PROCEEDINGS OF THE 28th INTERNATIONAL HERPETOLOGICAL SYMPOSIUM on CAPTIVE PROPAGATION and HUSBANDRY

Hosted by
The National Reptile Breeders Expo
and the Central Florida Zoological Park
Daytona Beach, Florida

August 10th - August 13th, 2004

International Herpetological Symposium, Inc.
28th Annual Meeting

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International Herpetological Symposium

28th Annual Meeting

Hosted by

The Central Florida Zoological Park
Lake Monroe, Florida USA

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Program and Abstracts

Welcome to the 28th Meeting of the International Herpetological Symposium

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INTERNATIONAL HERPETOLOGICAL SYMPOSIUM
28TH ANNUAL MEETING

PROGRAM

Tuesday, August 10th

5:00 - 8:00 p.m.	Registration – Adam's Mark Hotel
7:00 p.m. - ?	Ice Breaker – Hospitality Room

Wednesday, August 11th

8:30 a.m. - 3:30 p.m.	Open Registration – Adam's Mark Hotel
9:00 - 9:15 a.m.	Opening Remarks and Introductions
9:15 - 10:15 a.m.	**Dr. Peter Pritchard** "Keynote Address - Lonesome George and the Con Giai: Turtles Staring Extinction in the Face"
10:15 - 11:00 a.m.	**Chuck Schaffer** "Field Observations of *Manouria emys emys* in Malaysian Borneo, and *Manouria emys phayrei* in Thailand"
11:00 - 11:15 a.m.	*Morning Break*
11:15 - 12:00 a.m.	**Paul Moler** "Current Herpetological Conservation Issues in the Sunshine State"
12:00 a.m. - 12:45 p.m.	**Ray Ashton** "Using Behavior to Determine the Type and Size of Enclosures for Semi-wild Assurance Colonies of Upland Tortoises"
12:45 - 2:00 p.m.	*Lunch Break*
2:00 - 2:45 p.m.	**Dean Alessandrini** "Limiting Factors and Recovery Efforts of the Eastern Indigo Snake"
2:45 - 3:30 p.m.	**Vin Russo** "Dwarf Boas of Central America and Mexico"

3:30 – 3:45 p.m.	*Afternoon Break*
3:45 – 4:30 p.m.	**John Cann** "Australian Herps and Herpers "
5:30 p.m.	Shuttle Buses leave for **Field Trip to Central Florida Zoo and Hosted Picnic at the Central Florida Zoo**
6:30-10:00 p.m.	**Central Florida Zoo Reptile Department Open House**
8:00- 9:30 p.m.	Mystery Herp Quiz at Zoo – **John Tashjian** (Prize to winner!)
10:00 p.m.	Shuttle Buses Return to Adam's Mark Hotel

Thursday, August 12th

9:00 a.m. - 3:30 p.m.	Open Registration
9:00 - 9:45 a.m.	**Dr. James B. Murphy** "Intelligence in Varanid Lizards"
9:45 - 10:30 a.m.	**Steve Conners** "Breeding and Husbandry of Komodo Dragons at Miami MetroZoo"
10:30 - 10:45 a.m.	*Morning Break*
10:45 - 11:30 a.m.	**Dr. Muhammad Sharif Khan** "Present Status of the Angular-toed Geckos of Pakistan"
11:30 a.m. - 12:15 p.m.	**Dr. James B. Murphy and Dr. Gary Ferguson** "Chameleons: Biology and Captive Management"
12:15 - 1:30 p.m.	*Lunch Break*
1:30 - 2:15 p.m.	**Kent Vliet** "Neurobiology and Learning in Crocodilians "
2:15 - 3:00 p.m.	**Arianne Parton and Joclynn July** "Training as a Management Tool for Nile Crocodiles"
3:00 - 3:15 p.m.	*Afternoon Break*

3:15 - 4:00 p.m.	**Flavio Morrissiey** "Training Crocodiles for Entertainment and Husbandry"
4:00 - 4:45 p.m.	**Bruce Shwedick** "Husbandry and Captive Reproduction of *Tomistoma schlegeli*"
6:30 p.m. - ?	Banquet Dinner – Adam's Mark Hotel
	Announcement of the Photo Contest Winners
	Banquet Speaker – **Dr. James B. Murphy** "Herpetological Time Travel"
	Auction - Proceeds benefit next year's IHS! (Credit Cards Accepted)

Friday, August 13th

9:00 a.m. - 12:00 p.m.	Open Registration
9:00 - 9:45 a.m.	**William Becker** "Neotropical Pit Vipers"
9:45 -10:30 a.m.	**Dr. Stephen Mackessy** "Oral Glands of Reptiles: Venoms, Toxins and Saliva"
10:30 – 10:45 a.m.	*Morning Break*
10:45 – 11:30 a.m.	**Dr. Chris Parkinson** "Pitviper Systematics and Why Their Names Change"
11:30 a.m. – 12:15 p.m.	**Ernie Jillson** "Exotic Snakebite Envenomations"
12:15 – 1:30 p.m.	*Lunch Break*
1:30 – 2:15 p.m.	**Dr. Bruce Means** "For the Love of Frogs: Exploring the Lost Worlds of Gondwana"

2:15 – 3:00 p.m.	**Dr. Brad Lock** "An Epizootic of Chronic Regurgitation Associated with Chlamydophilosis in Recently Imported Emerald Tree Boas (*Corallus caninus*)"
3:00 – 3:15 p.m.	*Afternoon Break*
3:15 – 4:00 p.m.	**John Tashjian** "Scientific Nomenclature"
4:00 – 4:15 p.m.	Presentation of the Joseph Laszlo Memorial Award
	Closing remarks

Saturday, August 14th and Sunday, August 15th

10:00 a.m. – 5:00 p.m.	**2004 National Reptile Breeders' Expo at the Ocean Center**

CONTENTS

ABSTRACTS

DEAN ALESSANDRINI
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Limiting Factors and Recovery Efforts of the Eastern Indigo Snake

The Eastern Indigo Snake, Drymarchon couperi, is the longest and arguably most beautiful snake native to the United States. Man-made circumstances including habitat destruction and road mortality have caused significant population declines and in some regions, extirpation. In 1979, the eastern indigo was listed federally as a threatened species. Since the early 1990s I have been maintaining and successfully reproducing these remarkable animals in my collection. The introduction to this talk will provide a description of the eastern indigo snake; providing range, habits, feeding etc. I will then outline the limiting factors of the indigo to provide an understanding of why this species is in trouble. Conservation and recovery efforts of the indigo snake have been sporadic since its federal listing in 1979. I have been fortunate enough to have been invited to spend time in the field with researchers in both Florida and Georgia, as they track and study this species. Other conservation efforts are underway. In the closing section of the talk, I will describe conservation programs, and discuss methods for YOU to get involved. This talk contains MANY photos of indigo snakes habitat, and should appeal to a wide range of audience members.

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Using Intensive Natural History Studies to Establish Tortoise Assurance Colonies

Our research currently is centered on savannah or dry forest dwelling species of tortoises, in particular Indian star tortoises (*Geochelone elegans*), radiated tortoises (*G. radiata*), spider tortoises (*Pyxis a. brygooi*), and marginated tortoises, (*Testudo marginata*). At our field station, we have more than 400 wild gopher tortoises (*Gopherus polyphemus*) roaming the natural savannah habitat. The exotic tortoises are roaming in natural habitat that is broken up into eight 25-acre study plots. The research that we have been doing on gopher tortoises has been underway for more than 30 years. Along with just about all aspects of gopher tortoise behavior, we have been intensively studying forage and foraging behavior. We have also been studying tortoise social behavior and how these two things are the foundation for tortoise distribution on the landscape and the keys on how to manage tortoises in both natural and manmade habitats. If we are going to use captive breeding as an important conservation tool, much of the work we have been doing should be done on each species, both in the wild and in captivity. For example we have found that gopher tortoises feed on more than 400 species throughout their range. Interestingly enough, so do the other tortoises that we are working with. We know that any one tortoise in a habitat will feed on approximately 200 species of plants. In doing so, the gopher tortoise may travel over several hectares per year, just to find the right plants at the right time to eat. Under the captive conditions that are usually found in most zoos and private collections

tortoises are fed at most 18-20 species of plants, all at the same stages and usually artificially grown. This simplistic forage and other conditions such as eliminating an animal's home range and its ability to maintain distance from others, and a long list of other unnatural conditions may possibly be leading to rapid genetic changes in breeding stock and offspring which is then passed on in the altered genetic material. This may be why few species of tortoises or other reptiles rarely breed successfully in captivity after the second generation. This research is vital for the successful long term maintenance of Tortoise Assurance Colonies with individuals retaining the characteristics that make them well-suited for returning to the wild rather than living in captivity.

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Captive Husbandry of Neotropical Pit Vipers

The number of venomous snakes that have become commercially available to private herpetoculturists in the past decade has increased exponentially. The number of snake species that have become available during the same period has at least quadrupled. Neotropical pit vipers are ever increasing in popularity among venomous hobbyists. Popular literature regarding the proper captive husbandry techniques for these species is often conflicting or not available. The optimum captive condition for any species is to emulate its natural habitat. A discussion of these conditions will be presented for a number of species in the genera *Agkistrodon, Atropoides, Bothriechis, Bothriopsis, Bothrops, Crotalus, Lachesis*, and *Porthidium*. Natural history, allopatry and sympatry of congeners, captive versus wild dietary considerations, and captive breeding techniques for each species will be presented. The accelerated rate of habitat deforestation and the increasing difficulty to import these species from their native countries will be emphasized to encourage propagation of existing captive populations.

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Australian Herps and Herpers

This presentation is a travelogue of Australian reptiles which also includes some of the interesting human characters encountered along the way. Australia is host to many of the world's deadliest snakes and also boasts a long tradition of devil-may-care snake pit entertainers and antidote sellers. There are many amazing stories of individuals in the days of snake showmen and snake oil remedies in downunder Australia. John Cann is especially well-qualified to tell this story since he is a snake pit performer himself as was his brother, mother, and father.

