pieces of shed skin will remain on the ends of tails and toe tips. If the shed completely encircles the appendage, the blood supply can be restricted or completely cut off as the shed begins to dry. If this occurs, then the result can be as you have described. If you have not already done so, you might examine the remaining portion of the tail and toes of your animal for adhering ringlets of skin.

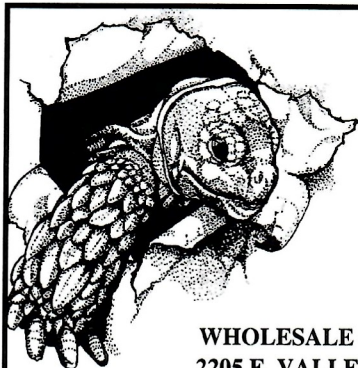
Q. I recently read that the Eastern indigo snake (*Drymarchon corais couperi*) is listed as a threatened species in the state of Florida. Is this the same as being an endangered species?

Jacksonville, FL

A. The state of Florida has three categories of endangered and potentially endangered species. Endangered species are those that are in immediate danger of extinction. Threatened species are those that are thought to be in immediate danger of becoming endangered. The third category, Species of Special Concern, is comprised of species which are thought to be vulnerable.

The Eastern indigo (*Drymarchon corais couperi*) is currently listed by both the State of Florida and the U.S. Fish and Wildlife Service as a Threatened species. At present, the primary threat to this and many other species is habitat destruction. Across much of its range, the indigo utilizes gopher tortoise (*Gopherus polyphemus*) burrows for shelter. Gopher tortoises primarily inhabit high, dry, sandy areas. Unfortunately, these areas are also considered prime real-estate for development in Florida. Gopher tortoises are also considered a prized delicacy in many areas, and their burrows are sometimes

gassed or destroyed in the effort to capture them. Fortunately, gopher tortoises are now listed as a threatened species, which may protect habitat for the indigo. For additional information you can write to the Game and Fresh Water Fish Commission, Farris Bryant Building, Tallahassee, Florida 32399-1600.



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Notes on the General Ecology of *Cryptosporidium* spp.

by
Chris T. McAllister, PhD,
Ronald Lenington, DVM
and Susanne Tucker

In caring for reptiles and amphibians, it should be routine procedure to perform fecal examinations to check for endoparasites. Endoparasites such as roundworms (nematodes) and tapeworms (cestodes) are relatively easy to control with proper medications. However, certain protozoan parasites, such as the coccidia, are not so easily controlled. *Cryptosporidium* is a coccidian parasite of great concern. This article provides information about the organisms' ecology and suggestions for its control.

The Organism

The coccidian *Cryptosporidium* is a minute (4–6 μm (micrometers) = 0.004–0.006 mm) protozoan parasite with oocysts containing four naked sporocysts. It infects the gastrointestinal, respiratory, and biliary systems of various vertebrates. Several species are currently recognized, including *C. muris* Tyzzer, 1907 of rodents, *C. parvum* Tyzzer, 1912 of mammals (and humans), *C. meleagridis* Slavin, 1955 of domestic turkey, *C. baileyi* Current, Upton, and Haynes, 1986 of birds, *C. nasorum* Hoover, Hoerr, Carlton, Hinsman, and Ferguson, 1981 of fishes, and *C. serpentis* Levine, 1981 of reptiles (Upton et al., 1989). It is this latter species that herpers should be concerned about and is the primary topic of this report.

Amphibian and Reptile Hosts

The species originally reported to cause gastritis in snakes was named *C. serpentis* (Levine, 1980) and is truly pathogenic, causing a number of cases of cryptosporidiosis in captive reptiles (Upton et al., 1989). However, based on morphological comparison of oocyst size and shape of several isolates of *Cryptosporidium* from both lizards and snakes, Upton et al. (1989) suggested that multiple unnamed species probably exist in reptiles (Fig. 1). The pathogenicity of these reptilian isolates is not presently known. Further, additional evidence is available that suggest gekkonid isolates of *Cryptosporidium* may represent a species separate from *C. serpentis* since developmental stages were found in the cloaca rather than in the stomach (Upton and Barnard, 1987).

Upton (1990) provided a summary of the species of lower vertebrates infected with *Cryptosporidium* spp. At least 11 species of lizards, 2 species of tortoises, and 28 species of snakes worldwide are reported as hosts (Upton, 1990). Interestingly, only a single amphibian, the leptodactylid ornate horned frog, *Ceratophrys ornata*, from the Toronto Zoo has been previously reported with cryptosporidiosis, and a specific epithet was not designated for this isolate (Crawshaw and Mehren, 1987). Indeed, Upton et al. (1989) were unable to find *Cryptosporidium* in the feces and intestinal contents of over 500 amphibians from Arkansas and Texas. Furthermore, it appears that the overall prevalence of *Cryptosporidium* in amphibians and reptiles is relatively low. Data also suggest that captive reptiles at zoos are more commonly infected with *Cryptosporidium* than are natural populations (Upton, 1990).

Diagnosis

Since the parasite is quite small and easily overlooked on microscopic examination, it is often difficult to diagnose. In addition, hosts may shed small numbers of oocysts in the stool at any given time. The presence of cryptosporidial oocysts can be established by simple direct microscopic examination of fecal wet mounts. Other methods of diagnosis are more costly and time consuming but appear to be more reliable. Rarely, gastric lavage is utilized to obtain gastric mucosal cells for cytologic examination. Concentration and centrifugation of fresh stool specimens with either Sheather's sugar solution (5-lb bag granulated sugar, 1450 ml tap water, 10 ml phenol; Barnard and Upton, 1994), zinc sulfate (33% to saturated), or sodium chloride (36% to saturated) in conjunction with coverslip flotation can be done. Centrifugal sedimentation techniques with formalin ether (modified Ritchie) or formalin ethyl acetate are also used to isolate oocysts. Numerous staining protocols have been utilized to detect oocysts and include modified acid-fast (Henrickson and Pohlenz, 1981; Current, 1990) and dimethyl sulfoxide-carbol fuchsin stains (Pohjola et al., 1984). A useful procedure for staining oocysts with auramine-O fluorochrome dye is provided by Heuschele et al. (1986). Acridine orange fluorescent staining has been used to detect *Cryptosporidium* species (Ma and Soave, 1983) as well as auramine-rhodamine

(Payne et al., 1984) and auramine-carbol fuchsin (Casemore et al., 1984). A further specialized technique uses a monoclonal anti-cryptosporidial-labeled antibody that binds to the wall of the oocyst. A commercial detection kit is available and marketed as Merifluor (Meridian Diagnostics, Inc., 3471 River Hills Drive, Cincinnati, Ohio 45244). This procedure visualizes a reaction with the aid of fluorescence microscopy. However, it is not known whether these kits will show reaction with reptile *Cryptosporidium*.

Life Cycle

The life cycle of *Cryptosporidium* is similar to other coccidia and is shown in Fig. 2. The parasite is homoxenous (utilizes only one host) and capable of recycling with the host (Current and Reese, 1986). Sporulated oocysts (those with infective sporozoites) are shed in the feces of an infected host and through contamination are ingested by other suitable hosts. Development is in three distinct phases: merogony (also called schizogony or asexual formation of merozoites by multiple fission), gamogony (sexual reproduction leading to formation of gametocytes), and sporogony (oocyst wall and sporozoite formation). About 4 days are required for completion of the entire life cycle (Current and Reese, 1986).

Transmission

Transmission of *Cryptosporidium* is by oral ingestion of infective oocysts in the environment. The parasite is rapidly becoming a public health concern and has been common in the groundwater of many areas of the country (Madore et al., 1987). Infection by *Cryptosporidium* in immunocompetent human hosts is self-limiting and appears to result in resistance to reinfection. However, this has not been proven in reptiles with *C. serpentis*. Further, the mere presence of *C. serpentis* in a reptile does not necessarily mean the animal will become sick.

The original notion "via infected prey" mode of transmission of Funk (1987) that infected rodents might serve as reservoir hosts and then transfer the parasite by feeding prey to captive reptiles in a zoo or personal collection has been largely disproven. A study by Tilley et al. (1990) suggested that food items such as laboratory mice do not appear to be capable of transmitting infections to susceptible reptilian hosts and that significant differences

Oocysts of *CRYPTOSPORIDIUM* spp from reptiles

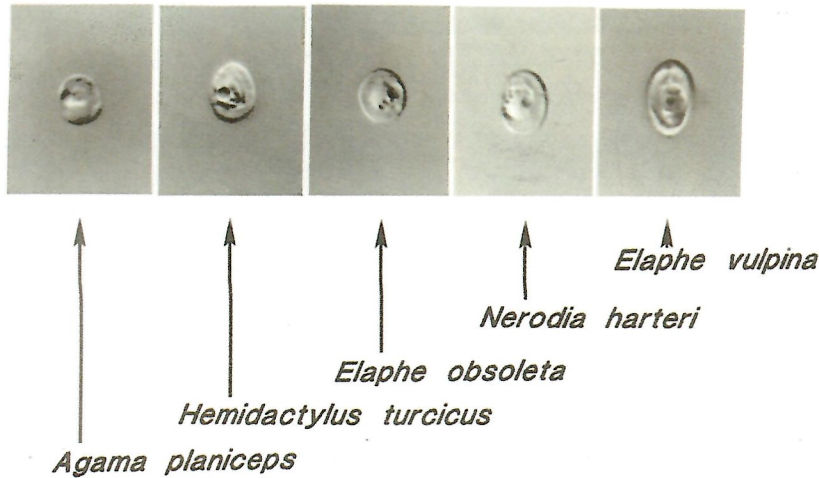


Figure 1. Nomarski interference-contrast photomicrographs of oocysts of isolates of *Cryptosporidium* spp. from the feces of various reptiles. Photo by S. J. Upton.

Life cycle of *Cryptosporidium*

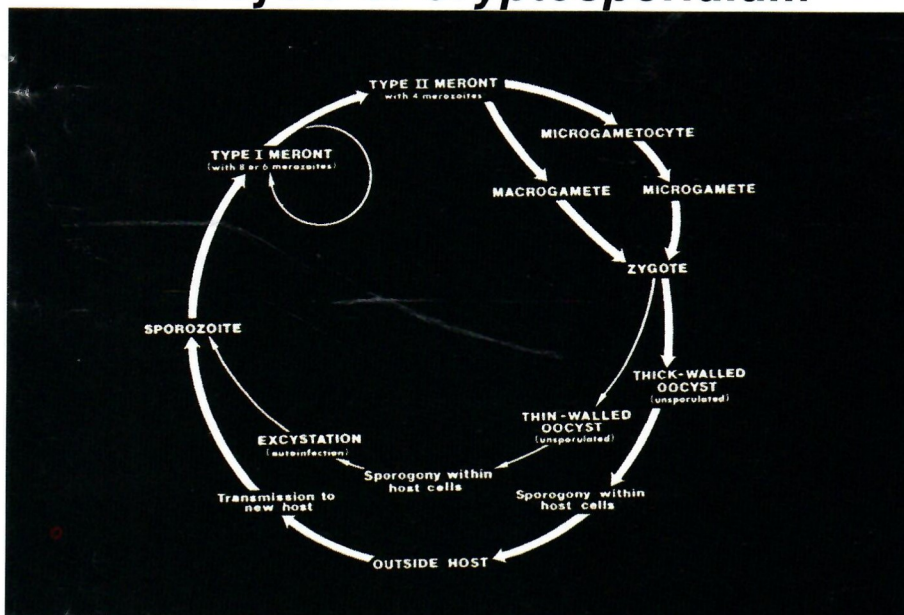


Figure 2. Generalized life cycle of *Cryptosporidium*. Adapted from Current and Long (1983).

exist between *C. serpentis* of reptiles and *C. parvum* of rodents. In addition, most recently, Fayer et al. (1995) demonstrated that it was unlikely that *C. serpentis* transmission to snakes "via infected prey" results when captive snakes are maintained on a diet of BALB/c mice.

Clinical Cryptosporidiosis in Reptiles

The parasite develops directly under the surface membranes of epithelial cells, projecting into the lumen of the stomach, intestinal tract, and cloaca (Fayer and Ungar, 1986). *Cryptosporidium serpentis* is known to infect the gastric mucosa of testudinids, chelonids, varanids, boids, colubrids, elapids, and viperids (see Upton

et al., 1989; Upton, 1990). Reptiles with moderate to severe cryptosporidiosis present with a suite of symptoms, including anorexia, bronchopneumonia, gastritis, lethargy, midbody swelling, progressive weight loss, and regurgitation of undigested prey (Brownstein et al., 1977; McKenzie et al., 1978; Frye, 1991; Heuschele et al., 1986; Marcus, 1981; Upton, 1990; Upton and Banard, 1987; Upton et al., 1989; Boylan et al., 1985; Dillehay et al., 1986; Godshalk et al., 1986).

Treatment

To date, no known effective antimicrobial therapy has been reported for the parasite (Fayer and Unger, 1986). An attempt to treat cryptosporidiosis in a black rat snake with gentamicin and sulfamethazine was unsuccessful (Szabo and Moore, 1984). In addition, Norton and Jacobson (1989) and Mirtschin and Ormerod (1990) reported the use of trimethoprim-sulfadiazide (DiTrim™; Tribissen®) and erythromycin trimethoprim-sulfamethazole (Bactrim®) therapeutics, respectively. However, these drugs are largely ineffective in the treatment of cryptosporidiosis and may even be toxic (Barnard and Upton, 1994). In reptiles, supportive care with oral hydration and tube feedings is the primary therapeutic intervention. Moreover, there are no vaccines for either animals or humans for the prevention of cryptosporidiosis.

Control

Obviously, control requires elimination of oocysts in the environment in which reptiles are kept. Transmission may be reduced or prevented by lessening the potential from contaminated soil, water, and food items. For herpers, avoidance of contact with infected material is most important. Precautions include handwashing, use of gloves and gowns, and strict quarantining or euthanizing infected animals. All contaminated materials should be autoclaved as commercial disinfectants have been found to be largely ineffective in killing oocysts of *Cryptosporidium* spp. (Campbell et al., 1982). All incoming reptiles should be individually housed and isolated from the rest of the collection prior to introduction. Screening for *Cryptosporidium* should be done several times over the period of isolation. Other procedures for quarantine and care should follow the suggestions of Murphy and Campbell (1987).

Conclusion

Cryptosporidium serpentis is a taxon distinct from other *Cryptosporidium* species. As such, *C. serpentis* does not infect laboratory mouse colonies, and the screening of rodents for feeding to reptiles by zoos/collectors is unnecessary. However, *C. serpentis* is a potentially pathogenic coccidian that can infect a variety of reptilian hosts, mostly in zoo collections and rarely in wild-caught reptiles. Unfortunately, if a reptile or part of a collection is infected with cryptosporidiosis, herpers may be faced with a tough decision, that of euthanasia.

Glossary

- type I meronts—asexual stage of some protozoa that undergoes merogony.
- type II meronts—with 4 merozoites.
- macrogametes—large, often non-motile reproductive cells, synonymous with ovum in metazoa.
- microgametes—male-like reproductive cells, smaller, synonymous with sperm in metazoa.
- sporozoite—infective stage that undergoes asexual reproduction in a host.
- zygote—fertilized diploid cell produced by union of two haploid gametes.
- sporogony—formation of sporocysts and sporozoites in members of the phylum Apicomplexa; multiple fission of a zygote.
- Merogony—also called schizogony; formation of merozoites by multiple fission.
- microgamont—a gamont that will eventually produce microgametes.
- microgametocyte—synonym of a microgamont.

Acknowledgments

We thank Dr. Steve J. Upton, Kansas State University, for critically reviewing this manuscript, and Mark Bayless for helpful comments. The senior author also thanks Dr. Upton for inspiring him to work on reptilian cryptosporidiosis.

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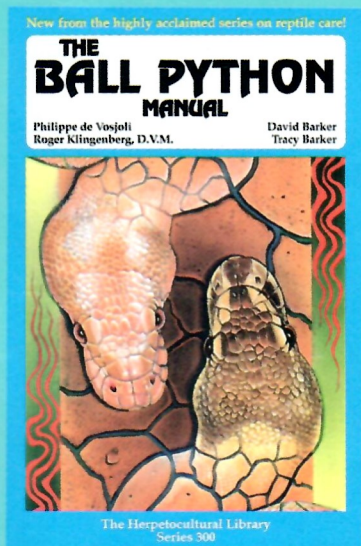
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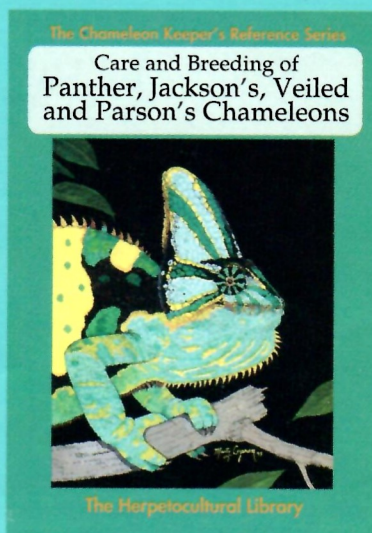


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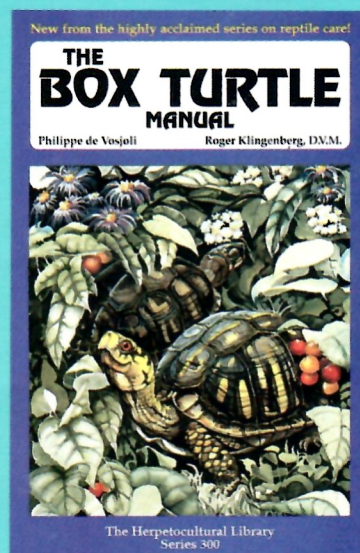
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How to Establish Ornate Uromastyx

by
Philippe de Vosjoli

This is a new column for *The Vivarium*; writers should follow the general format of this article for future submissions. The goal of the column is to provide, in a condensed no-nonsense format, guidelines for establishing imported and wild-collected animals in captivity. Breeding will not be covered in this column except in the most general manner.

