

the VIVARIUM

Journal of the American Federation of Herpetoculturists

Vol. 7 No. 6



BEARDED DRAGON SPECIAL!

- Water for Tortoises ● Preference For Formerly Frozen Mice By Seven Species of Snakes
Species and Morphs of Bearded Dragons ● The Misunderstood Gray Rat Snake
Captive Reproduction of Iguanas ● North American Garter Snakes

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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 \$28 for U.S. and \$36 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: Sandfire gold, *Pogona vitticeps*.
Photo by David Travis.

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

Since January of this year the AFH has gone through major reorganization. This long and tedious process caused numerous problems, most notably, an erratic magazine schedule. Changes were necessary to strengthen and streamline our internal structure, and we are confident that we will be able to offer our members better service and a nicer magazine because of this reorganization.

The AFH is steadily growing and we now have a record number of members. We have AFH representatives in many states, and partly as a result of their effort, we expect to double the circulation of the magazine by the end of the year. This is great news for all concerned!

Several months ago we decided to add a regular column on arachnids. I asked that readers write to me and offer their opinion on the new column. Many readers really liked the idea, others absolutely hated it. Although I received numerous replies, it is difficult to gauge overall reader opinion based upon responses from fewer than 1% of the readership (see Letters to the Editor). We will still publish arachnid pieces, but not in column format in each issue. This decision should please the purists and arachnophobes, and still provide a little diversity for those who actually like arachnids, and don't mind sharing a little herp space. I believe this is a reasonable compromise. We live and we learn!

I posted an E-letter in the rec.pets.herp newsgroup several months back. I asked readers of *The Vivarium* if they felt that our presentation of herp information was too "academic." I didn't receive many responses, but those received clearly indicated that our presentation of herp information hit the nail on the head! If readers are interested in further responding to this inquiry, please send responses to: Letters to the Editor (on disk if possible; address listed on masthead).

One of the most difficult duties of the Editor is to consistently produce a balanced issue—one that presents both technical and husbandry related articles in a manner that keeps the reader very interested and well informed. I believe we have accomplished this in the past, but I would like to hear reader opinion on this issue.

This is an exciting issue with expanded coverage on bearded dragons. Bearded dragons are an enormously popular saurian, very well suited for beginning and advanced herpetoculturists. Written by Robert Mailloux and Philippe de Vosjoli, this series of articles should prove invaluable for *Pogona* enthusiasts. We also have a great natural history article on North American gartersnakes written by Dr. Neil Ford. Gartersnakes are a well studied group, and Dr. Ford has made numerous contributions to our present knowledge of *Thamnophis* ecology. Dr. Ford is co-author

of the recently released book entitled, *Gartersnakes: Evolution and Ecology*.

Formal apologies are due Bill Love and Matt Russell for botching the orientation of three photos in the *Uroplatus* article in issue 7(5). In the same issue, a figure header was superimposed on a line drawing of an oocyst—barely noticeable, but a mistake none-the-less. Our apologies to Dr. Chris McAllister and Dr. Steve Upton. Finally, in issue 7(4) a couple of mistakes were made in the *Ensatina* article. Once again, our apologies to Danté Fenolio and Michael Ready.



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Successful Breeding of Green Iguanas, *Iguana iguana*, In a Seventh Grade Science Classroom

by
Doug Kranich

Reptiles have been a passion of mine since 2nd grade when I purchased my first 25 cent book on snakes. That beginning thirty years ago led me to my current collection of twelve breeding pairs of boids and colubrids. Perhaps it even influenced my interest in science education. Here in northern Maine, my 7th grade science students have had virtually no direct exposure to reptiles. Consequently, they seem to have a powerful curiosity and fascination about these wonderful creatures; an entire classroom can truly be captivated by the

presence of a live reptile. During the spring of 1992, Nate Kley, a friend and fellow 'herper' attending the University of Maine in Orono, had an attractive pair of green iguanas in his apartment. I mentioned how great it would be to add some iguanas to my classroom collection at school. To my surprise, he jumped right at the idea and donated them to the school. At this point the male's length was 30" (75 cm), the female's length 26" (66.3 cm). I built a cage measuring 2' x 2' x 4' (60 cm x 60 cm x 120 cm) which I considered appropriate.

In May of 1992, I brought my two new iguanas into the classroom, and they quickly adjusted to their new lifestyle and

settled down. My students were quick to discover that the animals were never named, so the male was declared Dino and the female Iggy. I was unaware of how much young iguanas ate and how fast they grow when fed and kept properly. The food supply was no problem. My garden supplied all the greens in summer and early fall. In winter and early spring, the produce section at the grocery store sufficed. This past year a new source was tapped, our lunch program. The cafeteria staff regularly sent left over salad vegetables up with students after lunch was over.

The daily maintenance of keeping these two lizards eventually became the eager responsibility of my students. They regu-



Nothing gets students' attention better than teaching with two 4 ft. iguanas.



Students preparing a nice variety of fruits and vegetables.



When the iguanas choose to bask on the cage top, they always seem to welcome the students' attention.

larly helped prepare salad each morning during my homeroom period. This provided one form of student-iguana interaction. Once the food was ready, students never passed up an opportunity to hand-feed the lizards, and I noticed that the iguanas would continue to eat hand-offered food longer than when they ate out of their own dishes. I remember one memorable occasion last May when I asked the students to keep track of how many consecutive dandelion flowers were eaten by the male while being hand-fed. I was astonished as I heard them keeping count and reaching the number fifty!

The other major interaction was students petting the lizards, which were usually basking on the cage top in the sunlight. The iguanas responded favorably to being touched and allowed almost anything except being picked up. This was one of my rules which I emphasized often, due to the possibility of a student getting scratched. Often the students would crowd around the cage before each class as the iguanas basked. The lizards never appeared stressed, in fact I believe they thrived in this noisy and active environment.

Teaching in a room that houses two large iguanas has presented some interesting challenges. Fortunately, despite their freedom to roam around the room this past year, they chose to spend almost all of their time basking on the cage top. This is the usual scenario and the iguanas are long forgotten by students once class begins.

Those who have had iguanas in a classroom know that it's not all fun and games. The reality is that in order to make it a

worthwhile experience, there's a good deal of planning and hard work involved. Fresh food must be provided daily. The cage and furnishings must be clean and presentable for hygienic as well as aesthetic reasons. The iguanas' husbandry needs must all be properly met in order to maintain their optimum health.

During their second year at school in September 1993, some changes were observed in the iguanas' behavior. Both were nearly four ft (1.2 m) long and sexually mature. Head bobbing of two types became evident, particularly with the male. The first was a repeated vertical movement of the head through the widest range possible. The second was a higher frequency movement through a much shorter range, usually directed toward the female at very close proximity.

Mock sparring matches occurred frequently. It was fascinating to watch these interactions. At first, they occurred inside the cage itself. I watched intently as the male would enlarge his body, stand on his tip toes, wag the tip of his tail like a stalking cat and advance toward the female, finally nipping at her flank. At first she would brace herself to keep from being pushed but then would finally try to escape. Her powerful back legs flung the substrate (rabbit pellets) until, within a matter of seconds, the entire volume was mounded into a rear corner of the enclosure. On occasion, the female was the aggressor by using identical tactics, but as a rule, the male still remained the victor. I never observed the intent to harm, only to dominate. The problem with all of this was the noise. It was happening frequently and was a major distraction during class. It was at this point that I decided to take a risk and allow the pair more freedom. By opening the cage door the conflict and noise were drastically reduced and provided the iguanas an escape if needed. The new freedom altered their behavior somewhat; further encounters were still intense but more abbreviated. The entire classroom was now their enclosure. This

arrangement worked well through 1994, but I decided to build a new and larger enclosure to display our two iguanas at school. I decided to keep them at home in their old enclosure until they could be moved to a new one at school.

While at home, I observed mating behavior on five different occasions over a seven week period between 24 February and 17 April, 1994. Each episode was similar. The male used his mouth to hold the female by the skin on the nape of her neck while his rear legs held her body in place. His tail was neatly tucked under her raised tail as copulation took place. No doubt this happened much more than what I witnessed. During the first two weeks in

continued on page 14



A tray of 16 eggs at day 60, showing the swelling which occurred during incubation.



The slightest disturbance at this point would send the lizard dashing from the egg.



This was the second iguana to hatch.

The Misunderstood GRAY RAT SNAKE

by
Thurgess and Eunice Cranston

An often overlooked rat snake subspecies, the gray rat snake, *Elaphe obsoleta spiloides*, makes an interesting captive. These animals grow quite large (over seven feet), are beautiful, and can be fairly hardy in captivity. The main reason this subspecies is overlooked is the nasty reputation for aggressive behavior many of the adults have. This is often true of wild-caught specimens. Captive-bred animals are fairly tractable if they are regularly handled from an early age. Furthermore, many wild-caught adults can be tamed down through regular, non-aggressive handling. We have maintained this subspecies in our collection since the fall of 1976, when a beautiful, light gray, six foot specimen caught our eye at the local pet store. This snake was maintained by itself

for almost 14 years, before we decided to acquire a couple of female gray rat snakes in an attempt to start a breeding program with this subspecies. During the winter of 1990, a young female was bought from a private breeder and an adult female was given to us from a friend on breeding loan. The juvenile female grew quickly and after 30 months, became large enough to breed. At that time, she measured approximately 40 inches (1.05 m) in length.

Gray rat snakes range from southwestern Georgia and northern Florida west to Mississippi and north to extreme southern Illinois and southwestern Indiana (Conant and Collins, 1991). According to these authors, the record length for this subspecies is 84.5 inches (214 cm). Our first breeder male reached a total length of approximately 80 inches (208 cm) and a weight of over four pounds (1818 grams) before he died at the approximate age of 21 years. These rat snakes are one of the few

rat snakes that maintain their juvenile pattern throughout their lives. The ground color is usually a light to medium shade of gray; the blotches are either a darker gray or brown. Our initial breeding stock originated from northern Florida, and is frequently referred to as the "oak phase." These animals have a light gray background with darker gray blotches—usually a very handsome beast, especially at maturity.

Captive Maintenance

In our collection, we maintain adult gray rat snakes in plastic Sterilite™ sweater boxes that measure 16" x 22" x 6" in size. The sweater boxes are housed in a melamine rack system manufactured by Sandmar™ Enterprises. We always provide a hide area on the warm and cool ends to let the animals regulate their body temperatures. The substrates we have used in the past include newspaper, paper towels, pine shavings (dustless and not



An adult gray rat snake, *Elaphe obsoleta spiloides*. This is a captive-bred individual. The mother was from northern Florida and the father was from unknown origin (but probably also northern Florida). This is the so-called "oak phase." Photo by Thurgess and Gern Cranston.



Sandmar Enterprises enclosures used for our larger colubrids, including gray rat snakes. Photo by Thurgess Cranston.

too strong in odor), and CareFresh™ animal litter. Heat, provided by heat tape, is utilized to provide a temperature gradient in the sweater boxes. Heat tape is routed into a groove at one end of the shelving system used to house our sweater boxes. The heat tapes are connected to a Helix Magnetics™ thermostat set at 92° F (31°C). Water is in with the animals at all times. Constant water availability is important with this species because they can dehydrate easily, causing problems with shedding, feeding, etc. Some sources (Rossi, 1992) recommend a sturdy climbing branch as part of the cage furniture for this arboreal subspecies. Our adult animals are fed three to four times monthly on adult mice. We humanely dispatch the mice before offering them to the snake or feed frozen, then thawed, mice.

Captive Reproduction

These snakes are fairly easy to breed in captivity. Our adults are brumated at temperatures to 50° F (10°C) for a period of three months. Prior to the cool down, snakes are allowed to "clear their guts" for a period of two weeks at normal temperatures. This practice prevents food from remaining in the gastrointestinal tract and rotting during the brumation period. During the spring "warm-up" these snakes can become fierce feeders, accepting all offered food immediately. Later in the year, most of our breeders are substantially shyer in their feeding habits. Adults are placed together within six weeks of the spring warm-up. Copulation usually ensues after the female has her first post-

emergence shed. Their breeding patterns follow the typical rat snake breeding sequences reported elsewhere (Gillingham, 1974; Brecke et. al, 1976).

Copulation lasts approximately 30 minutes. After breeding, our females are fed even larger amounts of food (approximately six to ten mice per month). We also provide a small amount of calcium (such as RepCal™ or Minerall™) by dipping the rump of the mouse into the supplement. This is to insure that females will have adequate calcium stores for egg development. Our females usually produce clutches within six to eight weeks after their initial copulations. Clutch size varies from 8 to 21 eggs with an average of approximately 15 in the ten clutches of eggs our animals have laid. The eggs are incubated in a vermiculite medium (at a 1:1 ratio by weight - vermiculite:water). The temperature in the incubator is 82° F (27°C). The eggs measure on average approximately 0.75 x 1.50 inches (1.8 x 2.8 cm). Neonates weigh approximately 8–10 g upon hatching after an incubation period of 60 to 70 days. Their length upon hatching ranges from 8.75 to 14 inches (22–35 cm). The young gray rat snakes can be quite feisty after hatching. In general, their feeding response is less strong than our corn snake neonates. These animals often need to be tricked into taking their first live pink mouse. Several of the tricks include lizard scenting, placement of the neonate and the pink mouse in a small "deli" cup and leaving them together overnight (Johnson, pers. comm.), and the infamous split-brain trick (Applegate, 1988). Other sources (Rossi, 1992) suggest the use of tree frogs, *Hyla* sp., as a potential food source for problematic hatchlings. As with any wild food item, there is always the potential for introducing parasites, so this alternative should be used only when other strategies have been tried and have failed. Usually after two months, over 90% of the neonates are accepting food on their own. Importantly, our young gray rat snakes are individually maintained in a shoe box rack. This allows the more reluctant feeders to develop a good feeding response and prevents the more aggressive feeders from eating a sibling! The animals are kept on paper towels with a small water bowl as the only cage furniture. On a diet of two appropriately-sized mice weekly, our young gray rat snakes reach a length of 22 inches (56 cm) at nine months of age. At that time, they weigh 1.63 ounces (40 g). Breeding size has been attained in as little as 18

months, although the normal time frame in my experience is 30 months.

It is a mystery to us why this beautiful animal is not more popular with reptile enthusiasts, especially beginners. Except for the initial difficulty in inducing the hatchlings to eat, and the sometimes nasty demeanor of wild-caught adults, these animals are like other rat snakes in terms of ease of care. They are powerful constrictors with a good feeding response. Their cost is reasonable, and successful breeding is straight forward, making them a worthwhile investment. These animals, especially when captive-bred, make an enjoyable addition to a collection or a great starter animal or single pet.

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HERP NEWS FROM AROUND THE WORLD

by
Ellin Beltz

TOKAY TWO GECKOS AND CALL ME IN THE A.M.

• Royal Ontario Museum herpetologist Bob Murphy is encouraging Vietnamese gecko hunters to turn into gecko breeders instead. Tokay geckos are getting few and far between where they've been intensively hunted. Geckos are an ingredient in traditional Asian medicine. Eating a Tokay reportedly relieves symptoms of tuberculosis, coughs and asthma. Murphy is looking for a few, good investors to help him get the project off the ground. "Even if you bred 100,000 [Tokays] a year, you wouldn't meet demand," he said. [New Scientist, September 9, 1995 from K&W HerpHaven]

THE WORLD GETS WEIRDER ALL THE TIME

• Toad wine fermented from a Cambodian toad mashed with honey and cane sugar is highly regarded as a cure for syphilis in Indo-China. Recently the "toad tittle" has become the best-selling liquor in the region, surpassing beer. [Wolverhampton, England Express-Star, October 31, 1995 from Mark O'Shea]

• "Gourmets in Hong Kong have a new delicacy: the tail from the Australian Crocodile. Its tender, pale-pink meat is reputed to increase the strength of those who eat it. The story of crocmeat became known after the Hong Kong swim team dined on the meat the evening before a major match, and subsequently won the Gold medal. The news spread quickly, and since then, local markets advertise the fare on little red signs imprinted with a white croc. A jar of the crocmeat sells for 30 Deutschmarks." [Welt am Sonntag, October 8, 1995 from West von Papineau and Kimberley Heaphy]

• Southern Indian drug addicts are trying to get high by trying to get snakes to bite them on their tongues. A drug therapy worker in Paloarivattom warned that snake venom can give addicts a 16 hour high but may be deadly. Dealers in Bombay and Goa have their snakes bite addicts' tongues for a price. [Tacoma News-Tribune, September 25, 1995 from Marty Marcus]

• "A member of the Iranian Parliament has made the bizarre claim that the international medical symbol, the snake and the caduceus, was Jewish and Freemason-inspired and has urged Iran's medical organization to solve the problem by designing a new one." [Dateline: World Jewry, October 1995 from Marty Marcus] Incidentally, the symbol represents the staff carried by Hermes in ancient Greek mythology. The snake wrapped around the staff represents fertility, wisdom and healing, all of which seem in short supply in certain areas of the world.

• Traditional healers in Cameroon reportedly burned a male and female crocodile to death because they said the animals were bewitched. Some local residents blamed the male for road accidents on a bridge under which the animal lived; others felt both of the crocodiles were at fault. A collection was taken to pay for the gasoline used for the immolation. [The San Francisco Chronicle, September 30, 1995 from Matthew and Laurie Aikawa]

GLOW-IN-THE DARK DINNERS?

• Workers wearing protective clothing and respirators surveying the "hot" zone around the Chernobyl nuclear reactor in Priapat, Ukraine have found mutant mice. The DNA from the mice is as different from normal mice as that between non-mutant mice and rats which diverged about 15 million years ago. [Tacoma News-Tribune, July 17, 1995 from Marty Marcus]

IGUANAS IN THE NEWS

• The Weekly World News reports that a 59-year old New York City man would have died from a heart attack if his pet iguana hadn't knocked over the phone and touch-toned 911. Police and paramedics responded. The police dispatcher said, "It was a one-in-a-million freak accident. We got a call and there was no one on the other end of the line. But I heard an agonized gasping and realized there was something wrong. So we traced the call and dispatched an ambulance - just in time to save the man's life." The man believes that he and his iguana have always had a special relationship, saying, "Somehow Lester read my mind and did what I was unable to do - call for help. No one will ever be able to convince me that what happened was an accident." [December 5, 1995 from Philip Venditto]

• A man was arrested and police seized \$3,275 which he had hidden in the aquarium housing three or four iguanas. The man allegedly was dealing *Cannabis sativa*, commonly known as marijuana. Other drug/herp stories over the years have included the iguana which allegedly ate the pot found growing in the yard and venomous snakes guarding the proceeds. Perhaps this guy just got confused, or something. [Ephrata, PA New Era, c. November 15, 1995 from Nancy and Michael Shrom]

• Ann Landers recently responded to a letter from a woman who became hysterical while visiting her brother and sister-in-law who had a pet iguana which lived in the spare bathroom. The woman repeatedly confuses "5-foot alligator" with "5-foot iguana" and wrote "I didn't get much sleep that weekend and I still shake when I think of it. Having an alligator in an adjoining room is not my idea of a restful weekend. Please tell me if something that looks like a crocodile is harmless and if an iguana can grow that big. No one in Grand Rapids has ever

seen one of those things." OK everybody in Michigan stop laughing now, please. It seems amazing after all these years that lizards are still experiencing fearful prejudice, but as the article immediately above shows, some people think lizards are scary. Fortunately, AFH and other herp societies members' letters to Ann Landers over the years have had an effect. Ms. Landers's reply is still a little off base but certainly not unreasonably prejudiced: "Iguanas can grow to be 5 feet long...That poor iguana was not meant to flop around in a bathtub. I hope your sister-in-law takes him to a zoo soon... Animals have rights, too." [Toronto Star, August 28, 1995 from Kimberley Heaphy]

"THELMA AND LOUISE" REPRODUCES

• The two-headed corn snake known as "Thelma and Louise" that lives at the San Diego Zoo reproduced in September, 1995. Just as thin as a pencil, and slightly over a foot long, the 15 babies hatched normally and are eagerly feeding on pinky mice. "Thelma and Louise" has one body, one spine, one set of internal organs and two heads. Zoo officials suggest she is the result of a twinning process gone wrong. [The Daily News, October 2, 1995 from Dale McDonald]

TOLL-FREE TUNNEL

• A 220-foot toad tunnel in Davis, California opened in September. Designed to provide toads with a safe way to cross a new roadway embankment. The senior engineer of the project for the City of Davis was interviewed for the report in the September 10, 1995 Oakland Tribune: "He explained that the tunnel was ordered after residents expressed fear that the road could prove a lethal barrier to young toads bred in the drain pond. Each spring, he said, lust-mad Western toads, the common, garden variety toad of Northern California, throng to the drain pond to engage in a frenzy of procreation. In due course, the tadpoles become young toads that set forth into the world to seek their fortunes. Every year things can get less than pleasant in the neighborhood as young toads by the legions lose their lives to passing cars." The toad tunnel should put an end to the unpleasantness. [from Matthew and Laurie Aikawa]

DA LAW'S DA LAW, DUDE.