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Captive Breeding and Husbandry of Komodo Dragons at Miami Metrozoo and Its Connection to Dragon Conservation

An adult pair of wild caught Komodo dragons (*Varanus komodoensis*) was acquired by Miami Metrozoo in 1995. Exhibit design and husbandry decisions resulted in successful reproduction two years later. Egg incubation techniques produced a 93% hatch rate of fertile eggs. Incubation period ranged from 212-246 days. Hatchlings were raised under two different artificial lighting regimes, and natural sunlight. Blood measurements of vitamin D levels were comparable to samples from wild specimens in hatchlings from all groups. A total of twenty seven offspring (100%) were reared successfully in variety of enclosures, without health problems. This breeding event was important for the genetic vigor and diversity of the captive North American population of this species. The majority of the young dragons were transferred to other zoos over the ensuing years. In return donations to Metrozoo's Conservation and Research Fund from the recipients have been used to support conservation and research projects in the dragons' natural habitat. This event illustrates how captive reproduction can support species conservation in several ways.

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Exotic Snakebite Envenomations

Miami-Dade County is the largest importer of exotic venomous snakes in the United States, and possibly the world, importing more than 1,500 snakes annually. From 1946 through 1988, the Miami Serpentarium handled the needs for antivenin throughout the state of Florida. Due to the closure of the facility in 1988, South Florida had no access to antivenin with a 250 mile radius and there has been an alarming increase of envenomations (venomous snakebites) and subsequent need for antivenin, Shortly after the closing of Miami Serpentarium, an adult male was bitten by a cobra, and it took 17 public and private agencies to bring this individual back to life. To date, the State of Florida has issued approximately 100 venomous reptile licenses to residents in Miami-Dade County, and an additional 400 permits have been issued throughout the entire state. According to the Florida Fresh Water & Game Commission, 3 to 5 times more people are keeping venomous snakes without acquiring permits. Venomous snakebite incidents continue to occur at an average rate of 300 per year in the state of Florida and at the rate of 8,000 nationally. According to the Florida Poison Control Center, Miami-Dade, Broward and Palm Beach counties average 150 snakebites a year, 40 percent of which are poisonous. However, there is a drastic reduction in the stocking of antivenin serum, and most hospitals are at a disadvantage when confronted with an envenomation incident.

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Chlamydophilosis in Recently Imported Emerald Tree Boas (*Corallus Caninus*)

Over a 4-mo period, one hundred and five wild-caught emerald tree boas (Corallus caninus) were added to a collection of 15 others in Central Florida. Eighty-one boas (67%) developed repetitive regurgitation during the 23 mo period after the initial addition of wild-caught boas and 61 (75%) of these died. Prevalence of regurgitation in this population of snakes was 25% /mo (range 0 - 42%) and incidence was 3.52/mo (range 0 - 13/mo). The cumulative mortality, for those boas developing repetitive regurgitation (61/120), over the 23 mo epizootic was 51%. Histologic evaluation of gastrointestinal tracts showed positive immunohistochemical staining for chlamydial antigen characterized by multifocal to diffuse lymphoplasmacytic inflammation with the formation of granulomas. Electron microscopic evaluation of granulomas identified organisms consistent with *Chlamydophila* spp. which were later identified as *Chlamydophila pneumoniae* by polymerase chain reaction (PCR) and sequence analysis.

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Oral Glands of Reptiles: Venoms, Toxins and Saliva

The oral mucosa of squamate reptiles is richly adorned with glands, many producing lubricant compounds (polysaccharide-rich mucus) which assist in swallowing of bulky prey. However, in numerous lineages, specialized oral glands have differentiated into producing primarily serous (protein-rich) secretions, and several of these glands, notably the Duvernoy's and venom glands, have become specialized for producing toxin-rich venoms which incapacitate, precondition and/or kill prey. Venom glands are most well-known in the front-fanged snakes (families Viperidae, Elapidae and Atractaspididae), but rear-fanged snakes of the polyphyletic family Colubridae and lizards of the family Helodermatidae also produce venoms with potent effects. Examples of venoms and toxins from each of these groups will be discussed, particularly with regards to new compounds from colubrid snake venoms. It appears that venoms arose very early in the evolutionary history of advanced squamate reptiles, and evidence exists for venom production in several fossil lineages, dating from the Cretaceous and the Triassic. Modern venomous reptiles represent the current stage in an evolutionary arms race between predator and prey, and continual coevolutionary adjustments likely drive the high degree of complexity in composition seen among many venoms. Additionally, the ancient occurrence of venom systems, the frequent motif of specific toxicity of certain venoms and the broad distribution of a wide variety of such systems among squamates suggests that venom production may also be present in lineages not commonly considered venomous.

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For the Love of Frogs: Exploring the Lost Worlds of Gondwana

In March and April I backpacked for 30 days on a National Geographic Ultimate Explorer expedition to the "Pantepui" of Mt. Roraima, the famous 9,000-foot high tepui that inspired Sir Arthur Conan Doyle's novel, "Lost World." On that trip I discovered at least two frogs new to science, plus some other really amazing frogs that were poorly known. The hour-long documentary has been airing on MSNBC since late January. I used my Roraima experience to pull together grant monies to return and climb a wholly unexplored tepui (name for cliff-fringed mesas rising mysteriously out of Orinocoan and Amazonian rainforests of Venezuela and Guyana) called Mt. Wokomung. It doesn't even occur on maps of the region. I collected there by myself for an additional 30 days and found at least 6 frogs new to science.

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Current Herpetological Conservation Issues in the Sunshine State

As in most of the world, the single greatest threat faced by Florida's herpetofauna is the anthropogenic loss and degradation of habitat. In addressing this problem, particularly in the case of the gopher tortoise, conflict arises between those wishing to focus maximal resources on habitat protection and those more focused on the rescue of wildlife displaced by development. On another front, Florida has not seen the levels of mysterious amphibian decline reported for some regions, although desmognathine salamanders appear to have disappeared from many areas where seemingly suitable habitat remains, and the long-term impacts of the recent, prolonged drought in the southeastern U.S. are largely undetermined. Commercial harvest of reptiles and amphibians, particularly turtles, remains controversial, although current levels of harvest have not been shown to be excessive. Another matter of concern perhaps unique to Florida, at least in scale, is the introduction of exotic herpetofauna. Florida now supports more non-native than native species of lizards, ranging from small, seemingly innocuous geckos to green iguanas, spiny-tailed iguanas, and Nile monitors. High-volume trafficking in exotic species from throughout the world, which has mushroomed in recent decades, risks not only the establishment of exotic herpetofauna but also introduction of alien diseases with the potential to decimate native wildlife populations.

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Training Crocodiles for Entertainment and Husbandry

Three case studies of crocodile training can enhance entertainment value and husbandry. The case studies are the means of managing large reptiles in captivity. Many conditions affect the way we care for crocodilians. With nutrition control, discipline, consistency of the programs, crocodiles can be trained to be less aggressive to their keepers and controlled to perform in an orderly fashion with the correct communication. With the ideas of the past and present the future of crocodilian training along with reptile training may provide safety to keepers of the dangerous animals.

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Banquet - Herpetological Time Travel Through The Zoo And Aquarium World

As a retired zoo person, there were four reasons why I was motivated to prepare this presentation. The first was my fear that much of our history, beginning with the first reptile building at the London Zoo in 1849, was in danger of being lost. The second was that many of my zoo and aquarium colleagues, especially those new to the profession, did not have a sense of the unique contributions of their predecessors; their accomplishments should be celebrated. The third was that some of my academic and museum associates had the perception that the work done in zoos and aquariums was not very important. Finally and most importantly, I am concerned that many zoo administrators view zoo and aquarium herpetological collections and buildings as a relict from the past; as a result, there has been a significant decline in new facilities, emphasis and financial support.

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Chameleons: Biology And Captive Management

This presentation focuses on the biology and captive management of chameleons by using rare historical illustrations and photographs mostly from the Smithsonian Institution libraries, beginning with woodcuts fashioned in the mid-1500s. Our 1991 study on natural history and color variation in the panther chameleon in Madagascar is included.

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Are Komodo Dragons Different From Other Reptiles?

We had two reasons for preparing this presentation: 1) Monitors have been our focus for many years and we have become intrigued with their prominent place in herpetological art and literature; 2) Our studies on Komodo dragons, both ex situ and in situ, have revealed some hitherto unknown aspects of their biology, especially play behavior and interaction with humans. In addition, we offer recommendations for captive maintenance and future research with varanid lizards.

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Pitviper Systematics and Why Their Names Change

The venomous snake family Viperidae includes 260 species in four subfamilies: Azemiopinae, Causinae, Crotalinae, and Viperinae. The Crotalinae (pitvipers) is the most species rich subfamily, containing over 190 species. Pitvipers are also the widest geographically distributed of the viperid subfamilies, ranging throughout Asia and the Americas, where they inhabit an impressive variety of ecosystems. Innumerable changes have been made to the taxonomy of pitvipers over the last several decades and the systematics of pitvipers continues to remain a dynamic work in progress. For example, prior to 1971 there were six recognized genera, by the mid 1970s this increased to 14 genera, and currently 29 genera are recognized. Here, I present the latest hypotheses for relationships among pitvipers based on mitochondrial DNA data. With these evolutionary perspectives I discuss the rationale behind the last 40 years of taxonomic changes and argue for the importance of revising taxonomy as more information about evolutionary relationships becomes available.

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Training as a Management Tool for Nile Crocodiles (*Crocodylus niloticus*) at Disney's Animal Kingdom

At Disney's Animal Kingdom, animal programs staff uses animal training as an integral part of their animal management. While animal training has been readily applied to mammalian and avian species, we are in the early stages of applying it to our reptilian species. We have found the benefits of using training as a management tool to be vast. Animal care staff is able to obtain better visual and tactile access to the animals in a protected contact situation that decreases the stress to the animals while increasing the safety of keepers and animals. In addition to these

benefits, we have found these animals to learn quickly making the initial time commitment to training the behaviors low and the payoffs high. This presentation will describe how we use training as a management tool for our crocodiles and will discuss the benefits that have been reaped from the program. Additionally, we will discuss the training of basic husbandry behaviors including: shifting off exhibit into the holding area on cue, shifting back into the exhibit on cue, shifting into crates for weights and visual inspection, and allowing for physical restraint within the crate to enable staff to access various body parts for procedures.

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Keynote - Lonesome George and the Con Giai: Turtles Staring Extinction in the Face
(Abstract not available)

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(Abstract not available)

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Field Observations of *Manouria emys emys* in Malaysian Borneo, and Manouria emys phayrei in Thailand.