The Ornate Uromastyx *Uromastyx ocellatus ornatus* Heyden, 1827

Common name: Ornate uromastyx

Scientific name: *Uromastyx ocellatus ornatus*; on price lists this species is usually listed as *Uromastyx ornatus*.

Distribution: Northwestern Saudi Arabia, eastern Egypt, Israel, and possibly Syria (Leviton et al., 1992).

Size: Up to 13 in (32.5cm) in total length for males; females are under 10 in (25cm).

Sexing: This species is sexually dimorphic in both size and coloration. Adult males are more brightly colored than females, bearing bright blue or bright greenish yellow head and dorsal background coloration, with pale yellow to lemon yellow crossbands and varying amounts of red. They rank among the most brightly colored of the lizards. Females are patterned like males, but in shades of tan, yellowish tan, yellowish brown, and brown. The heads of males are proportionately wider than those of females, apparently as a result of greater development of the masseter muscles. The femoral pores in males are markedly more developed than in females. During the breeding season (in the spring), males produce waxy femoral pore secretions that may extend up to $\frac{1}{4}$ in (7mm) from the pores, giving the impression of a fringe of elongated scales.

Availability: Ornate uromastyx are available primarily as imported animals from Egypt. At the time of this writing, claims of captive-bred and captive-hatched juveniles

are questionable. Most commercially sold hatchlings are wild-collected imports; a small number are captive-hatched from eggs obtained from gravid imported females.

Rating as captives: These lizards are best left to the more experienced herpetoculturist. They are relatively easy to maintain if deparasitizing and hydration are performed, and the proper lighting, heat, and diet are offered. If these requirements are not provided, these lizards are notoriously difficult to keep alive, even on a short-term basis.

Selection: If the animals are initially healthy, ornate uromastyx of all sizes eventually adapt to captivity. Hatchlings and juveniles are more difficult to treat for parasites or for other diseases. They are also more likely to develop problems (such as metabolic bone disease) if they are not fed and maintained properly.

Selecting potentially healthy animals: Healthy ornate uromastyx are alert and give a definite impression of muscular vigor when picked up. Any limp, inactive animals should be avoided. Animals which



Male ornate uromastyx rank among the most beautiful of the lizards. Although imported in large numbers, protocols for long-term maintenance have yet to be established. Photo by Jim Bridges and Bob Prince.

do not fully open their eyes should be avoided. The body contour should be rounded. The outlines of the hips and backbone should not be visible. When picked up and turned upside down, the tail should appear rounded. Ill or thin animals demonstrate loss of tail fat, visible as two collapsed strips or areas along the ventral side of the tail. In very thin animals the outlines of the dorsal and caudal spine is visible. Examine the vent area. Smearing of wet feces or dried fecal smears are a reliable indicator of probable *Entamoeba* infection. Unfortunately, this is common in certain groups of imported animals. Animals with any of the above signs should be avoided unless one is willing to take the risks associated with the treatment of these diseases.

Quarantine: Any newly purchased uromastyx should be quarantined for 60 to 90 days before being maintained near or with established animals. During that time an animal should be checked for parasites, treated for any diseases, monitored, and allowed to acclimate to captivity.

Number of animals per enclosure: Ornate uromastyx kept indoors seldom demonstrate much intraspecies aggression. However, under high ultraviolet-light conditions combined with high heat, or if they are kept outdoors, the usual uromastyx patterns of behavior becomes apparent; adult males are intolerant of each other and may fight and bite each other when they are kept together, particularly during the breeding season (in spring and early summer). Females may also demonstrate signs of aggression. Biting in the area just behind the arm pit is a common aggressive or territorial behavior. In animals just becoming sexually mature, tail biting has been observed, but the author has not noticed this in adults. The bright coloration of male *U. ornatus* suggests that males of this species are probably quite aggressive, at least during the breeding season. In the wild, adult males apparently are intolerant of each other. For the above reason, keeping these uromastyx in sexual pairs or in groups of one male with two females is recommended. Whatever you do, you should monitor your animals closely and segregate them in breeding groups or singly, depending on the aggression patterns observed.

Basic Husbandry Protocols

Enclosures: Minimum size for hatchlings is a 20-gallon (76 liters), long (30 in. [76 cm]), all-glass vivarium with a screen top, preferably larger. Minimum size for subadults and adults is a standard 55-gallon (209 liters) vivarium (48 in. [122 cm] long), preferably larger. Smaller enclosures do not provide the minimum standards for



These lizards as adults are primarily vegetarian although they also relish insects. The latter should make up no more than 15% of the diet. Too much protein in the diet and possibly too much dietary vitamin D3 may cause irreversible kidney damage. Photo by Chris Wood.



This enclosure designed for keeping the Egyptian uromastyx (*Uromastyx aegyptius*) indoors displays the large space, intense spotlights, high UVB full spectrum bulbs and BL type blacklights recommended for successfully keeping lizards of this genus indoors. Photo by Val Brinkerhoff.

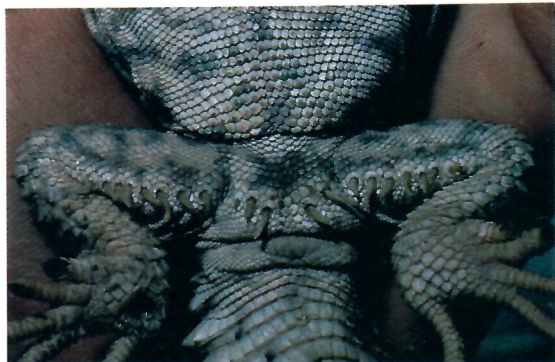
a high quality of life, notably because of lack of space for normal activity.

Substrate: For all imports the substrate should initially be newspaper. This allows you to monitor the feces, a critical consideration when keeping this species. Once the stools appear formed, firm, and with little moisture ring formation on the newspaper from absorbed and spreading liquid components, then the animals can be transferred to an alternative substrate. This should be a medium-grade pea gravel, sand such as a decomposed granite (not silica if possible), or alfalfa pellets. In the author's experience pea gravel is preferable for this rocky-habitat species. It causes some wear of nails and is also coarse enough that it is not ingested. Alfalfa pellets work fine and

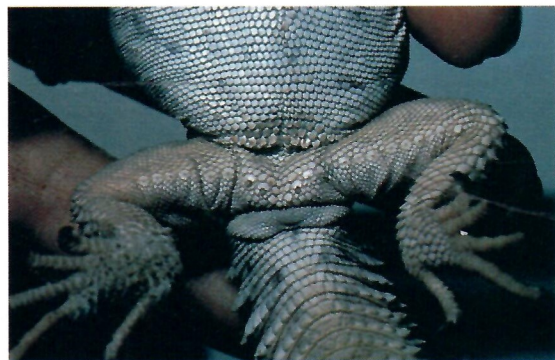
may be eaten, but over time this substrate generates a brown dust as a result of digging activity. Sand can be problematical with this species, although it has been used successfully by a number of herpetoculturists. One risk of using sand is sand impaction in juveniles from ingesting sand-covered food items. The digging tendency of this species and other uromastyx, as well as a habit of moving food items through front leg activity while eating, make the coating of food items with sand highly probable, even when the food is offered in a feeding dish. The author has autopsied juvenile *U. benti* which apparently died from sand impaction. Avoiding sand should be a consideration with small specimens of all *Uromastyx* species. Another problem with

silica sand specifically is the risk of silicosis of the lungs as a result of inhalation of silica dust. *Uromastix* are such active diggers that silica dust inhalation is definitely a potential risk.

Landscaping: Shelters and basking areas should be added to the enclosure; these can be made of shaped or molded concrete, cork bark sections, stacked rocks, and thick, wide sections of freshwater driftwood. The shelters should lie a significant



Male ornate uromastix, besides having brighter coloration and broader jowls, can be distinguished from females by their enlarged femoral pores and almost comb-like femoral pore secretions. The latter are particularly pronounced during the breeding season. Photo by Chris Wood.



Female ornate uromastix have smaller femoral pores. Photo by Chris Wood.

distance from the basking areas. Rocks can be used for designing topographical diversity. In addition, stacked rocks can be placed under the basking light to create one more basking site, depending on the number of animals in the enclosure.

Plants: In large enclosures, plants whose foliage is out of reach of these lizards can be added to a vivarium, e.g., some of the yuccas and pony-tailed palms. The thick cylindrical-leaved snakeplants, e.g., *Sansevieria cylindrica* or *S. pearsoni*, could also be tried in the more shaded areas of the enclosure.

Heating: Spotlights in reflector-type fixtures are recommended as an indoor heat source for these animals. The spotlights should be placed above the tops of the screen enclosure and away from any flammable materials or walls, and directed to-

ward the basking site. The wattage required varies, depending on enclosure size, but 75-watt spotlights work well with standard 20-gallon (76 liter) vivaria and 100 to 150-watt spotlights work well with 55-gallon vivaria. The temperature at the basking site closest to the spotlight should measure 100 to 110°F, so be sure to adjust the wattage accordingly. *These high daytime temperatures are critical for keeping uromastix healthy on a long-term basis. Although they may eat and appear to do well at lower temperatures, other problems, such as metabolic bone disease, may develop after a period of time at low temperatures.* A light dimmer can be used to adjust the heat at various times of the year. Ceramic infrared bulbs also work well as a heat source. Select a wattage that generates the high heat levels required for this species. A rheostat or pulse-proportional thermostat can be used to control basking site temperatures.

Lighting: In addition to lights used for heating, these lizards should be provided with two double-bulb fluorescent fixtures with one BL-type blacklight and three full-spectrum bulbs, such as some of the more efficient UV-generating full-spectrum bulbs on the market (e.g., Philips Chromacolor or UV-B 310 bulbs by Zoo Med®). They should be located within 8 inches of a basking site. This kind of lighting is a requirement for long-term success with indoor maintenance.

Photoperiod: Lights and heaters should be set on timers. During spring through fall the photoperiod should be 14 hours of light with 10 hours of darkness. During the winter the photoperiod should be reversed, with 10 hours of light and 14 hours of darkness. Although there is little information on indoor captive breeding of this species, following a standard protocol—with winter prebreeding conditioning consisting of a reduced photoperiod, with night temperature drops in the low-to mid-60s °F (16-18°C) and a daytime drop in temperature averaging 10 to 15°F—will probably lead to success.

Monitoring equipment: A digital thermometer with an external probe should be used to monitor basking and vivarium temperatures. The spotlight(s) or ceramic incandescent lights can also be set up on a thermostat, of either the on/off type or a pulse-proportional thermostat. The pro-

grammable day/night thermostats by Helix Controls are an excellent choice for temperature control. The lights and heat should be on a timer. The photoperiod should be 14 hours of daylight with 10 hours of darkness, from March through November or December. It should be reversed to 10 hours of daylight to 14 hours of darkness from December through February.

Smoke detector: Always have a smoke detector in any room where you are keeping reptiles. Note: If you have cats, dogs, or other animals loose in your house, do not allow them access to any room containing reptiles. Many fires have been started and valuable property lost from household pets knocking over heat lamps.

Acclimation: Parasite treatment of imported animals is critical for the survival of *U. ornatus* in captivity, particularly if the animals have watery feces—a sign of amoebiasis which can be common in certain groups of imports. Ideally, a qualified veterinarian should perform a fecal exam on all imported animals and provide treatment as needed. However, some protozoa and nematodes appear to be part of the normal intestinal flora of these lizards; thus, parasite treatment should focus primarily on certain protozoans such as *Entamoeba* and coccidia. A primary cause of death in imported animals appears to be *Entamoeba* combined with nematodes, leading to an associated secondary septicemia (Matthew Moyle, pers. comm.) If you cannot afford a veterinary exam, an alternative method of assessing possible internal parasite problems is as follows: if your lizard has runny stools, is listless and is losing weight, then it very likely has a parasite problem that needs to be treated. Failure to treat a lizard with watery stools usually results in the death of the animal. A uromastix that has normal-appearing feces but is losing weight may have an unusually high nematode count. A folk method for treating intestinal nematodes appears to work with uromastix: a small amount of garlic powder sprinkled on the food every 1 to 2 weeks can help keep nematode levels down and help a uromastix gain weight.

Rehydration of imported and parasitized animals: There is a myth about water being detrimental to *Uromastix*. Unfortunately, not providing adequate water probably contributes to the death of imports, especially if they are parasitized. In particular, *Entamoeba* causes serious dehydration. It is highly recommended that imports be rehydrated by soaking them in a pan of shallow (half the height of an animal at rest) water for approximately 10 minutes daily. If the uromastix have watery stools,

they should be rehydrated through oral administration of water or electrolyte solution such as Pedialite®. Any weakened, parasitized uromastix can be helped by being rehydrated through injection of an electrolyte solution by a veterinarian. Long-term dehydration can lead to kidney damage, which in turn can lead to other serious and fatal diseases.

Diet: This is certainly one of the most critical factors for successfully keeping *U. ornatus* on a long-term basis. It is also an area which will require adjustment and improvement until a dietary protocol for long-term maintenance and breeding is determined.

Basic diet: Greens, shredded or chopped. Use high-calcium greens such as kale, mustard greens, dandelion, mulberry leaves, hibiscus leaves and flowers. Romaine lettuce will work if it is lightly powdered with calcium carbonate. Greens should make up about 50% of the diet.

Vegetables and legumes: *Uromastix ornatus* appear to like leguminous plants, notably green beans, peas, lima beans, and other vegetables; they often reject cooked carrot and corn (although they will eat these raw or grated). Mixed grated and chopped vegetables should make up 40 to

45% of the diet of adults and 30% of the diet of immature animals. Do not overdo leguminous plants. If flowers are available such as mustard, dandelion, nasturtium, or hibiscus, offer them to your lizards. Strive toward variety in the diet; this is the best way to prevent deficiencies or excesses of dietary requirements.

Bird seed and dried legumes: *Uromastix o. ornatus* and *U. aegyptius* will take dried legumes such as split peas and lentils, as well as bird seed such as millet.

Insects: Ornate uromastix relish gray crickets, king mealworms, and waxworms. The crickets and mealworms should be fed a high-quality diet prior to offering them to uromastix; the insect diet should include high-calcium greens, grated carrots, and vegetables, sliced oranges, ground grains, baby cereal flakes, and ground rodent chow. Insects should make up no more than 20% of the diet of immature animals and only 5 to 10% of the diet of adults. As with other herbivorous reptiles, excessive protein may cause gout and/or kidney damage, which will eventually kill your animal(s).

Commercial diets: Dry commercial iguana diets have been tried on uromastix with a degree of success. Research will be necessary to determine whether iguana diets will be suitable long-term for uromastix. If commercial iguana diets are

used, they should only make up a small percentage of the diet because uromastix need fresh greens and vegetables as a source of water (iguanas are provided water in pans when they are maintained on dry commercial diets). Some keepers have mentioned that certain commercial iguana diets cause a caking along the edge of the mouth. Switching to low-sugar commercial diets will usually remedy this situation. Reed's and Pretty Pets iguana foods are two brands often mentioned by keepers of uromastix.

Supplementation: There are two alternatives to supplementation. If the animals are exposed to sunlight for at least 12 hours a week and are fed a variety of foods, then supplement (lightly sprinkle) the diet with a mixture consisting of one part calcium carbonate, one part brewer's yeast, twice a week for immature animals and once a week for adults. Feed your animals a varied diet and they will obtain all the necessary vitamins from their food. Vitamin D₃ will be synthesized as needed through exposure to sunlight. Animals kept indoors under the lighting regimen mentioned above (UV-B 310 bulbs, etc.) should be supplemented with a mixture consisting of one part calcium carbonate, one part Herptivite®, and one part Brewer's yeast, twice a week for immature animals and once a week for adults. This mixture can be sprinkled lightly over a dish of plant mate-

Continued on page 52



Shelters, basking areas and stacked rocks or rounded rocks are important for maintaining this saxicolous species. Photo by William B. Love.

Captive Care and Breeding of the Emerald Tree Boa, *Corallus caninus*

by
Okan Güney

Introduction

The emerald tree boa *Corallus caninus* is indigenous to the tropical rainforests of the Amazon Basin of Peru, Ecuador, Brazil, Bolivia and the Guianas (Dixon and Soini, 1986; Mehrtens, 1987). It is highly arboreal, rarely venturing to the ground, and nocturnal, spending the day draped over a branch in its characteristic manner, and nights hunting for birds and small mammals. The adult boa is, as its name implies, a brilliant green color; the leaf green dorsal scales are accentuated by the white diamond-shaped pattern along its vertebral ridge and the ventral coloration ranges from cream to yellow, depending on the individual and its geographic origin. *Corallus caninus* is ovoviviparous, giving birth to 2–15 young at a time.

These vary in color from brick-red to orange and brown. The young go through an ontogenetic color change until becoming mostly green at about one year of age.

Captive Conditions

The author maintains six emerald tree boas: two adult females, two adult males and a pair of yearlings. The snakes are housed in tall vivaria with high branches. Each adult female is housed in vivaria measuring 24" × 18" × 24" (61 × 46 × 61 cm), and each adult male in slightly smaller vivaria of 18" × 15" × 22" (46 × 38 × 56 cm). The vivaria are sparsely decorated with branches and artificial foliage, thus giving the animal some sense of security. To ease cleaning, newspaper is used as a substrate. All the vivaria are controlled with Vivguards® (digital thermoregulatory device manufactured by Microclimate®), and are heated with infra-red ceramic elements. Daytime temperatures vary from a low of 79°F to a high of 86°F (26–30°C). It has been observed that the

snakes seek out a temperature of 83°F (28°C) in which to bask most of the day. At night the temperature is allowed to drop to 70°F (21°C).