• A 30-year old owner of a Deerfield Beach pet shop was charged with violating the federal Endangered Species Act by selling seven alligators and importing 80 pancake tortois from Tanzania. If convicted, the man faces up to 10 years in prison and a maximum fine of \$500,000. Assistant U.S. Attorney Lynn Rosenthal said, "South Florida is the single major spot in the U.S. for the importation or the dealing in illegal wildlife from South America, especially reptiles. It's a big trade with a lot of money involved." The defendant said, "You'd think I was a drug dealer the way they came down on

me . . . I dealt in illegal animals, that was my thing." His lawyer claimed that the defendant had been "selling reptiles for some time. And he does the best he can to comply with what can really be very complicated business. And to the extent that he may have stepped over the line, he may be held responsible." [The Miami Herald and Sun-Sentinel, October 21, 1995 from Alan W. Rigerman]

SNAKES ESCAPE HOUSE OF DOOM

- As reported from the Deseret News, November 5, 1995: "Four snakes and their owners made it to safety out of a burning house early Saturday. Two 12-foot pythons and two smaller snakes were saved by fire fighters and the snakes' owner, Mike Doom. . . [The] house caught on fire just after midnight. The cause of the blaze is unknown." [from David Webb]

OLDEST FROG FOUND

- A fossil frog discovered on a northeastern Arizona Navajo Indian reservation is providing a view of what could be the earliest known anuran. A paleontologist at the University of Pennsylvania named the 190 million year old fossil *Prosalirus bitis*. The name means "to leap forward-high over it" and is a combination of Latin and Navajo. Frog is a deity who can make floodwaters go down and who plays a role in human fertility according to Navajo tales. [The Providence Sunday Journal, October 22, 1995 from Joe Sousa]

ANOTHER PLACE BANS LONG SNAKES

- A 53-year old resident of Glenshaw, Pennsylvania has to drive several miles to visit his 10-foot long albino Burmese python which is staying with a friend outside township limits. The python is four feet longer than the law of Shaler Township allows, and still growing. Township commissioners refused to make an exception even though the python and its man did education programs. [The Daily Herald, December 5, 1995 from David Webb]

ACCIDENTAL TOURISTS

- "A passenger on a flight from Uzbekistan to Krasnodar, Russia, had his luggage confiscated on arrival when it was discovered to include 14 bags full of poisonous snakes." [Independent, November 16, 1995 from Mark O'Shea]

- U.S. Customs Service Agents working the Eagle Pass, Texas-Mexico border crossing found six live snakes in the toolbox of a pickup truck and eight more live snakes, wrapped in socks and pantyhose, stuffed in the truck's occupants pants. A Customs Agent was quoted that they'd never had snakes in jockey shorts before. The two men were fined \$800 and released to return to their California homes. The six green rat snakes, a boa constrictor, three bull snakes, two Sinaloan milksnakes, a Nelson's milk snake and one Nuevo Leon king snake were sent to the San Antonio Zoo. [Dallas Morning News, August 4, 1995 from Gwen Nordman]

- The Wolverhampton Express-Star reports that "passengers and airport staff fled in panic when a python arriving with a circus act escaped from its cage into the airport lounge in Doha in the Gulf state of Qatar. Airport fire-fighters and security guards were called in to deal with the 13-foot snake as it slithered through the arrivals lounge. They managed to trap it in a rubbish dump and it was returned to its cage, the Al-Sharq daily reported today. It escaped

while the circus awaited customs clearance." [from Mark O'Shea]

- The book, "Divorces from Hell" relates the story of a wife who mailed her ex-husband a venomous snake. Contributor Wes von Papineau added, "In our house, this sort of event would have been seen as a 'term of endearment'!"

NON-URBAN LEGEND?

- This is one of those stories that makes me wonder if it was real, or invented by some bored journalist in Nairobi who had been reading the reports from Malaysia. The Kenyan Daily Nation newspaper reports that in two incidents in early October, pythons tried to eat Kenyan boys. One incident occurred in the western part of the country where a boy was partially eaten before gamekeepers shot the python and found a large dog in its stomach. The other incident occurred in suburban Nairobi where a boy was being constricted until passerby beat the python to death with clubs and stones, then beat each other up in a dispute over who had the rights to the skin. [Tacoma, Washington News Tribune, October 30, 1995 from Alan Tuley and Marty Marcus]

FLOODING, CROCODILIANS AND PEOPLE

- The Associated Press reports that more than 100 crocodiles escaped from crocodile farms upstream from Bangkok, Thailand after floods. The escapees slipped into the river and all Bangkok was gripped by "Crocodile fever." School children crowd the banks of the city's canals trying to catch a glimpse of the reptiles and residents are trying to bait them to the surface. The Prime Minister is skeptical, but has . . . "ordered officials to keep an eye out." No crocodiles have actually been sighted in the city, yet. [The Oakland Tribune, September 29, 1995] The next month, the same sort of thing happened in Florida, when 20 inches of rain fell in southern parts of that state in less than 24 hours. A state of emergency was declared for four counties. Some neighborhoods became islands and alligators prowled from flooded canals right up to porches and front doors. "We thought it was a dog, but then we saw this huge gator about 10 to 12 feet long. The fish and game agent said not to try to catch it or bother it. No problem there," said a resident of Palm Beach County. [The Oakland Tribune, October 20, 1995 both articles from Matthew and Laurie Aikawa]

DROP IN SOMETIME

- "Although we have had some difficulty producing newsletters, the local group has been active with 2-3 dozen people at monthly meetings." [the December, 1995 newsletter of the Oregon Herpetological Society, P.O. Box 1518, Eugene, Oregon 97440-1518, sirenag@peak.org.]

- The New Zealand Herp Society holds two monthly meetings, one in Auckland, one in Southland and an irregularly scheduled meeting in Waikata. Visitors are welcome. If you'd like to visit New Zealand in your mind, you can subscribe to their journal Moko by writing: The Secretary, NZ Herpetological Society Inc., 50 Pupuke Road, Birkenhead, Auckland 10 New Zealand.

- Although I've never been to Oregon or New Zealand, I just got back from a trip to Hot Springs, Arkansas which has long been a resort community due to the soothing and medicinal waters boiling up from deep underground. Much

to my surprise I found one of America's herpetological treasures on Central Avenue across from Bathhouse Row. It's a museum named "Arkansas House of Reptiles, Inc." and it has one of the finest collections of hot herps and neat herps I've ever seen. Each enclosure was designed to provide an impression of the animal's natural habitat while still allowing the animals to be cared for easily. Michelle Branch and two assistants somehow manage to keep this whole place fed, tidy, and clean. It was fabulous to be in a place where such enthusiasm for herpetoculture shows!

THE HISSING OF SUMMER LAWN

- Summer sunshine following heavy spring rains in California brought out all kinds of sun worshippers, human and otherwise. "Everything [in Orange County] seems so benign, so ordinary. That's until a rattlesnake shows up or a red-tailed hawk scoops your new kitty off the front lawn. . . the vast sun-baked suburban sprawl. . . looks worthy of Good Housekeeping. . . yet all this has been plunked on top of a vibrant desert ecosystem. . . thousands of creatures have hung on, resisting the best efforts to drive them out. . . now, as the heat of summer glares down. . . see what a critter colony the place is. Scores of bunnies chewing up the grass; millions of tiny ants march in and out of the neat houses like they own them. To fetch the morning newspaper from the driveway means a dance around the huge snails gobbling up all the imported vegetation. . . the real king of the desert, though, is the rattlesnake. . . in the past two weeks, my family and neighbors have seen four western diamondbacks within striking distance of our house. . . mostly the rattlers make their home in the dusty canyons that divide the housing developments. But they also show up on the streets for an afternoon sunbath. We've not heard of anyone getting bitten, but a rattler is some unfriendly—none of those 'Have a nice day' vibes you get at the mall. Just a rattle and hostile glare. . . I like all these wild pets, and so do many of the neighbors. They live up an otherwise strictly controlled environment, and a rattlesnake is more predictable than a guy with a gun." [Sheila Whyte writing in the Toronto, Ontario *Globe and Mail*, July 8, 1995 from Capt. Wes von Papineau]

Thanks to everyone who contributed this month and to Jett, Matthew and Laurie Aikawa, Valerie Haecky, David Webb, Joe Taffis, Gary Young, Dennis Sheridan, Danté Fenolio, Mark Paul Henderson, K.S. Mierzwa, Sandra Schumaker, Alan Tuley, Kevin Larry, Mark O'Shea, and the folks at K & W Herp Haven who sent in duplicates, photos, cards, cartoons and other material not easily summarized. You can contribute, too. Fold each clipping as few times as possible. Be sure the date/publication slug and your name are firmly attached to each one with tape, not staples, and mail to me in care of AFH. Letters only by e-mail to uebeltzuxa.ecn.bgu.edu.



Ask the Experts

by Winston Card



Q. There is a small population of very interesting looking lizards living in my backyard. Some are a green color while others are a dull brown. However, all of them have distinctive dark bands around the neck and shoulders. My son would like to catch one or two of these interesting lizards and maintain them in a terrarium in his room for a while. Can you tell us what these lizards are and if they can be maintained in captivity?

El Paso, TX

A. It sounds like you have a group of collared lizards, *Crotaphytus collaris*, in your backyard. Collared lizards are medium sized, robust iguanids with long tails found in southwestern North America from eastern Oregon to the Mississippi River and south to northern Mexico. There are numerous species including *C. collaris*, found from eastern Utah and Colorado to southwest Illinois, south through central Texas, into Mexico and west into central Arizona; *Crotaphytus insularis*, occurring from southeast Oregon to western Idaho, and

western Utah, south into Arizona and southeast California; *Crotaphytus reticulatus*, ranging from the Rio Grande valley of south Texas to adjacent Mexico, and the Baja black-collared lizard, *C. vestigium*.

Collared lizards are found in rocky areas, usually associated with hardwood forest or low brush. These beautiful lizards demonstrate strong basking tendencies (heliothermic) and can often be seen basking on rocky outcroppings and boulders. The green specimens are males and the brown, females. During the breeding season, usually between April and June, females develop deep red lateral spots. Females usually lay up to a dozen eggs in midsummer. These handsome lizards are noted for their tendency to escape would-be captors by fleeing at high speeds on their hind legs. Collared lizards are tenacious creatures and will often bite when first captured.

They make fairly hardy captives when a few basic needs are met. Enclosures need to be large enough for specimens to move freely about. You will also need enough space to provide adequate thermoclines (see below). Caution should be used when housing newly acquired specimens in glass aquariums, as they may slam into the sides when disturbed and this can cause serious injury. If aquariums are to be used it might help to cover the sides with paper. The paper can be removed slowly over time, as the animal gets use to its new environment. Cage furniture should consist of a small pile of rocks, a few low plants, and perhaps a piece of slightly elevated cork bark for the animal to use as a refuge. Sand makes an adequate substrate, but should be sifted through fine screen often to prevent waste buildup. A small water bowl should also be provided.

In the wild this species eats primarily insects, but will also consume just about anything smaller than they are. For this reason its probably best not to house specimens with other smaller lizards. The captive diet should consist of crickets, mealworms, waxworm larvae, and any other domestic insects that happen to be available where you live. If possible, its

best to feed potential food items a balanced diet for a few days before being fed off, rather than dusting them with a commercial vitamin supplement. Although some additional calcium would likely benefit gravid females, over-supplementation is a common problem in insectivorous lizards.

Captive specimens will not survive without exposure to unfiltered natural sunlight or an artificial ultraviolet light source. In addition, since collared lizards are heliothermic it will be necessary to provide animals with a basking site. This is best accomplished by focusing an incandescent reflector spotlight on a small rock pile in the enclosure. Thermoclines of 80–95° F (26–35°C) are recommended.

If captive hatched specimens are simply unavailable in your area, and your son is intent on his desire to maintain this species in captivity, I would recommend that you limit his captives to just a few



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specimens. You should also take a fecal sample to a local veterinarian who specializes in reptiles. This will make the whole process of acclimating your specimens much easier. Maintaining a small number of these lizards (perhaps a pair) can be a learning experience for your son and might spark a deeper interest in biology if you can encourage him to read more about these animals. I have provided a brief list of references below that might be of interest to him.

Suggested Literature

Behler, J. L. and F. W. King. 1979. The Audubon Society Field Guide to North American Reptiles and Amphibians. Alfred A. Knopf, New York. 718 pp.

Dixon, J. R. 1987. Amphibians and Reptiles in Texas. Texas A&M Univ. Press, College Station, Texas. 434 pp.

Halliday, T. and K. Adler. 1987. The Encyclopedia of Reptiles and Amphibians. Facts on File, New York. 159 pp.

Pianka, E. R. 1966. Ecology and Natural History of Desert Lizards. Princeton: Princeton Univ. Press. 216 pp.

Q. One of my neighbors has a large man-made pond in his backyard with a large population of Florida redbelly turtles. He has offered to let me harvest

a few to put in my own pond. I would like to be able to sex these animals before I catch them so that I end up with a good sex ratio. Is there a way to sex redbelly turtles before going through the trouble of catching them.

Paisley, FL

A. Florida redbelly turtles, *Chrysemys nelsoni*, are fairly easy to sex if you can get close enough for a good visual inspection. Males are smaller than females, but if you don't know the age of the specimens this may not be much help. A more accurate method is to inspect the front claws which are much longer in males than in females. Also, males have much longer tails to accommodate the copulatory organ.



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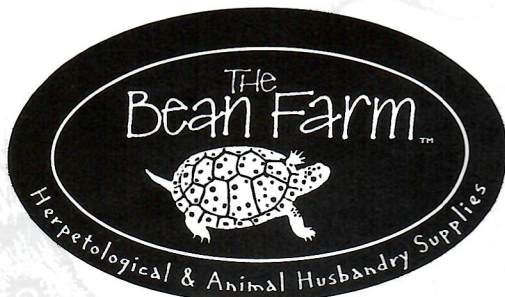
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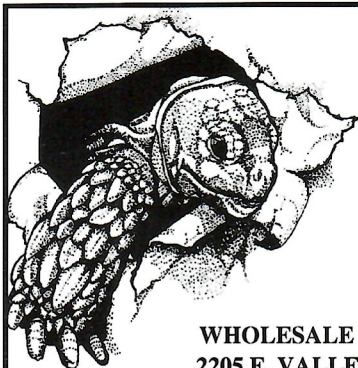


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Iguanas - continued from p. 7

April the female gained weight dramatically. My wife has taken only a casual interest in these lizards but even she noticed the increase in the female's weight.

A debate over which factors would be most vital to successful husbandry and breeding would no doubt include UV light exposure. The number of pages in herpetological publications devoted to lighting product advertisements would support this belief. Yet, my iguanas had minimal exposure to the proper UV light sources.

They were exposed to window-screen-filtered direct sunlight for three weeks in August 1993 and had only sporadic expo-

"The reality is that in order to make it a worthwhile experience, there's a good deal of planning and hard work involved."

sure to a Vita-lite (North Bergen, NJ) in their cage due to the minimal time spent there.

The day finally arrived for our iguana pair to be in their new cage at school. They seemed to respond well. The cage [5'high x 4'wide x 3'deep (1.5 m x 1.2 m x 9 m)] was roomy with lots of climbing space and a sufficient thermal gradient. The temperature was much easier to control with the 250 watt heat lamp suspended inside. Viewing was also wonderful with eight large glass panels covering the front and both sides. A ladder-type door was constructed to allow the lizards to climb to the cage top. Basking and student-iguana interaction were still possible. To maximize exposure to the sun, the cage's position was changed occasionally, by moving the cage on casters.

The female continued to grow. Both iguanas' appetites seemed phenomenal. The students' rumor was that the female was going to lay eggs, yet I was saying nothing to give them much support. As numerous students continued to ask, I began to answer "maybe." I also decided that I'd better get serious about her laying eggs, just in case.

During the second week of May, I placed a 13 gallon (49.4 L) plastic kitchen trash container filled with a 1:1 mixture of sand and peat moss on the cage bottom. Over the opening, I taped the lid with a 4" (10 cm) diameter hole cut in it. She began to try to "dig" into the solid glass and floor almost frantically. The bulging eggs appeared to be uncomfortable because the female chose to suspend her belly between two objects rather than rest it upon a flat surface. Despite that discomfort, she continued to eat voraciously along with the male. On June 1 I was pleased to walk into my classroom and finally discover the female inside the box digging around. The peat moss mixture was occasionally seen "splashing" against the back wall as it came flying out of the lid opening. June 2nd was truly a magic day. I walked into my classroom to get organized for the day and happened to glance back to the iguanas. The female looked like skin draped over bones and I realized what she'd been doing the previous day. I had no time to check anything as my homeroom students had already begun to stream in. Two of them spied the female and excitedly came to me saying "Mr. Kranich, Iggy laid her eggs!" The news spread through the homeroom in seconds, and it was the news of the day for the Millinocket Middle School.

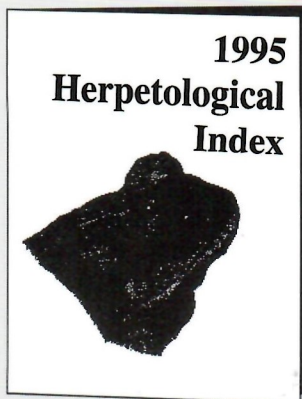
I intended to incubate the eggs artificially so they needed to be removed. I pulled off the duct tape holding the nest box lid in place, and I began to gently remove the peat moss by hand. It seemed odd to me that the volume of peat moss inside the nest box looked almost exactly the same as when it had been placed in the cage a few weeks before. I discovered the first egg on the lower left side of the box about 10" (25 cm) from the entrance. It was chalky white, 2" (5 cm) long and 1.25" (3.1 cm) wide; (all subsequent eggs turned out to be nearly identical). A plastic bowl containing peat moss served as temporary quarters to safely transport the eggs home. One by one as they were discovered, the eggs were placed in the bowl, maintaining the orientation in which they were laid. A total of 19 eggs were found.

My next job was to try to hatch all the eggs. Knowing of the infertility problem with captive bred iguanas, I tried not to let the students' hopes get too high. In addition to that, they had a hard time understanding that hatching wouldn't occur for nearly three months if they were in fact fertile.

Despite recommendations to incubate lizard eggs at 85 °F (29.5°C) (Alberts,

1995 HERPETOLOGICAL INDEX

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1993), I chose to incubate them with my colubrid snake eggs at 82° F (27.8°C). My reasoning was simple—I already had an incubator for the snake eggs set up and didn't have the supplies necessary to prepare a separate incubator for the iguana eggs. I used the following setup: A 10 gal. (38 l) aquarium had four bricks placed on the bottom and water was added to a level just below the brick height. Sheets of one inch thick Styrofoam insulation board were cut to size in order to cover all six sides of the aquarium. A piece of glass was also used to cover the top and finally, an aquarium heater was placed in the water and calibrated with a thermometer to 82° F (27.8°C). The 19 eggs were placed in a 1 gal. (3.8 l) covered tray of moistened vermiculite. The plastic tray's four sides each had two 1/8" (3 mm) diameter holes for air exchange. Eggs were placed half buried in the medium no closer than 1/2" (12.5 mm) to any other egg. The entire covered tray was placed in the incubator.

The eggs were checked daily for any signs of change. Within one week, two eggs began to mold and shrivel up and were removed. Further daily inspections found no problems until day 45 when another egg appeared to be in trouble. It had started to turn yellow and had begun to

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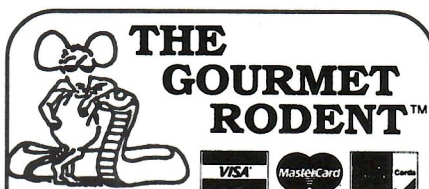
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collapse. Upon removing and opening the egg to check on its progress, I was both saddened and excited to discover a perfectly formed live pink lizard approximately 7" (17.5 cm) long. I don't know why the egg developed so differently from the others, but I decided not to touch any other eggs if similar changes occurred. By day 60, most of the eggs had increased in size dramatically, nearly closing the original 1/2" (12.5 mm) gap between them.