Poorly known since its description in 1844, *Manouria emys*, the Asian Forest Tortoise, is severely underrepresented in modern scientific literature, most of which restates old data. In comparison to other tortoises, even from the same region, it is virtually unknown. Considering the plethora of unique characteristics, it is astounding that only two in-situ and 12 ex-situ studies exist.

M. emys constructs and guards nest mounds, modifies nesting material, and is the largest Southeast Asian tortoise. Of terrestrial genera, it is the fourth largest worldwide with largest single clutches. Cryptic habits and decreased or disjunct populations make it virtually impossible to locate in the wild.

This study covered sites in Sabah, Malaysian Borneo, Peninsular Malaysia, and Thailand. Objectives achieved were observation of in and ex-situ animals, preserved specimens, food markets, and in-range researcher interviews. Additions to known diet included Alocasia, Begonia, Civet and Leopard scat. The extremely hilly terrain and 85% + canopy cover were unexpected, yet nest mounding behavior now makes more sense. Only four in-situ tortoises were observed in over 300 man-hours of survey time and none in food markets. It seems clear that populations of *M. emys* have declined even since receiving endangered status in 2000.

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Present Status of Angular-toed Geckos of Pakistan

Several assemblages of fragile gekkonid lizards inhabit deserts, scrublands, and alpine habitats throughout Pakistan (Khan, 1999). Taxonomy of these animals is yet little understood (Bauer and Russell 1991; Szczerbak and Golubev 1977, 1986, 1996; Khan 1997, 2001). Kluge (1983) placed Pakistani geckos in genera *Agamura, Alsophylax, Bunopus, Crossobamon, Hemidactylus, Stenodactylus, Cyrtopodion and Tropiocolotes, Microgecko, Ptyodactylus*, and *Teratoscincus*. With recent descriptions of several new angular-toed geckos from Pakistan (Szczerbak, 1991; Khan, 1980, 1988, 1989, 1991, 1993, 2001; Khan and Baig, 1992; Khan and Tasnim, 1990, my concept of the relationship among angular-toed geckos has been changed. My phylogenetic conclusions regarding angular-toed geckos of the Himalayan region have been expressed elsewhere (Khan 2001, 2003, and Khan and Rösler 1999). They are distinguished in four genera: *Alligekko* Khan 2003, are confined to high altitudes in the Greater Himalayas; *Siwaligekko* Khan 2003 are confined to the sub Himalayan Siwalik Range; *Indogekko* Khan 2003 are confined to the sandstone rocks at the bed of ancient rivers; while genus *Cyrtopodion* Fitzinger, 1843 constitutes the ground geckos in the Indus Valley.

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Husbandry and Captive Reproduction of the False Gavial, *Tomistoma schlegelii*

The Tomistoma (*Tomistoma schlegelii*), also known as the False Gharial, is a large slender-snouted crocodilian that inhabits rivers, lakes and peat swamp forests in parts of Peninsular Malaysia, Borneo and Sumatra. It is listed as an endangered species by the USFWS, Appendix 1 of CITIES and currently classified as EN C1 on the IUCN RED LIST. Current populations in the wild are estimated to consist of less than 2500 adults. This species may in fact be critically endangered due to loss of habitat as a result of illegal logging and the systematic drainage of peat swamps for agricultural purposes.

The first captive reproduction of this species took place in 1985 at the Wildlife Conservation Society/Bronx Zoo in New York and later that same year at the Miami Metrozoo in Florida. In Asia, this species is being reproduced in captivity on an annual basis at the Utairatch Crocodile Farm in Thailand. Jong\rquote s Crocodile Farm in Sarawak, Malaysia has reported successful reproduction occurring on a periodic basis The National Zoological Park of Sri Lanka in Dehiwala has also hatched this species, but has reported extremely high neonate mortality. The most recent reproduction in North America occurred at Florida Cypress Gardens in 1999. The history and results of that reproduction are presented in this report along with additional information on the husbandry and reproduction of Tomistoma held in captivity at other facilities in North America, Europe and Asia.

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Scientific Nomenclature

"Usos Latinae et Greccae non timete" or, translated freely by one who is intimidated even by English, Fear "Not the Use of Latin and Greek" and, one might add, all the other bases for scientific names. Because common names of animals (and plants) are different and may be unrecognizable in different countries as well as regions in a single country it is a good idea for a serious herper to learn and use scientific names. Scientific names may reflect descriptive characteristics, geography, habitat, habits and omomatopoeia (see text for that one), and others, providing us with information for better herpetoculture.

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Neurobiology and Learning in Crocodilians
(Abstract not available)

Abstracts

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Limiting Factors and Recovery Efforts of the Eastern Indigo Snake

The Eastern Indigo Snake, *Drymarchon couperi*, is the longest and arguably most beautiful snake native to the United States. Man-made circumstances including habitat destruction and road mortality have caused significant population declines and in some regions, extirpation. In 1979, the eastern indigo was listed federally as a threatened species. Since the early 1990's I have been maintaining and successfully reproducing these remarkable animals in my collection. The introduction to this talk will provide a description of the eastern indigo snake; providing range, habits, feeding etc. I will then outline the limiting factors of the indigo to provide an understanding of why this species is in trouble. Conservation and recovery efforts of the indigo snake have been sporadic since its federal listing in 1979. I have been fortunate enough to have been invited to spend time in the field with researchers in both Florida and Georgia, as they track and study this species. Other conservation efforts are underway. In the closing section of the talk, I will describe conservation programs, and discuss methods for YOU to get involved. This talk contains MANY photos of indigo snakes habitat, and should appeal to a wide range of audience members.

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Using Intensive Natural History Studies to Establish Tortoise Assurance Colonies

Our research currently is centered on savannah or dry forest dwelling species of tortoises, in particular Indian star tortoises (*Geochelone elegans)*, radiated tortoises (*G. radiata),* spider tortoises *(Pyxis a. brygooi),* and marginated tortoises, (*Testudo marginata*). At our field station, we have more than 400 wild gopher tortoises *(Gopherus polyphemus)* roaming the natural savannah habitat. The exotic tortoises are roaming in natural habitat that is broken up into eight .25-acre study plots. The research that we have been doing on gopher tortoises has been underway for more than 30 years. Along with just about all aspects of gopher tortoise behavior, we have been intensively studying forage and foraging behavior. We have also been studying tortoise social behavior and how these two things are the foundation for tortoise distribution on the landscape and the keys on how to manage tortoises in both natural and manmade habitats. If we are going to use captive breeding as an important conservation tool, much of the work we have been doing should be done on each species, both in the wild and in captivity. For example we have found that gopher tortoises feed on more than 400 species throughout their range. Interestingly enough, so do the other tortoises that we are working with. We know that any one tortoise in a habitat will feed on approximately 200 species of plants. In doing so, the gopher tortoise may travel over several hectares per year, just to find the right plants at the right time to

eat. Under the captive conditions that are usually found in most zoos and private collections tortoises are fed at most 18-20 species of plants, all at the same stages and usually artificially grown. This simplistic forage and other conditions such as eliminating an animal's home range and its ability to maintain distance from others, and a long list of other unnatural conditions may possibly be leading to rapid genetic changes in breeding stock and offspring which is then passed on in the altered genetic material. This may be why few species of tortoises or other reptiles rarely breed successfully in captivity after the second generation. This research is vital for the successful long term maintenance of Tortoise Assurance Colonies with individuals retaining the characteristics that make them well-suited for returning to the wild rather than living in captivity.

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Captive Husbandry of Neotropical Pit Vipers

The number of venomous snakes that have become commercially available to private herpetoculturists in the past decade has increased exponentially. The number of snake species that have become available during the same period has at least quadrupled. Neotropical pit vipers are ever increasing in popularity among venomous hobbyists. Popular literature regarding the proper captive husbandry techniques for these species is often conflicting or not available. The optimum captive condition for any species is to emulate its natural habitat. A discussion of these conditions will be presented for a number of species in the genera *Agkistrodon*, *Atropoides*, *Bothriechis*, *Bothriopsis*, *Bothrops*, *Crotalus*, *Lachesis*, and *Porthidium*. Natural history, allopatry and sympatry of congeners, captive versus wild dietary considerations, and captive breeding techniques for each species will be presented. The accelerated rate of habitat deforestation and the increasing difficulty to import these species from their native countries will be emphasized to encourage propagation of existing captive populations.

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Australian Herps and Herpers

This presentation is a travelogue of Australian reptiles which also includes some of the interesting human characters encountered along the way. Australia is host to many of the world's deadliest snakes and also boasts a long tradition of devil-may-care snake pit entertainers and antidote sellers. There are many amazing stories of individuals in the days of snake showmen and snake oil remedies in downunder Australia. John Cann is especially well-qualified to tell this story since he is a snake pit performer himself as was his brother, mother and father.

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Captive Breeding and Husbandry of Komodo Dragons at Miami Metrozoo and Its Connection to Dragon Conservation

An adult pair of wild caught Komodo dragons (*Varanus komodoensis*) was acquired by Miami Metrozoo in 1995. Exhibit design and husbandry decisions resulted in successful reproduction two years later. Egg incubation techniques produced a 93% hatch rate of fertile eggs. Incubation period ranged from 212-246 days. Hatchlings were raised under two different artificial lighting regimes, and natural sunlight. Blood measurements of vitamin D levels were comparable to samples from wild specimens in hatchlings from all groups. A total of twenty seven offspring (100%) were reared successfully in variety of enclosures, without health problems. This breeding event was important for the genetic vigor and diversity of the captive North American population of this species. The majority of the young dragons were transferred to other zoos over the ensuing years. In return donations to Metrozoo's Conservation and Research Fund from the recipients have been used to support conservation and research projects in the dragons' natural habitat. This event illustrates how captive reproduction can support species conservation in several ways.

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Exotic Snakebite Envenomations

Miami-Dade County is the largest importer of exotic venomous snakes in the United States, and possibly the world, importing more than 1,500 snakes annually. From 1946 through 1988, the Miami Serpentarium handled the needs for antivenin throughout the state of Florida. Due to the closure of the facility in 1988, South Florida had no access to antivenin with a 250 mile radius and there has been an alarming increase of envenomations (venomous snakebites) and subsequent need for antivenin, Shortly after the closing of Miami Serpentarium, an adult male was bitten by a cobra, and it took 17 public and private agencies to bring this individual back to life. To date, the State of Florida has issued approximately 100 venomous reptile licenses to residents in Miami-Dade County, and an additional 400 permits have been issued throughout the entire state. According to the Florida Fresh Water & Game Commission, 3 to 5 times more people are keeping venomous snakes without acquiring permits. Venomous snakebite incidents continue to occur at an average rate of 300 per year in the state of Florida and at the rate of 8,000 nationally. According to the Florida Poison Control Center, Miami-Dade, Broward and Palm Beach counties average 150 snakebites a year, 40 percent of which are poisonous. However, there is a drastic reduction in the stocking of antivenin serum, and most hospitals are at a disadvantage when confronted with an envenomation incident.