No artificial lighting is provided, and illumination varies according to seasonal light fluctuations in Oxford, England. The emerald tree boa requires an environment with high humidity. Within the vivaria this fluctuates between 65% and 75%. This is accomplished simply by placing a ceramic water bowl on a heatmat. The humidity is further controlled by changing the amount of ventilation. Prior to shedding, the humidity is increased to 75–85%. At this level the snake will generally shed its skin in one piece, whereas at lower humidity levels, shedding problems have occurred which then required manual removal of the skin, normally around the head and especially over the eyes. Drinking water is provided by hanging water containers near their basking sites.



Adult female emerald tree boa *Corallus caninus*. Photo by C. M. Garrett.



A newly born *c. caninus* showing juvenile colors. Photo by author.

All the boas are fed small meals, usually a small to medium sized defrosted rat, once every two weeks. Using long forceps, the food item is presented right up to the nose of the snake. The snake will then normally just open its mouth and gently take the prey item off the forceps.

The emerald tree boa is a sedentary animal and defecation is not frequent, therefore, feeding is monitored so as not to over-feed them between each defecation. Over-feeding can result in intestinal impactions and internal complications. However, this problem is easily prevented by placing the snakes in a bath of luke-warm water, where they will invariably defecate.

Very few feeding problems (which are sometimes associated with this species) have occurred. If animals are proving a little difficult to feed, they can be encouraged by pinching them on the underside, which may annoy them sufficiently to elicit a strike. Males have been observed to fast for a while. Although this is not a cause for concern with a healthy animal, and is believed to be quite normal behavior, it is usually overcome by offering an alternate food item.

The aforementioned conditions are maintained throughout the year, except during preparation for, and through the breeding season. Careful records are kept

of noteworthy behavior (i.e., feeding, shedding, and defecation).

Conditioning for Breeding

Three months prior to the cooling-off period, the females were fed weekly in order that they gain sufficient bodyweight to sustain several months of fasting while gravid. The feeding frequency of the males remained biweekly. Excess weight gained by overfeeding the males seems both detrimental to their health and to their breeding activity.

In late November, the cooling period began. The daytime high temperature was maintained, but the nighttime low temperature was gradually dropped to 68°F (20°C) over a period of four weeks. On colder nights a low temperature of 65°F (18°C) was recorded. This decrease in temperature caused an increase in humidity (80–85%) which seemed to further encourage breeding attempts. Throughout this period the feeding regimen remained normal.

Breeding

In January the male snakes were paired with the females. The male of the first pair, upon introduction to the female, immediately encircled her and attempted to stimulate her with his spurs. At the same time he was trying to align his tail with hers to bring their cloacae together. Within a short time, the female became re-



Adult female A in resting coil. Photo by author.



Close-up head shot of adult female A. *Photo by author.*

ceptive to the male by everting her cloaca and elevating her tail. The male immediately wrapped his tail tightly around the female's cloaca. In the first week, several matings were observed. Copulation lasted from just a few minutes to up to two hours. In the subsequent weeks the matings were less frequent, and the female seemed to gradually become less receptive to the advances of the male.

With the second pair, similar courtship behavior by the male was observed, but the female showed no initial signs of being receptive. In the second week several matings were observed, and matings increased in frequency over the next few weeks. During this period the males were separated from the females on two occasions for feeding. The females accepted food readily, but the males were less interested. Several days following, both males

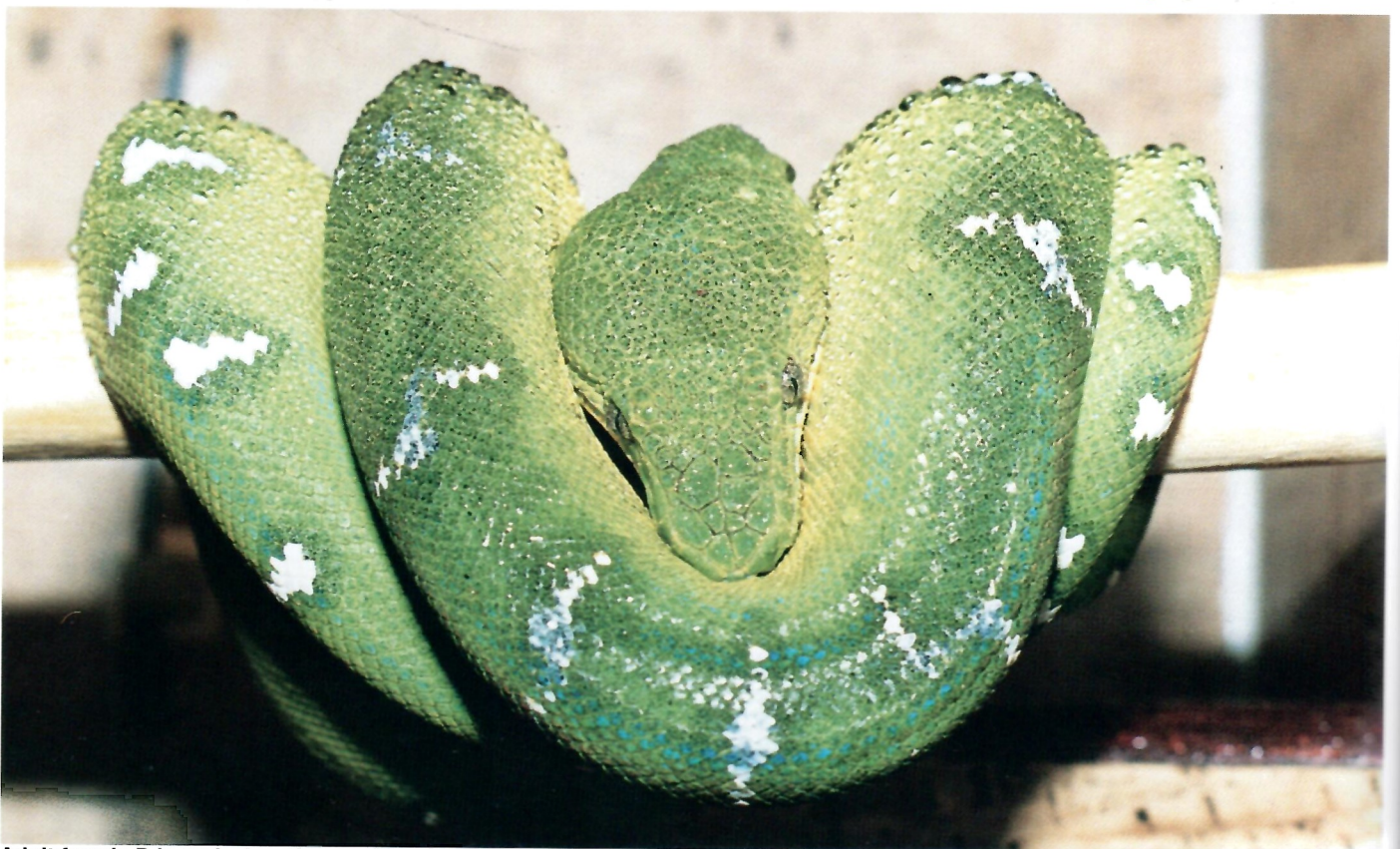
were placed together with a single female to establish if male combat would occur, and to determine if this would stimulate the female. No male combat was apparent and no sexual activity was observed. The males were then placed back with their respective partners.

Toward the end of February, sexual activity in both pairs seemed to have ceased. The decision was made to separate them



Unfertilized ova produced by female B. *Photo by author.*

once again for feeding, and to swap the males around hoping for renewed sexual activity. Several matings of both pair combinations were observed. In the last week of March the females became irritable and restless, possibly searching for a warm spot to gestate. At this point, the nighttime low temperature was increased, and over a period of two weeks normal temperatures



Adult female B in typical resting position. *Photo by author.*

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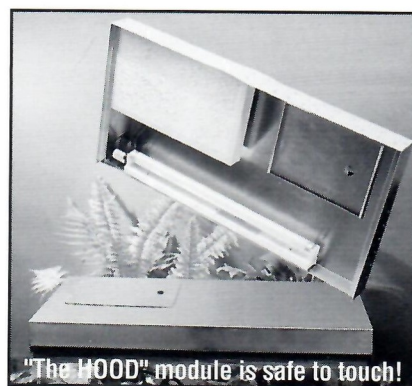
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were established. The males were removed, and they resumed feeding within one week of being separated. The temperature in the females' vivaria was increased to a daytime high of approximately 88°F (31°C). Nighttime temperatures were 83°F (28°C). Following the increase in temperature, both females resumed feeding.

The First Signs

In the first week of May, the two females (referred to as A and B) were offered food, but refused to eat. This behavior was possibly the first sign of their being gravid. Both females shed their skins within a week of each other. Food was offered after shedding. After much persuasion, female A fed, but female B refused to eat.

Throughout the month of June, the females were presented with food on several occasions. Food items were varied, and different methods were employed to entice them to feed, all to no avail. Female A retreated and ignored the prey, and female B showed signs of aggression. Early in July, a great increase in girth was obvious in female A, and she was spending more time near the heat source (ca. 89°F [31°C]). I was now confident that she was gravid. Female B had not shown any of these signs and still refused to feed. For the following two months, there was little change in the appearance and behavior of the snakes. All nocturnal activity had ceased by this time. Female A showed a further increase in girth and the interstitial skin was plainly visible. Female B showed little sign of being gravid, except for her refusal to eat. No further attempts were made to feed female A, and by the first week in September, she began to spend more time on the lower branches where the temperatures were cooler. Over the next two weeks it was noticed that the area around the cloaca was greatly swollen, indicating that the unborn young had moved to a more posterior position in the

oviduct. The gravid female A seemed a little restless, possibly looking for a place suitable for giving birth.

The Birth

In the last week of September, after a gestation period of approximately 7 months, I noticed a single baby "emerald" climbing on the branches. Within a few minutes female A had given birth to several more, and after half an hour, the vivarium was so overrun with babies it was hard to count them. Throughout parturition, contractions of the female's body made the babies traveling down the oviduct clearly visible. After approximately one hour, the last snake was born. Thirteen babies were born, and close inspection showed that all were perfectly formed. Eleven of them appeared healthy but two showed no signs of life. The babies were removed from the females vivarium and placed temporarily in an aquarium with a substrate of damp matting, and heated with a heatpad and overhead lighting. At birth, the babies weighed an average of 1.32 oz (37.5 g) and measured approximately 16" (41 cm) TL.

The following week, female B discharged six unfertilized ova. Within two weeks of giving birth, both females resumed feeding.

Husbandry of the Neonates

Shortly after birth, babies were housed individually in the large glass jars with a small twig and a little artificial foliage. The jars were capped with a plastic mesh to provide adequate ventilation. A little water was put into the jars which increased humidity to 70%. The two apparently lifeless babies were placed in a small ventilated plastic shoe box, with damp paper toweling as substrate. All of the containers were then placed in a large vivarium where the temperature was maintained at a maximum of 83°F (28°C). After a few hours all the neonates had settled down and assumed their characteristic resting position, with coils draped

over the branch, and the head resting on top. The following day, while checking the babies, one of the previously assumed stillborn babies was found alive, and subsequently transferred to a glass jar. The other neonate showed no signs of life and was removed from the vivarium. During the next 11 to 16 days, all twelve neonates shed their skin without complications. In preparation for feeding, each individual was moved from its jar into a specially prepared small vivarium.

In the wild, *C. caninus* feed on small birds and lizards. Neonates were offered defrosted, two-week-old mice that had been scented with a freshly killed bird. Snakes were gently tapped on the nose with the prey item to illicit a strike. The snakes struck, but were hesitant to coil around and consume the prey. After 14 hours, six young had accepted food.

Neonates not accepting scented rodents were offered small lizards, which were left in their jars overnight. This proved unsuccessful. The following night, the neonates were offered freshly killed lizards, but to no avail. Three of the six remaining young accepted defrosted mice over the next few days. The remaining 3 babies accepted live fuzzy mice.

After two months, all the babies were healthy and had established a satisfactory feeding pattern. I kept two babies which I believed to be females. However, when sexing them at one year of age, one proved to be female and the other male.

The two young boas are housed in small vivaria measuring 12" x 15" x 15" (30 x 38 x 38 cm), controlled and heated in a similar fashion to the adults. The temperature is not allowed to go above 83°F (28°C). The juvenile snakes are fed weekly with an appropriately sized mouse. Regular shedding of their skin has occurred every two months. A few shedding problems were encountered at first, but as the juveniles grew there were no further problems. The juveniles, at 16 months of age, weighed 8.25 oz (235 g) and 9 oz (255 g) and measure 36 in (91.5 cm) and 36.5 in (93 cm) TL, respectively.

Color Changes

During their first year, emerald tree boas go through an ontogenetic color change from their juvenile colors to the adult green. At birth all the neonates were brick-red with green speckling, and distinctive white dorsal markings. They remained this color for at least two months. Gradually, as the snakes grew, the green blotches spread and the red began to fade. Between 5 and 6 months of age, the scales of the snakes took on a golden-yellow tint, obscuring the patterns and colors beneath.



At 8 months of age this juvenile has lost most of its orange pigment, and is approaching the adult color of predominantly green. *Photo by author.*

By the time they were 8 months old, most of the scales had turned lime green with just the neck and head remaining mostly red. The black that borders the white dorsal markings had faded to a deep green. The last scales to turn green were the ones on the head, and by the time the snakes reached one year of age they were almost completely green. The snakes are green at 16 months of age, but paler than the adults. It will take many months before they reach their deep emerald green coloration.

Conclusion

In the following winter of 1994, the emerald tree boas bred again and shortly afterwards both were confirmed to be gravid. Late August 1995, Female A gave birth to 19 babies of which 2 were still-born and in early September, Female B gave birth to 3 babies of which 1 was still-born and 13 unfertilized ovum. To date all neonates are doing well and most of them have fed.

The emerald tree boa has been considered difficult to keep and rear in captivity. However, this species can be kept successfully if attention is paid to critical factors such as temperature, humidity and ventilation. Emerald tree boas are prone to respiratory problems. Early symptoms may include: wheezing, gaping of the mouth,

fluid in the nostrils and excess fluid in the mouth. Proper hydration and temperatures will help prevent these problems.

An important factor in the successful breeding of this specie, is the simulation of key elements of their environment. Many specimens caught in the wild for the pet trade have difficulty adapting to captive conditions, and as a result many fatalities occur. In hopes of reducing the demand for imported specimens, captive breeding of this snake is encouraged. If this article helps other enthusiasts achieve greater success with this species, then I feel I may have made a small contribution to the conservation of this beautiful snake, the emerald tree boa.

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Keeping and Breeding the Argentine Black and White Tegu, *Tupinambis teguixin*

by
Bert Langerwerf

In 1985, I moved my large-scale lizard breeding operations from Holland to the Canary Islands, off Spain. Then, in 1988, I was selected to direct the breeding operations of Agama International, Inc. in Montevallo, Alabama. In 1989, I received my first group of Argentine black and white tegus (*Tupinambis teguixin*). Comparing the temperate climate in Argentina with the climate in Alabama, where I now live, I felt that Argentine tegus could be kept and bred here outdoors. The key would be to design large outdoor terraria in such a way that the microclimate would be similar to the one found where these lizards naturally occur (see Tables 1 and 2).

According to Dr. J. M. Cei (1986), the Argentine black and white tegu is wide ranging in Argentina. It occurs in

Misiones, Corrientes, Entre Rios, Santa Fe, the province of Buenos Aires, and in Cordoba in Rio Cuarto where it is partially sympatric with the red tegu (*T. rufescens*), the latter which is found in western Argentina. In the province of La Pampa, the Argentine black and white tegu is common in the eastern part and also occurs in the province of San Luis. The southernmost point of its range in Argentina is 41°S latitude. Outside the country of Argentina, this lizard occurs in portions of Uruguay and Brazil.

The Argentine black and white tegu is a versatile lizard. It ranges from tropical Amazonia south to more temperate regions that have moderate temperatures and cold winters. I chose to try to duplicate the climate of Victorica in the mid-north of the province of La Pampa, at 36°13'S and 65°26'W. This region of Argentina is temperate, and it is also home to the red tegu (*T. rufescens*). The data on the climate in

this region were easily obtained from a book which I heartily recommend to other herpetoculturists—*The World Weather Guide*, published by Times Books.

In the country of Uruguay, the Argentine black and white tegu lives in stony meadows, river valleys and in the mountains. Dr. F. Achaval describes its burrowing activities between and beneath stones at night and during cooler portions of the year. Both Achaval and Cei state that this tegu is an excellent swimmer, and that, if threatened, it can stay under water for a long time.

According to Achaval (1977), its food consists mainly of insects, snails, bird eggs, fruits, and vegetables. Dr. Cei (1986) writes that this lizard eats birds, small mammals, insects, mollusks, fish, amphibians, and fruit. Claudia Mercolli and Alberto Yanosky describe the food more extensively in the *Journal of the British Herpetological Society* (1994, vol.



A newly emerged neonate tegu. Photo by B. Langerwerf.

4). They examined the stomach contents of 70 Argentine black and white tegus (bought from hide-hunters) in northeastern Argentina. They found that 66.8% of the stomach contents consisted of vegetable matter (fruits, seeds, palm fruits); 12.9% were invertebrates (snails, caterpillars, beetles); and 20.3% were vertebrates (frogs, fish, snakes, assorted eggs, and mammals).

This research is especially interesting in that it shows that bird eggs and rodents together represent, by weight, only about 5% of their food in nature. This stands in contrast to what herpetoculturists tend to feed their tegus: almost 100% rodents and eggs.