On 9 August (day 70) I was out of town with my family and returned late in the evening. A routine check provided an unexpected surprise as I removed the lid from the iguana egg tray. At that moment, a lizard shot out from the tray onto the workbench. I have never had difficulty moving hatchling snakes around, but I discovered that transferring newly-hatched lizards by hand is a different story. Photographing the event was also more difficult than I had anticipated because once the iguanas had slit their shells and poked their heads out, the slightest disturbance would send them dashing directly out of the egg.

In all, 15 of the remaining 16 eggs hatched normally over a period of 10 days. Despite varying egg size, all the hatchlings were virtually identical in length 10 1/2" (26.3 cm) and weight 1/2 oz. (13 g). One variable was very obvious though, the size of their yolk sac. I observed the sacs' disappearance occurring in two ways. Some of the sac was absorbed as nutrition, while the remainder simply dried up and fell off, usually within two days. I determined that one egg was going to require some assistance. This egg had sunken in around the shell and a light touch usually initiated a strong movement from within. Four days had passed since all surrounding eggs had hatched, hence the decision to assist. A small slit and flap were cut into the top end of the shell. A fully developed lizard was observed and it continued to move when gently prodded, yet no attempt was made to leave the egg in the next 12 hours. I decided to continue carefully cutting the egg shell away. The hatchling's upper body swung away from the egg but it just groped in the vermiculite, a far different behavior than the others; something was obviously wrong. Closer inspection after three days of this suffering revealed the problem. The iguana had absolutely no trace of its two front legs. At that point the lizard was euthanized.

All the hatchlings appeared healthy with bright eyes and a high activity level. At first, the slightest movement, including a hand reaching into their cage, caused panic. This subsided a little each day as the

iguanas became calmer and more willing to be picked up. The first oral intake I observed was the licking of finely diced cucumbers, soon followed by consumption of all finely chopped greens. The lizards were all eating what was offered to them within two weeks of hatching, some as quickly as three days. Some appeared to balloon in size from eating such large amounts of food. An overhead 75 watt heat lamp pro-

"This egg had sunken in around the shell and a light touch usually initiated a strong movement from within."

vided daytime temperatures up to 95° F (35°C), while an under-tank heating pad maintained an 80° F (26.7°C) reading at night.

This was a tremendous learning experience for me and for my students. I believe all of my colleagues, particularly the seventh grade teachers, gained knowledge about iguanas and nature as well. I know they gained a respect for the students' powerful interest; it was often a topic at our planning sessions. The afternoon custodians gave a lot of their attention to the pair of iguanas and often shared their observations with me. Everybody wants to know what's happening with the lizards, and I never tire of explaining what I can. Likewise, students like to share what they've learned; I have often listened to students with little academic motivation explain to their peers the finer points of iguana husbandry. These reptiles have flipped on the curiosity switch like no other tool in my classroom.

I often wonder if this breeding sequence I've described will be repeated in the coming year. Certainly I will not try to interfere with the process. If I were to hypothesize which factors were most important in breeding our pair of iguanas and producing fertile eggs, four would stand out in my mind. First, the iguanas had the freedom of a large classroom-size enclosure. Second, they appeared to be in a no-stress environment. Third, they had great exposure to the naturally occurring photoperiod. Lastly, they received a highly-varied diet entirely of freshly prepared fruits and veg-

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etables lovingly provided by a group of seventh graders excited about science, herpetology and herpetoculture!

I thank two of my colleagues, Marian Fowler and Danny Johnston for their time and professional expertise in assisting me with the production of this article.

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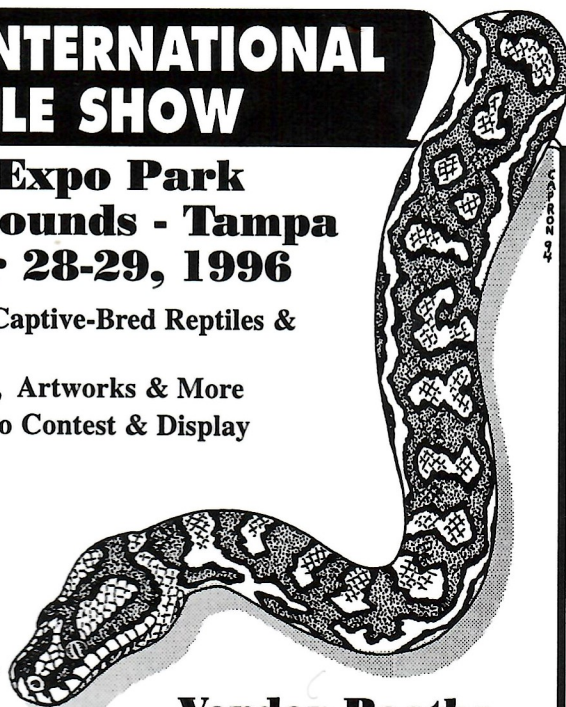
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Preference for Formerly Frozen Mice Over Freshly Euthanized Mice by Captive Snakes of Seven Species from Families Boidae and Colubridae

by
**Vernon Veer,
David Chiszar, PhD
and Hobart Smith, PhD**

Love (1993) claimed that formerly frozen mice promoted better digestion and faster growth in snakes than did fresh mice, presumably because freezing ruptures many cell membranes, exposing cytoplasm to snake digestive enzymes. Snakes feeding on fresh mice must first lyse the cell membranes of prey, before cytoplasm becomes accessible. Hence, formerly frozen prey might be digested more completely and with less energy expenditure by snakes than is the case for fresh rodents, resulting in greater growth rate.

Although some snakes will not accept thawed mice, this is rare (Van Sooy, 1994) provided that thawed prey are warmed to normal body temperatures near 100° F. Indeed, it has been our experience that thawed and warmed prey are readily accepted by most individuals of numerous ophidian species. Love's article suggests the possibility that formerly frozen mice might even be preferred by snakes over fresh killed prey because the ruptured cell membranes of the thawed and warmed carcasses should give rise to chemical cues not present in comparable quantities in fresh prey. If odors and vomodors arising from exposed cytoplasm and other intracellular fluids stimulate investigation and ingestion by snakes, then formerly frozen rodents should be preferred over fresh counterparts. The present study was designed to test this hypothesis.

Method

Twenty-two snakes in the collection of the first author (7 *Lampropeltis getula*, 2 *L. ruthveni*, 1 *L. mexicana*, 3 *Elaphe guttata*, 1 *Acrantophis dumerilii*, 4 *Lichanura trivirgata*, 4 *Morelia spilota*), maintained individually, were observed when a pair of euthanized mice (*Mus musculus*) were placed into the home cages for 10 min. Mice were at identical body temperatures (90° - 95°F) and were wrapped in hardware mesh bags that were mounted on a wood platform (6 × 6 in). This apparatus was

placed into a snake's home cage and all tongue flicks aimed at each bag were recorded for 10 min, as were all attempts to grasp each bag.

Cage temperatures were maintained at 80° F (27 °C) and photoperiod was 14L - 10D (photophase: 0600-2000). Snakes were normally fed *Mus musculus* during photophase, and all observations were made during photophase. Snakes had been deprived of food for 7-14 days prior to observations, and a single *M. musculus* was presented within an hour after each observation. Repeated observations on the snakes were always separated by at least seven days.

All snakes were sexually mature and had been in captivity for at least one year, feeding on *M. musculus*, both fresh killed and formerly frozen.

Results

All snakes investigated the mice on all trials. The thawed carcass received an average of 120 of these tongue flicks (range: 14-368), whereas the fresh carcass received an average of 65 tongue flicks (range: 0-177). Because of the large ranges for all of these statistics, it was necessary to place scores on a common scale. Hence, tongue flick counts for each snake were converted to percents by dividing the number aimed at each mouse by the total aimed at both (Table 1). Percents were averaged over repeated trials for each snake, and then the scores were averaged over snakes for presentation in Table 1. The difference between values for thawed versus fresh prey was assessed by a single sample t test comparing the mean percent of tongue flicks aimed at thawed carcasses to 50%, the value that would be expected if no preference existed ($t = 2.61$, $df = 21$, $p < 0.05$). This significant value confirmed that thawed prey were investigated more than were fresh ones.

A total of 158 grasp attempts were observed, 118 aimed at thawed carcasses and 40 aimed at fresh ones. The difference be-

tween the means shown in Table 1 was significant ($t = 2.10$, $df = 21$, $p < 0.05$). Of the 22 snakes, 14 attempted to grasp prey. Ten of these tried more often at the bag containing a thawed mouse than at the bag containing a fresh one.

We do not have adequate sample sizes to test for differences among the seven species of snakes studied here, and no such tests were conducted. However, we should point out that all individuals responded similarly in the tongue-flick measure, di-

Table 1

Mean Percent of Tongue Flicks and Mean Number of Grasps Aimed at Thawed and Freshly Euthanized Mice by Twenty Two Snakes.

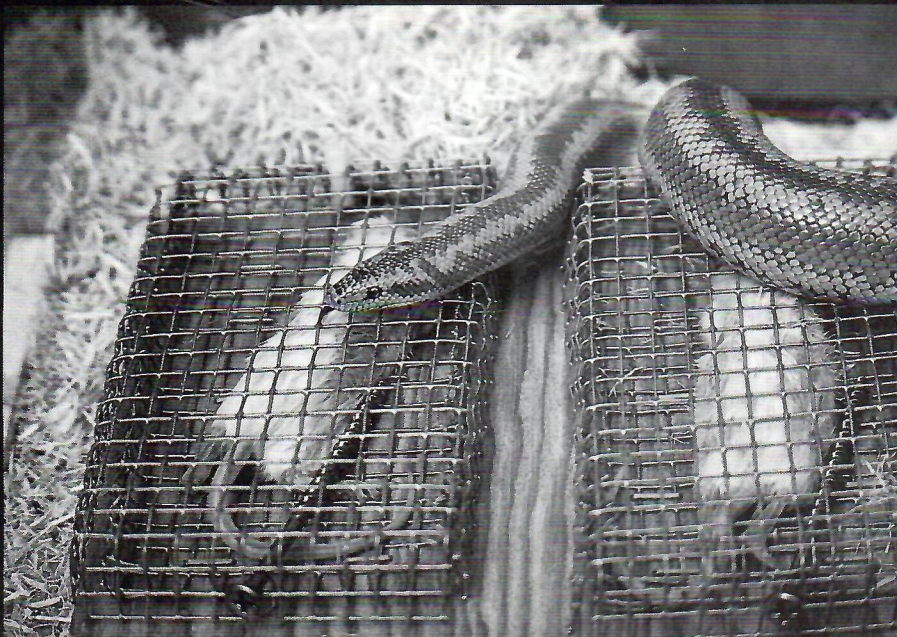
	% of Tongue Flicks		Number of Grasps	
	Thawed	Fresh	Thawed	Fresh
Mean	60.0	40.0	5.4	1.8
Standard Error	3.7	3.7	1.9	0.5

recting more tongue flicks at formerly frozen prey than at freshly euthanized ones. Hence, this preference has comparative generality. Subsequent comparative studies may reveal species differences in the magnitude of the preference, but we expect that most rodent-feeding snakes will exhibit some degree of preference for formerly frozen over freshly euthanized prey, provided their temperatures are equal.

Discussion

All of our snakes probably would have eaten both mice in each test if this was permitted. Accordingly, there is no question in our minds that thawed and fresh mice are palatable to the snakes studied here. By blocking ingestion, we forced the snakes to exhibit only pre-ingestive behaviors, and this allowed us to observe that significantly greater attention was directed to the thawed carcasses. We conclude, therefore, that the suggestion arising from Love's (1993) article is correct in that physiological consequences of freezing and thawing result in rodent carcasses with enhanced appeal. A practical importance of this finding is reflected by cases in which formerly frozen prey are more readily accepted than are fresh prey. At present we are aware of only one anecdote along these lines involving a king cobra at Rapid City Reptile Gardens that would accept only formerly frozen

A Rosy Boa, *Lichanura trivirgata*, identifying a previously frozen mouse, now thawed and warmed.



A Corn Snake, *Elaphe guttata*, in the process of sampling chemical information from the two mice.



Gray-banded Kingsnake, *Lampropeltis alterna*, tested after the completion of the study reported here, also behaved in a manner consistent with our results, preferring previously frozen over freshly euthanized mice.



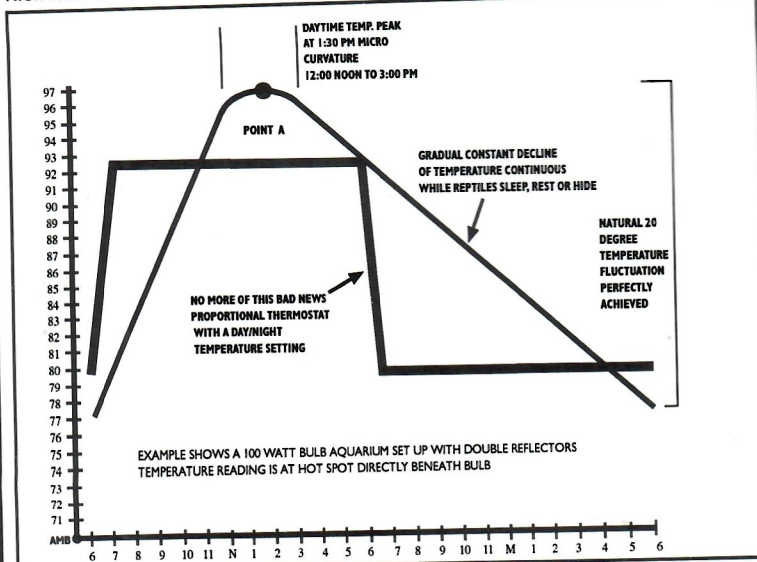
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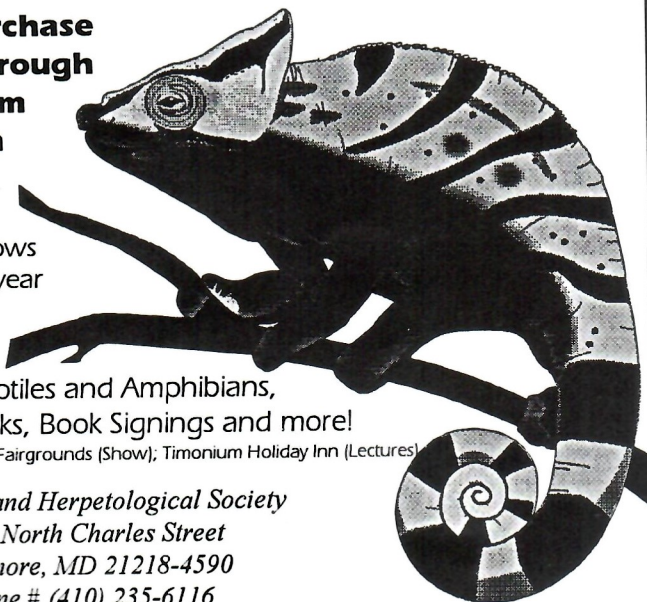
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snakes as prey, never live or fresh killed
snakes (Earl Chase, personal communica-
tion to HMS).

Although numerous snakes are known to
take carrion, we believe it would be an er-
ror to link the present results with this be-
havior, partly because the chemical cues
associated with tissue decomposition in
carrion are unlikely to have much in com-
mon with the chemical cues arising from
freezing and thawing, and partly because
ingestion of carrion appears to depend upon
detoxifying specializations that are not in-
volved in digestion of thawed but
nonputrescent prey. Until we learn more
about chemical effects of freezing and
putrification, it is probably wise to keep
these phenomena in conceptually separate
categories.

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gravel and water as long as the leaves are not submerged. It will also grow if cut sections are planted in moist green moss such as is often used as a surface substrate in gravel bed vivaria. It does best if kept well watered but not soggy when growing in potting soil. This is a tropical plant that requires warmth.

Lighting: At least one fluorescent bulb but preferably two or more within 18 inches of leaf surfaces.

Types of vivaria: Tropical and gravel bed shallow shoreline vivaria.



Zebrina pendula, is a beautiful plant that can be used as a rambling ground cover or grown in an elevated area such as a hollow log. Only the smallest herps can be kept with this species.

Uses in vivaria: The silvery wandering jew is best used as ground cover or as a hanging trailing plant if planted in a raised cavity in wood or rock. It is only recommended with small species of amphibians and reptiles. With medium species there is the risk of these plants being damaged although they will work with arboreal species such as larger anoles or medium-sized geckos. This plant is also ideal as a ground cover or water-edge plant in gravel bed shoreline vivaria. The standard method is to add this plant at the end of the vivarium landscaping, inserting cut sections in wet gravel or in the green moss substrate surface.

Propagation: Propagate this plant by cuttings which will easily root in perlite, soil or water.

Maintenance: This is a fast growing plant and it needs to be pruned regularly or will invade your vivarium and cover the surfaces of low-growing plants.

Boston Fern
Nephrolepis exaltata cultivars and
Pigmy Sword
Nephrolepis duffii
Polypodiaceae

Of the many plants we tested few ferns survived indoor vivarium conditions for very long. These *Nephrolepis* are some that have proven reasonably hardy in tropical and subtropical vivaria. They are commonly available in plant stores as small potted plants as well as hanging baskets.

Country of origin: *Nephrolepis exaltata*. Widespread from Florida to Brazil, Africa and from Southern Asia to Australia. *Nephrolepis duffii* is from New Zealand and Polynesia.

How to grow: These ferns should be grown in a good quality potting soil either in pots or directly in the vivarium. They do best at moderately warm temperature, so should be placed at the cool ends of tropical vivaria. Keep moist but not soggy.

Lighting: One to two fluorescent bulbs within 18 inches of plants.

Types of vivaria: Tropical and subtropical.

Uses in vivaria: These ferns grow moderately tall so can be used as background or midlevel plants in the design of vivaria. Ferns can tolerate little physical abuse so they are a bad choice with species likely to make frequent physical contact with them. They work with small amphibians and reptiles better than with medium species. We have had good luck in setups with alligator lizards (*Elgaria multicarinata*), with anoles, small frogs, fire-bellied toads

and Bibron's geckos. A key factor for success is not to keep these ferns too wet or too dry. Mound type of plantings work well with these species. Use a low density of animals with these ferns.

Propagation: By division.

Maintenance: Remove old fronds as needed. Keep moist but not soggy. Remove divisions if plants get too large.

Bird's Nest Fern

Asplenium nidus

This is another kind of fern which can be grown successfully in vivaria but it is by no means an easy species. After several failures, an experiment was done using the mound approach to vivarium planting, essentially piling the growing medium to form a mound at one end of the vivarium. This led to success. A well drained airy soil is essential; soggy soil will kill them.

Country of Origin: Wide range from India to Queensland, Australia to Japan.

How to grow: The bird's nest fern can be grown on vivarium substrate mounds, in epiphyte logs or in elevated growing areas such as hollows in logs or porous rock. The soils needs to be airy and peaty. Small orchid grade orchid bark is a useful addition to the mix. Keep moist but never soggy. These ferns like light. At least two fluorescent bulbs at 15-18 inches of leaf surfaces is recommended. These ferns like heat and high relative humidity of at least 70%. Temperatures in the mid 70's to upper 80's should be provided. If things aren't right this species will quickly let you know by producing atrophied, deformed or narrow frond growth or with browned frond edges.

Types of vivaria: Tropical/rainforest.

How to use in vivaria: This is a species that grows large and in due time will overtake most vivaria. Nonetheless until it reaches that point, which can take several years, it can make an outstanding showpiece once adapted to vivarium conditions. The fronds are leathery but too thin for medium herps with sharp claws. Best used with small to medium frogs, arboreal salamanders, anoles, geckos and small to medium tropical snakes.