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Chlamydophilosis in Recently Imported Emerald Tree Boas (*Corallus Caninus*)

Over a 4-mo period, one hundred and five wild-caught emerald tree boas (*Corallus caninus*) were added to a collection of 15 others in Central Florida. Eighty-one boas (67%) developed repetitive regurgitation during the 23 mo period after the initial addition of wild-caught boas and 61 (75%) of these died. Prevalence of regurgitation in this population of snakes was 25% /mo (range 0 - 42%) and incidence was 3.52/mo (range 0 - 13/mo). The cumulative mortality, for those boas developing repetitive regurgitation (61/120), over the 23 mo epizootic was 51%. Histologic evaluation of gastrointestinal tracts showed positive immunohistochemical staining for chlamydial antigen characterized by multifocal to diffuse lymphoplasmacytic inflammation with the formation of granulomas. Electron microscopic evaluation of granulomas identified organisms consistent with *Chlamydophila* sp which were later identified as *Chlamydophila pneumoniae* by polymerase chain reaction (PCR) and sequence analysis.

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Oral Glands of Reptiles: Venoms, Toxins and Saliva

The oral mucosa of squamate reptiles is richly adorned with glands, many producing lubricant compounds (polysaccharide-rich mucus) which assist in swallowing of bulky prey. However, in numerous lineages, specialized oral glands have differentiated into producing primarily serous (protein-rich) secretions, and several of these glands, notably the Duvernoy's and venom glands, have become specialized for producing toxin-rich venoms which incapacitate, precondition and/or kill prey. Venom glands are most well-known in the front-fanged snakes (families Viperidae, Elapidae and Atractaspididae), but rear-fanged snakes of the polyphyletic family Colubridae and lizards of the family Helodermatidae also produce venoms with potent effects. Examples of venoms and toxins from each of these groups will be discussed, particularly with regards to new compounds from colubrid snake venoms. It appears that venoms arose very early in the evolutionary history of advanced squamate reptiles, and evidence exists for venom production in several fossil lineages, dating from the Cretaceous and the Triassic. Modern venomous reptiles represent the current stage in an evolutionary arms race between predator and prey, and continual coevolutionary adjustments likely drive the high degree of complexity in composition seen among many venoms. Additionally, the ancient occurrence of venom systems, the frequent motif of specific toxicity of certain venoms and the broad distribution of a wide variety of such systems among squamates suggests that venom production may also be present in lineages not commonly considered venomous.

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For the Love of Frogs: Exploring the Lost Worlds of Gondwana

In March and April I backpacked for 30 days on a National Geographic Ultimate Explorer expedition to the "Prow" of Mt. Roraima, the famous 9,000-foot high tepui that inspired Sir Arthur Conan Doyle's novel, "Lost World." On that trip I discovered at least two frogs new to science, plus some other really amazing frogs that were poorly known. The hour-long documentary has been airing on MSNBC since late January. I used my Roraima experience to pull together grant monies to return and climb a wholly unexplored tepui (name for cliff-fringed mesas rising mysteriously out of Orinocoan and Amazonian rainforests of Venezuela and Guyana) called Mt. Wokomung. It doesn't even occur on maps of the region. I collected there by myself for an additional 30 days and found at least 6 frogs new to science.

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Current Herpetological Conservation Issues in the Sunshine State

As in most of the world, the single greatest threat faced by Florida's herpetofauna is the anthropogenic loss and degradation of habitat. In addressing this problem, particularly in the case of the gopher tortoise, conflict arises between those wishing to focus maximal resources on habitat protection and those more focused on the rescue of wildlife displaced by development. On another front, Florida has not seen the levels of mysterious amphibian decline reported for some regions, although desmognathine salamanders appear to have disappeared from many areas where seemingly suitable habitat remains, and the long-term impacts of the recent, prolonged drought in the southeastern U.S. are largely undetermined. Commercial harvest of reptiles and amphibians, particularly turtles, remains controversial, although current levels of harvest have not been shown to be excessive. Another matter of concern perhaps unique to Florida, at least in scale, is the introduction of exotic herpetofauna. Florida now supports more non-native than native species of lizards, ranging from small, seemingly innocuous geckos to green iguanas, spiny-tailed iguanas, and Nile monitors. High-volume trafficking in exotic species from throughout the world, which has mushroomed in recent decades, risks not only the establishment of exotic herpetofauna but also introduction of alien diseases with the potential to decimate native wildlife populations.

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Training Crocodiles for Entertainment and Husbandry

Three case studies of crocodile training can enhance entertainment value and husbandry. The case studies are the means of managing large reptiles in captivity. Many conditions affect the way we care for crocodilians. With nutrition control, discipline, consistency of the programs, crocodiles can be trained to be less aggressive to their keepers and controlled to perform in an orderly fashion with the correct communication. With the ideas of the past and present the future of crocodilian training along with reptile training may provide safety to keepers of the dangerous animals.

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Banquet - Herpetological Time Travel Through The Zoo And Aquarium World

As a retired zoo person, there were four reasons why I was motivated to prepare this presentation. The first was my fear that much of our history, beginning with the first reptile building at the London Zoo in 1849, was in danger of being lost. The second was that many of my zoo and aquarium colleagues, especially those new to the profession, did not have a sense of the unique contributions of their predecessors; their accomplishments should be celebrated. The third was that some of my academic and museum associates had the perception that the work done in zoos and aquariums was not very important. Finally and most importantly, I am concerned that many zoo administrators view zoo and aquarium herpetological collections and buildings as a relict from the past; as a result, there has been a significant decline in new facilities, emphasis and financial support.

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Chameleons: Biology And Captive Management

This presentation focuses on the biology and captive management of chameleons by using rare historical illustrations and photographs mostly from the Smithsonian Institution libraries, beginning with woodcuts fashioned in the mid-1500s. Our 1991 study on natural history and color variation in the panther chameleon in Madagascar is included.

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Are Komodo Dragons Different From Other Reptiles?

We had two reasons for preparing this presentation: 1) Monitors have been our focus for many years and we have become intrigued with their prominent place in herpetological art and literature; 2) Our studies on Komodo dragons, both *ex situ* and *in situ*, have revealed some hitherto unknown aspects of their biology, especially play behavior and interaction with humans. In addition, we offer recommendations for captive maintenance and future research with varanid lizards.

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Pitviper Systematics and Why Their Names Change

The venomous snake family Viperidae includes 260 species in four subfamilies: Azemiopinae, Causinae, Crotalinae, and Viperinae. The Crotalinae (pitvipers) is the most species rich subfamily, containing over 190 species. Pitvipers are also the widest geographically distributed of the viperid subfamilies, ranging throughout Asia and the Americas, where they inhabit an impressive variety of ecosystems. Innumerable changes have been made to the taxonomy of pitvipers over the last several decades and the systematics of pitvipers continues to remain a dynamic work in progress. For example, prior to 1971 there were six recognized genera, by the mid 1970's this increased to 14 genera, and currently 29 genera are recognized. Here, I present the latest hypotheses for relationships among pitvipers based on mitochondrial DNA data. With these evolutionary perspectives I discuss the rationale behind the last 40 years of taxonomic changes and argue for the importance of revising taxonomy as more information about evolutionary relationships becomes available.

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Training as a Management Tool for Nile Crocodiles (*Crocodylus niloticus*) at Disney's Animal Kingdom

At Disney's Animal Kingdom, animal programs staff uses animal training as an integral part of their animal management. While animal training has been readily applied to mammalian and avian species, we are in the early stages of applying it to our reptilian species. We have found the benefits of using training as a management tool to be vast. Animal care staff is able to obtain better visual and tactile access to the animals in a protected contact situation that decreases the stress to the animals while increasing the safety of keepers and animals. In addition to these

benefits, we have found these animals to learn quickly making the initial time commitment to training the behaviors low and the payoffs high. This presentation will describe how we use training as a management tool for our crocodiles and will discuss the benefits that have been reaped from the program. Additionally, we will discuss the training of basic husbandry behaviors including: shifting off exhibit into the holding area on cue, shifting back into the exhibit on cue, shifting into crates for weights and visual inspection, and allowing for physical restraint within the crate to enable staff to access various body parts for procedures.

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Keynote - Lonesome George and the Con Giai: Turtles Staring Extinction in the Face
(Abstract not available)

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Dwarf Boas of Central America and Mexico
(Abstract not available)

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Field Observations of *Manouria emys emys* in Malaysian Borneo, and *Manouria emys phayrei* in Thailand.

Poorly known since its description in 1844, *Manouria emys*, the Asian Forest Tortoise, is severely underrepresented in modern scientific literature, most of which restates old data. In comparison to other tortoises, even from the same region, it is virtually unknown. Considering the plethora of unique characteristics, it is astounding that only two in-situ and 12 ex-situ studies exist. *M. emys* constructs and guards nest mounds, modifies nesting material, and is the largest Southeast Asian tortoise. Of terrestrial genera, it is the fourth largest worldwide with largest single clutches. Cryptic habits and decreased or disjunct populations make it virtually impossible to locate in the wild. This study covered sites in Sabah, Malaysian Borneo, Peninsular Malaysia, and Thailand. Objectives achieved were observation of in and ex-situ animals, preserved specimens, food markets, and in-range researcher interviews. Additions to known diet included Alocasia, Begonia, Civet and Leopard scat. The extremely hilly terrain and 85% + canopy cover were unexpected, yet nest mounding behavior now makes more sense. Only four in-situ tortoises were observed in over 300 man-hours of survey time and none in food markets. It seems clear that populations of *M. emys* have declined even since receiving endangered status in 2000.