Dr. Fred Frye (1981) warns that the overuse of infertile bird eggs, such as readily available chicken eggs that are commercially available in the United States, can result in a lack of biotin.

When comparing the climate in Victorica, Argentina with that of Birmingham, Alabama, it became obvious that,

theoretically, Argentine tegus from the southern part of their range should be able to be kept outside year-round in Alabama, especially if I could, through enclosure design, create a drier winter for the tegus. I accomplished this by having a sliding glass cover set in wood grooves over wire screening, which could be opened and closed as needed to keep out any rain or snow. Additionally, the earth floor of each enclosure was covered with a thick layer of leaves to cover potential brumation (hibernation) sites for the lizards.

An outdoor vivarium of 8 × 8 ft (2.4 × 2.4 m) was constructed. The substrate for this enclosure consisted of 1½ to 2 ft (0.45 to 0.61 m) of soil. The sliding glass top allowed the interior of the vivarium to be protected from winter rains and frost.

In the initial enclosure, there were problems once the tegus reached sexual maturity. The terrarium size was too small and the gravid females became

restless and tried to get out of the enclosure. In 1992, one of the females which was gravid escaped at the end of June. She

must have used considerable force as she pushed away a very heavy stone which was lying on the lid. While gravid, she may have wanted to distance herself from the two other tegus in her enclosure. (Mr. J. J. de la Fonteyne mentions in *Lacerta* magazine how a male tegu ate the eggs of the female immediately after deposition.) Fortunately, on 8 July, I recaptured the female. She had lost a lot of weight and was looking for food in my rat barn. I searched, but could not find the eggs. However, between 9 and 14 October of that year, we collected 7 recently hatched tegus behind the rat barn. They were 3.1 in. (8 cm) in snout-vent length (SVL) and 7.8 in. (20 cm) in total length (TL). They had hatched under natural Alabama climatological circumstances and after their parents were already weeks in hibernation.

In 1993, I split up the adult tegus, each to one terrarium of 8 × 8 ft (2.4 × 2.4 m), after the females were gravid. There were metal and concrete shelters in the terrarium under which the female could retreat to lay eggs. However, this did not work out either, since again the females



The author holding an adult female Argentine black and white tegu, *Tupinambis teguixin*. Photo by Vitaly Charny.



Sub-adult female *T. teguixin* emerging from hibernation. Photo by B. Langerwerf.



Young tegus (3 or 4 months old) hibernating beneath a large flat stone. Photo by B. Langerwerf.



Video sequence of neonate tegus emerging from eggs. Note how rapidly they leave the egg. Videography and photos by B. Langerwerf.



Tegus have strong teeth for crushing nuts, palmfruits, eggs, and small vertebrates. Photo by B. Langerwerf.

tried to escape and eventually reabsorbed their eggs.

Therefore, during the winter of 1993–94, I decided to build a much larger terrarium of 4 × 35 ft (1.2 × 11 m), with a wall in the middle so that it could be divided into two terraria 17 and 18 ft (5.2 and 5.5 m) long. The wall had an opening so that during breeding season (May) one male and two females could use the entire space. After one female laid eggs, I split up the terraria in two with one female on each side. However, this did not work out as I had planned. All three tegus had become so accustomed to going through the opening in the wall that they were often scratching and rubbing their noses there. It seemed that no matter which side they were on, they always wanted to be on the other side. So, after a few days, I reopened the wall.

This large terrarium has 1 to 1½ ft (0.3 to 0.45 m) of soil in it. The floor of the terrarium is covered with many types of potential laying sites such as plastic trays, pieces of metal, and carpeting. During this time of the year the enclosure is open at the top, except for the strong wiring. At one end where the soil is 1½ ft (0.45 m) deep, I put a surface layer of concrete along that entire side, extending out for 3½ ft (1.1 m) for hibernation. In October,



T. teguixin in breeding terrarium/hibernaculum. Photo by B. Langerwerf.

I covered this site with a layer of fallen leaves from nearby trees and put fiberglass over all of this to a length of 10 ft (3 m) to keep the area dry enough during winter.

Reproduction

It appears that hibernation is necessary for reproduction. In Table 3, I give the hibernation habits of the three Argentine black and white tegus that were breeding for me. Breeding began at 3 years of age. The tegus were juveniles, only a few months old at the time, when I initially got them in May 1989.

The life cycle of the Argentine black and white tegu in my outdoor enclosure has been extremely interesting to observe. In the middle of August, when it is still hot here in Alabama, they start to refuse food and begin preparing their burrows for hibernation. They tend to all dig and prepare one large sleeping chamber. In the

middle of September, they are all inside that chamber despite temperatures of 80 to 90°F (27–32°C) during the day. The tegus close the burrow from inside with earth. Any time during the winter when I open this to check it, they closed it again with earth afterwards. They stay in this burrow or chamber for 6 months to emerge again, covered by dirt and mud, in mid-March. It is not until April that they resume feeding. They have a 4-month activity burst in April, May, June, and July. During this time, they eat all they can find and catch. In April and May, they are actively walking around the whole terrarium throughout the day. During May, the male is frequently mating with either of the females that come close to him. I have documented this behavior with my camcorder which was placed inside the terrarium. In July, the lizards begin to become inactive. Typically, in August, they feed only during the first week of the month. So, my tegus are actively eating 4 to 4½ months a year and then living on their reserves for the remaining 7½ to 8 months.

The first reproduction I observed with captives of this species was at 3 years of age, which includes 1½ years hibernation during this period. The subadult female produced at least seven eggs, which hatched after 3 months under natural conditions. The neonate Argentine tegus were shiny green and about 3.1 in. (8 cm) in SVL and 7.8 in. (20 cm) in TL. In 1994, when the trio were fully adult in size, I observed them regularly mating in May within the large 35-ft (10.7 m)-long terrarium.

On 29 May 1994, I had some visitors (Bill and Marcia Brant, Richard Funk, and Laura Bailes from Florida). While showing them around my terraria, I discovered five tegu eggs mixed with feces laying on the surface of the earth. I immediately entered the terrarium with aggressive biting tegus all around me. After a little digging, I soon discovered 30 good eggs under a plastic tray which formed a nice chamber in which the female could lay. This female was the same animal who, as a subadult, had produced a quantity of at least 7 eggs in the summer of 1992 when she was 3 years of age.

Although slightly different in size, the eggs were all between 1.8 and 2.0 in. (45 and 50 mm). I put 10 eggs on a scale and found them to weigh 7 oz (198 g) all together, which comes to an average weight of 0.7 oz (20 g) per egg. The eggs were removed and a camcorder installed, which showed that the female was still protecting the egg-laying site. The eggs, which had

Average Daily Values: Victorica, Argentina					
Month	Record high temp. °F (°C)	Record low temp. °F (°C)	Max. temp. °F (°C)	Min. temp. °F (°C)	Precipitation in. (mm) °F (°C)
January	112 (44)	36 (2)	93 (34)	59 (15)	2.8 (71)
February	109 (43)	36 (2)	90 (32)	58 (14)	2.8 (71)
March	102 (39)	30 (–1)	83 (28)	54 (12)	2.8 (71)
April	98 (37)	21 (–6)	75 (24)	46 (8)	1.2 (30)
May	89 (32)	16 (–9)	66 (19)	38 (3)	1.0 (25)
June	78 (25)	0 (–18)	59 (15)	32 (0)	0.7 (18)
July	82 (28)	12 (–11)	59 (15)	37 (3)	0.6 (15)
August	85 (29)	13 (–11)	64 (18)	34 (1)	0.7 (18)
September	97 (36)	20 (–7)	68 (20)	40 (4)	1.1 (28)
October	106 (41)	26 (–3)	75 (24)	46 (8)	3.0 (76)
November	105 (41)	28 (–2)	83 (28)	51 (11)	2.5 (64)
December	110 (43)	36 (2)	89 (32)	57 (14)	3.0 (76)

Table 1: Climatic Conditions for Victorica, Argentina. Elevation: 1024 ft (312 m); Latitude: 36°13' S; Longitude: 65°26' W; Data collection for 24 years.

Average Daily Values: Birmingham, Alabama					
Month	Record high temp. °F (°C)	Record low temp. °F (°C)	Max. temp. °F (°C)	Min. temp. °F (°C)	Precipitation in. (mm) °F (°C)
January	77 (25)	1 (–17)	55 (13)	37 (3)	5.4 (137)
February	82 (28)	–10 (–23)	57 (14)	38 (3)	4.8 (122)
March	90 (32)	12 (–11)	66 (19)	46 (8)	5.9 (150)
April	90 (32)	28 (–2)	73 (23)	53 (12)	5.0 (127)
May	99 (37)	38 (3)	81 (27)	61 (16)	4.3 (109)
June	101 (38)	47 (8)	88 (31)	68 (20)	4.4 (112)
July	107 (42)	57 (14)	90 (32)	70 (21)	5.3 (135)
August	103 (39)	55 (13)	90 (32)	70 (21)	4.2 (107)
September	106 (41)	41 (5)	86 (30)	66 (19)	3.1 (79)
October	84 (29)	27 (–3)	76 (24)	55 (13)	2.4 (61)
November	84 (29)	14 (–10)	64 (18)	44 (7)	3.5 (89)
December	77 (25)	5 (–15)	55 (13)	38 (3)	4.8 (122)

Table 2: Climatic Conditions for Birmingham, Alabama. Elevation: 610 ft (186 m); Latitude: 33°34' N; Longitude: 86°45' W; Data collection for 35 years.

probably been laid earlier that same day, were put in moist vermiculite. After an incubation of 64 days, on 1 August 1994, 17 of them hatched. On 2 August, 7 more hatched, and on 3 August, 2 more. One neonate died at hatching. It was properly preserved and sent to the Department of Herpetology at the Field Museum in Chicago. So, in total, 26 neonates hatched after 64 to 66 days of incubation in moist vermiculite at approximately 80 to 85°F (27–29°C). I noticed that a few days before hatching, some of the eggs started leaking without losing pressure. So, the vermiculite was probably too moist and needs to be drier than I normally use for most my other lizard eggs. [*Two parts vermiculite to one part water is used for most lizard species* — Ed.]

I measured the eggs again on 1 August at the time that a few others hatched and found that they were between 2.1 and 2.2 in. (53 and 55 mm) long. One egg had a weight of 1.6 oz (45 g).

I weighed 12 neonates and found that their average weight was 0.7 oz (20 g). Therefore, the remaining eggshell and liquid weighed, on the average, 0.9 oz (25 g).

I also measured the snout–vent length and total length of the 6 hatchlings. They were as follows:

SVL	TL
3.5 in. (90 mm)	9.6 in. (245 mm)
3.5 in. (90 mm)	9.4 in. (240 mm)
3.5 in. (90 mm)	9.3 in. (237 mm)
3.5 in. (90 mm)	9.3 in. (237 mm)
3.4 in. (87 mm)	9.3 in. (237 mm)
3.3 in. (85 mm)	9.1 in. (230 mm)

Hurt (1995) gives a total-length measurement of 9.5 in. (241 mm) for red tegu hatchlings. This figure is similar to that of my Argentine black and white tegus. With eggs from most species of lizards that lay pliable-shelled eggs, it is common for the eggs to indent before hatching. However, this was not the case with the Argentine black and white tegu eggs.

I recorded the hatching of these tegus with my camcorder. In each case, the egg remained firm until each hatchling opened the egg. Then, the fluid inside the egg squirted out to a distance of about 1 ft (0.3 m). Once each neonate tegu stuck its nose out, it took less than 10 seconds for it to



exit the egg. This was followed by a quick run for cover. Hurt (1995) describes this "exploding" from their eggs also, but he believed it was caused by outside disturbance. Disturbance is not the cause. During my observations, my camcorder ran silently and continuously. This behavior should be thought of as normal for this species.

My juvenile Argentine black and white tegus regularly accept crickets, mealworms, and pinkie mice. They grow quite quickly in outdoor vivaria with exposure

the hatchlings would appear sometime in the second half of August, when the adult tegus have stopped feeding. This, however, still leaves enough warm weather for the young black and white tegus to be actively searching for food. For conditions in Argentina, we need to add 6 months to all the above periods. On 24 August 1994, I measured one tegu, born in October 1992 and found it had grown to 13 in. (33 cm) SVL and 31.9 in. (81 cm) TL.

Nesting Behavior

In May 1995, I observed a gravid female busily moving dry plant material under a large, upside down $2 \times 2\frac{1}{2} \times \frac{1}{2}$ ft ($61 \times 76 \times 15$ cm) plastic tray. The tray was one of several objects from which the gravid female tegus could select to make a nest. In 30 years of breeding lizards of many different families, I have never before observed a lizard using nesting material not already in the nest hole.

I decided to see what would happen if I added a few handfuls of hay to their terrarium. The results amazed me. The hay was moved by each of the gravid females to under the tray. The next day, I unloaded an entire wheelbarrow full of hay into the enclosure. Within about an hour, the gravid female tegus had moved all of the hay underneath the same tray. These lizards were making nests as crocodilians do.

A week later on May 12th, the female that laid 30 eggs in 1994 disappeared from view. The other female continued to move about restlessly. I decided to see what was happening with the female that was out of sight. I entered the enclosure and lifted up the plastic tray. When I removed some of the

top layer of hay, I encountered a rounded chamber inside the hay. However, when the female tegu moved away in response to my presence, no eggs were visible. I gently dug deeper in the hay and discovered a second chamber under the hay where the female had been staying, possibly to guard the nest. Underneath this area there was more straw and then a lower chamber. In this lower chamber I discovered 52 eggs. These were completely surrounded by hay. It was now clear that the female had dug a deep burrow, then filled it with hay. During the night, the female had laid the eggs, covered them and then built a second chamber of hay above the first one.

Something else that was unusual was that the earth below the hay was moist, al-

Date lizards begin digging burrows.	Date lizards disappear into hibernation.	Day/Night temperature on date of disappearance into hibernation.	Date when lizards emerge from hibernation	Day/night temperature on date of emergence from hibernation.
14 Aug 1990	18 Sept 1990	90°F/60°F (32°C/16°C)	10–19 Mar 1991	65°F/28°F (18°C/–2°C) 72°F/42°F (22°C/6°C)
14 Aug 1991	4 Sept 1991	90°F/70°F (32°C/21°C)	24–28 Mar 1992	64°F/30°F (18°C/–1°C) 72°F/47°F (22°C/8°C)
12 Aug 1991	15 Sept 1992	80°F/60°F (27°C/16°C)	23–28 Mar 1993	68°F/50°F (20°C/10°C) 75°F/42°F (24°C/6°C)
No notes made	No notes made	No notes made	10–17 Mar 1994	No notes made

Table 3: Dates of hibernation of Argentine tegus under semi-natural conditions in Alabama.

In the first 2 months of life, young Argentine black and white tegus exhibit an interesting behavior. If caught and handled, their tail starts vibrating in a manner not unlike that of some colubrid snakes.

At the annual National Breeders Expo in Orlando, Florida, I had the opportunity to compare my juvenile Argentine black and white tegus with both young Argentine red tegus and young Columbian black and white tegus. In all respects except for their color, my tegus looked much more like the young Argentine red tegus, and very different from young Columbian black and white tegus. In reviewing the literature, I noticed that according to Köhler (1989), Columbian black and white tegus have an incubation period of 152 to 171 days. The big difference in both the incu-

to natural sunlight in Alabama. At 19 days after hatching, they start shedding their skin and their green color begins to fade. At 1 month of age, the green color is gone. At 32 days old, the length of one was 5.1 in. (13 cm) SVL and 14.6 in. (37 cm) TL. At 2 months of age, one tegu was 5.8 in. SVL (14.8 cm) and 16.3 in. (41.6 cm) TL, and weighed 5 oz (142 g). At 2 months of age, the juvenile lizards were seven times their original weight. Two weeks later, in the middle of October, most of the juveniles were in hibernation. In the spring of 1995 they came out of hibernation, 3 to 4 weeks later than the adults.

It is interesting to note that these young Argentine black and white tegus hatch at a time when their parents are no longer eating. The actual incubation period in nature is between 2 and 3 months. So, it is likely



Overview of terraria at Agama International. Photo by B. Langerwerf.



Winter at Agama International. Photo by B. Langerwerf.

though this part of the enclosure had not been watered. Normally, tegus do not drink a lot of water. However, I had observed both gravid females drinking at least once every half hour. Could they have been bringing water to the nest? Next year I will try to create a Plexiglas viewing area on one side to test this hypothesis.

I soon noticed that the second gravid female was using the same nesting area and appeared ready to lay, so I removed the 52 eggs the first female had laid. The total weight of this first clutch was $2 \frac{5}{16}$ lb (1.0 kg). The female parent had a SVL of $17 \frac{3}{4}$ in. (45 cm) and weighed 6 lb (2.7 kg) after her eggs had been deposited.

The next morning, on May 13th, I discovered the second female had laid her eggs during the preceding night. The nest had been reconstructed in exactly the same manner as the first nest by the other female with a lower section for the eggs covered with hay and a second chamber above for herself. This female, which is also 6 years of age, laid 41 eggs, 37 of which later proved to be fertile. This second female had a SVL of $15 \frac{3}{4}$ in. (40 cm). She weighed only 5 lb (2.3 kg) after

egg deposition. The 41 eggs had a combined weight of $1 \frac{21}{32}$ lb (0.75 kg).

When I reintroduced the first female that had laid eggs a week later to her regular enclosure, the two females began fighting outside the plastic tray nest site, so I immediately removed her. She was returned several months later after the eggs had hatched. It is interesting to note this first female laid 7 eggs at age three, 30 eggs at age five, and 52 eggs at age six.