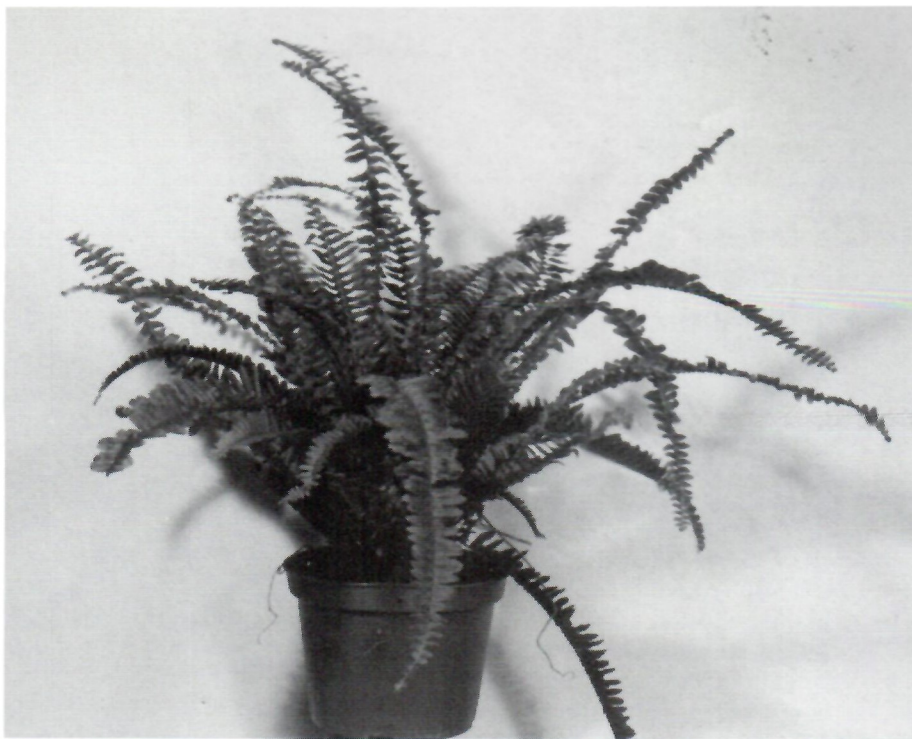
Propagation: By spores. It's easier to buy them as small plants from nurseries.

Arrowhead Plant

Syngonium podophyllum
and cultivars

Araceae

Arrowhead plants are among the most common potted plants sold in the trade. They are available in pots and hanging baskets. There are several varieties, some



Nephrolepis exaltata is a touchy species to use in vivaria. Soggy soil, dry air and too warm temperatures can lead to its demise.



Top view of a birdsnest fern (*Asplenium nidus*).



The birdsnest fern in a vivarium with miniature waterfall. In the wild it is often found above ground level almost growing as an epiphyte.

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of which can be quite impressive in a well designed vivarium. Several other species of *Syngonium* are occasionally available through mail-order catalogs and will be covered in future articles.

Country of Origin: The arrowhead plant is found from Mexico to Costa Rica.

How to grow: This hardy species can be grown in soil, in water or in gravel bed vivaria. It does best at warm temperatures.

Lighting: One or more fluorescent bulbs within 15 inches of leaf surfaces.

How to use in vivaria: This aroid thrives in tropical vivaria and gravel bed shoreline vivaria. It does have certain limitations because of the thin stems and leaves which initially may grow vertically but in time can produce vinelike trailing growth.

They are a good choice with smaller species of amphibians and reptiles. They are outstanding for gravel bed vivaria designed for poison dart frogs, small frogs

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An attractive arrowhead (*Syngonium*) cultivar with strong variegation used in combination with other vivarium plants.



Arrowhead plants like moist tropical and shoreline vivaria. Although they initially clump they eventually become scrambling vines.

and small tropical lizards. Because of their rapid growth, they need to be pruned regularly and because they may in time sprawl, they may have to be replanted so that they remain vertical. In large vivaria, they can be planted in concealed pots and the trailing vines allowed to hang.

Some of the varieties such as the white variegated form can add color to an otherwise dull vivarium.

Propagation: From cuttings or divisions which will root readily even in water.

Maintenance: Prune back when needed and plant vertically when needed. Remove divisions if it becomes too bushy. Remove dead leaves and stems.





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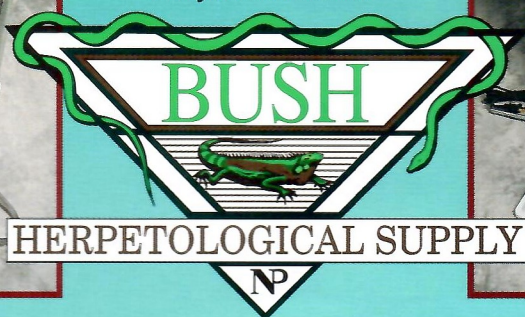


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VITTIKINS DRAGONS

by
Marcia Rybak

Mating readily occurs between the inland bearded dragon, *Pogona vitticeps*, and

the Rankin's dragon, *Pogona brevis*, when they are kept together. The resulting hybrid offspring, which I have dubbed "vittikins" share a combination of features from the two parent species. Features such as body

I acquired the five original vittikins in my collection from two sources. Three came from an unintentional mating between a female *P. brevis* and a male *P. vitticeps*. The other two were sold to someone else as *P. brevis*, but as the dragons grew it became obvious they were vittikins. (see Table 1).

The vittikins make a wonderful pet. Their relatively small size allows for housing in a 60-gallon aquarium, which is usually the largest stock tank sold in pet shops. Many reptile owners find it too costly to have a custom cage built for a large lizard, so a compact size becomes an important factor when selecting a pet. The care and maintenance of these animals is the same as for bearded dragons in general. In addition, my vittikins exhibit a temperament more outgoing than *P. vitticeps* even into adulthood and will eagerly eat any suitable food items put in front of them.

Vittikins are not sterile as is sometimes the case with hybrids; they are prolific breeders, producing vigorous young. My four females laid at least three clutches of eggs each and one female laid four clutches (Table 2). Upon hatching, second-generation vittikins had similar weights and lengths to those of the first generation but as they began to grow noticeable differences appeared. While most young vittikins looked like their vittikin parents, some of the young favored *P. vitticeps* and some favored *P. brevis*. It will be interesting to discover the genetic trail that future offspring will follow if subsequent breeding occurs.

There is some controversy regarding the creation of hybrids in herpetoculture. As long as hybrids are properly identified as such, I don't feel there is a problem. The problem occurs when a hybrid is represented as a purebred species either on purpose or accidentally, as was the case with two of the vittikins I acquired. To avoid confusion, make sure you keep good records and properly identify your animals.



Vittikins dragon in defensive posture. Photo by David Northcott. Nature's lens.

Table 1

Vittikin	Sex	Weight	SVL	Ttl. Length
#1	M	163 g	15.2 cm	35.6 cm
#2	F	205 g	15.9 cm	37.5 cm
#3	F	156 g	14.0 cm	33.0 cm
#4	F	142 g	14.0 cm	28.6 cm
#5	F	130 g	14.6 cm	33.0 cm
Averages		159 g	14.7 cm	33.5 cm

size, head shape, spine length and number, temperament, tail length, color and pattern. *Pogona vitticeps* and *P. brevis* are sympatric, meaning their ranges overlap. Little is known of *P. brevis* and very few specimens have been collected for study but this hybridization may very well occur in the wild.

Table 2

CLUTCH 1					CLUTCH 2			
	Date Laid	Date Hatched	# of Eggs	# Eggs Hatched	Date Laid	Date Hatched	# of Eggs	# Eggs Hatched
#2	03/16/95	05/15/95	8	8	03/29/95	05/20/95	9	9
#3	03/18/95	05/18/95	7	7	04/29/95	06/28/95	8	8
#4	03/18/95	05/15/95	9	8	04/28/95	06/25/95	15	13
#5	03/21/95	05/18/95	17	15	04/28/95	06/23/95	16	15
CLUTCH 3					CLUTCH 4			
	Date Laid	Date Hatched	# of Eggs	# Eggs Hatched	Date Laid	Date Hatched	# of Eggs	# Eggs Hatched
#2	04/29/95	06/29/95	7	7				
#3	06/11/95	08/07/95	9	8				
#4	07/20/95	09/15/95	10	7				
#5	06/09/95	08/05/95	15	10	07/24/95	09/18/95	17	9



Vittikins dragon, *Pogona vitticeps* x *P. brevis*. Photo by David Northcott. Nature's lens.

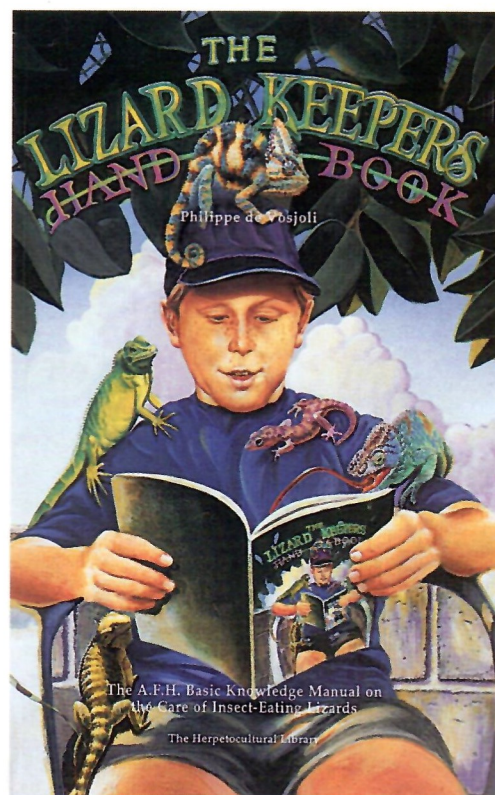
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Species and Morphs of **BEARDED DRAGONS** *Pogona* in U. S. Herpetoculture

by
**Philippe de Vosjoli and
Robert Mailloux**

Bearded dragon is a popular term for certain members of the genus *Pogona* which display a prominent "beard"—the result of muscular depression of the hyoid apparatus causing the extension of a gular pouch when threatened. For the purpose of this article all members of the genus *Pogona* are called bearded dragons, although all do not display "beards". There are eight species in the genus *Pogona* (family Agamidae) which is endemic to Australia.

The origins of bearded dragons in U.S. herpetoculture can be traced to the early 1980s when several dealers imported both adult and captive-bred specimens from Germany. The authors purchased several of these imports and were the first to develop large scale breeding programs for these species in the U.S., initially with the bearded dragon, *Pogona barbata*, and

Rankin's dragon, *Pogona brevis*, and later the inland bearded dragon, *Pogona vitticeps*. In the long run the inland bearded dragon proved more consistent and easier to successfully breed over multiple generations than the two former species. It is currently one of the most popular species of lizard captive-bred today. Although a very small number of the smaller *Pogona* species, (*P. minima*, *P. minor*), also became available in the 1980s; there were not enough imported to allow establishing viable captive populations. In addition, the commercial potential of these small species appeared limited. U.S. captive populations of small *Pogona* species have since dwindled into herpetocultural oblivion. Today the bearded dragon, *Pogona barbata*, and Rankin's dragon remain in a precarious position in the hobby. Because of difficulties in multigeneration breeding they cannot be said to be established as self-sustaining populations in U.S. herpetoculture.

The following article is an overview of the species of bearded dragons currently in U.S. herpetoculture, with a special emphasis on morphs, some of which have been selectively bred by commercial breeders.

Inland Bearded Dragon

Pogona vitticeps

Along with the leopard gecko, this is a lizard species which is in the process of being domesticated for the pet trade. It has all of the characteristics of an ideal reptile pet: dinosaur like appearance, attractive, handleable and a propensity for tameness, interesting behaviors, omnivorous feeding habits, relatively easy to maintain and a near ideal size which can be easily accommodated in one's home (in contrast to green iguanas), yet not so small that it can be easily injured or lost. The inland bearded dragon is found over a large area in the eastern half of central Australia and displays a range of variation in terms of size, color and pattern. Specimens from the southern central portion of the range where



Young Sandfire morph of the inland bearded dragon, *Pogona vitticeps*.
Photo by David Travis.

desert sands are bright orange are said to be the source of the red and orange colored morphs which are becoming so popular in the trade. In addition captive-bred inland bearded dragons demonstrate a wide range of variation in captivity which can be selected for and or increased by backbreeding (offspring to parents), inbreeding (offspring to offspring) and line breeding (specimens with similar traits).

Currently, selective breeding has led to unusual patterns including near absence of pattern and various color morphs from solid flaming orange specimens with little pattern, such as the Sandfire morph, to specimens with bright red, and others with bright yellow. The color of the iris will also vary from a dark gold to a bright white gold, where the pupil stands out prominently. However, many of the color morphs are not yet genetically fixed to the point of being independent of other variables. In short, buying a red or yellow morph hatchling bearded dragon will not guarantee that you will end up with a bright red or yellow adult. Other factors are involved in the end color of adult bearded dragons including light quality, temperature, and possibly diet. Many adult bearded dragons do not show off their best colors unless exposed to sunlight and high temperatures (90s F; 30s C). Typically morning coloration will be darker and more patterned and will lighten with exposure to bright light and higher temperatures. On the other hand, some bearded dragons become lighter in darkness much like true chameleons. Through selective breeding, color and pattern morphs will eventually become fixed traits relatively independent of environmental variables. At the present time there is also a size morph sold as the German Giant, which is said to commonly exceed 24 inches (60 cm) in total length for males. Selective breeding for size will also result in larger or smaller lines depending on the whims of the market. The future of inland bearded dragons is very promising, and we can expect to see many new morphs of this interesting species. A preliminary and tentative outline of current morphs is as follows:

Color and pattern morphs

Normal: If there is such a thing anymore, these are the inland bearded dragons with tans and browns and grays which are said to originally have come from northern and eastern portions of the range. In herpetoculture, "normal" is a category where the less colorful specimens get dumped.

Red/gold: The specimens of this morph are quite variable and characterized by or-



Young pastel *P. vitticeps*. Photo by David Travis.



Red/gold bearded dragons, *P. vitticeps*. Photo by David Travis.



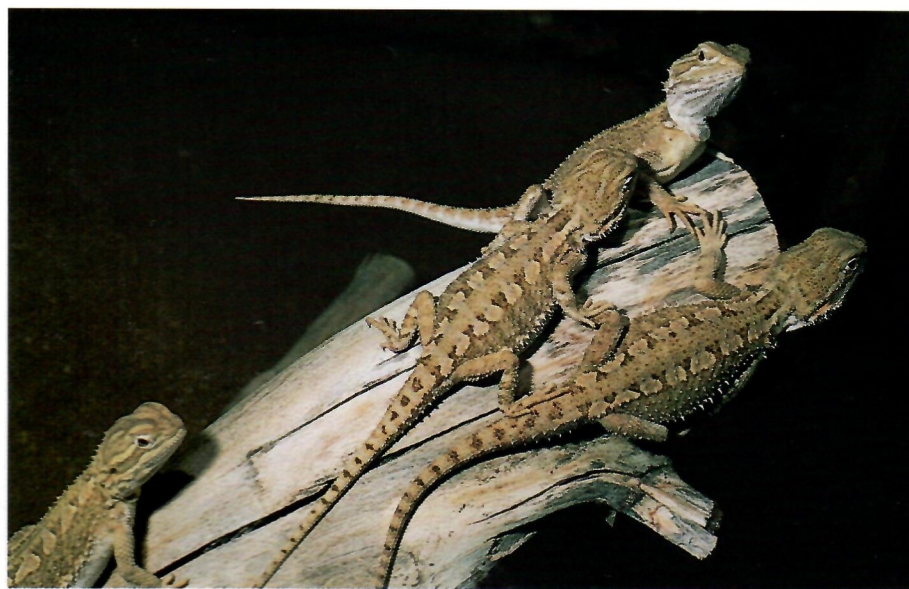
Pastel *P. vitticeps* in shed. Photo by David Travis.



Young red/gold *P. vitticeps*. Photo by David Travis.



Bearded dragon *Pogona barbata*, light inland morph. Photo by Alan Repashy.



Young Rankin's dragons, *Pogona brevis*. Photo by David Travis.

ange, gold or red heads. The body may be gray or with varying degrees of red, orange or yellow. These originated from the south central portion of the range and have formed the core population from which many of the new morphs are derived.

Red: These are red/golds selectively bred for a preponderance of red coloration. They tend to be quite variable although breeders are trying to genetically fix the red coloration. Red bearded dragons typically retain a prominent dorsal pattern.

Yellow: Specimens with pale yellow to cream yellow heads with varying amounts of yellow on the body. In most cases these yellow specimens are simply gold specimens of the red/gold morphs raised indoors. Lighter, paler coloration is a consequence of husbandry and appears in part the result of not being exposed to sunlight. UV exposure may play a role in causing a darker pigmentation to develop. Nonetheless these are very pretty dragons with great appeal to herpetoculturists.

Gold: Red/gold morphs with golden yellow heads often with golden yellow on the forelimbs or body.

Gold with white/gold iris: This a rare morph characterized by gold head with a bright almost white gold iris in sharp contrast to the black pupil. It will be several years before this morph is available in any numbers. A "wild-eyed" looking lizard.

Sandfire™: This was a line developed by Robert Mailloux through selective breeding of red/gold dragons. The name Sandfire is trademarked. This morph under ideal conditions is nearly patternless with flaming orange/red coloration. This coloration extends to the fringe of lateral spines between forelimbs and hindlimbs. A characteristic of Sandfire™ dragons is their ability to undergo considerable color change from a dark patterned dorsum to the bright orange and nearly patternless features of this morph.

Sandfire™ Yellow: Specimens that under ideal conditions may be entirely golden yellow with little pattern. Like all Sandfire™ bearded dragons the color can vary greatly in the course of a day. Sandfire™ dragons may be dark and highly patterned during the cool morning hours.

Pastel: This morph is based on a genetic trait that can be readily identified in homozygous hatchlings and that is characterized by hypomelanism (reduction of dark pigmentation). Hatchling pastels have faded patterns and a greenish gray coloration. Pastel dragons originated in red/gold stock of inland bearded dragons, and consequently, as adults have bright orange heads and straw yellow bodies, with pale



Red/gold normal. Photo by David Travis.



Young Sandfire™ Dragon. Photo by David Travis.

blue gray in the dorsal pattern. Some pastels are so pale as to appear almost amelanistic. Pastels are one of the most exciting new introductions in bearded dragons because of the many opportunities they offer for selective breeding. Hypothetically a pastel version of every existing morph will be available in the near future.

Size Morph

German Giant: A size morph recently imported from Germany and offered by breeders such as Peter Weiss. They attain a large size and produce large clutches of up to 68 eggs. Males can exceed 24 inches (60 cm) in total length.

Vittikins

***P. brevis* x *P. vitticeps*:** This is a term coined by Marcia Rybak (see article this issue) for hybrids between the inland bearded dragon, *Pogona vitticeps*, and Rankin's dragons, *Pogona brevis*. These hybrids are intermediate in size between the two species and resemble an inland bearded dragon with somewhat more slender bodies. Smaller size and outgoing personalities make them desirable for those with limited space. Because these hybrids can be the result of crossing a range of *P. vitticeps* morphs with Rankin's dragons, as much variation as is found in *P. vitticeps* can be expected in the future of these hybrids.

Vittikins can probably be bred with both *P. brevis* and *P. vitticeps* which could further increase the variation in these hybrids. This needs to be experimentally determined.

Rankin's dragon

***Pogona brevis*:** About the only thing that has remained stable in the name of this species is the common name Rankin's dragon which was first coined by Ron Tremper. The scientific name has been the subject of controversy but is now generally accepted as *Pogona brevis*. This is a personable, entertaining, heavy-bodied medium size *Pogona* which does not display a beard when threatened. Initially this appeared to be a very promising species, easy to breed and easy to raise, but in time captive populations dwindled, and a variety of factors from inbreeding to oversupplementation were blamed for the long term failure of establishing this species. The future of *P. brevis* in herpetoculture is uncertain although concerted efforts are in progress to resolve the problems of long term herpetoculture. These are attractive and interesting lizards that can easily be kept and displayed in home vivaria and it would behoove herpetoculturists to resolve the problems of multigeneration long-term breeding.



Bearded dragon, *Pogona barbata*, dark coastal morph. Photo by Robert Mailloux.



Sandfire morph. Photo by David Travis.



White/gold Iris morph. Photo by Corey Blanc.

Bearded Dragon *Pogona*

The VIVARIUM Volume 7 Issue 6



Sandfire gold. Photo by David Travis.



Sandfire yellow. Photo by David Travis.



Pastel dragons. Photo by David Travis.



Red/gold x Normal. Photo by Corey Blanc.



Green morph. Photographed in the wild by Robert Mailloux.



Red/gold morph. Photo by David Travis.



LC morph (Left) and HC (High contrast) morphs of Rankin's dragon, *Pogona brevis*. Photo by Robert Mailloux.



Vittikins dragon, *P. vitticeps* x *P. brevis*. Photo by David Northcott. Nature's lens.



"German Giant" morph of *P. vitticeps*. Photo by Kevin Dunne.



Gravid female "German Giant" morph of *P. vitticeps*. This morph can produce large clutches of 60 or more eggs per clutch. Photo by Kevin Dunne.

Two morphs are available in the hobby which for the time being we have labeled as the HC, or high contrast morph, with sharply contrasting color and pattern, and the LC morph, with low contrast color and pattern.

Bearded dragon

***Pogona barbata*:** This is a large species which displays the largest and most impressive beard of the genus when threatened. It is not as colorful or as personable as *P. vitticeps*, and generally shyer. In addition, it is much more difficult to raise from hatchlings than *P. vitticeps* and is recommended for the more serious and experienced hobbyist. Very few are currently in U.S. herpetoculture, and the future of this species in the hobby is not very encouraging.