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Present Status of Angular-toed Geckos of Pakistan

Several assemblages of fragile gekkonid lizards inhabit deserts, scrublands, and alpine habitats throughout Pakistan (Khan, 1999). Taxonomy of these animals is yet little understood (Bauer and Russell 1991; Szczerbak and Golubev 1977, 1986, 1996; Khan 1997, 2001). Kluge (1983) placed Pakistani geckos in genera *Agamura, Alsophylax, Bunopus, Crossobamon, Hemidactylus, Stenodactylus, Cyrtopodion* and *Tropiocolotes, Microgecko, Ptyodactylus,* and *Teratoscincus.* With recent descriptions of several new angular-toed geckos from Pakistan (Szczerbak, 1991; Khan, 1980, 1988, 1989, 1991, 1993, 2001; Khan and Baig, 1992; Khan and Tasnim, 1990, my concept of the relationship among angular-toed geckos has been changed. My phylogenetic conclusions regarding angular-toed geckos of the Himalayan region have been expressed elsewhere (Khan 2001, 2003, and Khan and Rösler 1999). They are distinguished in four genera: *Altigekko* Khan 2003, are confined to high altitudes in the Greater Himalayas; *Siwaligekko* Khan 2003 are confined to the sub Himalayan Siwalik Range; *Indogekko* Khan 2003 are confined to the sandstone rocks at the bed of ancient rivers; while genus *Cyrtopodion* Fitzinger, 1843 constitutes the ground geckos in the Indus Valley.

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Husbandry and Captive Reproduction of the False Gavial, *Tomistoma schlegelii*

The Tomistoma (Tomistoma schlegelii), also known as the False Gharial, is a large slender-snouted crocodilian that inhabits rivers, lakes and peat swamp forests in parts of Peninsular Malaysia, Borneo and Sumatra. It is listed as an endangered species by the USFWS, Appendix I of CITIES and currently classified as EN C1 on the IUCN RED LIST. Current populations in the wild are estimated to consist of less than 2500 adults. This species may in fact be critically endangered due to loss of habitat as a result of illegal logging and the systematic drainage of peat swamps for agricultural purposes.

The first captive reproduction of this species took place in 1985 at the Wildlife Conservation Society/Bronx Zoo in New York and later that same year at the Miami Metrozoo in Florida. In Asia, this species is being reproduced in captivity on an annual basis at the Utairatch Crocodile Farm in Thailand. Jong\rquote s Crocodile Farm in Sarawak, Malaysia has reported successful reproduction occurring on a periodic basis The National Zoological Park of Sri Lanka in Dehiwala has also hatched this species, but has reported extremely high neonate mortality. The most recent reproduction in North America occurred at Florida Cypress Gardens in 1999. The history and results of that reproduction are presented in this report along with additional information on the husbandry and reproduction of Tomistoma held in captivity at other facilities in North America, Europe and Asia.

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Scientific Nomenclature

Usos Latinae et Greccae non timete or, translated freely by one who is intimidated even by English, fear not the use of Latin and Greek and, one might add, all the other bases for scientific names. Because common names of animals (and plants) are different and may be unrecognizable in different countries as well as regions in a single country it is a good idea for a serious herper to learn and use scientific names. Scientific names may reflect descriptive characteristics, geography, habitat, habits and omomatopoeia (see text for that one), and others, providing us with information for better herpetoculture.

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Neurobiology and Learning in Crocodilians
(Abstract not available)

Husbandry and Captive Reproduction of the Tomistoma (*Tomistoma schlegelii*)

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Introduction

The amazing teeth of a juvenile Tomistoma. Photo by George Miskimon.

The Tomistoma (*Tomistoma schlegelii*), also known as the False Gharial, is a large slender-snouted crocodilian that inhabits rivers, lakes and peat swamp forests in parts of Peninsular Malaysia, Borneo and Sumatra (Neill, 1971). Historically this species had a much larger range in south-east Asia (Stuebing et al., 1988; Bezuijen et al., 1988; Simpson et al., 1988). Their have been recent sightings of Tomistoma in Java (Auliya, 2003). Though similar in appearance to the Gharial (*Gavialis gangeticus*), it is taxonomically distinct. Adult females are known to reach a length of over 3 meters and adult males are known to reach 4.7 meters (Neill, 1971). Larger specimens have been reported, but as of yet, not well documented. In the wild its diet includes shrimp, fish, frogs, snakes, birds and mammals (Bezuijen et al., 1997). Predation on primates such as the crab-eating macaque (*Macaca fascicularis*) and proboscis monkey (*Nasalis larvatus*) has been documented (Galdikas & Yeager, 1984; Galdikas, 1985; Yeager, 1991). Although stomach contents have included human remains, no direct human predation by Tomistoma has been confirmed (Stuebing, et al., 1998). Females construct a mound nest of leaf litter and soil with clutch sizes typically ranging from 16 - 35 eggs (Stuebing et al., 1998, Bezuijen et al., 1998) Eggs found in wild nests in Sumatra had a mean measurement of 99.4 mm. X 64.4 mm. with a mean mass of 251 grams (Bezuijen et al. 1998).

The Tomistoma is listed as an endangered species by the USFWS. It is listed on Appendix 1 of CITES and currently classified as EN C1 on the IUCN RED LIST. Current populations in the wild are estimated to consist of less than 2500 adults (Hilton-Taylor, 2000; Bezuijen et al., 2001) This species may in fact be critically endangered due to loss of habitat as a result of illegal logging and the systematic drainage of peat swamps for agricultural purposes (Webb,in lit., Stuebing, pers. com.).

In captivity, Tomistoma is maintained in many zoological parks and private collections. There are a total of thirty-three specimens held in a total of 13 collections in North America (Pfaff &Long, 2002, Pfaff, in litt.). Twenty-six specimens are held in 12 European collections (Somerlad, in. lit.). The author observed two very large adult Tomistoma at Brazil's Sao Paolo Zoo in 1993. A female held at the Silver Springs Theme Park in central Florida has survived in captivity for 44 years. Nest construction and egg laying has been reported at many facilities, but successful captive reproduction has occurred at only a few. The first captive reproduction took place in 1985 at the Wildlife Conservation Society in New York and later that same year at the Miami Metro Zoo in Florida (Zeigler, 1995). In Asia, this species is being reproduced in captivity on an annual basis at the Utairatch Crocodile Farm in Thailand. (Sommerlad, in. lit.). Jong's Crocodile Farm in Sarawak, Malaysia has reported successful reproduction occurring on a periodic basis (Jong, in. lit.). The National Zoological Park of Sri Lanka in Dehiwala has hatched this species, but reported high neonate mortality (Whitaker, 2000). A successful reproduction has been achieved at Malaysia's Zoo Negara in 2003. Seven neonates hatched, of which four survived (Mathew et al., 2004).

The most recent reproduction in North America occurred at Florida Cypress Gardens in 1999 (Shwedick & Sommerlad, 2000). The history and results of that reproduction are presented in this report along with additional information on the husbandry and reproduction of Tomistoma held in captivity at other facilities in North America, Europe and Asia.

Materials and Methods

The pair of Tomistoma involved in this reproduction were imported into the United States as small juveniles in the early 1970s. Based upon their size at the time, it is the belief of the author that they are hatched in wild no earlier than 1968 and no later than 1970. The specimens were reared by the author at a reptile center located near Bowie, Maryland. They were held separately in enclosures consisting of galvanized stock watering tanks. The tanks were enclosed with a top constructed of plywood over a pine frame and ventilated with a heavy galvanized wire mesh screen. In order to provide a basking area, a shelf made of smooth pine board was mounted inside the tank on galvanized "L" brackets, 10 cm above the water level. Water level was maintained at a depth sufficient to allow the animals to completely submerge. Room temperature was kept at a minimum of 28° C and poultry brooder lamps with ceramic fixtures were mounted above the wire screen in order to provide higher temperatures for basking using incandescent bulbs. Initially the stock watering tanks used had dimensions of 1.83 m. X 61 cm. with a depth of 61 cm. As their size increased the specimens were moved into larger tanks until they reached the size of sub-adults in tanks that measured 3.66 X 1.22 m. with a depth of 61 cm. Infrared heat lamp bulbs were used over the basking areas of these large tanks and were kept at a distance from the animals sufficient to prevent thermal burns. Feeding

Male *Tomistoma schlegelii* using narial geyser display. Photo courtesy of Florida Cypress Gardens, Inc.

ensured once each week. The diet at first consisted of small live fish.

As the specimens increased in size their diet was changed to include mice, rats, chickens (from day old to adults), chicken parts, and fish heads. Enclosures were cleaned on average once each week. Tanks were rinsed thoroughly and specimens were gently rinsed from head to tail, including dentition with water pressure controlled by hand.

Female Tomistoma using narial geyser display. Photo courtesy of Florida Cypress Gardens.

In 1993, the pair was moved to individual outdoor enclosures at a crocodilian exhibit located near Plant City, Florida. At this time the male had reached a total length of 2.80 m. and the female had reached a total length of 2.59 m. Each enclosure measured 12.2 X 12.2 m. and was constructed using vinyl-coated chain link fence. Each enclosure held a smooth concrete pool measuring 6 X 4.88 m. with a depth of 75 cm. The pools were coated with fiberglass epoxy paint to prevent abrasions occurring on the underside of the specimen's feet and the ground surrounding each pool was covered in sod to reduce the amount of any sand or dirt particles from entering abrasions, if they did occur. Since the pair had been reared indoors, they were moved to the outdoor exhibit in early summer and 70/30 agricultural shade cloth was used to cover a portion of the pool and the surrounding land to provide sufficient shade during their acclimation to this new environment.

The pair was isolated from the sight of other crocodilians but could easily maintain visual contact with each other except when submerged in their respective pools. The time that the pair spent on exhibit was uneventful, with the exception of the notice of slight damage to the fence that divided the pair. It appeared as if the fence was damaged in several places and this may have been due to aggressive behavior on the part of one or both of these animals. The pair was later moved to another crocodilian facility also located near Plant City, Florida. They were held separately in enclosures of similar dimensions to those at the exhibit, with the exception that the pools were constructed of vinyl.

In September 1996, the pair was removed from their holding enclosures, measured and examined prior to being transported to a large public exhibit where they were to be introduced for reproductive purposes. The male had reached a total length of 3.15 m. The female had a total length of 2.83 m and a total weight of 86.8 kg. During the physical examination conducted at the time, an unusual soft bulge was noticed on the female's abdomen directly above her cloaca. Radiographs taken shortly thereafter revealed no apparent internal abnormalities. After conferring with Dr. Richard Funk, our veterinarian, and Scott Pfaff, the AZA Tomistoma studbook keeper, it was agreed that the introduction of this pair should proceed.