Conclusion

The Argentine black and white tegu can be bred outdoors in Alabama and probably elsewhere in the southeastern United States. For successful breeding, there are three points of great importance: hibernation is needed; the terrarium should be large; there needs to be egg-laying sites inside this terrarium, forming a private area into which the female can fit and which has relatively high humidity.

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Notes on Herping in the
TROPICAL WET FORESTS
OF COSTA RICA

by Winston Card



I was lucky to grow up in an area of North central Florida that supports an incredible concentration of amphibians and reptiles. On any spring day, when the urge struck me, I could walk a mile or so and watch alligators basking on the shore of the large lake near my home, or go splashing through the swampy margins that lined it looking for anything that hopped, crawled, or slithered. At the time, I looked upon those adventures as just a form of amusement to distract me from an

place and seeing these creatures in their natural habitats. I guess this urge was especially deep-seated in me because of those spring days spent romping around in the woods when I was younger. However, since I chose a career path that doesn't offer much in the way of financial benefits, I always assumed travel would have to wait until my numbers came up in the lottery, or for my wife to finish her degree and begin making enough money to support my travel whims.

While zoo professionals are occasionally given the opportunity to travel to exotic locations, these opportunities are often limited to Curators or other members of the administrative staff. However, upon joining the staff of the Department of Herpetology at the Dallas Zoo in 1991, I was happy to discover that all the staff members in the department had been participating in an ongoing field project in Costa Rica for the previous three years, and I was scheduled to make the summer trip the upcoming year.

An Introduction to Costa Rica

Costa Rica is a small country, approximately the size of West Virginia, 21,630 square miles (56,022 sq. km), located on the Central American Isthmus between Nicaragua and Panama. Because Costa Rica is bordered by both the Atlantic and Pacific oceans and is divided by a high mountain range, 12,850 ft (elevation 3,918 m), it offers diverse life zones ranging from deciduous dry and tropical wet forest to cloud forest on the highest peaks. These areas support a remarkably diverse biota including approximately 800 species of birds, 200 species of mammals, 350 species of amphibians and reptiles, and 8,000 species of higher plants (Janzen, 1983). The number of invertebrates found within Costa Rica is not known. However, DeVries (1994) estimates a conservative 479 species of butterflies and skippers occurring within the boundaries on the La Selva Biological Research Station alone. This is 200 more species than occur in the United States east of the Great Plains. It is obvious why so



The red-eyed treefrog, *Agalychnis callidryas* is a spectacular species often encountered during seasonal rains. Photo by C. M. Garrett.



A large colorful spider devours a bush cricket. Photo by C. M. Garrett.

otherwise boring afternoon of homework, or, on occasion, from school itself (sorry, Mom). However, those days spent crashing through the forest and swamps trying to escape what I felt was an unnecessary attempt to educate me (I already knew everything anyway) turned out to be as much of a classroom as the one I was trying to elude. I found myself spending more time in the library than was considered normal for a child of my sordid background. I am certain to this day that my parents thought I was up to something devious. It never occurred to me then that someone would pay me to do much the same thing later in life.

Like most people who work with animals, either as professionals or as amateurs, I have spent an inordinate amount of time fantasizing about traveling to some exotic



Boa constrictors, such as this juvenile specimen, are fairly common in the lowlands. Their cryptic coloration renders them inconspicuous to unsuspecting prey. Photo by C. M. Garrett.



The eyelash palm-pitviper, *Bothriechis schlegelii*, an arboreal species, occurs in many colors and patterns throughout its range. This species is named for the raised superciliary scales above the eyes. Photo by C. M. Garrett.

many scientists from all disciplines flock to this country.

Since 1989, Dallas Zoo staff members have been traveling to the La Selva Biological Research Station in Costa Rica to study the bushmaster (*Lachesis muta*) in collaboration with Harry Greene of the University of California at Berkeley. This poorly-known species has reproduced at the Dallas Zoo since 1987 (Boyer et al., 1989). A large group of captive bushmasters provided staff with opportunities to document certain aspects of this species' behavior in the lab. The majority of the studies conducted at the Dallas Zoo were focused on predatory behavior and locomotion. However, only a limited amount of information can be gleaned in the lab, so field observations are required to fill in the many missing pieces that make up the complicated puzzle of its ecology.

In previous years, bushmasters have been collected in fair numbers by staff members. This year only a single specimen was found. Residents at the station suggest that the decline in this species over the past few years may be attributed to the recent increase in javelina populations within the reserve borders. In the past, javelina (collared peccary) numbers in the reserve have been controlled; recently this practice was suspended as part of a long-term study on this species. Javelina are known to eat snakes, even large venomous species, and their destruc-

tive effects on the undergrowth in areas in the reserve where bushmasters were once more common are obvious. However, there is no conclusive evidence to link the increase in javelina populations to the seemingly declining bushmaster numbers.

My first trip to Costa Rica was in late June 1992, accompanied by Dr. James B. Murphy, then Curator of the Department of Herpetology at the Dallas Zoo. My wife might have accompanied me on this trip had I not convinced her that I would be living on tree bark and camping under mostly primitive conditions. Little did I know that the La Selva Biological Research Station, where we spent most of our time, is actually a modern facility with air-conditioned laboratories, electricity, hot water, and even washing machines. At first, these modern conveniences sort of took some of the adventure out of the trip, but I later came to

appreciate them after hiking through mud and jungle all day!

The direct flight from Dallas-Fort Worth International Airport took about three hours. After arriving in San Jose, the capital city of Costa Rica, at around 10:00 PM, we collected our gear, had our passports stamped, and were motioned through customs with a smile. One peculiar thing about this country is that it seems as though everyone is always smiling. Even the kid that grabbed my suit case was smiling as he ran away. Not to worry, he was only leading us to one of the dozen or so taxis that were waiting for arriving passengers. The taxi driver probably sensed that I was a novice traveler and therefore easy prey. However, Dr. Murphy was certainly not new to this



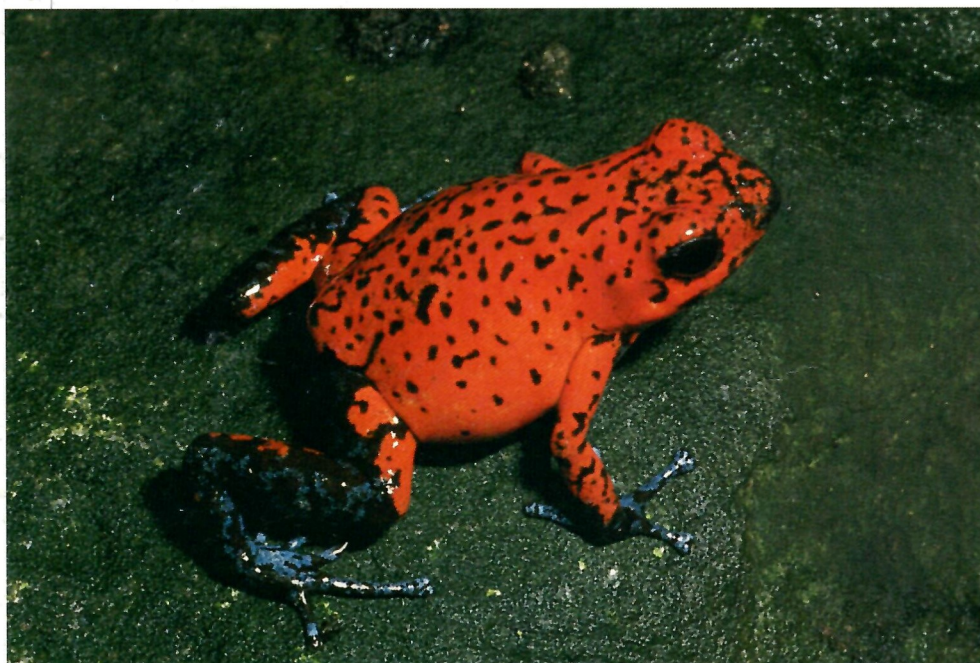
This crimson longwing butterfly was photographed while making a brief stop on understory foliage. Unlike many butterflies, longwings are pollen feeders and thus have a longer life span. Photo by C. M. Garrett.



Lush green vegetation blankets all available surfaces in the cloud forests of Monteverde. Photo by C. M. Garrett.



The smokey jungle frog, *Leptodactylus pentadactylus* can usually be found sitting near the entrance to its deep burrow. These frogs are known to share their burrows with terrestrial crabs. Photo by Winston Card.



The strawberry poison frog, *Dendrobates pumilio* is the most common dendrobatid encountered in the Atlantic lowlands of Costa Rica. Photo by C. M. Garrett.

business, and after a frightening flurry of negotiations we were soon on our way to our hotel at least ten dollars the richer!

The next day was spent investigating the San Jose. It is pretty much like any other large city: lots of noise, cars, and bad odors. I soon discovered (and sampled) the local McDonalds, Pizza Hut, and Burger King. Those of you who know me well understand the importance of this. It also has a wonderful museum full of the region's history, several beautiful parks, and lots of tourist shops. Although there is some petty



This female tropical leaf frog *Agalychnis calcarifer* has recently deposited eggs above a water-filled depression in the trunk of a fallen tree. Such egg deposition sites are characteristic for this species. Photo by David T. Roberts © Nature's Images Inc.

crime, I always felt safe walking alone in the city, and never once witnessed the impoliteness that often afflicts the inhabitants of crowded cities.

Entering the Forest

Early the next morning, we loaded our gear into a jeep provided by the Organization for Tropical Studies (OTS), and left for La Selva Biological Research Station. The station is owned and operated by OTS, which is a consortium of universities from Costa Rica, Puerto Rico, and the United States. The trip takes about two hours on improved roads.

We finally arrived at the station near lunch time. It was decided we would eat before walking to our rooms as they were a fair distance from the dining hall. The meal included black beans and rice, fish or chicken (I still don't know which), and fresh fruit. Every meal included black beans. I used to love black beans. Anyway, despite the black bean overkill, the food was actually of exceptional quality, with much of the fruit grown right on the reserve.

After lunch, as we started for our rooms in a heavy down-pour, I was beginning to understand why no one ever went anywhere here without an umbrella. We crossed a long suspension bridge over the Rio Sarapiquí, which divides the central compound from the rest of the reserve. After walking on the bridge for several yards I spotted an enormous male green iguana

just above my head, my first real encounter with an exotic herp in the field. To my surprise, no one walking along with me was the least bit interested in this creature. I eventually came to all but ignore these animals too, as I saw them daily while coming and going from the dining hall. After crossing the bridge, we walked across a small clearing containing the labs, library, several greenhouses, and a variety of other buildings. Shortly after passing these buildings the scenery changed dramatically, and we were suddenly surrounded by lush, green vegetation. A few moments later I was surprised as a large keel-billed toucan (*Ramphastos sulfuratus*) landed in a tree not more than 10 feet in front of me. Even though I had seen these beautiful birds many times in zoos, to encounter this animal in the wild was an entirely novel experience! The toucan sat on its perch for a few moments seemingly oblivious to our

small group, and then flew off through an opening in the canopy.

The next few days were spent trying to get acquainted with my new surroundings. At first, I found the cascade of sights, sounds, and smells somewhat overwhelming to my domesticated senses. This soon passed, and I settled into as much of a routine as circumstances would allow, one which basically consisted of logging data on specimens collected the previous day, and then releasing them at the collection site each morning. Short hikes were taken



An outrageous beetle from the high elevations of Monte Verde. Photo by C. M. Garrett.



Coral snakes are represented by approximately 50 species in the Latin American tropics. Allen's coral snake *Micrurus alleni* is a fairly large species, reaching a maximum length of over 3 ft (ca. 1000 mm). Photo by C. M. Garrett.



The red-handed tree frog, *Hyla rufitela* is easily distinguished from other hylids by the red webbing between the digits of the hands and feet. Photo by Winston Card.



Photographed in situ, this large adult male bushmaster *Lachesis muta stenophrys* rests among the roots of a large tree. Bushmasters are very sedentary, and may remain in a single location for several weeks. Bushmasters are the largest venomous snakes in the western hemisphere, and the only new-world crotalid that lays eggs. Photo by David T. Roberts © Nature's Images Inc.

in the early afternoons, when birds, monkeys, and other peculiar diurnal mammals and insects could be seen. On one occasion, while walking alone down a narrow trail during the late afternoon, I heard a loud crash in the trees above my head. I looked up into a gap created by a large tree fall, where a troop of spider monkeys (*Ateles geoffroyi*) began moving directly above my head. It was then that I discovered the regrettable habit these animals have of urinating on their observers! Capuchin (*Cebus capucinus*) and howler monkeys (*Alouatta palliata*) are also commonly seen here.

The Business of Collecting

While a few species of herps, such as the terciopelo (*Bothrops asper*), the local ranid frog (*Rana vaillanti*), and strawberry dart-

poison frogs (*Dendrobates pumilio*), were collected during the day, the most productive collecting was done at night. Night-hikes usually began around midnight, or as soon as the evening rain started. Although, the small swamps that dot the reserve are quiet during the day, at night they are teeming with animals swimming, crawling, and hopping almost everywhere your flashlight shines. The only difficulty encountered in collecting here is convincing oneself to climb into the cold, murky water to catch your quarry. It was in these swamps that we



Lush green vegetation blankets all available surfaces in the cloud forests of Monteverde. Photo by C. M. Garrett.



Ranid frogs are often seen at night waiting to ambush prey. Photo by C. M. Garrett.

found some of the more common amphibians, such as the red-eyed treefrogs *Agalychnis callidryas* and *A. saltator*. These gaudy frogs are nocturnal and usually spend their days in bromeliads or plastered to a leaf high in the canopy. Breeding occurs during the night, after periods of heavy rain. Males give a single-noted "cluck" from trees or other vegetation overhanging temporary pools. Each species has its own unique call, but these are difficult to distinguish with the inexperienced ear. The male's calls eventually attract a receptive female and they go into amplexus with the female carrying the male on her back. The female then climbs down to the pool below and fills her bladder with water. The pair then moves back up into the vegetation, where the female deposits her egg mass on

a leaf, where the male fertilizes the eggs. The jelly surrounding the eggs absorbs the water from the female's bladder to protect them from desiccation. Hatching occurs in about 5 days. The tadpoles fall into the pond, where they will metamorphose in about 80 days (Pyburn, 1963; 1970). On several nights, when it was raining particularly hard, we were lucky enough to observe large breeding aggregations of *A. saltator*. On one of those occasions, I counted some 45 individuals in less than 15 minutes.

A third taxon, *A. calcarifer* also occurs within the reserve. This species deposits its eggs near pools of water that have formed in hollows in the trunks of fallen trees.

Another common anuran we often found at night perched on the vegetation in the swamps, was the small, bright-yellow, hourglass treefrog (*Hyla ebraccata*). During the rainy season, this species was



This spectacularly colored diurnal moth is an hymenopteran mimic that uses aposematic coloration as a means of defense. Photo by C. M. Garrett.



A hognosed pitviper *Porthidium nasutum* captures and consumes a small anoline lizard. Photo by David T. Roberts © Nature's Images Inc.

almost always represented in fairly large numbers throughout the night. The male emits a call that is clearly audible, which makes them easy to locate. At least another half-dozen species of anurans were collected or observed in the swamps, such as *H. loquax*, *H. phlebotes*, *Scinax boulengeri*, and *Ololygon elaeochroa*.

Two species of blunt-headed snakes, *Imantodes cenchoa* and *I. inornatus*, were the most frequently seen colubrids in the swamps.



The terciopelo, *Bothrops asper*, is a large, opportunistic species that does well near human habitation, thus is responsible for many serious snake bites in Central America. This beautiful adult female was photographed in situ early one morning following a gentle rain. Photo by C. M. Garrett.

These unusual looking snakes were most often found sitting on broad-leaf plants, or crawling across aquatic vegetation in search of lizards, small frogs, and frog eggs. A variety of small lizards were easily collected at night while sleeping on the aquatic vegetation. These included: juvenile green iguanas (*Iguana iguana*), basilisk (*Basiliscus plumifrons*), and various species of anoline lizards (*Norops* spp.). Spectacled caiman (*Caiman crocodilus*), both large and small, were also collected in the swamps.

On one of my nightly trips into the forest, I was asked by the Station Director if I would be willing to take along a group of high school students visiting from the United States. I enjoy sharing things that I find interesting with just about anyone who will listen, so I eagerly agreed. Since no one in the group was carrying a particularly strong flashlight, I elected to take them on a short walk through one of the nearby swamps. The rains at this time were heavier than usual and the boardwalk crossing the swamp was under several feet of water. There were no hand railings on one side, which made crossing at night a bit treacherous. I instructed the students to keep their lights focused on the submerged boardwalk, so as not to step off into the swamp. When we were about half-way across, I spotted an adult male basilisk sleeping on the side of a small tree just above our

heads. The moment I pointed the animal out, every flashlight was trained on it. Seconds later I heard a splash and loud shrieking from behind. I turned in time to see one of the young girls with the group flailing frantically in the murky water. She had an interesting vocabulary for a girl her age. It took only a few minutes to remove the three or four leeches that came out with her, and we were on our way. Another would-be biologist turned accountant!

The Find of a Lifetime

After visiting the swamps, we usually headed up one of the many trails in the reserve in search of whatever crossed our path. On these long night hikes we observed most of the venomous species of snakes found in the area. Terciopelo (*Bothrops asper*), hognosed pitvipers (*Porthidium nasutum*), and the arboreal eyelash palm-pitviper (*Bothriechis schlegelii*) were commonly observed. However, bushmasters (*Lachesis muta*) proved

to be much more elusive. In the seven weeks I spent searching for this snake, I found only one. I spotted the animal basking late one afternoon on top of a leaf-cutter ant (*Atta cephalotes*) mound, a young specimen, not more than 2 ft (61 cm) in length. No matter, it was still a bushmaster, and worth all the time I had invested in trying to find it.