There are two morphs of *P. barbata* in the hobby. A dark morph which originated from more coastal areas of Australia, and a lighter more colorful morph which is said to originate from more inland areas. Currently it seems that the lighter morph is more readily available than the dark morph. As mentioned earlier, this is a species best suited for more advanced herpetoculturists.

The future of bearded dragons

Most herpetoculturists would agree that inland bearded dragons are one of the best things to happen in herpetoculture in the last two decades. It is a nearly ideal lizard pet that will not require collection from the wild to supply the commercial trade. The future of the inland bearded dragon as a domesticated animal is very exciting with selective breeding leading to a range of color, pattern and size morphs as well as more de-

sirable temperaments. In time inland bearded dragons will make up a significant portion of the lizards sold in the general pet trade and may decrease demand for wild collected species more difficult to establish and maintain in captivity. The hybrid Vittikins will also increase in popularity for those with limited space, and hopefully herpetoculturists will also solve the long-term multigeneration breeding of Rankin's dragon and the bearded dragon. All in all, the future of dragons seems quite promising.

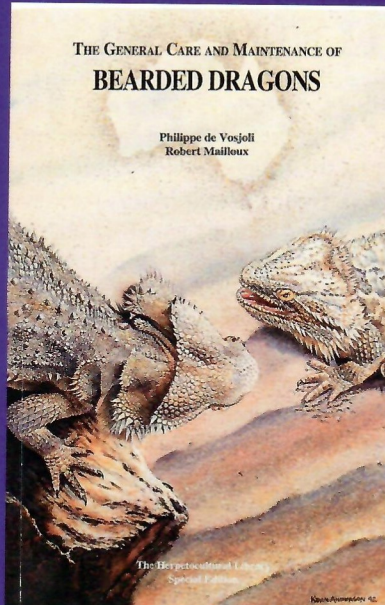
Acknowledgments

The authors thank David Travis, David Northcott Allen Repashy, Marcia Rybak and Kevin Dunne for their help in assembling the information and photographs for this article.

Philippe de Vosjoli and Robert Mailloux are the authors of The General Care and Maintenance of Bearded Dragons and the upcoming Bearded Dragon Manual to be published by Advanced Vivarium Systems. Robert Mailloux developed the Sandfire lines of inland bearded dragon and the pastel inland bearded dragon.



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STEP BY STEP VIVARIUM DESIGN

A Naturalistic Vivarium For Small Bearded Dragons

by
Philippe de Vosjoli

Inland bearded dragons can be displayed in attractive vivaria that can also include live plants. The following is a step by step procedure for designing a naturalistic vivarium for juvenile bearded dragons.

Enclosure

Ideally enclosures for inland bearded dragons should be at least four feet long, preferably six feet long (ca. 2 m) and 18 to 24 inches (45–60 cm) wide. Juveniles can be started in smaller enclosures, and for the purpose of this article we selected a 30 × 18 inch (75 × 45 cm) Virtual Nature 2000 vivarium because of the special features for naturalistic vivarium design,

such as front opening doors, watertight base and non staining anodized aluminum frame. The black acrylic background of these top of the line enclosures will enhance the contrast of all their contents including animals. For adults, large custom enclosures can be special ordered from Vivarium Research group. Other enclosures such as the inexpensive all glass screen top vivaria now commonly sold in the trade will also work for this purpose as long they are watertight and have a screen top.

Substrate

A substrate of Play Sand purchased at Home Depot was selected for the vivarium. Granitic sand or oolitic limestone sand are other good choices. Silica sand can be problematical because it can generate silica dust and is quite abrasive if

ingested. Because inland bearded dragons grow rapidly and would outgrow the 30 (75 cm) inch vivarium within 9 months, it was decided to use the sunken pot approach to vivarium design. For this reason a single simple substrate was selected. In a larger vivarium a two inch (5 cm) layer of pea gravel would have been placed first then a suitable growing medium containing pumice, then finally a surface substrate such as sand or gravel.

Landscaping the vivarium

The most common mistake made by vivarists is to design flat, boring vivaria laid out on a single plane. To make vivaria topographically interesting, you need to use landscape elements such as wood and rock to create a practical and visually appealing three dimensional environment. Books on desert habitats, Japanese gar-



Completed naturalistic vivarium using the sunken pot approach to landscaping.

dening, and zen gardens are good sources of inspiration for interesting designs, and for learning how to balance landscape elements.

Rocks: No rocks were used in the design of this vivarium, but could have been substituted for wood.

Wood and bark: Grape vine and fig wood were selected for this vivarium. Cholla skeleton, cork bark, and dry desert woods are also good choices.

The wood was piled or stacked to create a basking site and a shelter.

Plants

Because bearded dragons may eat tender plant material we opted to use only three species of tough plants which consistently perform well in desert vivaria: pony-tail palm, *Beaucarnea recurvata*, and two species of thick-leaved *Sansevieria*. The ponytail palm was selected as a centerpiece of the vivarium with the *Sansevieria* to be placed to the sides in a manner that resulted in a balanced vivarium composition. The plants were transferred from their pots into shallower food storage containers with multiple holes for drainage drilled in the bottom. They were placed in relationship to rocks by burying their containers in the sand substrate. Placing plants often means moving landscape structures around and changing their original position. Such is the task of the vivarist.

Composition

A completed vivarium is a work of art. As with any work of art the first step is to acquire the components required to complete it. For the vivarist, this means assembling all of the landscape elements, usually more than you think you need because some elements will work better than others. Vivarium design is a process that is subject to change in the course of assembly. Stepping back during the course of design to assess the aesthetic appeal of one's creation is typical vivarist behavior. Changing things around because you suddenly have a new design inspiration is also common, much to the frustration of those around you. And yet there comes a point, usually towards the end, where it all seems to come together and you end up with a beautiful and functional display. With experience you will get better at putting vivaria together.

Heating

A hot rock was placed inside the vivarium as a secondary heat source to remain on around the clock.

Lighting

A fixture with two 24 inch (60 cm) Reptisun UVB 5.0 bulbs (Zoomed®) was placed above the screen along with an incandescent reflector type fixture with a 75 watt spotlight over the basking area. Both of these fixtures were plugged into a surge suppressor multi-outlet unit which was plugged into a three prong (with ground) appliance timer set to be on 14 hours a day (6 am to 8 pm).

Temperature control

A digital thermometer with probe was used to assess the temperature of the basking site, and is used intermittently to monitor the vivarium temperature.

Water

A small storage food container was submerged in the substrate as a water container.

Maintenance

The plants are watered once a week. All light and heating devices are on timers. Water is added daily and the water container washed and disinfected at least twice weekly. Food is introduced daily (see *A Simple System For Rearing Baby Bearded Dragons Indoors* on page 42).

Philippe de Vosjoli is the author of *The Design and Maintenance of Desert Vivaria* published by Advanced Vivarium Systems.

The enclosure for this article was donated by Vivarium Research Group, manufacturers of the highest quality enclosures for naturalistic vivarium design. Custom vivaria are available by special order. See their color ads in this issue on page 36.



(1) A Virtual Nature® vivarium was selected because of its outstanding features including sliding glass front doors, screen top and black background which enhances the contrast of all vivarium components.

(2) Play Sand is used as a substrate.

(3) A section of sandblasted grape wood (left and center) was selected as the centerpiece of the vivarium. A section of dried sandblasted fig was added on the right to balance the composition and because of its textural characteristics.

(4) A small pony tailed palm *Beaucarnea recurvata*, with well developed caudex was inserted inside an opening formed by the grape wood. A thick-leaved snakeplant, *Sansevieria singularis*, was placed behind the fig section. Another snake plant, *Sansevieria* "Baseball bat," was added to the front right to add three dimensionality to the composition.

(5) A spotlight and fluorescent high UVB reptile light are set on the top of screen.

1



2



3



4



5



Review by James B. Murphy

The Lizard Man Speaks

The Lizard Man Speaks. by Eric R. Pianka. 1994. 16 color and 32 black-and-white photographs, 4 figs., 4 maps. University of Texas Press, Austin. Cloth: ISBN: 0-292-76552-5. 224 pages. \$24.95.

More years ago than either of us would care to remember, I met Eric Pianka. He had published several papers on the ecology of Australian monitor lizards, which was a group of great interest to me. Since he had spent some years in the Great Victorian Desert located in central Western Australia, his observations on the lizard assemblage there would be of inestimable value in setting up suitable habitats for captive saurians at the Dallas Zoo where I was employed. As he told me about his experiences there, it was clear that lizard diversity in his study area was as great as any region in the world: forty-seven species in five families. In addition, his love of field work vividly surfaced and his intent on returning to Australia whenever possible was evident.

In 1989, I attended the First World Congress of Herpetology in Canterbury, England. As I was strolling along the path toward the dormitory, a tall figure wearing an embroidered shirt with the image of a pygmy monitor lizard, *Varanus eremius*, was walking ahead. It had to be Eric as this species was his favorite lizard in the world. We retired to a pub to down a few pints and his enthusiasm for returning to Australia was evident. Eric was honored as one of the plenary lecturers for the conference and his presentation can be read in its entirety (Pianka, 1992).

Reading his book is bound to be a great pleasure as his love for the remote regions of Australia and its lizard fauna is reflected throughout. The first chapter recounts his childhood during which he was severely injured by an exploding bazooka shell which he found on a National Guardsman firing range. The agony of his brush with

death and the efforts to reconstruct his badly damaged leg with surgery are told in chilling detail. He describes his college career as an undergraduate student at Carleton College in Minnesota. Curiously, a high school friend of mine was a student there at the time and told me during our summer break that I had to meet Eric as he was also interested in herps. We didn't meet until years later. After graduate school where he investigated lizard diversity in western North American deserts for his Ph.D. dissertation, he was awarded a post-doctoral stipend to work with the late Robert MacArthur, a prominent ecologist at Princeton University. Eric wished to do

Australia. In chapter six, he recounts an amusing series of misadventures as the locals feared that he and his ex-wife were lost in the "outback." The press coverage was extensive and a number of press clippings have been reproduced which demonstrates how misinformation can increase dramatically as each article builds on the errors of its predecessor.

So you want to do fieldwork in Australia, eh? The chapter on bush flies might change your mind. The density of these pests is overwhelming as the photographs on pages 121 and 122 demonstrate. Other sections cover the importance of bush fires on ecosystems, Australian Aborigines and a comparison between Australian and African deserts.

The book is an enjoyable read for any fancier interested in herpetological fieldwork. The modest price is an added bonus.

The book may be purchased from University of Texas Press, P.O. Box 7819, Austin TX 78713-7819. The toll-free telephone number is 1-800-252-3206, FAX (512)320-0668.

Additional Titles by Eric R. Pianka

1966. Convexity, desert lizards, and spatial heterogeneity. *Ecology* 47:1055-1059.

1967. On lizard species diversity: North American flatland deserts. *Ecology* 48:333-351.

1968. Notes on the biology of *Varanus eremius*. *Western Australian Naturalist* 11:39-44.

1969. Notes on the biology of *Varanus caudolineatus* and *Varanus gilleni*. *Western Australian Naturalist* 11:76-82.

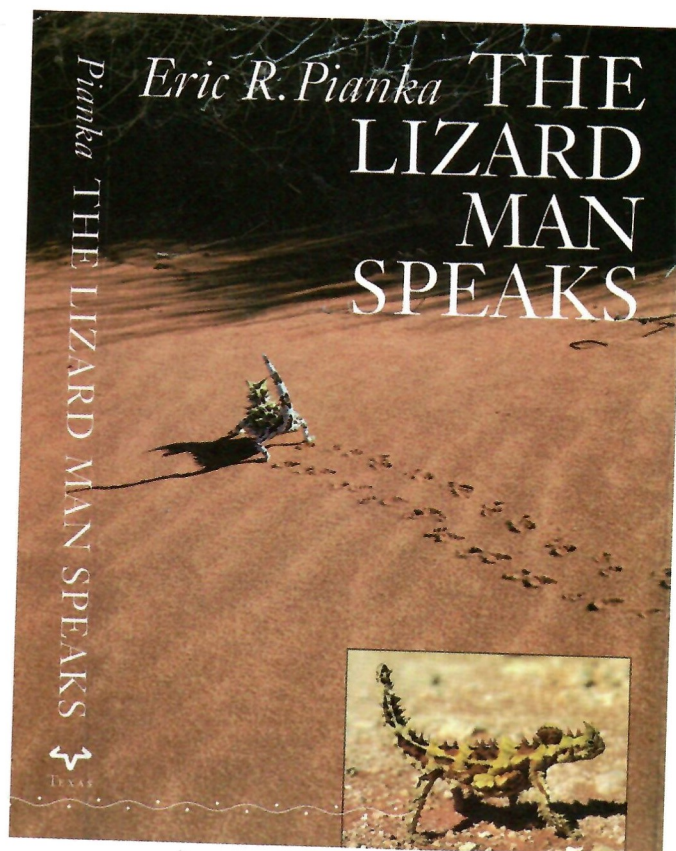
1973. The structure of lizard communities. *Annual Review of Ecology and Systematics* 4:53-74.

1982. Observations on the ecology of *Varanus* in the Great Victorian Desert. *West. Aust. Nat.* 15: 1-8.

1986. Ecology and Natural History of Desert Lizards: Analyses of the Ecological Niche and Community Structure. Princeton University Press.

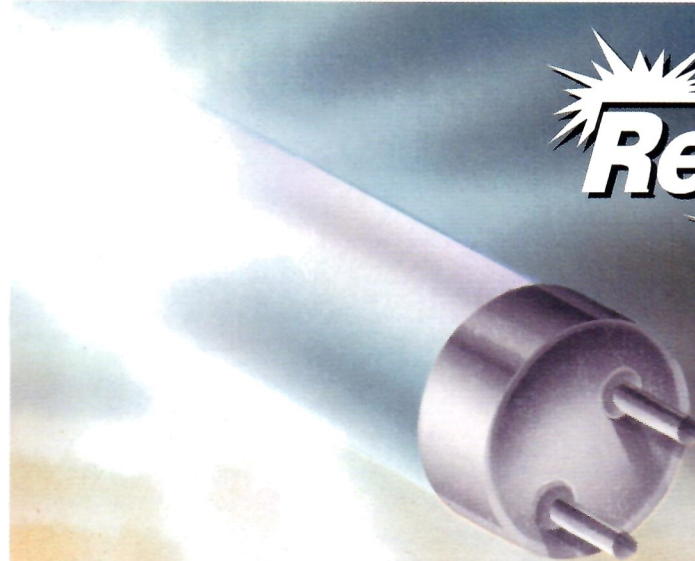
1992. The state of the art in community ecology, p.141-162. In: K. Adler (ed.), *Herpetology: Current Research on the Biology of Amphibians and Reptiles*. Proceedings of the First World Congress of Herpetology. Soc. Study of Amphibians and Reptiles, Oxford, OH.

1995. Evolution of body size: Varanid lizards as a model system. *Am. Nat.* 146(3): 398-414.



a comparative study of lizard diversity in Australia so he and his ex-wife Helen set off for the Land Down Under. The next two chapters describe his travels throughout Australia and his herp collecting adventures.

Chapter four should be of considerable interest to the herpetoculturist as Pianka describes lizard natural history. Topics such as use of time and space: thermal relations, feeding ecology, adaptive suites, reproductive tactics, and escape from predators are included. The next chapter describes the biogeographical history of



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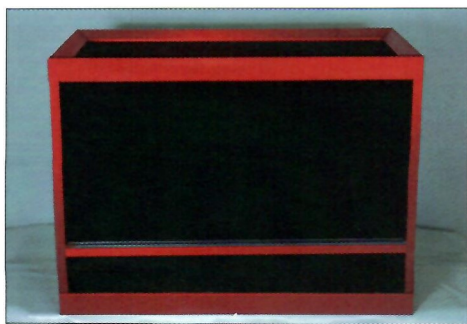
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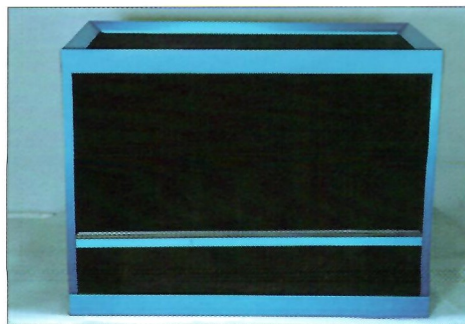
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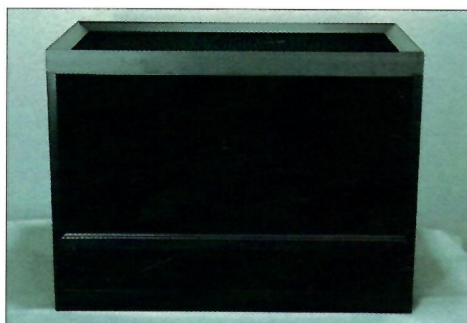
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AFH Guidelines for the Responsible Keeping of Green Iguanas

Developed by
Philippe de Vosjoli and
Clay M. Garrett

Introduction

The green iguana, *Iguana iguana*, is one of the most popular and widely-kept species of reptile, with current estimates of at least 1.6 million iguanas in captivity in the United States alone, and the numbers are continuing to rise. Unfortunately, with an increase in popularity, a wide range of associated problems have developed ranging from irresponsible pet ownership to serious human illness due to infections with *Salmonella*. Because salmonellosis can be a life threatening disease, it is probably the problem of greatest concern associated with the green iguana, and has lately received considerable attention by the press. Stories involving reptiles have the potential for sensationalism, and public reaction to reptile related problems frequently generate an exaggerated reaction.

The following guidelines were developed to provide protocols for responsible iguana ownership, and for responsible commercial trade in the green iguana. Careful consideration needs to be given before buying a green iguana as a pet. Because of its large adult size, potentially aggressive behavior (in males), and because of the risk of salmonellosis, the green iguana is not the ideal choice for most people seeking to own a pet reptile. The following are the cons and pros that should allow you to determine whether a green iguana is the right pet for you.

Cons

(1) Green iguanas are potential carriers of salmonella, the bacteria that causes salmonellosis, a serious disease of the gastrointestinal tract which can be fatal in young children, immunosuppressed individuals and older people. For this reason they are not recommended as pets for young children or in households where young children may be at risk of contact with fecal material. They are not recommended for immunosuppressed individuals or older people unless strict hygienic protocols are followed, but these precautions will not necessarily eliminate a potential risk.

(2) Green iguanas get large. They end up looking like small 3 to 6 ft dinosaurs. That may sound appealing to some people, but there are consequences to large size. Adult

iguanas will require enclosures that will take up a significant part of a room. To keep them in small enclosures is unethical and does not consider the importance of quality of life when keeping an animal as a pet. In areas where the weather permits, large outdoor enclosures are often the best choice. In addition, because of their large size, adult green iguanas can inflict serious scratches with potentially serious consequences, especially if directed to the face. Because they are large and have powerful jaws, adult green iguanas can also inflict serious bites with potentially serious medical consequences. For these reasons, they are not recommended as pets for young children.

(3) Male iguanas, as they become sexually mature, may challenge their owners and can become unusually aggressive. Bites by adult green iguanas can be a very serious matter. Inexperience in dealing with this kind of behavior can have serious consequences.

Pros

(1) For people who desire a large reptile and who can dedicate the space required for responsible keeping, green iguanas can make an impressive, and with proper attention and training, a responsive reptile pet.

(2) Unlike most other lizards and snakes, green iguanas can be fed on food from the supermarket. This is often a major consideration for first-time reptile owners.

A selection of alternatives to the green iguana as a lizard pet

If you want a lizard as a pet the following are choices which will be more suited to the conditions available in most households.

(1) Insect eating lizards: Bearded dragons, *Pogona vitticeps*, are generally tame, endearing and easily maintained lizards that are now captive bred in large numbers. They rank among the best lizard "pets." Leopard geckos, *Eublepharis macularius*, are the easiest to keep of all lizards and are also captive bred in large numbers. With regular handling subadult and adult animals can also become good pets. As pets to be observed and not handled, few reptiles are as easy to keep or as interesting to observe as the common green anole, *Anolis carolinensis* (readily available in the pet trade).

(2) Omnivorous lizards: Northern blue tongue skinks, *Tiliqua s. intermedia*, can be

raised and kept on food from the supermarket. Many become very tame and very amenable to handling. As with all lizards, hygienic procedures should be practiced.