The enclosure utilized for this breeding program was part of an outdoor, educational wildlife exhibit located at Florida Cypress Gardens, in Winter Haven. The enclosure itself was originally designed to exhibit primates, but had been used by the author during the previous seven months to exhibit a group of adult *Alligator mississippiensis*. It was a circular pit-style enclosure that featured a center island surrounded by a pool in the

The beautiful, well-planted island in the Tomistoma exhibit and breeding enclosure at Florida Cypress Gardens. Photo by Bruce Shwedick.

form of a moat. The diameter of the entire enclosure varied from 17.7 - 20.3 m. The diameter of the center island varied from 7.3 - 9.1 m. The pool had a width that varied from 5.1 m. - 5.7 m. and a depth that varied from 58.4 cm - 68.6 cm. The pool was constructed of fiberglass and was surrounded by a smooth concrete wall with a height of 1.53 m. The public had visual access to one-half of the exhibit which was protected by an outer railing and inner concrete wall both at a height of approximately 1 m. To prevent members of the public from extending their hands over the moat by leaning over the outer rail and inner wall, a net constructed of nylon mesh was mounted with L brackets to the inner top edge of the wall. It had a width of approximately 45.7 cm and was hung around the entire circumference of the inner wall above the moat.

The island had been previously planted with oak trees. Dwarf banana trees were added for additional shade and seclusion. A large artificial log divided the center of the island and created a visual barrier for the animals. One area on each side of the island was left without trees and covered with sod. This provided each animal with a separate area in which to bask. Water level was maintained with the use of a stand pipe. The PVC pipe had a diameter of 10.2 cm and the opening was covered with a heavy galvanized wire mesh screen to prevent large amounts of leaves and other plant debris from clogging the drain line. The pool was filled with well water that entered at a temperature of 22.2°C. and this water was allowed to flow constantly into the pool during the cooler months, from October thru May. This allowed adequate water temperatures to be maintained all year.

Once each month the stand pipe was removed so that the pool could be drained. The net was opened at the rear of the enclosure to allow a ladder to be lowered into the pool. The animals were trained to station in the pool on the opposite side of the island.

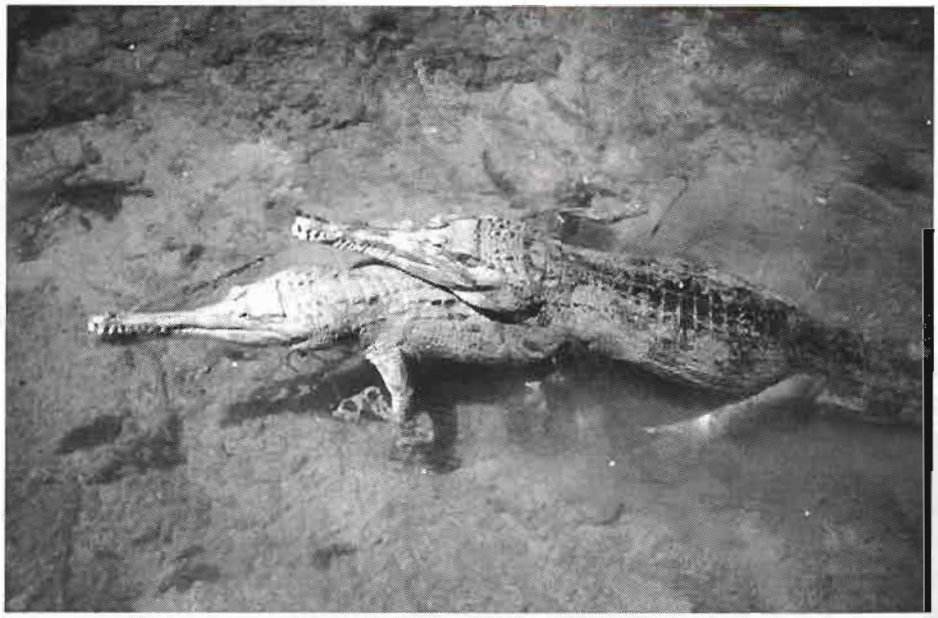
Audible cues were used to signal the presentation of food, which was offered as positive reinforcement. One staff member provided food to the animals, while two staff members acted as observers on opposing sides of the exhibit. This allowed the author the opportunity to safely enter the pool in order to remove the stand pipe. Feeding was then completed while the pool drained. Operant conditioning training was also used in order to increase the distance between the animals while they were being fed. This protocol was used to prevent injuries that could result from bites occurring accidentally during feeding. Training was also used to assist animals in locating undetected food floating on the surface of the pool. This protocol was used to prevent undetected food from remaining in the pool after feeding in order to maintain hygiene and record the exact food consumption of each animal. Food was provided to the animals on a regular basis as determined by their previous food consumption and the weather. Feeding did not take place during the coolest months from December to March, unless air temperatures were predicted to remain above 25° C for a period of three to four days. This protocol was put in place to ensure that the temperatures needed on the surface of basking areas to allow sufficient thermoregulation for digestion would be available to the animals. After the pool was drained, horticultural maintenance was performed on the island and the pool was then thoroughly rinsed with a high volume of water. Plant debris, fecal material, shed teeth, and foreign objects such as coins were collected and removed. Bleach or other disinfectants were not used in order to protect algae growing on the surface of the fiberglass. The author believes these algae protected the animals feet from abrasions that might have occurred from contact with certain surfaces of the pool that had an abrasive texture.

Results

The pair was introduced into the exhibit and breeding enclosure on September 27th, 1996 and they were observed for short periods as often as possible during daylight hours and twice during the night for the next several days. No aggressive behavior was observed by the pair, but on the morning of September 30th bite marks were noticed around the head and on the dorsal scalation of both animals. These were white in color and had the appearance of scratches up to 2.4 cm in length.

Food placed in the pool overnight during the first week was eaten and additional bite marks were observed on the female's tail and neck, but by the end of the week the bite marks appeared to be healing and no new marks were observed. The male began basking on the island on the 7th and the female began basking on the 11th. On October 25th the pair was observed basking together with the male resting his head on the female's back. On March 22nd, 1997 and again on April 7th and 15th, the male was observed on top of the female and it appeared that he was attempting to copulate. On May 5th the female arched her neck and raised a portion of her tail above the water as she was being pursued by the male. The female hissed and used a nasal geyser display with her nostrils above the water. The pair attempted to copulate but was disturbed by the presence of the observer. On May 26th the female seemed to be avoiding the pursuit of the male. Mulch, grass cuttings and banana leaves were provided to the female on the island for nesting material. On June 8th, it appeared that the female had added material to the nest. She refused food and her abdomen appeared distended on both sides of her body. On June 14th the female remained close to the nest when on the island or in the water. She was observed on the nest in the evening of the 24th and 25th. On the morning of June 26th, 13 eggs were recovered after being laid in the water by the female.

The eggs ranged in weight from 143 to 169 grams with a mean weight of 159.6 grams. These eggs were incubated on a substrate of moist sphagnum moss at 31.5° C, but no indications of fertility were observed. The female resumed feeding on June 28th. On July 2nd the male was observed swimming around the pool in an aggressive manner. He chased the female out of the water and on to the island with his reproductive organ extended. Seven additional eggs were laid individually by the female on the island or in the water between July 13th and September 9th. During the past year, the pair's diet has consisted of adult rats, adult hamsters and chicken parts. The male was observed eating a wild squirrel (*Sciurus carolinensis*).



Courtship behavior observed at Florida Cypress Gardens in 1997. Photo by Bruce Shwedick.

In 1998, head slapping behavior by the female was observed on April 3rd and attempted copulation was observed on the 4th. The pair was observed copulating on April 24th for a ten minute period and again on the 25th. On May 26 the female's abdomen was noticeable large. The female was observed on June 2nd pushing and chasing the male off the nest and out of the nesting area. On June 4th it appeared that female had added nesting material. Two bales of long fiber sphagnum moss were added to the nest. The female was observed on June 7th and 8th using all four limbs to scrape material backwards towards her nest. An additional bale and a half of moss was provided to the nest. The female refused food on June 18th and on the evening of June 22nd she was observed digging into the nest with her hind limbs. The next morning the nest appeared smooth and the female appeared cautious about our presence. She was again observed digging in the nest. Four freshly laid eggs were recovered from the water on June 23rd. Two of these eggs had poorly calcified shells and a fifth egg was crushed by the female as we attempted to remove it from the water. On June 30th the female resumed feeding.

Several bite marks were found on the female's dorsal scales on July 7th and on July 8th three more freshly laid eggs were found in the water. All of these eggs were placed in incubation under similar conditions used in the previous year, but no indications of fertility were observed. The diet during this past year included adult quail, rats, hamsters, chicken parts, and skinned rabbits.

In 1999, whole adult rabbits containing Vitamin E (200 I.U.) as a supplement were added to their diet. The male was observed pursuing the female on May 17th and attempted copulation was observed on May 18th. On May 5th at 1600 hrs. the pair was observed copulating for a period of about eight minutes. Nesting material in the form of fallen leaves from tropical tree species collected in the park's botanical garden was added to the female's nest in late May. In June, the male abraded the undersides of his feet while attempting to reach the female on the island after the pond had been drained. His reproductive organ was exposed again at this time. The undersides of his feet were treated topically with betadine and antibiotic ointment. This was applied with the aid of a long aluminum pole.

The female refused food on June 27th and was later observed on her nest. On July 4th at 1630 hrs. the female laid ten eggs in the pool. She laid one additional egg two hours later. The largest of these eggs weighed 190 grams. These eggs were artificially incubated on moist sphagnum moss at 32° C. The following day small white spots were noticeable on several of the eggs. On July 6th three eggs were distinctly banded. On July 7th bands were observed on two more eggs. On July 9th the bands were noticeably wider. At 0900 hrs. on September 29th it appeared that one egg had begun to pip. We removed a small amount of the eggshell and waited. At 2245 hrs. we opened the inner membrane.

We observed a live neonate inside the egg and could see its head and tail, but its body was hidden from view by a large external yolk sack. Several hours later the neonate brought its head out of the egg shell. Its progress was observed every four hours and water was dripped on its eyes and over its jaws from a container kept inside the incubator. On October 1 the neonate was observed completely outside of the egg and it could be heard vocalizing from outside the plastic container used to hold the eggs and substrate during the incubation period. We continued observations and hydration every four hours. During the next several days the neonate was observed sleeping on its back and sleeping with its head and upper body resting on another egg. On October 4th it appeared that it's activity levels were not increasing so we decided to move the neonate out of the egg container. It was then placed in a fifteen gallon aquarium with a secure screen top inside a larger incubator. Warm shallow water only deep enough to allow the neonate to submerge was added and the aquarium was elevated at one end to allow for a basking area. The remaining eggs were then opened. One embryo had apparently died after development was advanced. The remaining three eggs contained full term embryos that had apparently died within the several previous days. These embryos also had large external yolk sacs.