The bushmaster (*L. muta*) is the largest pitviper, and the only species in the Western Hemisphere which lays eggs. Unlike the terciopelo (*Bothrops asper*), which seem to be ubiquitous, bushmasters are only encountered in undisturbed habitat.



Tent bats, *Ectophylla alba*, roost on the underside of a large leaf they have modified for shelter. Photo by David T. Roberts © Nature's Images Inc.



When threatened, the red-bellied earth snake, *Rhadinaea decorata*, raises its tail to expose the bright red warning coloration of its venter. The conspicuous tail may also serve to draw a predatory attack away from a vital body part. Photo by David T. Roberts © Nature's Images Inc.



Hyla phlebotes can often be found perched on a large leaf waiting for its next meal. Photo by C. M. Garrett.



A mass of hylid frog eggs developing on the tip of a leaf overhanging a temporary pool. Photo by C. M. Garrett.

This suggests that this beautiful snake might also be an important indicator species as to the health of primary forest.

Three species of coral snake, *Micrurus alleni*, *M. mipartitus*, and *M. nigrocinctus* occur in the reserve. Only *M. nigrocinctus* seemed common in September. Six specimens were collected, usually in the early evening, foraging along the trail just down from our rooms. Nearly all of these specimens were collected while I was walking back from dinner. On one occasion, a small group, consisting of fellow researchers not particularly thrilled with snakes, gathered to watch the activity. Subsequently, I noticed that many of these people replaced their sandals for boots for their walks to and from the dining hall.

A Confounding Frog Experience

Ten of the fourteen recorded species of *Eleutherodactylus* found in this area were also collected. *Eleutherodactylus mimus*, not known to occur within the boundaries of La Selva, was also collected and added to the species list for the area. These are small, nondescript frogs that require an experienced eye or a good key to identify. Several species display a polychromatism of color, pattern, and skin texture, in one case causing a single species, *E. bransfordii*, to be described seven different times (Savage and Emerson, 1970). This group of frogs deposits their eggs in leaf litter where they develop directly into tiny froglets. We were successful both day and night collecting these frogs. During the day specimens were found by walking through the leaf litter. At night, we simply followed the sharp "tink" of the calling males.

Another leptodactylid frog encountered frequently was the smoky jungle frog (*Leptodactylus pentadactylus*). Specimens were usually seen sitting near the entrances to their burrows. These massive frogs leap for their burrows when approached and can be quite difficult to capture. When one is finally grasped, the loud squalls emitted by the struggling animal can be somewhat unnerving. Adults also secrete skin toxins that can be very irritating, especially to open wounds (Scott, 1983).

On one particularly wet evening, I was permitted to accompany a group of graduate students from the University of Costa Rica who were conducting long-term amphibian decline surveys in various reserves throughout the country. On that day we were to walk a set distance into the forest to randomly select four different sites to lay out a 10-square meter plot for an intensive survey. This involved getting down on all fours and lifting every piece of debris on the forest floor, in search of whatever herps happened to be in the plot.

The students were clearly skilled at this type of survey and very little escaped their attention. The survey produced a few unusual herps, including a night lizard (*Lepidophyma flavimaculata*). A small animal about 4 in (10 cm) in length, its coloration is mostly brown with round yellow spots on the body. The small family to which this species belongs (Xanthusiidae) contains 12 species. This group maintains an uncertain systematic position, but is thought to be closely related to the Gekkonidae. All xanthusiids bear live young and have the unusual habit of cleaning their spectacles occasionally with their tongue as do geckos.

After conducting the plot surveys, the students walked a transect through two of the research swamps and counted every frog they could see. The students' ability to identify specific species of frogs by their calls was extraordinary. The fact that they could easily identify frog calls was not unusual in itself, but what amazed me was their ability to do so in spite of the hundreds, perhaps thousands of competing voices. While these calls were only coming from a few dozen or so species, their combined chorus made it all but impossible for me to identify more than a few of them.

A Trip Down the Rio Sarapiquí

One afternoon, Dr. Murphy and I decided to rent a small motorboat owned by OTS, and travel down the Sarapiquí for as far as we could in one day. This turned out to be a fairly disappointing diversion. Once we were outside of the borders of the reserve, all we could see for miles were banana plantations, cleared pastures, and large stands of bamboo. The mature bamboo is cut and used to support the banana trees. Since most of larger plantations are owned by large corporations from North America and Europe, one can hardly be too critical of Costa Rica on this issue. To be fair, this country has a higher percentage of its natural areas set aside as parks and reserves than any other Latin American country.

After several hours on the river we saw an American crocodile (*Crocodilus acutus*) basking on the river bank; just around the bend were a group of banana plantation workers swimming in the river.

Monteverde

At the end of the second week, Clay Garrett, then employed at the Dallas Zoo, joined us for the beginning of his rotation. After nearly 3 weeks at La Selva working, it was time to make a side-trip to see another part of the country. Clay and I decided the best place to go in the little time we had to travel would be the Monteverde Cloudforest Reserve, famed home of the apparently extinct golden toad (*Bufo periglenes*). Monteverde offers a very different array of habitats compared to the tropical wet forest of La Selva. Monteverde was settled by a group of Quakers from Alabama during World War II. Many of the original settlers and their descendants still live around the reserve, and a few operate small hotels and shops to accommodate the tourists.

Because of our limited finances, we elected to travel by bus, which is an interesting experience in Latin America. Most of the buses are reconditioned Blue Bird school buses which are in a real state of disrepair. Large numbers of people are packed

into these contraptions with little thought given to where they will all sit. The trip takes about 4 hours.

Stepping into this forest reserve is like stepping into the pages of Alice In Wonderland. Every branch and stump is covered with epiphytic plants, including countless species of orchids, and clouds constantly bathe the forest. There are several beautiful waterfalls and spectacular vistas. Since we were not able to leave the trail system in the reserve, or hike at night, there was not much opportunity to observe the areas' unique herpetofauna. However, the aforementioned scenery made the trip worthwhile.

After a few days in Monteverde, it was time to return to our research site, and for me to begin preparing for the return trip home. Physically the trip only takes a few hours; mentally it takes weeks. Consider for a moment leaving a country with a population of just over 4 million and returning to a city with a similar population. Actually, the Dallas-Fort Worth metroplex has a population of around 3.5 million, but who is counting? Upon my return, I found all of the traffic, noise, and pollution every bit as overwhelming as the rainforest had first been, to my now undomesticated senses.

I thank Clay Garrett, Don Boyer, Dave Roberts, Dr. James B. Murphy, and Ardell Mitchell, who were all my able traveling companions, at one time or another. I also thank Alan Caldwell for his much needed editorial comments; good editors are hard to find and he is certainly among the best.

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BIG SNAKE BITES

part II

by
Dave and Tracy Barker

In continuing our discussion of big snake bites from our last column, we offer the following observations, based on our own experiences:

Offensive bites hurt worse than defensive bites. Pythons deliver an offensive strike with the objective being maximum tooth penetration and holding on. Plus, the bite hurts more when the teeth are pulled into the bite as coils are drawn up in the following attempts at constriction. The object of a defensive bite is to not hold onto the target; pythons defending themselves do not want to lock their head onto something they perceive as dangerous or fearful. Pythons never constrict in self defense.

Offensive bites are more dangerous than defensive bites. Being bitten by any captive snake that thinks it's being fed is always more complicated than a defensive strike.

In the case of pythons, feeding strikes are followed by attempts at constriction. In the case of big pythons, the very real danger exists that constriction can be life-threatening. How big is dangerous? A python weighing over 40 lb (18.2 kg) in instinctive feeding behavior can be a dangerous force with which to reckon. Once a python weighs more than half the weight of his keeper, the potential of dangerous constriction becomes very real; snakes of this size should not be handled alone. Once a python outweighs his keeper, fatal constriction is at the discretion of the python. [Be aware that these safety size guidelines are approximately the same for dogs as for pythons; both are large carnivorous household guests, and dogs kill at least 25 people every year in the United States.]

The bigger the python, the more painful the bite. Well, this one may be pretty obvious; bigger snakes give bigger bites. But

the increased pain mostly does not come from the increased force of the bite, or pressure from the jaws, but from the longer teeth. We have never witnessed bruising to result from the pressure of the bite, as is common in mammal bites. Mammals bite *hard*, and the resulting painful bruise lasts for days. Sometimes python bites appear as bruised from small amounts of internal bleeding around the tooth wounds

The bites of some species hurt worse than others. The length of the teeth of pythons, relative to the size of the individual snake, varies from species to species. The front teeth of green tree pythons, *Morelia viridis*, are much longer than, say, those of a spotted python, *Antaresia maculosa*, of the approximate same length and weight; consequently the bite of a green tree python is typically a lot more painful than the bite of a spotted python. The front teeth of white-lipped pythons, *Leiopython*



The beautiful reticulated python, *Python reticulatus*, is capable of delivering a serious bite.



Green tree pythons, *Morelia viridis*, have rather long maxillary teeth, as do many other arboreal boids.



Care should be taken when handling scrub pythons, *Morelia amethystina*, due to their agility and large size.



Due to its large size, this hypomelanistic Burmese python could be hazardous to handle without assistance.

albertisii, and scrub pythons, *Morelia amethystina*, are very long and their bites can really capture one's attention. The award for the longest front teeth in the Pythoninae goes to the rough-scaled python, *M. carinata*; this is the rarest python species in the world, and we can't comment on the bite because we have never seen a living specimen. We've seen the teeth on a museum specimen and their length would indicate that the bite must be quite a memorable experience.

The manner of the bite itself has a lot to do with the degree of discomfort of a bite. Ball pythons, *Python regius*, have always seemed to us to have a very painful bite, relative to their size, though their teeth are not especially long. Reticulated pythons, *P. reticulatus*, and Burmese pythons, *P. molurus bivittatus*, have very similar dentition, yet the bites of reticulated pythons have always seemed more painful than the bites of Burmese pythons.

Most bites do little or no real damage to the person bitten. Not counting pride, of course. Also not considering the complications and damage that may result from the person struggling to get the snake to release. Python bites typically cause intense pain during the duration of the bite. The bite itself results in numerous simple shallow punctures (in the pattern of the teeth in

the python's mouth), very minor bleeding at most of the tooth wounds, and no resulting infection. Once the snake lets go, there typically is little or no pain in the area of the bite. First aid is usually to wash the bite with antiseptic soap, pat it dry, and get on with life. Usually it's not a big deal.

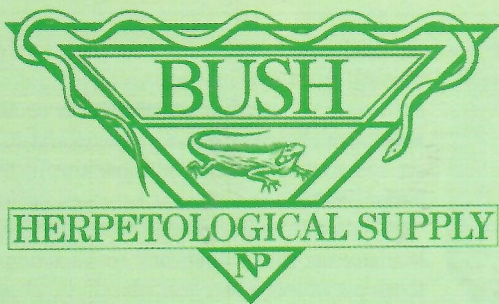
The more you flinch or try to pull away from a bite, the more likely you are to increase the damage from the bite. Of course we're referring to feeding bites here, bites where the python holds on and likely tries to coil the bitten area. One hears occasionally about teeth being broken off and left in a bite wound. In all of our bites we have experienced this only once or twice, it's not a common event. Pythons shed their teeth on a regular basis, so sometimes a tooth left behind in a bite was already loose in its socket and just about to fall out. However, usually teeth left in the bite wound are indicative that the bitten has struggled during the bite, and tried to pull the bitten body part out of the snake's mouth. **DO NOT DO THIS!** You cannot pull your bitten part out of a python's mouth, it's not physically possible without damage to the bitten area.

Several years back a friend of ours, in a panicked reflex, literally pulled his hand out of the mouth of his 14-foot, 90-lb (4.3 m, 41 kg) reticulated python when it missed its offered food and got his hand instead. He pulled loose all the skin on the

back of his hand, cut three tendons on the back of his hand, and cut or nicked a good-sized artery on the palm of his hand. He lost about two pints of blood, required hand surgery to repair the tendons, and permanently lost some of the grip and flexibility in his hand.

After mistakenly biting a keeper in a feeding bite, most pythons will let go, usually in about a minute. Some pythons may instantly realize their mistake and release quickly; it depends on how intensely the feeding behavior instinct takes hold in that particular python at that particular moment. We've had a few optimistic pythons hang on as long as 30 minutes (of course, this has usually been on feed day, and our hands smelled of rodents.)

After a feeding strike and bite, a python is in the instinctive mode; once the stereotypic feeding behavior is satisfied or interrupted, the python changes to a conscious mode, and then typically voluntarily lets go, since it didn't intend to eat a person. In this case the bite-wound damage is minimal. It's difficult to "interrupt" feeding behavior since a python typically instinctively interprets just about anything that happens as "struggling prey," which prolongs the constriction portion of the feeding behavior. In the case of feeding bites, it is our own preferred course of ac-



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Volume 7 Issue 3 **THE VIVARIUM**

two of the lower front teeth penetrated the large group of tendons above and behind the knee on the outside of the leg; this wound caused a lot of pain in the tendon for 2 months. About 20 stitches were required to close the three most torn areas, healing was uneventful. This was the largest snake that had ever bitten either of us, and it really opened our eyes to the possible damage that could result from a feeding bite from similar or larger sized pythons. It's our intention and our recommendation to never be bitten by a snake of this size.

When a python makes an offensive bite there is no sure way to get him to release his bite. As you might suppose, we've been told almost every way imaginable to make snakes stop constricting and release from a feeding bite. In our line of work we've been able to try nearly every single one of them, many of them more than once, and we can say that, without exception, not all of them work, at least not every time. Sure, you say, you held your hand with a python attached under cold water and the python let go. Well, don't bet your life on it, it doesn't always work. In fact it usually doesn't work. Yes, eventually the snake will have to breathe, but *eventually* could be 20 minutes to an hour. It also doesn't work to pour alcohol or spray mace in a python's mouth when your hand is in there (it does really sting your hand, though.) It doesn't work to hold them under really hot water, but it does make them bite harder. It doesn't work to gouge their eyes or bite their tails. Someone once told us that a sure-fire way to make a python release its bite is to stick a finger in its cloaca (anus); we just haven't got around to trying that one yet, and we're a little dubious—what if it doesn't work and then your nose itches? It doesn't work to try to pry the python's mouth off the bite. It doesn't work to blow air in the nostrils of the python while it's biting, it doesn't work to poke it in the mouth or on the body with a sharp implement. It doesn't work to stab into a python's body with a knife; many pythons will keep constricting until they die or their prey quits struggling, it's an instinctive command that in some circumstances they just don't seem to be able to override.

Anyone who thinks that a big Bowie knife is a safety tool against a really big python has never dissected many snakes. It's nearly impossible to sever a dead big snake's spine with a knife, even a knife so sharp that it will shave you and so big that it takes both hand to pull it out of its sheath. In a panic situation with a big snake constricting you so hard that one of your

shoulders is out of joint and your eyes are so bugged out that you can't close them, you'd be as likely to stab yourself through the chest into your own spine as doing any damage to the snake's spine.

The only thing that might work, and we stress the word *might* because we have never tested this, is a stun gun. A long blast from a 100,000-volt stun gun held over the spine of a snake in the neck region probably would override the nervous system control of the snake, stop constriction, and break the feeding behavior. Of course it would probably shock whoever was being constricted and it would definitely make the bite hurt worse because the snake would thrash and twitch—but as an emergency measure, it just might work.

The thing that does work is to grit your teeth, quit struggling, be motionless and quiet, and the snake will let go as soon as the instinctive mode passes, usually not a long time. This method does the most minimal damage to the biter and the bitten.

The sweetest, tamest, most trustworthy python (or any snake) can bite. Of course, this statement is also true for ferrets, parrots, dogs, cats and grasshoppers. Pythons can be as tame, predictable, and as trustworthy as any animal, sometimes more so. We own a 25-year-old python named Christian that has been touched or handled by an estimated 300,000 people. He was the public relations animal for the City of Dallas for about 5 years and the Dallas Zoo Education Department public contact animal for another 5 years; one time he was on display in a city booth and in a 6-hour period he was touched by over 10,000 people. We've caught young children biting this snake, but he's never even hissed in public; in private he's bitten people five times during his long life.

Over the years we've known completely tame pythons that would bite if they flicked their tongue into human hair. We've had pythons that would only bite if a human exhaled or blew air into their face. We've had pythons that wouldn't bite the person holding them, but would bite anyone else. We've had pythons that favored one of us and bit the other. And we've known wonderful, gentle, and deliberate pythons that simply wouldn't bite anyone, probably no matter what was done to them. But all of us who are the keepers of pythons must never forget that they all *can* bite.



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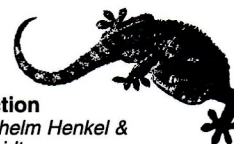
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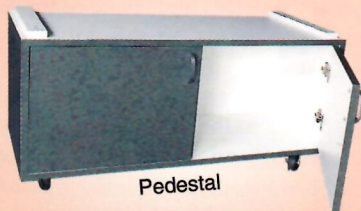
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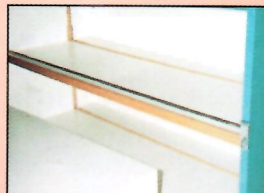
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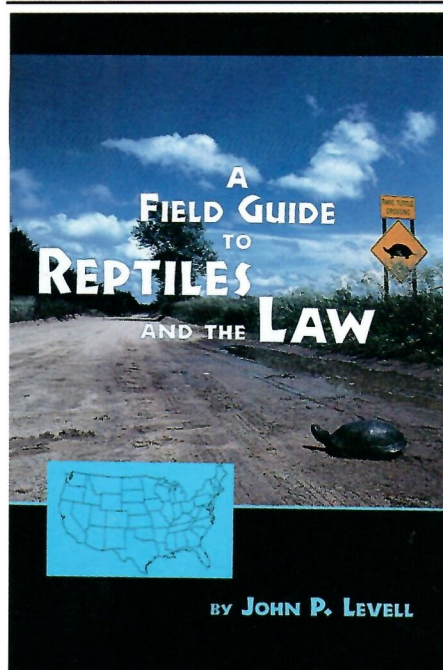
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Reviews by James B. Murphy

A Field Guide to Reptiles and the Law by John P. Levell. 1995. *Serpent's Tale Natural History Book Distributors, Excelsior, Minnesota.* 15 black-and-white photographs. 7 figures. 240 pages. ISBN 1-885209-03-7. \$29.25.