Other AFH Guidelines Are Available

This is the fourth in a series of guidelines for the keeping of herptiles in captivity. The AFH has previously published guidelines for the keeping of Monitor Lizards, Large Constrictors, and Large Boids in Schools.

These guidelines are distributed freely to the public and we encourage you to pass them on to individuals, organizations, and reptile stores. Please give credit to the AFH and do not alter the text in any way without express permission from the AFH.

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Hygienic practices for minimizing the risk of *Salmonella* infection by the green iguana

1) Keep your iguana in an enclosure, not loose in the home or in a room used by members of the household. Never let an iguana have free run of a house.

2) Always wash your hands with an antibacterial soap or an antibacterial scrub such as Betadyne® after handling your iguana or after maintenance procedures associated with your green iguana. Instruct any children in the household about the importance of these procedures. Tell them that not doing so can make them very sick. Tell them never to kiss the iguana and not to put their hands in their mouth during or after handling a green iguana. Remember that green iguanas are not suitable pets for young children and that any interaction with children should always be supervised by an adult.

3) Never soak your iguana in a bathtub or sink used by members of a household. Always disinfect the area with a 10% bleach solution whenever and wherever such procedures are practiced.

4) All maintenance procedures such as cleaning dishes or a cage should be done in areas not used by other members of a household. If this is unavoidable then strict hygienic procedures including disinfection should be adhered to.

5) Keep your iguana enclosure clean, particularly water and food dishes. Disin-

Continued on page 44

A Simple System For Raising Juvenile Bearded Dragons (*Pogona*) Indoors

by
**Philippe de Vosjoli and
Robert Mailloux**

Inland bearded dragons have become one of the most popular of all lizards kept in captivity. They grow to a manageable size, are attractive, personable and very hardy as subadults and adults. The one area of husbandry where many continue to have problems is in raising hatchling animals. The first step as with any reptile species is to initially select potentially healthy specimens.

Healthy baby bearded dragons are active and appear alert with wide open eyes when awake. Some hatchlings for the first ten days tend to sleep more than older animals. This does not necessarily mean that they are unhealthy. Healthy dragons have rounded body contours with no outline of the pelvis or backbone apparent. They do not have swollen limbs, digits or tails, or missing limbs, toes or tails. Their feces are more or less formed but never runny. Examine the underside of bearded dragons when selecting animals. Bearded dragons with dry smeared fecal material around the vent may have a gastrointestinal disease. If allowed to select from a group hatched out of the same clutch, avoid animals which are obvious runts (do not confuse this with females which tend to be smaller than males) unless you are interested in selective breeding for small size.

Enclosures

Bearded dragons can initially be raised in simple and relatively bare enclosures, including all glass enclosures with sliding screen covers and large plastic storage containers with custom-built screen tops. At least a 24 inch (60 cm) long enclosure is recommended for raising baby bearded dragons, and low breeder type tanks are initially preferable so the lizards can benefit fully from the effects of high UVB full spectrum bulbs. Small enclosures can be inadequate because they do not allow for a proper thermocline. In addition, the most popular species, the inland bearded dragon, has a rapid growth rate requiring at least a 48 inch (120 cm) vivarium by the age of six months under ideal rearing conditions. Many beginners have killed their baby

bearded dragons by keeping them in a ten gallon tank with a 100-150 watt spotlight and effectively cooking them. Heed this warning.

Screen cover

A secure screen cover is recommended in most cases, particularly in households with children or free roaming pets.

Substrates

Inland bearded dragons can be raised in enclosures with no substrate, or with sand such as Play Sand, granitic or limestone sands.

Landscaping

The minimal requirements are a "hot rock" which can serve as a basking site. A shelter on the "cool" end of the vivarium can be included but is not required. Additional rocks or dried wood or cork bark can be included for decorative purposes.

Heating

One of the most critical factors for successfully rearing bearded dragons is heat. After having experimented with several methods, it has become apparent that baby bearded dragons fare best when provided with basking areas of rock or clay over which an incandescent spotlight is placed so that the temperature reaches 95–105° F (35–41°C) at the area closest to the light (60–75 watt for standard 24 inch (60 cm) breeder tanks; higher wattage for larger and taller vivaria). The basking light and site should be placed at one end of the vivarium so that a heat gradient is created. Only in very long vivaria can they be placed in the center. DO NOT use red incandescent bulbs as day time heat sources, only standard white incandescent bulbs. The basking light provides both heat and a daytime simulating light level which is beneficial. The light should be on 12–14 hours a day and turned off at night. A good alternative to a rock is a "hot rock" type of heater which should be placed under the basking light as a basking site. It should remain on 24 hours a day. A screen top should always be placed on enclosures with hot rocks because the babies can climb up the cords. The latter can make a big difference in the health and growth of baby bearded dragons in part because ventral heat available 24 hours a day can greatly facilitate and speed up the rate of digestion. Subtank heat strips or heat tape

under one end of an enclosure will also work well as an alternative to hot rocks. We feel that heat is critical for proper calcium metabolism and can help significantly reduce the probability of metabolic bone disease as long as adequate amounts of calcium and vitamins are provided in the diet.

Night Temperatures

Bearded dragons tolerate cool nighttime temperatures between 60–70° F (16–21°C). Only the "hot rock" should remain on at night. Other incandescent sources of heat should be turned off (e.g. no ceramic incandescent heating element).

Lighting

In experiments that we have carried out we were able to successfully raise a group of 15 hatchling bearded dragons with no mortality using an incandescent bulb and a fluorescent fixture with two Vita Lite® twist bulbs within 12 inches (30 cm) of the hatchlings. In the experiment only calcium carbonate with magnesium was used as a supplement and no dietary vitamin D3 other than whatever residual D3 remained in commercially raised crickets. During our experiment the crickets were fed a diet with no D3. In 16 weeks the largest dragon was 14 inches long and none showed signs of metabolic bone disease. We are in the process of carrying out research whereby no fluorescent lighting is used to evaluate the actual role of full spectrum lighting. Assuming that these bulbs at close distance may play a role in the synthesis of vitamin D3 and the absorption of calcium, our current advice is to place a fixture with one or two of the new high UVB full-spectrum fluorescent bulbs such as Zoomed's Reptisun UVB 5.0 or ESU's Reptile Daylight, or Fluker's Reptasun within twelve inches (30 cm) of the hatchlings. These have higher UV outputs than the Vita Lite bulbs currently on the market. Full spectrum fluorescent bulbs should be replaced every six to twelve months to remain effective in generating UVA and UVB. These bulbs should rest on top of enclosures to be effective with no physical barrier such as glass or acrylic to impede UVB exposure. As an alternative, exposure to natural sunlight in outdoor screened enclosures with shelters and shade areas for several hours a

day will definitely benefit hatchling bearded dragons.

Feeding

Baby bearded dragons grow rapidly and need to be fed frequently. Failure to provide food around the clock will often result in various forms of intraspecies mutilation and cannibalism when baby bearded dragons are kept in groups. These lizards should be offered initially two to three-week-old crickets two or more times a day, with extra crickets left over to feed on between feedings. After three or four weeks, baby bearded dragons can safely be offered mealworms, wax worms and small king meal worms (*Zophobas*), as long as the proper kind of heating is provided (see above). In addition to insects baby bearded dragon should be offered greens and finely chopped or grated vegetables. Kale, mustard greens, mustard flowers and hibiscus flowers are good leafy greens to make available at all times. Finely chopped mixed vegetables, grated squashes, carrots and other vegetables should also be offered on a regular basis. Variety of diet can contribute to overall health.

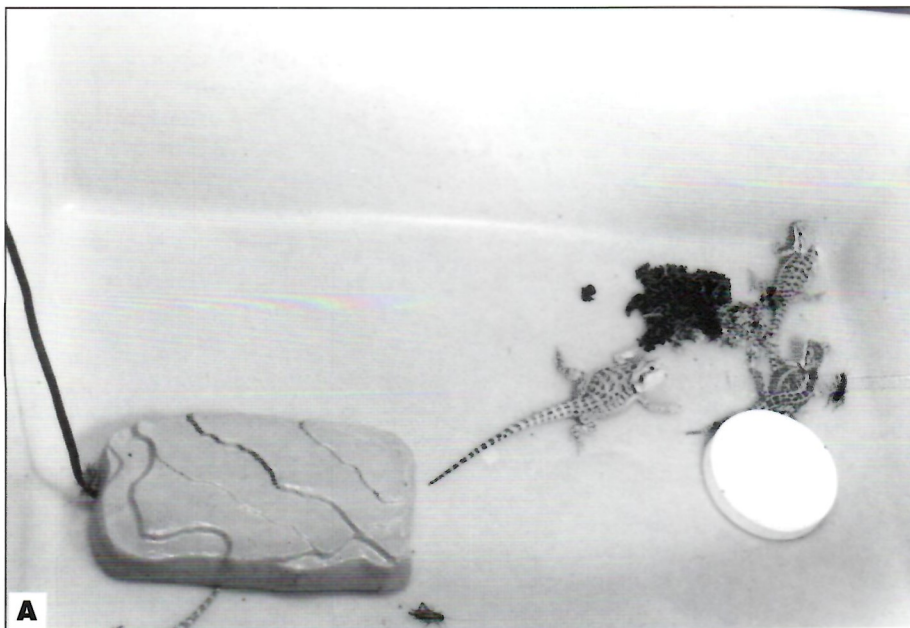
Supplementation

Under the heat, lighting, and feeding regimens mentioned above, daily supplementation by light coating of insects will be all that is needed for rearing healthy bearded dragons. One part vitamin/mineral supplement such as Reptivite®, Herptivite® or HerpCare® Cricket Dust, to four parts calcium carbonate will provide enough vitamins for healthy growth. To provide vitamins, a pinch of the mix is added to a jar, the insects introduced and then lightly stirred until they have a light

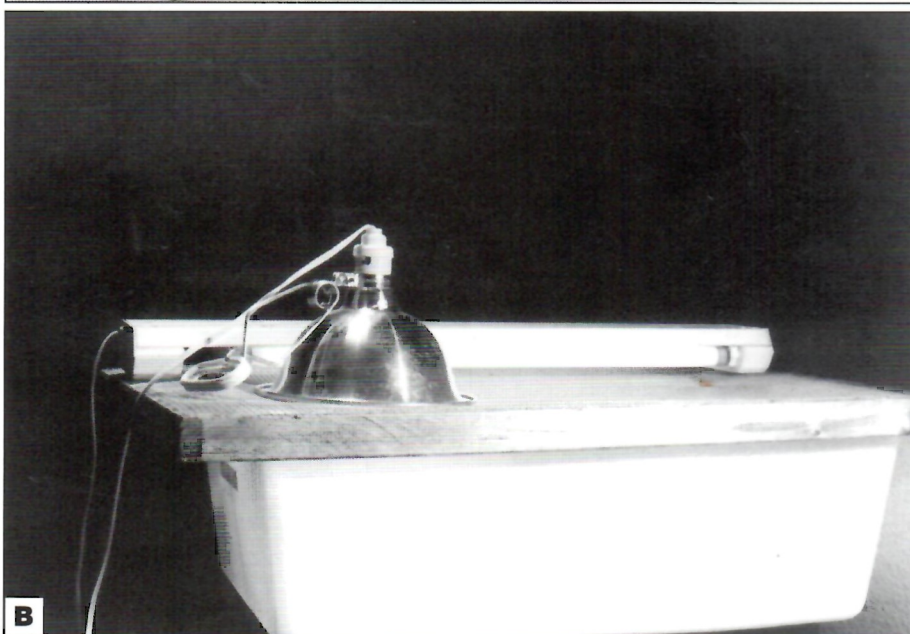
A. A container by Dorskoci® was selected for this particular system. The floor is kept bare and a "Sizzle Stone" (Terra Terra fauna®) hot rock is placed on one side. Baby dragons are offered crickets daily with enough left over so that food is available at all times. Greens in the form of kale and mustard flowers are also offered daily.

B. A screen cover is required not only to prevent possible predation by household pets but also to prevent possible escapes. Bearded dragon babies will climb up the electrical cord of the hot rock. An incandescent bulb in a reflector type fixture is placed over the hot rock and a fluorescent fixture with high UVB full spectrum reptile bulbs such as Reptasun 0.5 by Zoomed R., ReptiGlo by Hagen® or Reptile Daylight by ESU on the screen top.

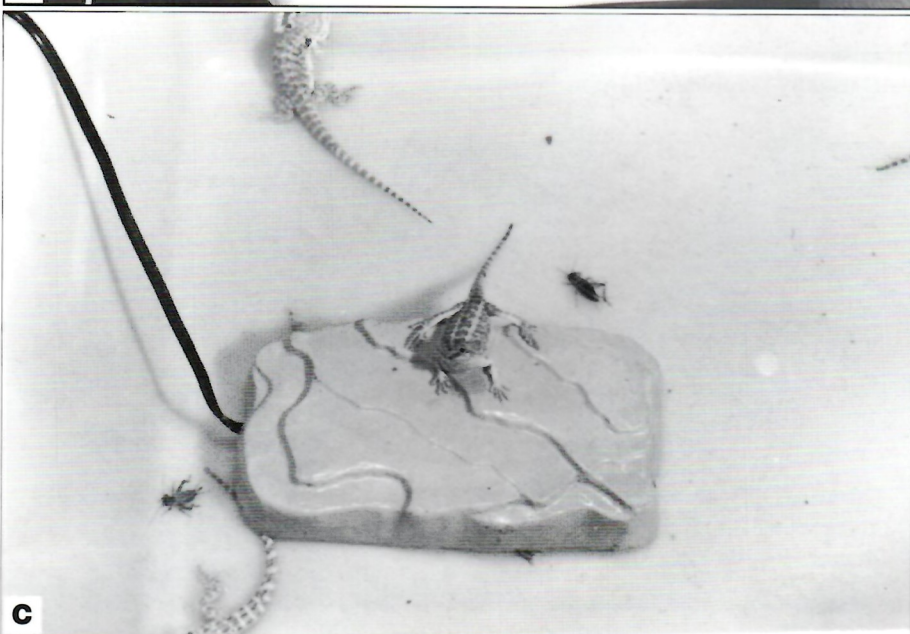
C. After having tried different hot rocks, "Sizzle stones" by Tetra Terra fauna® with a surface sealer, held up to repeated cleaning, did not crack and did not absorb water. Some of the other hot rocks absorbed water, cracked and after having absorbed water conducted electricity to the point of causing an electrical shock.



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B



C



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coating of mix. They are then introduced into the enclosure. For juvenile and sub-adult animals (under six months) food insects can be supplemented one feeding every one to two days. For adults, supplementation two feedings per week will be adequate. Both undersupplementation and oversupplementation can lead to disease and poor breeding success, particularly under indoor conditions. Bearded dragons raised outdoors and fed a variety of foods will require little supplementation other than calcium carbonate, although breeders will usually supplement food insects

lightly once or twice a month with a powdered vitamin/mineral supplement.

Water

Water should be provided daily to baby bearded dragons in shallow water dishes such as jar lids. Bearded dragons under four weeks old do not always readily drink from a water dish. They are more inclined to drink from water droplets sprayed on the sides of the enclosure or dripped onto their snouts. The water should be replaced daily and water containers washed with an antibacterial detergent at least twice a week. In areas where the quality of tap water is poor, bottled drinking water or carbon filtered water should be offered to bearded dragons.

Diseases

Under the regimen mentioned above diseases related to diet and husbandry will be unlikely to occur. Inland bearded dragons are generally a hardy bunch not particularly prone to disease. However, gastroenteric disease from parasites is not uncommon in captive-bred bearded dragons. Coccidian parasites in particular are often diagnosed in captive bearded dragons. If your animals have moist and unusually smelly feces and show signs of weight loss and dehydration, have a fecal sample examined by a qualified veterinarian. He or she will then be able to prescribe the most effective drug for treatment.

Conclusion

Inland bearded dragons are an ideal lizard pet. They are easy to raise as long as proper heat, lighting, diet and supplementation are provided.



AFH Guidelines - Continued from page 41

fect them on a regular basis using a 10 % bleach solution. Rinse them thoroughly afterwards.

6) If symptoms of *Salmonella* infection (vomiting, nausea, diarrhea) occur among those exposed to the green iguana, contact a physician immediately, particularly if children or older people are involved.

Practices for minimizing the risk of injury by green iguanas

1) Keep claws trimmed using nail clippers or specialized pet and bird nail clippers sold in pet stores. The most serious injuries that iguanas can unintentionally inflict with their claws are to the face, particularly the eyelids. Generally the handling of medium to large green iguanas by young children is to be discouraged.

2) Some imported green iguanas that have a low threshold for fight or flight behavior can inflict a nasty bite, but most cases of bites are by young adult males that are becoming sexually mature and want to challenge their owners for dominance. As a result of aggressive behavior, some iguana owners have become terrified of their pet. This aggressive behavior is seldom demonstrated by females. When aggressive behavior occurs, avoid direct contact with the animal. The soft side of a broom can be used to swat the animal during these attacks. Do not back down, thus reinforcing aggressive behavior. This kind of behavior by green iguanas generally cannot be tolerated because of the risk of injury to owners. Generally a male iguana that is trying to challenge its owner and assert dominance should be challenged. Failure to respond in the appropriate manner to such behaviors can result in a dominant, aggressive iguana. As males become older and more settled in, some of these adolescent challenges and behaviors will often diminish, but this will vary between individuals. Aggressive behavior may also be seasonal, corresponding with a reproductive period. Remember that the aggressive behavior of adult iguanas can have serious medical consequences causing injuries that often require stitches, and in some cases can result in serious muscular and nerve damage to hands.

Guidelines for pet stores

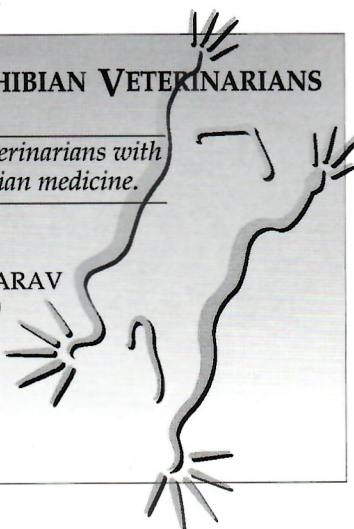
Green iguanas are probably the most income generating reptile in the general pet trade. Nonetheless, because of potential liabilities, it is critical that pet store owners and sales personnel inform their customers of the risks and problems of green iguana ownership. It is recommended that pet store owners provide these guidelines to all potential buyers of green iguanas. If this is a deterrent to their buying a green iguana,

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then the pet store owner should inform them, and direct them toward a reptile pet which may be more suitable for their needs. As a rule, green iguanas should not be sold to minors without the approval of their parents. To do so entails considerable risks and potential liabilities. All iguana buyers should be informed of the potential risk of salmonellosis associated with iguana ownership.

What to do when you don't want lggy anymore

Because they grow large and in some cases aggressive, increasing numbers of iguana owners no longer want to keep their pets. The alternatives are generally as follows:

- 1) The animal can be sold through classified ads in the newspaper or in specialized animal publications;
- 2) The animal can be sold to a local pet store;
- 3) The animal can be given away to a store or through the adoption committees of herpetological societies;
- 4) In some areas, animal control agencies will consider taking green iguanas.

Under no circumstances should green iguanas ever be released. This is irresponsible and could affect the rights of those wishing to responsibly keep green iguanas.