Neonate Tomistoma in incubator. Photo courtesy of Florida Cypress Gardens, Inc.

The surviving neonate measured 31.1 cm and weighed 68 grams. Defecation and shedding was observed on October 8th. Its weight increased to 77 grams by October 9th and it was observed basking for the first time. The female was observed during this time period pushing the male away from the nest area and using the narial geyser display with her nostrils held below the surface of the water. The male responded with a similar narial geyser display. On October 12th its weight decreased to 76 grams and on October 17th its yolk sac was completely internalized and its ventral scales now touched on each side of its mid-line. On November 3rd it ate its first meal consisting of two small fish and was fed a similar meal every four to five days. By March 25 it had reached a length of 42.2 cm and a weight of 109 grams. At six months of age it was fed pink mice in addition to fish and its diet has consisted of fish and small rodents to the time of this writing in August 2004. This animal now measures 1.016 meters. and has reached a weight of 1.93 kilograms.

Conclusion

Though the female involved in this breeding program has continued to lay eggs periodically, no fertile eggs have been recovered for incubation. The pair was moved to the crocodilian holding and breeding facility at the Miami MetroZoo in October 2001. It is the author's hope that this report will encourage greater efforts to reproduce this species in captivity in North America and elsewhere and that the observations and other data contained herein will prove to be useful in those endeavors. It is also the author's hope that the young men and women that read this report will find encouragement to undertake the study of crocodilians and that they will find this to be worthwhile.

This breeding program has given observers a glimpse of the diverse behavioral repertoire possessed by this unique and secretive crocodilian. The surviving offspring, nicknamed "Pip" is currently a part of the North American captive population of Tomistoma that is being managed for conservation purposes and which may yet play a vital role in the future survival of this endangered species. The full term embryos that did not survive will be deposited in the Herpetology Department of the Florida Museum of Natural History so that they will be accessible for future study.

Acknowledgements

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Table 1: Captive Reproduction of Tomistoma

Institution	Clutch Size	Incubation Temperature	Incubation Period	Number of hatchlings	Reference
Florida CypressGardens	11 total/5 fertile	32° C.	87 days	1	Shwedick, B.M. and Sommerlad, R. 2000
Jong's Crocodile Farm	19 total/10 fertile	30° C.	92 days	1	Stuebing, R.B. et al., 1998 Jong, J. in litt.
Miami MetroZoo	Data not available	28.8-30° C.	112 days	5	Zeigler, B. pers. com.Conners, S. in litt.
Wildlife Conservation Society	21 total/20 fertile	32.2-34.4°C.	87-89 days	9	Ramos, L. in litt. Holmstrom, W. in litt.
Zoo Negara	19 total/11 fertile	26-32° C.	90-110 days	7	Mathew, A. et al. 2004

Table 2: Captive Tomistoma Diets

Institution	Juvenile Diet	Adult Diet	Supplement	Reference
AlligatorAdventure		Skinned nutria chicken leg quarters	Burris Millsalligator/ vitaminsupplement	Alfieri, K. in lit.
Audubon Zoo		Nutria, beef heart skinned rats, skinned chickens	SeaTab vitamins 200 IU Vitamin E	Ferri, D. in litt.
Busch Gardens		Trout	500 IU Vitamin E,	Kruse, C. pers. com.
Jong's Crocodile Farm	Live fish, prawns, tadpoles	Fish, chicken		Jong, J. in litt.
Los AngelesZoo	Small live fish, Mice, quail			Smith, R. pers. com.
Miami MetroZoo		Whole rats, rabbits, fish		Conners, S. in lit.
Madras Crocodile Bank	Fish, frogs	Fish, rats, crabs		Whitaker, N. in lit.
Riverbanks Zoo	Live fish	Whole rats, quail	Herptivite multi-vitamin, vitamin, Burris Mills alligator/vitamin supplement	Pfaff, S. in lit.
San Antonio Zoo		Whole rats, horse meat, pig parts, live fish		Kardon, A. pers. com.
Silver Springs		Skinned nutria		Frisch, T. pers. com.
St. Augustine Alligator Farm		Dallas Crown Carnivore diet Mixed with Burris Mills Alligator chow		Kledzik, D. in lit.
St. Louis Zoo		Whole rats, fish		Taylor, P. pers. com.
Utairatch Crocodile Farm	Live fish, chicken parts	Fresh fish, red meat with bone, whole feathered chickens		Youngprapakorn, U. in lit.
Wildlife Conservation Society		Whole rats, fish		Ramos, L. in. lit.
Zoo Negara		Fish, whole rats, guinea pigs, lean beef		Matthews, A. et. al. 2004

CAPTIVE BREEDING AND HUSBANDRY OF KOMODO DRAGONS, *Varanus komodoensis,* AT MIAMI METROZOO AND ITS CONNECTION TO CONSERVATION

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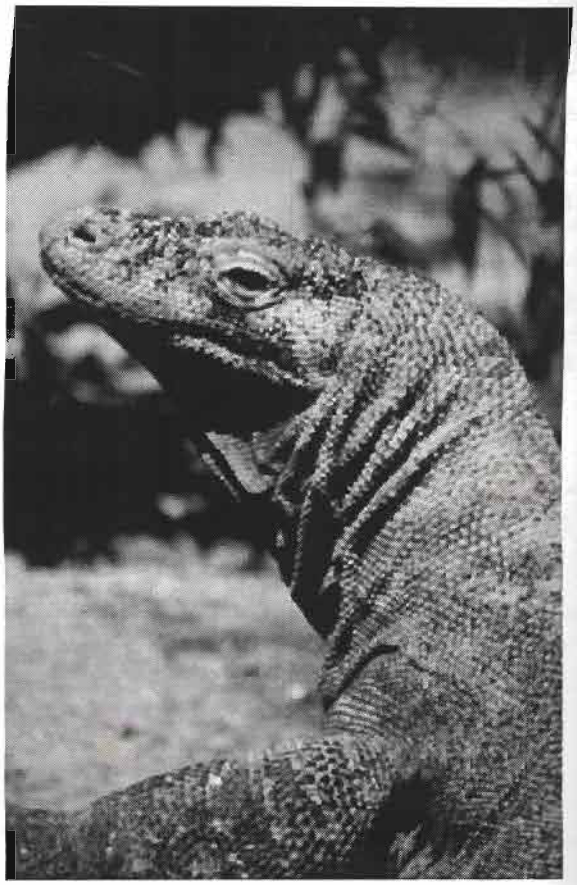
Introduction

The Miami Metrozoo received a pair of Komodo dragons (Varanus komodoensis) in June of 1995. They are wild-born animals from the island of Flores that were sent to Miami from the Taman Safari Zoo in Bogor, Indonesia. The male, "Jack", is approximately 2.5 m total length and weighs 77 kg. The female, "Lubier", is about 1.8 m long and weighs 36 kg. They are estimated to have hatched in 1987.



Portrait of an adult Komodo Dragon. Photo by Jim Pether.

The pair was moved to their present quarters in January of 1996. The area includes a spacious 480 m" outdoor exhibit yard with a large, shallow stream flowing through it, as well as two smaller 25 m" outdoor holding pens. Attached to these areas is a building containing five indoor 76 m" holding cages connected by shift doors to one another and/ or to outside enclosures. The climate in Miami is such that the animals are able to spend some time outdoors 350+ days of the year. An infrared heater on the exhibit, and lamps in the holding yards make it possible to allow the animals access outside even when air temperatures are in the range of 15-20YC. Ambient temperature in the building is maintained at 30YC with circulating underfloor hot water and forced air systems. Infrared hotspots up to 41YC are available during the breeding season. The lizards are maintained separately (except for breeding introductions) and brought indoors each evening.

Courtship and Copulation

Introductions were made in February of 1996 which resulted in a bite wound to the female's hind leg. Another wound on her shoulder forced their separation in order to give Lubier a chance to heal. The dragons were introduced again beginning in October. The female behaved aggressively toward Jack and they were separated. Introductions continued on a weekly to biweekly basis with the usual outcome being courtship attempts on the part of the male, and slow but persistent escape behavior on the part of the female. Gradually the male would become frustrated as evidenced by his attempts to bite the female, and at this point they were

separated. At the end of January 1997 Lubier showed a greater degree of receptivity than before by remaining still and elevating her tail. Unfortunately this happened only briefly and copulation did not occur. Sporadic introductions took place through June. In that month the female seemed very interested in the male, but Jack showed no interest in her. Shortly thereafter the male was sent on loan to another zoo, and introductions did not resume until November. In the ensuing introductions aggression was not observed, and it was felt that the female was gradually becoming more receptive. In January of 1998 the pair was introduced in the exhibit yard and copulation was observed over a five day period.

Oviposition and Incubation

The female dragon regularly utilized the indoor basking area after copulation. Some months previously she had dug a burrow in her outdoor holding yard, and this was the intended nesting area. Infrared lamps were set up in this area also since the weather had become cool and damp. On 14 February, 25 days after the last observed copulation, she was given access to the outdoor yard for the first time since mating. The following morning the burrow was found filled with sand and soil and had actually been turned into a mound. Lubier was moved back inside to allow for nest excavation, at which point she deposited three eggs in the holding cage. Twenty seven additional eggs were removed from the burrow for a total clutch of 30. After removing the eggs the female was allowed to return to the nesting area where she reburied the burrow opening.

A clutch of Komodo Dragon eggs before being removed to an incubation container. Photo by Jim Pether.

The eggs were all similar in size and shape and the shells were immaculate white, with the exception of one, which had been laid in the indoor cage, that was pale yellow. This egg was later found to be infertile. The eggs were set up in groups of three in plastic containers with tightly fitting lids which were left cracked at one corner. The substrate was a mixture of vermiculite and water in a ratio of 3:1 by weight. Prior to weighing, the vermiculite was dried in a conventional oven at 200YC for at least 30 min. The eggs were weighed and measured then buried approximately halfway in the substrate.