It is not altogether unreasonable for the herpetoculturist to be completely overwhelmed and confused by the myriad federal and state regulations dealing with the protection of amphibians and reptiles. In these days of increased vigilance by wildlife officials, the conscientious herpetoculturist must be careful about adherence to laws pertaining to collection, importation, commercial trade, and captive maintenance of herpetofauna. The old adage that ignorance of the law is no excuse remains true, so this book is an important and welcome addition. The author has done a wonderful job in compiling the vast material dealing with these issues. The book begins by outlining the history of The Convention on International Trade in Endangered Species of Wild Fauna and Flora (C.I.T.E.S.) which applies to worldwide traffic in amphibians and reptiles. Depending on the perceived threat to populations by various regulatory agencies in the countries of origin, amphibians and reptiles are listed in categories (Appendix I through III) according to vulnerability and protective measures.

The next section outlines the history and provisions of the U.S. Endangered Species

Act. A list of federal and threatened species is provided. In addition, rules and regulations for application for licenses and permits, designated ports of entry, marking and clearance of shipments, commercial importation and exportation, and special turtle regulations are presented.

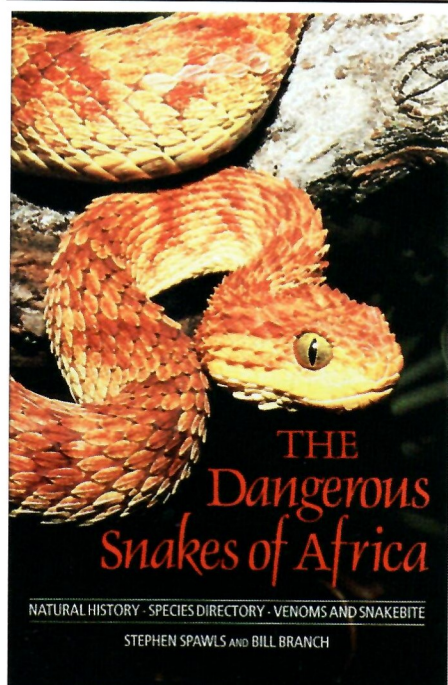
The following chapter is a listing of laws and regulations which apply to each state. This is the most important aspect of the book as all appropriate legislation is provided in a comprehensive format for easy consultation.

Finally, appendices of addresses of state and federal regulatory agencies, an index to state protected species, and an extensive bibliography are offered to the reader.

This book should occupy a prominent place on every fancier's book shelf. The author has approached a scattered and confusing topic in a systematic manner by distilling and compiling all relevant material so that it is accessible and understandable.



The Dangerous Snakes of Africa by Stephen Spawls and Bill Branch. 1995. *Ralph Curtis Publishing, Inc. Sanibel Island, Florida* 33857. 115 color photographs. 8 figures. 108 range maps. 192 pages. ISBN 0-88359-029-8. \$39.95.



With the resurgence of interest of all things herpetological in Africa, the herpetoculturist finds a plethora of publications dealing with the herpetofauna in the region but none covers all of the dangerous serpents. This new book, written by two eminently productive and experienced authors who have published widely in this arena, nicely fills a void relating to the slightly more than 90 dangerous snakes of Africa. The scope is broad and should offer something of interest to a wide audience. Herpetoculturists, herpetologists, medical practitioners, fieldworkers and native African people will benefit from reading this book as there is much of value for all.

In the Introduction, the major groups of snakes are covered, followed by a plea for their conservation. The next section offers clear suggestions for identification with diagnostic characters for comparison of venomous and non-venomous snakes.

The next chapter presents species descriptions of potentially dangerous snakes (including the African rock python). Each species account includes diagnostic features for identification, races (subspecies), similar species, behavior, distribution,

habitat, natural history, venom, snakebite, case histories, and treatment. In some cases, information for some categories may be non-existent. Range maps are included and most taxa are accompanied by a color photograph. The quality of the photographs is first-rate, but the overall aesthetic quality of the book would have been enhanced if the photos had been larger, especially since some of the species (i.e., Usambara bush viper *Atheris ceratophorus*, Mount Kenya bush viper *A. desaixi*, Ethiopian mountain viper *Bitis parviocula*, and several others) are rarely photographed. The herpetoculturist will find the behavioral and natural history information to be of particular value.

The following section on snakebite is written superbly and is one of the most coherent accounts on this topic ever presented. A review within various geographical regions in Africa introduces the reader to the most current information available by reviewing pertinent literature, case histories, and the history of antivenin production. The authors conclude that early estimates of snakebite deaths (400–1000) are much too low and probably are 10 to 100 times more frequent. This confusion and uncertainty about the scope of

the problem stems from inadequate reporting and record keeping, a large rural population, low number of health clinics and use of traditional snakebite remedies. Spawls and Branch provide recommendations for avoiding snakebite, including hazardous times and seasons where the likelihood of encountering a snake is greater. They review symptoms, their severity and potential for a successful outcome. Their narrative for treatment is excellent since it covers first aid, medical treatment, a description of antivenin production and effects, a list of antivenin producers with addresses and the use of antivenin by the layman. There are several vivid color photographs depicting puff adder, burrowing asp, and Mozambique spitting cobra envenomations which serve as a reminder of how catastrophic a venomous snakebite can be!

Appendices of taxa found in different regions in Africa, a list of institutions dealing with African snakes, and a comprehensive bibliography of African snakebite are included.

There is much to recommend about this tome. The scholarship is first-rate, the writing style is clear, the layout is attractive and user-friendly, and the breadth of coverage of African snakes of medical significance supersedes any earlier publication related to this topic. It is a very nice work and the authors should be justly proud of their creation. The herpetocultural community expects nothing less from them and they have not disappointed!



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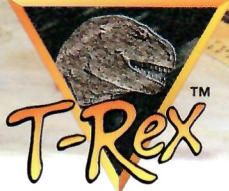
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EDWARD DRINKER COPE

by
Roy Pinney

Young, brilliant, and handsome, Edward Drinker Cope was soon to become recognized as the leading American herpetologist of the nineteenth century.

With limited formal education plus some private tutoring supplemented by one year at the University of Pennsylvania, at 19 he went to Washington D. C. to study reptiles under Spencer Fullerton Baird at the Smithsonian Institution. He published his first paper in the *Proceedings of the Academy of Natural Sciences of Philadelphia*, "On the Primary Division of the Salamandridae, with a Description of Two New Species," in 1859.

Returning to Philadelphia, Cope worked under Joseph Leidy, the effective founder of American paleontology at the University of Pennsylvania. In 1861 he was elected to the Academy of Natural Sciences when only 21 years old, having by then already published 31 papers on reptilian classification. He became a curator at the age of 25, and was already recognized as the country's outstanding herpetologist, comparative anatomist, and an authority in paleontology.

His major herpetological works include *The Batrachia of North America* (1898) the *Classification of the Ophidia* (1895), and *The Crocodilians, Lizards and Snakes of North America*, the latter which was published in 1900, three years after his death. Cope found that the overall appearance of the hemipenes is quite constant within a species, but differs from one species to

another, and he proposed classifying snakes on the basis of this structure. Today, modern herpetologists, primarily Dr. Herndon G. Dowling, have used the morphology of the hemipenis as an important tool in snake classification.

The majority of Cope's published works were on Asian, South American, and African species as well as those from the United States. From 1878 until his death in 1897, he was senior editor of the *American Naturalist*, a major scientific journal.

herpetological publication was named in his honor.

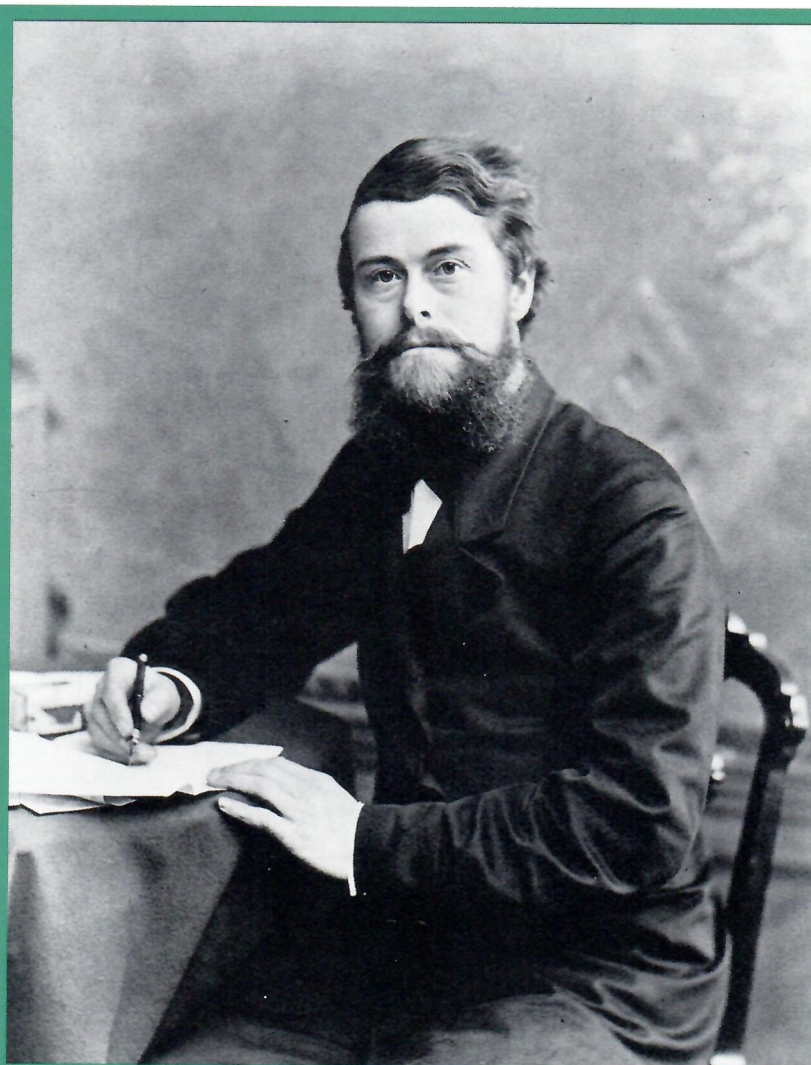
In 1864, Cope accepted the the position of Chair of Comparative Zoology and Botany at Haverford College. But a sedentary professor's life was not enough for the adventurous Cope. He made frequent trips to marl pits in New Jersey, paying quarrymen to notify him of interesting fossils. In the summer of 1866, a hadrosaur bone turned up, and Cope began to spend more and more time at the pits.

Soon after, he wrote his father that he had found "a totally new gigantic carnivorous Dinosaurian . . . the devourer and destroyer of Leidy's (his teacher's) Hadrosaurus, and of all else it could lay claws on." He named the beast "Laelaps," gave up his teaching post, and bought a house near the quarries. He then spent much of his time describing fossils, including those of dinosaurs, collected by the Hayden Survey in Wyoming and other explorations; much of this work was done together with Leidy.

"He was also jealous, combative and downright underhanded. But without his raw egotism and ambition, the dinosaur halls of the great museums would not have become so quickly packed with Mesozoic saurians" according to Richard Milner in his classic *Encyclopedia of Evolution*.

"Although he came from a respectable Philadelphia Quaker family, Cope was any-

thing but quiet and peaceable. Almost a century after his death, his reputation still lingers as one of the most aggressive, belligerent scientists of all time. He was known to settle scientific arguments with



Edward Drinker Cope

Photo courtesy of Kraig Adler

Clearly, herpetology in the United States had its roots in the Academy of Natural Sciences of Philadelphia and originated at an early time in this nation's history. *Copeia*, the respected ichthyological and

his fists and did not shrink at outright thievery from his competitors.

Once he stole the entire skeleton of a whale. When the huge carcass washed up at Cape Cod, the Agassiz Museum at nearby Harvard sent out a team to collect its bones. They labored all day under a hot sun, hacking away tons of blubber and decomposing flesh and finally loaded the bones onto a railroad flatcar. Cope, watching from a distance, waited until the workers left, then bribed the stationmaster to change the shipment's destination from Harvard's Museum to his own in Philadelphia. For several years, the Harvard curator had no idea what had become of his whale skeleton.

In 1868, Cope began a series of digs in the American West that would lead to discovery after discovery. He held rebellious field crews together and charmed the hostile Cheyenne, who were warring on white intruders in the region.

"One hundred years ago, the world's greatest collections of fossils were made by two rival paleontologists who loved dinosaurs and hated each other. Edward Drinker Cope of Philadelphia and Othniel C. Marsh of Yale's Peabody Museum would try almost any underhanded trick to beat the other to a new discovery" according to Milner.

Marsh was equally adept at gathering dinosaur skeletons in hostile Indian country, bribing railway employees to reroute shipments, and claiming first discovery of species that Cope had already written up.

Because both rushed to publish and never checked with each other, they often wrote up the same species at about the same time. Many dinosaurs therefore entered the scientific literature with two names: a Cope name and a Marsh name. It took museum paleontologists 30 years to straighten out the resulting confusion, determine who had named a species first, and unify those that were named twice.

Once Marsh even managed to insult his rival by naming a mammal fossil *Anisconchus cophater*, the "jagged-toothed Cope-hater." His joke was not spotted; the species name was officially accepted and still stands.

In later years, the feud died down, and the fortunes of both men declined. Cope had a bitter dispute with the government over a fossil collection he had made on the Hayden expedition. The National Museum claimed total ownership even though Cope had spent \$75,000 of his own money to ensure the project's success. He had also made some bad investments and finally

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had to sell most of his vast lifelong dinosaur collection to the American Museum of Natural History for only \$32,000.

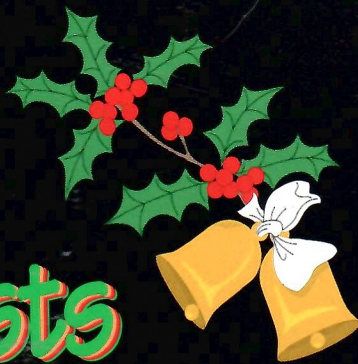
Cope ended his days in a Philadelphia brownstone that was packed floor to ceiling with fossils and papers, but had virtually no furniture. Here the great dinosaur artist Charles R. Knight spent several weeks with him shortly before he died. Their intense discussions were fruitful, and Knight produced a remarkable series of paintings based on Cope's insights about the extinct monsters he loved."

Suggested reading

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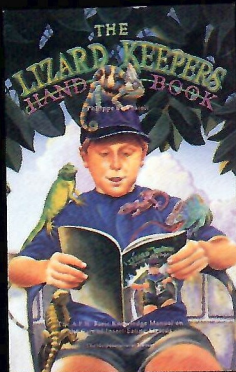


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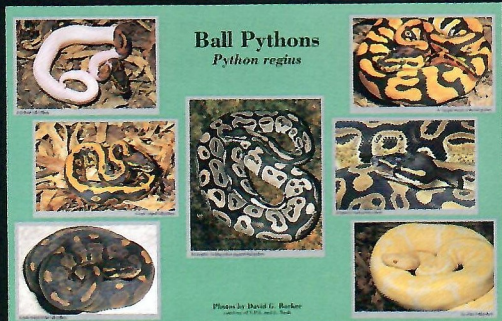
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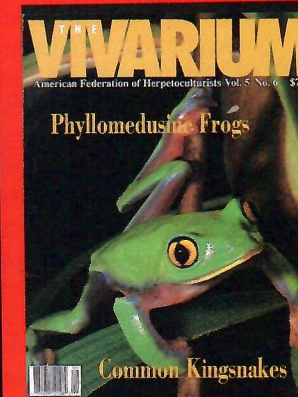
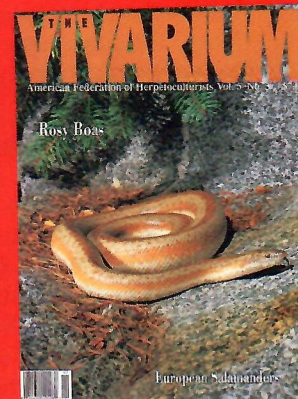
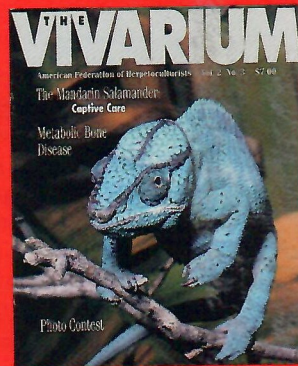
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This year's index includes more than 3,000 references to papers published primarily during 1994. In addition, Professor Dr. P. Zwart has contributed 2,000+ references on the topic of veterinary medicine, disease & pathology. This index is an ongoing project designed to compile as much herpetological literature as possible into a single volume. It is compiled by Breck Bartholomew and is distributed by the American Federation of Herpetoculturists. Available in book format and on DOS disks (*text and Endnote files*), and Macintosh disks (*text and Endnote files*).

1994 Herpetological Index



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Uromastix – Continued from page 17

rial or alternately placed in a plastic bag and used to coat insects prior to offering them as food.