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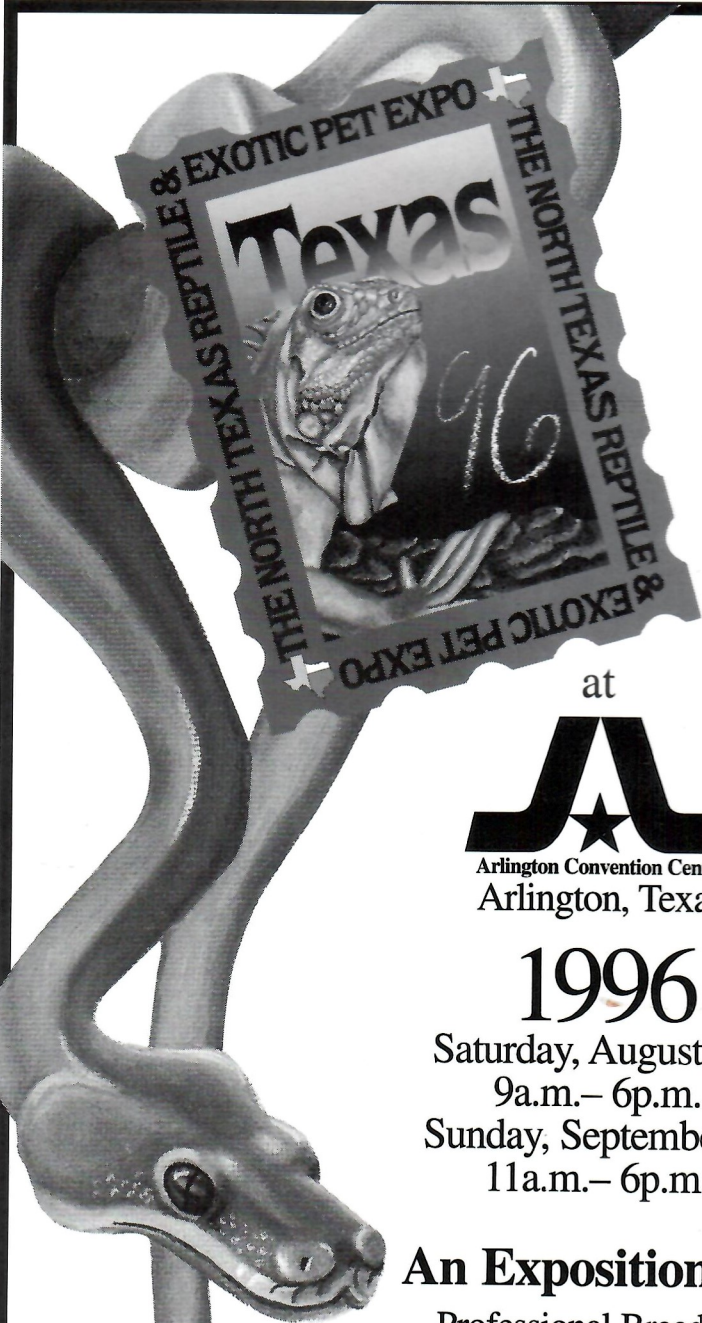
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Water for Tortoises

by
Thomas H. Boyer, DVM

Recently I was discussing improving reptile husbandry with a conscientious reptile caretaker in a pet store. We came to an obvious tortoise setup, although no tortoises were present—they had died the week prior. The 15 gal aquarium had two inches of alfalfa pellets, an under-tank heating pad, an overhead incandescent light with reflector, as well as full spectrum fluorescents. When I inquired as to the whereabouts of the water bowl, the caretaker told me he had been chastised by several tortoise breeders to remove it. With good intentions, the tortoise breeders had insisted it was bad to provide water within the enclosure, especially those containing hatchlings. Instead tortoises should be soaked in shallow water three times per week. I wondered how such ideas came to be.

Granted, tortoises can be messy with water and they do like to soak in it. Most small to medium sized tortoises can be set up with a water bowl for soaking as well as for drinking. Soaking often stimulates urination and defecation which may decrease uric acid buildup and stone formation in the bladder. Daily water changes can become a chore, and often water is spilled by the tortoises. From the keepers perspective a water bowl can be a real chore, yet soaking three times a week is no less a chore. To the pet store worker it seemed logical not to provide a water bowl, some tortoises were, after all, desert species.

While it is true that some species have evolved to survive in arid extremes, the pet store environment is radically different. With under and over-tank heat, a dry substrate, and air further dried by a furnace, relative humidity can be as low as 10 to 40%. While it is true that some tortoises thrive in econiches with relatively low surface humidity, they are able to do so by retreating to humid escapes for most of the day and night. For example, Wilson et al., (1994) report that juvenile gopher tortoises, *Gopherus polyphemus*, were underground in burrows 90% of the

time. Adult desert tortoises, *G. agassizii*, were below ground 95 to 98% of the time (Marlow, 1979; Nagy and Medica, 1986). The relative humidity of burrows can be quite high (85%) which undoubtedly reduces cutaneous and respiratory water loss. In contrast, the dry conditions in captivity exacerbates water loss through the skin as well as when the tortoise exhales humid air and inhales dry air. One might be surprised to learn that water loss through the skin represents 76% of the daily evaporative total for the desert tortoise (Bently, 1976).

Keep in mind that when we discuss tortoises we are talking about a diverse ecological group. Water flux in tropical reptiles is more than twice that of desert species (Nagy, 1982). Thus restricted water intake by a tropical species with a higher rate of water loss can quickly prove disastrous.

How then can desert species survive with little surface water for extended periods? Many species are effective at using rainshowers to collect water. Some tortoises assume a stereotypic stance to funnel water down their shell, onto their neck, then into their mouth. Others excavate shallow wallows before a rainstorm to collect water. Many turtles can take up water through their cloaca. Some drink from standing puddles, others graze on moist vegetation or run through wet grasses with their mouths agape. The urinary bladder also acts as a reservoir from which water can be reabsorbed during times of need. Some species limit their surface activity during the dry season and remain in their moist burrows. There is evidence that tortoises may actually slow their metabolism during dry periods while in their cool burrow to further reduce their need for water and food. Still, others travel considerable distances to known water holes on a regular basis.

Smaller reptiles have higher metabolic rates than larger reptiles in part because more of the smaller reptile's internal mass is exposed to the surface. Greater surface area exposure correlates with a greater rate of body water loss. Therefore, hatchling tortoises will desiccate

much faster than larger ones. It is imperative that hatchlings have constant access to water.

Do certain desert reptiles acquire large amounts of water from food sources when they don't have access to water? Certainly this is true to a certain extent in nature. As noted previously, the much drier captive environment is not analogous to the natural environment. Furthermore, we can only begin to guess if the mineral and water content of the cultivated foods that keepers generally provide is similar enough to natural foods to meet water needs in this manner.

Water is the most essential of nutrients for the majority of life as we know it. Consider that mammals can survive after losing almost all of their glycogen and storage fat, and half their protein, yet a 10% loss of total body water causes severe illness; a 15% loss results in death (Lewis et al., 1987). Reptiles are capable of surviving more extreme dehydration, but it may cause severe problems for their primitive renal (kidney) system, especially with the rich diets fed in captivity. Tortoises, like most terrestrial reptiles are uricotelic—meaning their primary nitrogenous waste is insoluble uric acid. An obvious advantage of insolubility is that it requires less urine to void it. A disadvantage is that when dehydrated, uric acid accumulates, which then begins to precipitate in various tissues such as the surface of the kidney, liver, heart, or various joints, leading to the well known conditions of visceral or articular gout.

Soaking three times a week is probably all right for larger tortoises. Hatchlings should have water on a daily basis, either by soaking or by access to a water bowl. Water bowls should be shallow enough that a hatchling will not drown if overturned. One problem with soaking is that it is occasionally forgotten. With a water bowl this can still happen but is much less likely. Soaking can be difficult with large numbers of tortoises; in this case water bowls are much easier.



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Charles Powell	A hobbyist view of the <i>D. quinquivittatus</i> species

For information contact: Charles Powell:
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LETTERS TO THE EDITOR

Note: This section contains both standard and E-mail letters.

C. M. Garrett made the following post in the usenet group rec.pets.herp:

"I'd like to get response from readers of *The Vivarium*."

Over the past year the articles in our publication have become broader in scope, offering more detailed information on species. On occasion we have covered animals that are difficult or impossible to obtain by many herp enthusiasts; our way of bringing these jewels to your living room! We have also encouraged stronger bibliographies so as to be a better reference source. Does anyone feel that *The Vivarium* is too "academic" in its presentation of herp information?"

I've read *The Vivarium* since Vol 1, Issue 1. Still have it in a plastic wrapper somewhere. I personally enjoy the addition of new columns, like the arachnid stuff that showed up this month, even though I'm a snake-only keeper. Broadens our minds, shall we say.

I also look to *The Vivarium* to be semi-academic. You shouldn't require readers to get a graduate degree in herpetology; there are publications for that audience. At the same time, a pedantic "look at the pretty snake" approach isn't interesting for more than one or two issues.

At a recent herp conference, someone pointed out that of the tens of thousands of species of reptiles and amphibians, only a few dozen are regularly kept in captivity. Your magazine is a great forum to present unfamiliar species, talk about husbandry both general and specific, keep us all posted on news and legislative events, and increase our awareness of conservation issues.

I think you do a great job of all the above.

Beth

Please reconsider the decision to add an arachnid column to *The Vivarium*. By straying from the stated purpose of the AFH you do service to neither the herp nor arachnid enthusiast. Every page devoted to some distraction is a significant loss to the herp reader. At the same time, it is doubtful that persons seeking information only on arachnids would purchase the magazine

for a single column per issue. If there is a need for an arachnid periodical, someone will publish it.

In the last editorial, you report on a review that found *The Vivarium* the best herp magazine. I have to agree. There is no arguing, however, that you will not be improving *The Vivarium* as a herp resource by widening its scope beyond herps. By trying to be everything to everybody, you wind up fully satisfying very few.

Bob Garby

Ed. I want to applaud *The Vivarium* for its new column "Arachnids and Such". I think they should definitely be considered "honorary herps", as they have been maligned in much the same way as reptiles. Sharing a small portion of a respected journal is a small price to pay to educate the public about these misunderstood creatures. After all, look at the difference education made in the world of herps.

Thank you for a wonderful journal and for sharing space with arachnids!

Susan Ashburn

I was proud to see a discussion of my recent article in your editorial (*The Vivarium* Vol 7 No. 4). Your discussion was thoughtful and well reasoned. Imagine my disappointment when you failed to document the source of your discussion. Please rectify your glaring omission, both for my sake, and more importantly, for the recognition of one of the best society newsletters being published today: *Intermontanus*.

Joel Eidbo

Dear Mr. Eidbo,

Thank you for the letter and for the favorable review published in *Intermontanus*. I apologize for not mentioning your name—in hindsight, an error on my part.

Ed.



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Board Nominations Requested

The AFH board of directors has several openings that will be available at the end of this year. Please send your nominations for the following positions to the AFH.

Vice President
Treasurer
Secretary
Education Coordinator
Member at Large

The deadline is September 15. Look for more information on how you can vote in the next issue.

Iguana Guidelines

You will find the AFH *Guidelines for the responsible keeping of green iguanas* on page 41 of this issue. These guidelines are offered to the public free of charge. We encourage reptile dealers, organizations and individuals to distribute this information free of charge. We only ask that you give credit to the AFH and not modify the text in any way.

You can find the entire series of AFH guidelines on the world wide web at our site: <http://ally.ios.com/~afh>

Thanks for your support!

We receive much support throughout the year from our membership and we want to take a moment to thank just a few of them.

Brian Baker has represented the AFH at two herp shows. He recruited a number of volunteers and sold hundreds of dollars of merchandise with no compensation.

Ray Busby, International Reptile Breeders Association, donated a table at two recent IRBA Conventions in Mesa, AZ and San Diego, CA. Ray went out of his way to call us when he saw that we hadn't signed up yet. He has also offered us a table at the two upcoming 1996 shows.

David Good also contributed a table to his herp swap meet a few months back.

Special thanks to Wayne Hill, organizer of the National Reptile Breeder's Expo, for making a table available to us.

Thanks to all for your efforts to support our cause!

Membership Update

The AFH has recently reached an all time membership high of 4,616! We currently have members in over 70 countries around the world.

Special Issue

We have received lots of positive feedback on the bearded dragon special format. So much, in fact, that our next issue will feature chameleons. You can expect a variety of articles covering captive breeding, different species, vivariums and more.

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Coming Events

August 10-11, 1996: 2nd Annual Captive-Bred Reptile and Small Exotic Animal Show and Sale will be held Seattle, Washington. For info, contact Rick Sims, NW Captive Breeder's Expo, P.O. Box 77267, Seattle, WA 98177, ph (206) 363-9095, fax (206) 333-4205.

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.

August 17-18, 1996: Exotics & Family Pet Showcase will be held in Edison, New Jersey. For info, contact: Vicki Clark, 372 Meadow Wood Lane, Souderton, PA 18964, ph (215) 721-7199, fax (215) 721-7979.

August 25, 1996: NY Metro Reptile Expo will be held in White Plains, New York. For info, contact Bruce Lowder, 1 Seneca Rd, Putnam Valley, NY 10579, ph (914) 526-4845.

August 23-27, 1996: Association of Reptilian and Amphibian Veterinarians 3rd Annual Conference will be held in Tampa, Florida. For info, contact Julie Fazlollah, ARAV Conference Registration Office, (770) 993-2323, or Dr. Wilbur Amand, Executive Director, (610) 358-9530.

August 25, 1996: Demo's Pit Herpetological Expo will be held in Wilmington, Delaware. For info, contact Rich Denmon, PO Box 197, Chadds Ford, PA 19317, ph/fax (610) 872-2247 or ph/fax (800) 441-6980.

August 31, 1996: Atlanta Reptile and Amphibian Breeder's Expo will be held in Atlanta, Georgia. For information, contact: Georgia Herpetological Society, P.O. Box 464778, Lawrenceville, GA 30246 or ph (404)653-9966, or David Bowman (770)445-6176, or Marc Farber, ph/fax (770)396-4414.

August 31, 1996: Miami Valley Herp Expo will be held in Dayton, Ohio. For info, contact Chad Arment, 7905 S. Kessler-Frederick Rd, Tipp City, OH 45371, ph (513) 698-5439.

September 7, 1996: Second Annual Frog Day will be held in San Jose, California. For info, contact Charles Powell, 2932 Sunburst Dr., San Jose, CA 95111-2264, ph (408) 363-0926.

September 6-8, 1996: East Texas Herp. Society's 6th annual conference and Breeder's Expo will be held in Houston, TX. For info, contact: Dave Doherty, ph (713)367-4963 or Russ Walker, ph (409) 594-5554.

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.

September 14, 1996: IRE's All California Reptile Swap Meet will be held in Santa Monica, California. For info, contact Dave Good, (619) 583-4055 or (619) 268-9004.

September 21, 1996: Bay Area Amphibian and Reptile Society's Annual Fundraising Bazaar and Show will be held in Palo Alto, California. For info, contact Pete Marshall, BAARS, Palo Alto Junior Museum, 1451 Middlefield Rd, Palo Alto, CA 94301, ph (408) 450-0759.

September 28-29, 1996: Florida International Reptile Show will be held in Tampa, Florida. For more info, contact: Doug Wagner, P.O. Box 2725, Dunedin, FL 34697, (813) 771-1368.

September 29, 1996: Big Apple Annual Reptile Show will be held in Melville, New York. For info, contact Steven Spitz <sspitz@pb.net>.

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.

October 5-6, 1996: Vicki Clark's Expo USA will be held in Souderton, Pennsylvania. For info, contact: Vicki Clark's Expo USA, 372 Meadow Wood Lane, Souderton, PA 18964-2019, ph (215) 721-7199, fax (215) 721-7979.

October 6, 1996: Nebraska Herpetological Society Swap Meet will be held in Omaha, Nebraska. For info, contact Paul Edwards, Nebraska Herp Society, 2876 Read Street, Omaha, NE 68112, ph (402) 393-5500.

October 18-20, 1996: 12th annual Midwest Herpetological Symposium will be held in St. Louis, Missouri. For info, ph (314) 677-6652.

October 27, 1996: Northern Ohio Association of Herpetologists (Noah), Reptile and Amphibian Showcase will be held in Cleveland, Ohio. For info, contact: Matt, (419) 433-3639. American Legion Hall, 2201 Brookpark Road, Cleveland, OH.

November 3, 1996: Demo's Pit Herpetological Expo will be held in Wilmington, Delaware. For info, contact Rich Denmon, PO Box 197, Chadds Ford, PA 19317, ph/fax (610) 872-2247 or ph/fax (800) 441-6980.

November 8-10, 1996: Seattle Reptile, Exotics and Family Pet Expo will be held in Seattle, Washington. For info, contact Rainforest Productions, (909) 352-3420, Fax (909) 352-1079.

November 9-10, 1996: San Diego Herpetological Society's 9th Annual Amphibian and Reptile Exhibition and sale will be held in Del Mar, California. For info, contact Jack Stafford, (619) 693-8363.

November 14-17, 1996: The Long Island Pet Expo will be held in Long Island, New York. For info, contact Expositions Inc. (516) 889-6000 or (800) 886-8000.

November 16-17, 1996: International Reptile Breeders Convention will be held in Mesa, Arizona. For info, contact: Ray Busby, IRBA, PO Box 8512-279, San Diego, CA 92186, ph (800) 497-3550 or fax (619) 263-6898.

November 17, 1996: Demo's Pit Herpetological Expo will be held in Wilmington, Delaware. For info, contact Rich Denmon, PO Box 197, Chadds Ford, PA 19317, ph/fax (610) 872-2247 or ph/fax (800) 441-6980.

November 24, 1996: NY Metro Reptile Expo will be held in White Plains, New York. For info, contact Bruce Lowder, 1 Seneca Rd, Putnam Valley, NY 10579, ph (914) 526-4845.

November 30, 1996: Eastern Herpetological Expo will be held in Downingtown, Pennsylvania. For info, contact G. Leonard Knapp, 215 Lawn Ave, Sellersville, PA 18960, ph (215) 257-6088.

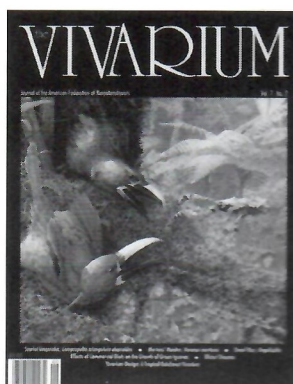
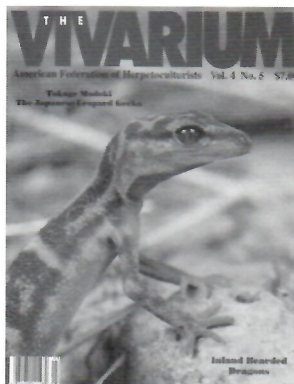
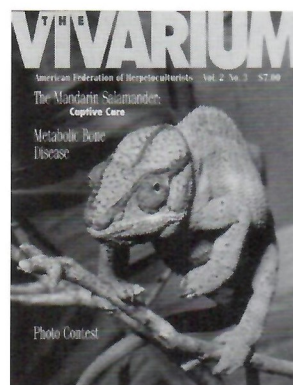
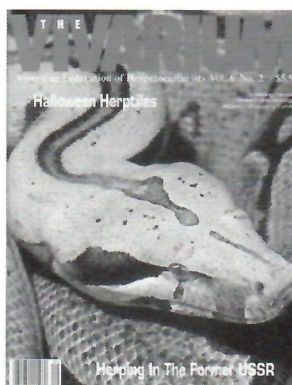
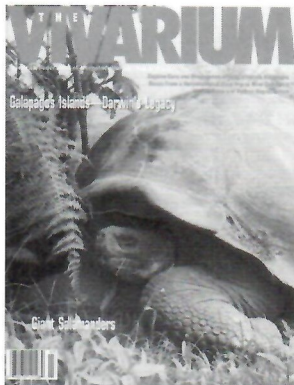
November 30-December 1, 1996: Vicki Clark's Expo USA will be held in Souderton, Pennsylvania. For info, contact: Vicki Clark's Expo USA, 372 Meadow Wood Lane, Souderton, PA 18964-2019, ph (215) 721-7199, fax (215) 721-7979.

December 22, 1996: Northern Ohio Associations of Herpetologists (Noah), Reptile and Amphibian Showcase will be held in Cleveland, Ohio. For info, contact: Matt, (419) 433-3639. American Legion Hall, 2201 Brookpark Road, Cleveland, OH.

August 2-10, 1997: Third World Congress of Herpetology will be held in Prague, Czech Republic. For info, contact Third World Congress of Herpetology, c/o Czech Medical Association J.E. Purkyně, Congress Department, P.O. Box 88, Sokolska 31, 120 26 Praha 2, Czech Republic. Fax (+42 2) 29 46 10, or (+42 2) 24 21 68 36.

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

It's a jungle in here . . .



See page 21 for an index listing of all available back issues.

Classifieds

HOW TO PLACE A CLASSIFIED AD IN THE VIVARIUM: Type or clearly hand write your ad in 30 words or less for a total of \$15.00. Any ad over 30 words costs \$0.50 per additional word. Payment must be made in advance and must include the correct amount in order to be placed in the next issue. Classifieds that run for one year (6 times) paid in advance, qualify for a 5% discount. For additional info, call (619) 747-4948 or fax (619) 747-5224.