Water: For the first 4 to 8 weeks of acclimation, clean water should be provided either by misting the heads and mouths of the animals while holding them (preferable) or by soaking them in a shallow pan of water two to three times a week for 10 minutes. Parasitized animals should be rehydrated orally and/or through injection (see veterinarian). Once these animals are established, soaking them in a pan of water once a week is recommended. If kept on gravel or outdoors, the lizards can be lightly misted every 2 or 3 days in the early morning. If you are wondering why I'm recommending offering water to uromastix, it's because in the wild, the relative humidity in burrows is probably at least moderately high, which results in less water loss through breathing. In addition, day/night fluctuations in temperature may also provide water in the form of dew. Keeping animals well hydrated can also help prevent kidney disease, a common cause of death in captive uromastix.

Common diseases of imported animals and protocols for treatment: Virtually all imported *U. ornatus* arrive with parasites; the most common are nematodes including strongyles. Treating imports that fail to gain or maintain weight with Panacur® (fenbendazole) (see Klingenberg, 1993) is recommended. In 1993 large numbers of ornate uromastix were imported into Florida; for the most part these animals subsequently died, often within a few weeks of importation. The stools of these ornate uromastix and the first loads of ornate uromastix imported in 1994 typically were runny to the point of being liquid. Fecal exams revealed infection by *Entamoeba*. Unfortunately, despite even early treatment most specimens died. It has been speculated that in these imports the combination of amoebiasis with high nematode loads caused lesions in the gastrointestinal tract, which led to septicemia. Matthew Moyle (pers. comm.) has recommended oral treatment with chloramphenicol in conjunction with treatment with Flagyl® and Panacur®. Others have reported good success with Baytril (enrofloxacin). The success in establishing these amoeba-infected animals with supportive antibiotic treatment is significantly greater than without supportive antibiotic treatment (the dif-

ference between success and failure to establish these animals in captivity). Another critical procedure when treating amoebiasis is rehydration (see *Acclimation* above).

Behavioral problems: A common behavior of newly imported ornate uromastix is clawing at the corner of an enclosure and arching the back ventrally so that it appears as though the back is broken or collapsed. This behavior problem is probably the result of the animals lack of experience in confronting transparent or opaque vertical surfaces. Usually once the animal moves away from the corner or side of the enclosure where it is performing this behavior, the back returns to its normal position, but in some cases the animal remains at least temporarily with a ventrally collapsed spine. This can often be remedied by reversing the process, by simply placing large rounded rocks in the enclosure forcing the spine to arch dorsally, but often permanent damage will occur to the spine (possibly some of the spinal processes fracture). Placing rocks or plants such as pony tail palms in pots in corners and along the sides will help deter animals from performing this disturbing and potentially harmful behavior. Do whatever is necessary to prevent this.

Common problems and diseases of captive animals: A commonly reported symptom in adult ornate uromastix that have spent between 3 and 12 months in captivity is single or multiple raised hard bumps along the spine. These can be felt by running a finger lightly along the backbone. Animals with these symptoms often die within a few weeks or months of the appearance of the spinal bumps. In the later stages of this disease syndrome, hind limb paralysis is common. The initial interpretation by herpetoculturists has been that this must be a sign of metabolic bone disease, wherein small fractures may occur along the spine. After consulting several veterinarians, no definite conclusions were reached, although a likely hypothesis was suggested. Kidney disease (possibly the result of dehydration), overfeeding of insects, combined with oversupplementation with vitamin D₃, and failure to expose the animals to natural sunlight may be contributing factors. Of the several species of uromastix the author has kept, the ornate uromastix is the only species the author has seen show the above symptoms; these have also been reported by many long-term owners of this species. Interestingly, these symptoms usually are not reported in small animals but in adults, another indication that excess vitamin D₃ may be a factor. It appears that there is something that we are

not getting quite right. Keeping animals hydrated, cutting down excess protein in the diet, not oversupplementing vitamin D₃, and providing natural light or UV-generating bulbs should get us on the right track

Respiratory illnesses: All *Uromastix* can develop respiratory infections if kept too cool and too wet or at high relative humidities. Mucus emerging from the nostrils, puffed out throats, gaping, lethargy, and loss of appetite are all possible symptoms of a respiratory infection. Some forms of respiratory diseases do not respond well to treatment, and uromastix may contract respiratory infections which can be fatal. The best procedure is to avoid keeping them under conditions which leave them susceptible to disease. When attempting to breed *Uromastix*, the best protocol is to have long cool and dry nights alternated with relatively warm and dry days. They should not be maintained at round-the-clock cold temperatures during prebreeding conditioning.

Human hygiene: As with many herbivorous reptiles, there is a possible risk of salmonellosis when handling uromastix or performing tasks associated with their maintenance. Always wash your hands, preferably with a bactericidal soap, after handling uromastix or performing a maintenance chore. Never perform cleaning of dishes and other materials associated with your uromastix in areas used by humans, e.g., in the sink or bathtub. Always disinfect the maintenance area with a strong bleach solution or other disinfectant if working in these human-use areas is necessary.

Conclusion: *Uromastix ornatus* certainly ranks as one the most beautiful species of lizards in the world. The males are a sight to behold. In addition, they grow to a reasonable size and captives that are kept indoors have a personality which is as endearing as that of any bearded dragon or any other personable lizard species. *Uromastix* kept outdoors and exposed to sunlight quickly revert to their normal skittish and flighty behaviors; indeed, they appear to be very different creatures than the tame passive animals in our indoor vivaria. At the time of this writing, *U. ornatus* is being imported in some numbers and sold at a low price—which reflects neither their relatively low reproductive rate nor their population densities in the wild. Every effort should be made to establish this species in captivity and to solve long-term problems of maintenance and captive propagation while these creatures are still available.

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Acknowledgments

Special thanks to Randy Gray, Matthew Moyle, Jeff Jenkins DVM, Judy Veterinary Clinic, Roger Klingenberg DVM, and Douglas Mader DVM for support and input on various topics.

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Moody, S. 1987. A Preliminary Cladistic Study of the Lizard Genus *Uromastix*, with a Checklist and Diagnostic Key to the Species. In Proceedings of the Fourth Ordinary Meeting of the Societas Europea Herpetologica. (eds) J. J. Vand Gelder, H. Strijbosch and P. J. M. Borgers.

Philippe de Vosjoli is the author of the new booklet, *The Basic Care of Uromastix*, now available from Advanced Vivarium Systems, Lakeside, CA.

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AFH Invades Cyber World!

The AFH recently set up a Web site on the internet. We thank Ray Price of Irvine, CA for the use of his Web site and technical expertise.

The site is currently in beta form, but you can expect it to grow over the next year. It is a great way to preview our t-shirts, posters and limited edition prints. In addition, we will offer a selection of articles from THE VIVARIUM. Check it out and send us your feedback and suggestions to: 73132.2726@compuserve.com

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Annual Meeting

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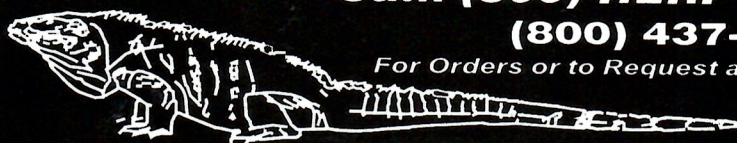
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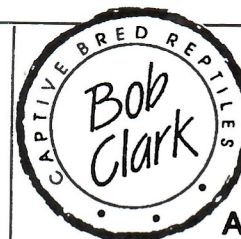


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November 11-12, 1995: California Family Pet Expo will be held in Riverside, California. For info, contact Rainforest Productions, 4500 Van Buren Blvd, Riverside, CA 92503, ph (909)352-3420.

November 11-12, 1995: San Diego Herpetological Society's Eighth Annual Reptile Show will be held in Del Mar, California. For info, contact: Jack Stafford, 820 Jefferson, Chula Vista, CA 91911, ph (619)691-8363.

November 12, 1995: Reptile Attraction's Annual Reptile and Amphibian Showcase and Sale will be held in Matamoras, Pennsylvania. For info, Contact: (717)296-5877 or (717)296-4235.

November 18-19, 1995: Reptile Expo presented by Cedar Hill Enterprises will be held in Phoenix, Arizona. For info, contact: Cedar Hill Enterprises, 3442 Primrose Ave, Santa Rosa, CA 95407, ph (707)578-Expo or fax (707)571-1111.

November 19, 1995: New York Metro Reptile Expo will be held in White Plains, New York. For info, contact: Bruce Lowder, NY Metro Reptile Expo, 256 Second St., Palisades Park, NJ 07650, ph (201)461-0770.

November 25-26, 1995: Third annual Pennsylvania Exotics & Family Pet Showcase will be held in Port Washington, Pennsylvania. For info, contact: Vicki Clark, Expo USA, 503 E. Penn Blvd., Woodbury, NJ 08096, ph. (609)848-3312 or fax (609)384-6704.

December 2-3, 1995: Reptile Expo presented by Cedar Hill Enterprises will be held in San Francisco, California. For info, contact: Cedar Hill Enterprises, 3442 Primrose Ave, Santa Rosa, CA 95407, ph (707)578-Expo or fax (707)571-1111.

December 9-10, 1995: Reptile Expo presented by Cedar Hill Enterprises will be held in Pomona, California. For info, contact: Cedar Hill Enterprises, 3442 Primrose Ave, Santa Rosa, CA 95407, ph (707)578-Expo or fax (707)571-1111.

December 16-17, 1995: California Reptile Expo will be held in Orange County. For info, contact: Rainforest Productions, 4500 Van Buren Blvd, Riverside, CA 92503, ph (909)352-3420 or fax (909)352-1079.

March 8-9, 1996: San Diego Science Educator's Association's (SDSEA) Twelfth Annual Conference will be held in San Diego, California. For info, Contact: Bart Hays, ph (619)444-2826.

May 11-12, 1996: International Reptile Expositions First National Symposium on Captive Husbandry of Varanids and Iguanids will be held in San Diego, California. For info, Contact: David Good, ph (800)850-1580.

June 26-30, 1996: Twentieth Annual International Herpetological Symposium will be held in San Antonio, Texas. For info, contact: Dave Humes, ph (201)427-0768.

July 13-14, 1996: International Reptile Breeders Convention will be held in San Diego, California. For info, contact: Ray Busby, IRBA, PO Box 8512-279, San Diego, CA 92186, ph (800)497-3550 or fax (619)263-6898.

August 16-18, 1996: National Reptile Breeders Reptile and Amphibian Art Show will be held in Orlando, Florida. For info, contact: Linda Taylor (941)294-6556.

August 17-18, 1996: National Reptile Breeders Expo will be held in Orlando, Florida. For info, contact: Wayne Hill, ph (813)294-2235.

September 14-15, 1996: Mid-Atlantic Reptile Show will be held in Baltimore, Maryland. For info, contact: Tim Hoen, The Maryland Herpetological Society, 2643 N Charles St, Baltimore, MD 21218-4590, ph (410)557-6879.

October 5-6, 1996: International Reptile Breeders Convention will be held in San Diego, California. For info, contact: Ray Busby, IRBA, PO Box 8512-279, San Diego, CA 92186, ph (800)497-3550 or fax (619)263-6898.

Editor's Note: Herpetological societies and organizations are encouraged to notify AFH of events of interest so they may be included in our Coming Events section.

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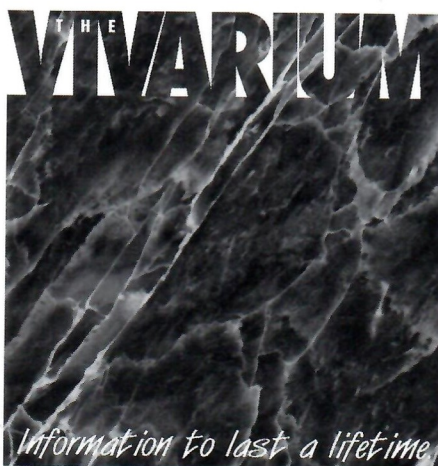
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Each manuscript submitted is reviewed by up to three referees. In most cases, the referees' comments are incorporated into a revised manuscript which is sent to the author for comment and approval. In some cases, especially those manuscripts with a substantial amount of missing information, the referees' comments are sent to the author who will then resubmit a revised manuscript for further review.

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LITERATURE CITED

Charles, N., Field, R. and R. Shine. 1985. Notes on the reproductive biology of Australian pythons, genera *Aspidites*, *Liasis*, and *Morelia*. *Herp. Review* 16(2): 45-48.

Scott, N. J., Jr., Maxwell, T. C., Thornton, O. W. Jr., Fitzgerald, L. A. and J. W. Flury. 1989. Distribution, habitat and future of Harter's water snake, *Nerodia harteri*, in Texas. *J. Herpetol.* 23(4): 373-389.

Verrill, P. A. 1988. Intrinsic male mating capacity is limited in the plethodontid salamander *Desmognathus ochrophaeus*. *J. Herpetol.* 22(4): 394-400.

ARTICLE IN BOOK

Halliday, T. R. 1983. The study of mate choice. In P. Bateson (ed.), *Mate Choice*, pp. 332. Cambridge University Press, Cambridge.

Waterston, A. R. (ed.) 1975. *Larousse Encyclopedia of the Animal World*. Larousse and Co., Inc., N.Y. 640 pp.

Wells, K. D. 1981. Parental behavior of male and female frogs. In R. D. Alexander and D. W. Tinkle (eds.), *Natural Selection and Social Behavior: Recent Research and New Theory*, pp. 184-197. Chiron Press, N.Y.

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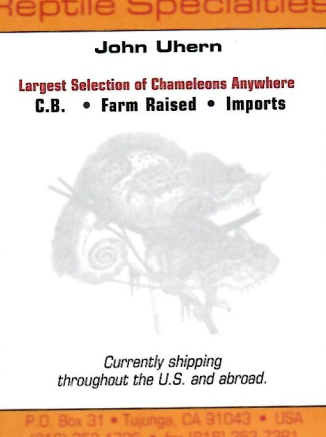
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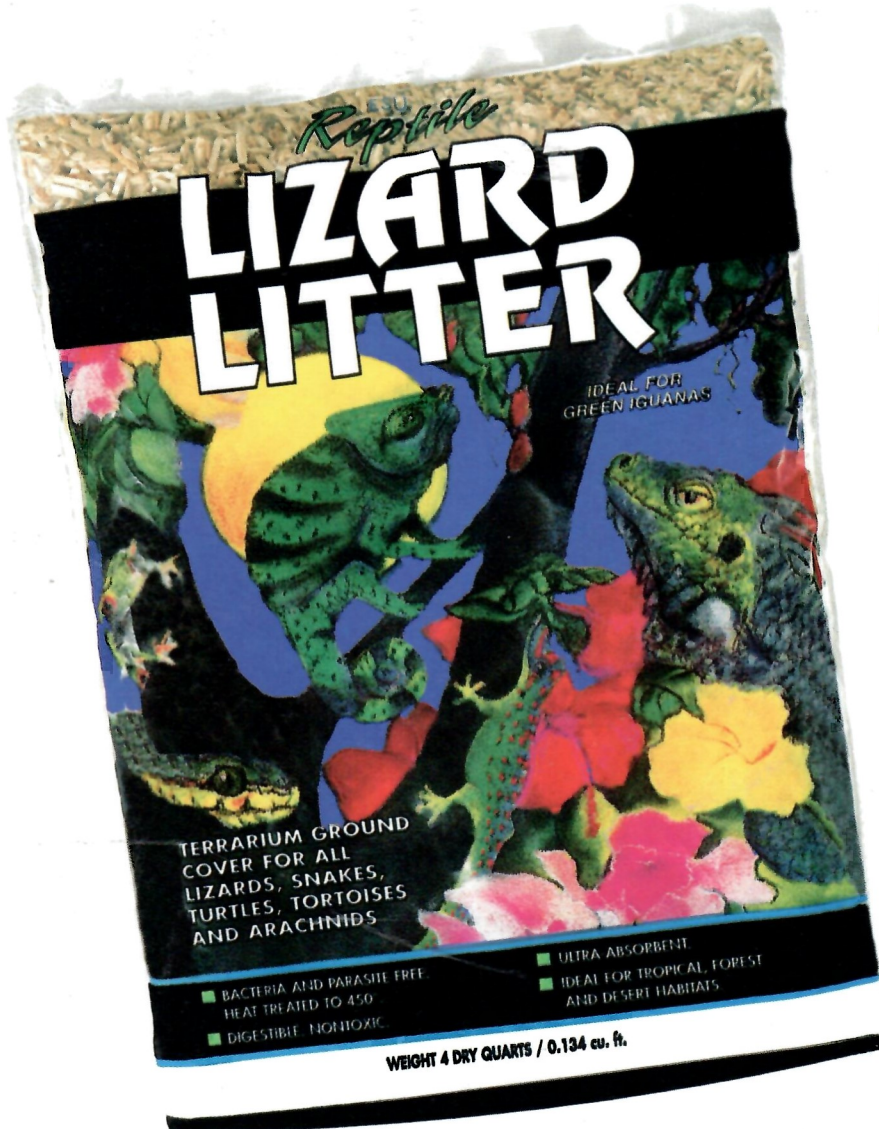


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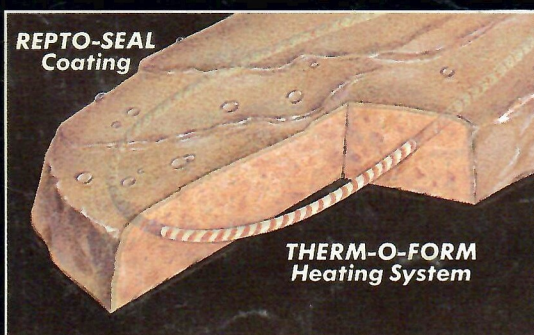
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