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Issue

Deadline

(8.1) August 30

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The North American Garter Snakes

by
Neil Ford, PhD

The garter and ribbon snakes of the genus, *Thamnophis*, are among the most common and widespread snakes in North America. Most people, if they are familiar with any local snakes, can recognize these striped colubrids. Garter snakes often occur in urban areas and are generally active during the day, so are frequently observed in many areas of the United States, Canada, and Mexico. Their abundance and visibility has also led to the members of *Thamnophis* being chosen as the subjects of research by field biologists. In addition, the availability and the general docility of many species has made them common snakes to be maintained in captivity by professional herpetologists. In terms of scientific research, the common garter snake, *Thamnophis sirtalis* is probably the best known snake in the world. Many of the other species of *Thamnophis* found in the U. S. and Canada have also been extensively studied both in the lab and in the wild. Yet two species of *Thamnophis*, the exiled garter snake, *T. exsul*, and the Tamaulipan Montane garter snake, *T. mendax*, may qualify as two of the least known colubrids in the world. Only two dozen total specimens are known for both these Mexican species. Several other *Thamnophis* such as Godman's garter snake, *T. godmani*, and the Golden-headed garter snake, *T. chrysocephalus*, of the mountains of southern Mexico, the Mesoamerican Highland's garter snake, *T. fulvus*, and the Southern Durango spotted garter snake, *T. nigrionuchalis*, are almost as poorly known. Additionally, some species of garter snake have populations in the U. S. that have been studied but have subspecies and populations in other parts of their ranges that are unknown. For example, the black-necked garter snake, *T. cyrtopsis* has subspecies occurring in Guatemala; the checkered garter, *T. marciannus* and western ribbon, *T. proximus* range to Costa Rica; and the narrow-headed garter, *T. rufipunctatus* and Mexican garter, *T. eques* have been studied in Arizona but both have unstudied subspecies in Mexico. As a group, garter snakes may therefore qualify as both the best and the least known colubrid snakes in North America.

In 1908, Ruthven wrote a comprehensive monograph on the garter snakes. He tended to lump some of the then known species as subspecies within a species and therefore described the characteristics of only 13 species. In Wright and Wright's 1957 classic *Handbook of Snakes of the United States and Canada* they discussed only 10 species. That book however, did not include the Mexican and Central American forms. The current monograph by Rossman, Ford and Seigel (1996) uses the most current taxonomic methods and elevates the number of garter snakes to 30 species. However, they accept that the current names may still change as more detailed information is gained on this complex group. Ruthven's comment that "this genus has long stood in the minds of herpetologists as a synonym for chaos" still applies today. In our current understanding of garter snake taxonomy, a number of the *Thamnophis* that Ruthven discussed have been split into distinct species. In particular, a number of the "subspecies" of the Sierra garter snake group, *T. couchii*; the Plains garter snake, *T. radix* and the Western Terrestrial *T. elegans* have been elevated to species over the last few decades. Many of the currently designated garter snake species have a number of distinct subspecies, i.e. *T. elegans* with 6 and the common garter, *T. sirtalis*, with 11. So any discussion of the natural history characteristics of garter snakes must be qualified with the caveat that much of the data used is known only from some of the members. Still, for some species and some populations we do have a remarkable amount of information and I will present a general discussion of that data. Very detailed discussion of the same information is available in Rossman, Ford and Seigel's new book on the garter snakes.

Garter snakes are the most widespread snakes in North America. At least one species occurs in every state in the U. S. and many range up into Canada and all the way through Mexico and Guatemala down to Costa Rica. They are often the most abundant reptile at a particular locality. What features of their natural history have made this group so successful? We know enough about some species of *Thamnophis* to at least examine this question.

The common garter snake, *T. sirtalis*, has the widest range of any *Thamnophis* and occurs farther north in Canada than any other snake. It is also the best known species. For example, 35% of the reproductive data on garter snakes comes from some subspecies of *T. sirtalis* (Rossman, Ford and Seigel, 1996). Information from other northern species, such as the plains garter, *T. radix* and the western terrestrial, *T. elegans* make up much of the rest of our knowledge on reproduction and other ecological aspects of the lives of garter snakes. Data on southern forms are generally much less available. Accepting this limitation we can still suggest some aspects of the ecology and behavior of the whole group.

The activity of garter snakes follows the seasons. In northern regions they become active as late as May and remain active only until August or September. Farther south they may be active much longer, even hibernating for only short periods in the deep south. Obviously, their seasonal activity is temperature dependent but garter snakes can be seen out on sunny days even when the air temperature is near freezing. Thermoregulatory behavior allows them to maintain body temperature often above the air temperature. In more southern climates, cold temperatures are less of a problem than are too high temperatures in midsummer. Snakes at this time of year in these areas may retreat during the heat of the day. Some populations are even known to become nocturnal and others may aestivate (staying underground and lowering metabolism) through the hottest and driest part of the year.

Surprisingly, the differences in preferred body temperatures between species and populations from different areas are relatively minor. For most garter snakes a body temperature of around 82.4° F (28°C) is optimal. Only the eastern ribbon snake *T. sauritus*, has a slightly higher preference for about 86° F (30°C) (Rosen, 1991). Variation in the temperature microenvironments available influence how well a garter snake can regulate its temperature. In many areas in the spring the temperature of all substrates, even underground, drop at night and so the body temperatures of the snakes must also. In the summer however, most animals can regulate their temperature around their preferred value. Other constraints, the need to



Western Terrestrial Garter Snake, *Thamnophis elegans*.

forage, mate and other behaviors may require the animal leaving the sites where thermoregulation is possible. For example, male garter snakes often show more variable body temperatures than gravid females that need to carefully regulate their temperature to develop their embryos properly. An interesting aspect to thermoregulation is the role of increased melanin in the skin. Both the common garter snake, *T. sirtalis* and Butler's garter snake, *T. butleri*, have populations in Northern regions with melanistic individuals that may be able to heat up more rapidly than normal colored snakes.

One of the life history traits that is well-documented for many species of garter snake is reproduction. In general, male garter snakes begin spermatogenesis in late summer and fall (Ford and Seigel, 1987). Testosterone levels are highest at this time (Gans and Crews, 1992). Yet courtship occurs most often in spring when the snakes come out of hibernation. Therefore, the behavior of the males is independent of testosterone and appears to be based on neuroendocrine changes in the brain. The females go into hibernation with small follicles and rapidly enlarge the eggs when they come out in the spring. The estrogen level of the female is high in



Checkered Garter Snake, *T. marcianus*.

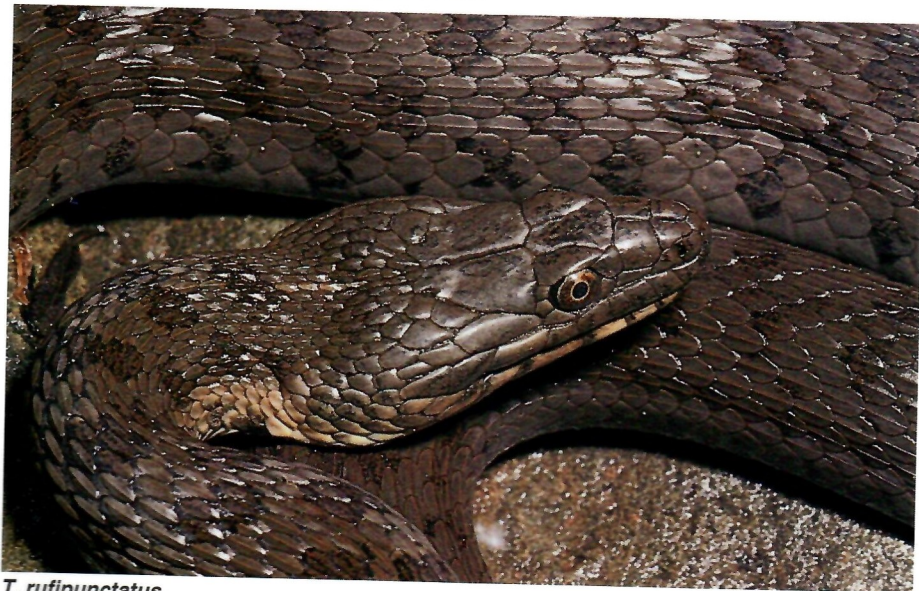
the spring and does influence the male's courtship. The cue regulating the timing of courtship appears to be primarily the change from the cold temperature in the den to the warmer environmental temperature as the snakes emerge (Whittier and Tokarz, 1992). In northern climates, males emerge from the den first and court the females in mass (called mating balls) as each female emerges. Pheromonal cues from the female's skin are involved in

both stimulating the male and in allowing him to trail the female (Ford, 1986). After mating, the male's semen may form a plug inhibiting other males from mating that female. However, paternity testing has shown that offspring often are sired by multiple males so the effectiveness of the plug is questionable.

Southern populations of garter snakes show some modification of these patterns. Females may have enlarged follicles in the



Narrow-headed Garter Snake, *T. rufipunctatus*.



T. rufipunctatus.

fall, (i.e. Mexican garter snakes, *T. eques*; Rosen and Schwalbe, 1988). Courtship may not occur immediately but rather several weeks later (checkered garter snakes, *T. marcianus*; Ford and Cobb, 1992). In fact, fall mating is known to occur in a number of species including populations of Pacific coast aquatic garter snakes, *T. atratus*, northwestern garter snakes, *T. ordinoides*, plains garter snakes, *T. radix*

and western terrestrial, *T. elegans*. Obviously, temperature changes are less dramatic for southern species and some evidence suggests that the condition of the females in the population (i.e. fat levels) may trigger an estrogen surge in some females which then through odors stimulates all females to cycle (Mexican black-bellied garter snakes, *T. melanogaster*,

around lakes in the Mexican plateau; Gartska and Crews, 1985).

The fecundity, or number of young produced in a clutch, of some species such as western terrestrial garter snakes, *T. elegans* and common garter snakes, *T. sirtalis* has been documented from several localities. However, for most species we have limited data on clutch size and for some such as golden-headed garter snakes, *T. chrysocephalus*, exiled garter snakes, *T. exsul* and Mesoamerican Highland's garter snake, *T. fulvus*; it is nonexistent. Clutch sizes average from a low of 6 in eastern ribbon snakes, *T. sauritus* to 33 for common garter snakes, *T. sirtalis* in Maryland. Populations of the same species vary in average clutch sizes but because authors often select the biggest most obviously pregnant snakes to keep, the data may be skewed upward. Foraging success can also effect clutch size of individual females (Ford and Seigel, 1989) so yearly variation relative to the prey availability affect the validity of clutch size data.

Offspring size information is available for only 12 species. The smallest young occur in Pacific coast aquatic garter snakes, *T. atratus* and the largest in giant

garter snakes, *T. gigas*. It also appears that geographic differences within species may occur but more study is needed to evaluate that possibility.

The frequency of reproduction has been studied in 9 species of garter snake. Most reproduce each year but some northern eastern ribbon snakes, *T. sauritus* and common garter snakes, *T. sirtalis* skip a year (Larsen et al., 1993). In captivity, western ribbon snakes, *T. proximus* can produce multiple clutches in one year but no confirmation of this phenomenon for any garter snake in the wild has been attempted. A female two-striped garter snake, *T. hammondi* produced young after isolation from males for 53 months and sperm storage is known to occur in other species.

Communal hibernation is an important feature of garter snake populations in areas where the winter temperatures remain below freezing for any length of time. Adequate dens may be limited so sites are used by many individuals and orientation mechanisms such as sun compass and pheromone trailing are used to locate the den (Lawson, 1994). Often the snakes are underwater for periods of time in the den and the submersion has been shown to reduce the animal's metabolism (Costanzo, 1989).

For 10 species of garter snake no data on their prey exist. However, the other 20 species are known to eat a great diversity of items from invertebrates such as earthworms, leeches, slugs and even crabs and gastropods to vertebrates such as fish, salamanders and frogs, snakes, lizards, birds and small mammals such as voles; even such unusual items as bats. The great variation in diets of garter snakes is created by differences in prey eaten by different species but also difference among populations of the same species. Additionally, different prey are taken by different size classes within species and prey eaten during different seasons and even among years at the same locality.

Some species such as western terrestrial garter snakes, *T. elegans* and common garter snakes, *T. sirtalis* are generalist feeders and are known to take a wide variety of prey. In general they eat whatever appropriate prey is available, so diet is strongly related to prey availability. Other species specialize on specific prey. For example, the short-headed garter snake, *T. brachystoma* and Butler's garter snake, *T. butleri* eat only earthworms and leeches in the field but ribbon snakes, *T. sauritus* and *T. proximus*, will not eat earthworms but rather chase down amphibians. The Mexi-

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Black-necked Garter Snake, *T. cyrtopsis*.



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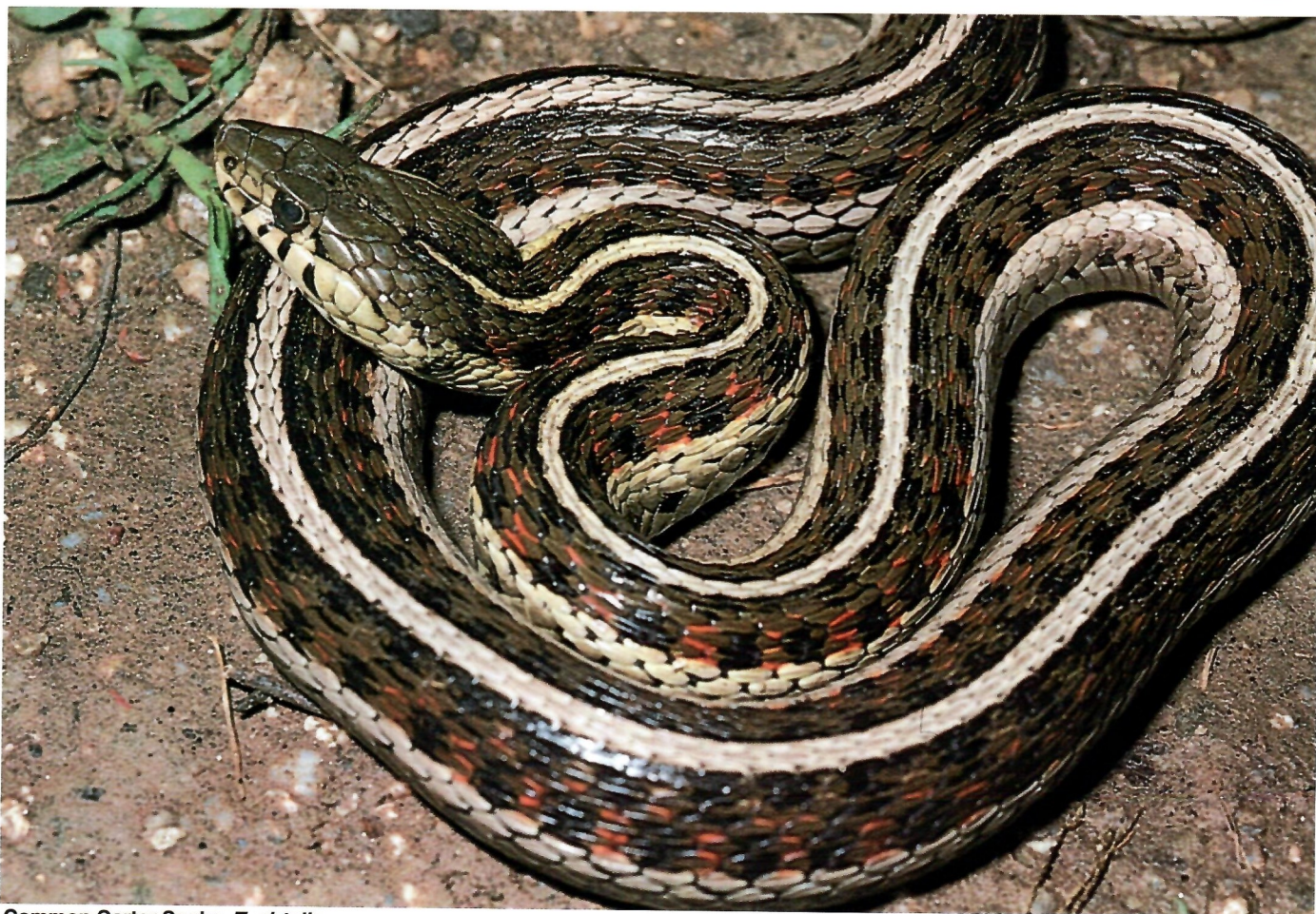
Plains Garter Snake, *T. radix*.

can Alpine blotched garter snake *T. scalaris* eats only lizards. The Pacific coast aquatic garter snake, *T. atratus* catches fish from perches above the water (Lind and Welsh, 1994) whereas the Sierra garter snake, *T. couchii*, has negative buoyancy and crawls along underwater to catch fish and giant Pacific salamanders, *Dicamptodon ensatus*. The Mexican garter snake, *T. eques*. Mexican black-bellied garter snakes, *T. melanogaster*, and the narrow-headed garter snake, *T. rufipunctatus*, all use a head swaying motion underwater to catch the fish that they specialize on. Another extreme specialization is the ability of some populations of common garter snakes, *T. sirtalis* resistance to the neurotoxin, tetrodotoxin, which enables them to eat the toxic Pacific newt, *Taricha granulosa*.

For generalist species of garter snakes the prey taken is often seasonally variable, and whatever is available is eaten. Plains garter snakes, *T. radix*, and common garter snakes, *T. sirtalis*, often eat earthworms in spring and fall but switch to the more abundant frogs in summer. Mexican garter snakes, *T. eques*, also make a similar switch. Yearly variation in the diet of garter snakes is also known. The prey of a California population of western terrestrial garter snakes, *T. elegans*, was monitored over 7 years and was related to how dry the year was because that affected what food was available (Kephart and Arnold, 1982).

Because of the great size difference between newborn and adult garter snakes, the prey selected would be expected to vary with age of the individual. Although studies on ontogenetic changes are limited in number, the young of many species of garter snake eat mostly earthworms and switch to larger prey such as fish and frogs as they reach adulthood. For species that eat mammal, (i. e. *T. elegans*), only the largest members eat rodents. This species is also known to produce toxic saliva that helps subdue those small mammals. As garter snakes grow, the general trend is for them to increase the diversity of prey taken, not to delete the items eaten as young from the adult diet.

Habitat preferences also effect diet in garter snakes. Species like the Northwestern garter snake, *T. ordinoides*, in British Columbia prefer less dense forests than the sympatric common garter snake, *T. sirtalis* and western terrestrial garter snake, *T. elegans* (Gregory, 1984). Prey items available in the different areas would influence what shows up in the diet of each species. However, some innate



Common Garter Snake, *T. sirtalis*.

differences are known to occur. Coastal and inland populations of the northwestern garter snake, *T. ordinoides*, differ in their tendency to eat slugs and the slug refusing trait is heritable (Arnold, 1977; 1981).

Genetic differences in antipredator behavior also occur in garter snakes. Most garter snake species will musk and try to escape by fleeing but some such as Mexican black-bellied garter snakes, *T. melanogaster*, and western ribbon snakes, *T. proximus*, are aggressive biters. Others such as Butler's garter snake, *T. butleri*, almost never bite. An interesting situation occurs in some polymorphic populations of northwestern garter snakes, *T. ordinoides*. Individuals with stripes have a genetic predisposition to try to escape by fleeing whereas spotted and solid colored forms tend to be more aggressive and strike at predators (Brodie, 1993). The stripes may be associated with fleeing behavior because they make the snake hard to track visually.

Although we tend to think of garter snakes as abundant snakes the actual density of populations of these animals is only known for 8 species. Densities can be locally as high as 845/ha (for plains garter



Mexican Garter Snake, *T. eques*.

snakes, *T. radix*) or as low as about 2/ha. Because of lack of information on most populations, few species are listed as endangered or threatened. The giant garter snake, *T. gigas*, and the San Francisco garter snake, *T. sirtalis infernalis*, in California are listed by the federal government as endangered. Habitat loss is involved in the first case and limited dis-

tribution in the second. Both of these factors play roles in the listing of several state endangered garter snakes. Sometimes this is because the snake's range is peripheral to that state such as the checkered garter snake, *T. marcianus*, in Kansas but some have small total populations such as the short-headed garter snake, *T. brachystoma*, in Pennsylvania and New

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York. The Mexican garter snakes, *T. eques* and *T. rufipunctatus*, have small populations in Arizona and New Mexico where they are protected. Although these two species have larger distributions in Mexico their status there is unknown. The abundance and stability of most Mexican and Central American garter snakes is unknown.

In most cases the main danger to garter snake populations is local habitat modification. Although many species cohabit well with humans, uncontrolled human activities can take a serious toll on garter

snakes. Roadkills, for example, are a significant source of mortality in garter snakes in urban areas. If some protection is afforded local populations of these snakes, they can thrive, but they can just as easily be extirpated. We have a multitude of examples of where we have lost an abundant species of animal due to our lack of concern. Let us hope we have learned that to retain such interesting animals we must pay attention and take care of them.

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