Four different makes of incubators were used at various times, and the recommended temperature protocol of the National Zoo was followed as closely as possible (Walsh 1996). The preferred units were Humidaire model 20 and Grumbach incubators in which the turning mechanism (used when incubating bird eggs) had been disabled. Some eggs were also placed in Lab Line ambi-hi-low chambers, but several eggs became dehydrated and dented early in incubation and these units were soon abandoned. The containers were checked weekly, weighed, and any weight loss was made up with the appropriate amount of distilled water. Additional water was added if an egg began to dent, but this was done subjectively based on the appearance of the egg in question and the others in the container.

After five weeks of incubation blood vessels were visible in the eggs when candled. Candling proved that all of the remaining 29 eggs were fertile. During the rest of the incubation period some eggs were weighed and candled, but apart from that handling was kept to a minimum. The first two eggs hatched after 212 days of incubation. Hatching continued through 246 days, and one egg was manually opened at day 257 from which a live neonate emerged the following day. Twenty-seven eggs produced healthy neonates, and two full-term embryos died in the shell.

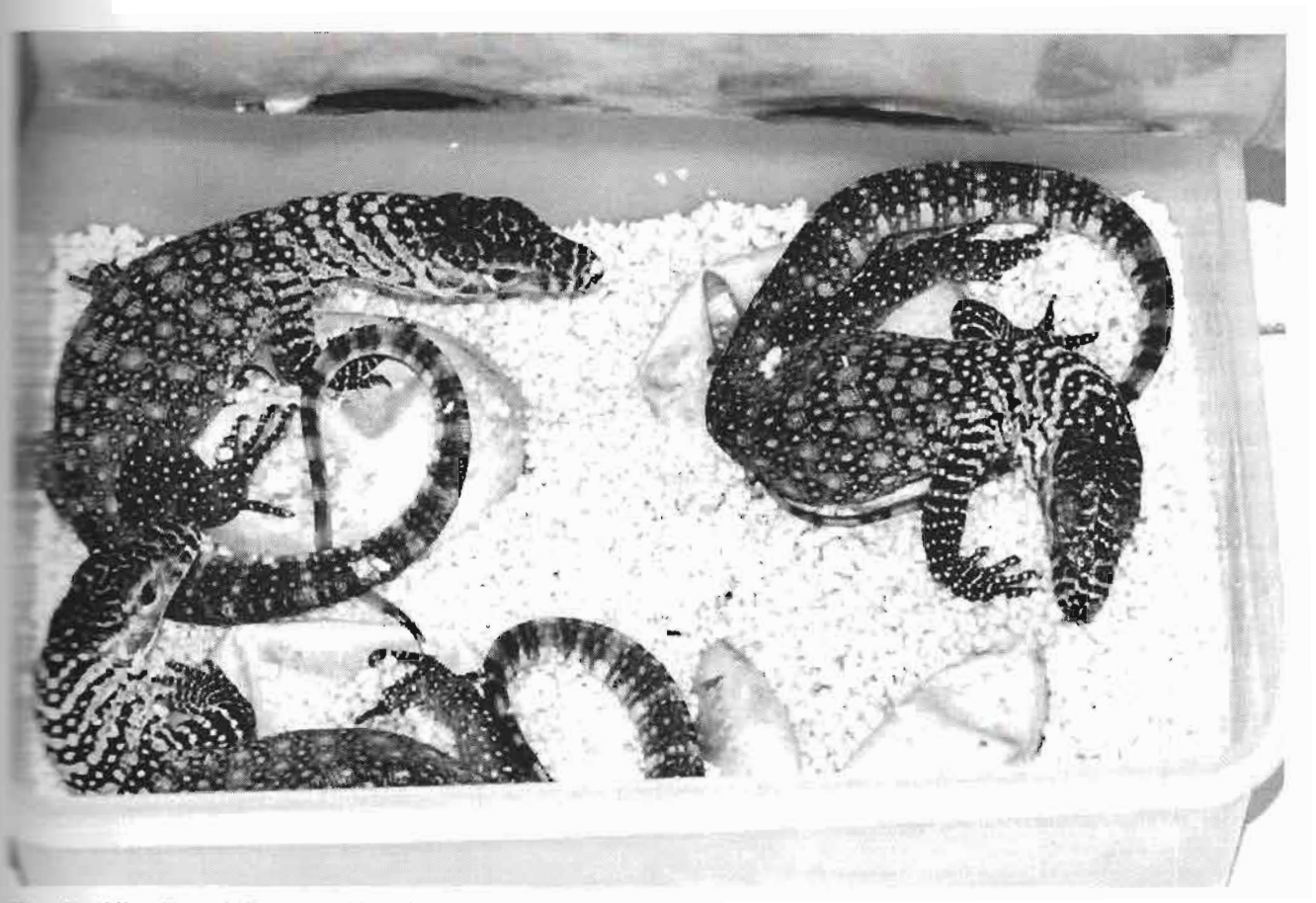
Hatchling Management

The somewhat unexpected high hatch rate forced zoo staff to generate creative solutions for housing the hatchlings. Once the umbilicus was broken (1-3 days post emergence) the youngsters were weighed and moved into individual cages - either fiberglass cages, aquaria, 50 gal. stock tanks with screen covers or other suitable terraria. Hatch weight ranged from 80-142 g (mean = 122 g) Food was offered within a week of hatching and measurements taken within the first two weeks. All of the hatchlings were eager feeders and extremely aggressive toward the keepers.

The hatchling enclosures were illuminated with either Westron mercury vapor bulbs or ZooMed UVB fluorescent lights. Some were also housed outdoors under natural sunlight. Blood samples were taken from nine animals, some of which were housed under each type of lighting regime, and Vitamin D3 levels measured. Levels ranged from 156-376 ng/ml, comparable to levels measured in wild dragons (Gillespie, et. al. 2000). An escaped hatchling that was recovered after living outdoors for over two months was sampled the day it was recaptured. This animal had a level of 588 ng/ml of D3. The lizards were fed a combination of mice, horsemeat and a prepared Bird of Prey diet (Nebraska Brand). Rapid growth indicated that this combination provided adequate nutrients. A computer analysis of the diet confirmed that levels of vitamins and minerals were appropriate (Duane Ullrey, pers. com.).

As dragons approached one meter in length they were moved to covered, outdoor, welded wire mesh cages that provided access to sunlight for part of the day. These enclosures had concrete floors and were furnished with perches. Climbing was common on the wire mesh and perches in these cages, and didn't pose a problem at this size. As the dragons grew, climbing and falling onto the concrete floor became problematic. Their ability to travel upward in a coordinated fashion far exceeded their skills at coming down. Two lizards suffered leg fractures, and although the actual incidents were not observed, it was assumed that this was the cause. In one case the fracture was healing well without treatment when discovered. The other required stabilization surgically with a plate and screws, but healed without complications. Climbing opportunities are now eliminated for lizards over 1.5 m in total length.

Another problem that affected both adults and offspring was an infestation of exotic ticks in the exhibit building. The adults, having been collected from the wild, carried with them the tick, *Aponoma komodoense*, native to Komodo and now known from Flores, where our specimens originated. Ticks never seemed to pose a serious health threat to the lizards, but were irritating to the keepers and something we wanted eliminate if possible. They were most frequently found on the face and ear openings of the lizards. The parasites were opportunistically removed manually and also controlled using Sevin (carbaryl insecticide), but the effectiveness of this product was short lived. A research project was undertaken in 2001 to test the efficacy of a new product, Provent-a-mite® (a permethrin formulation) in controlling or eliminating the ticks. A conservative protocol was developed that involved spraying exhibit and enclosure surfaces and preventing dragon access until the areas were completely dry. The numbers of ticks dropped rapidly in the first two months of the study and had dropped to zero after six months of treatment (Burridge et. al., 2004). Treatments were discontinued at this point and over two years later the exhibit area remains tick free.

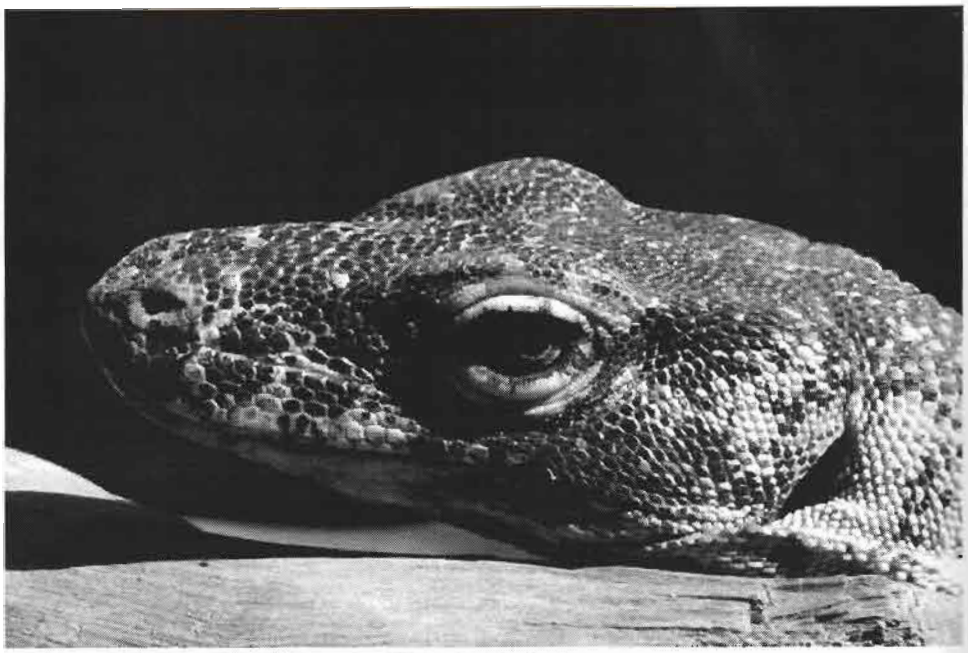


Three hatchling Komodo Dragons. Photo by Jim Pether.

Conservation Connections

Breeding Komodo dragons has resulted in several opportunities for Miami MetroZoo to take actions that benefit the prospects for the continued survival of this unique and fascinating reptile. Genetically, the captive population benefits from the representation of two additional founders. Prior to this breeding, all dragons hatched in North America were descended from only two males and a single female. This infusion of unrelated animals into the population enhances the prospects for its long term survival by greatly increasing its genetic diversity (Lacy, 1994).

With the addition of 27 new specimens into the population, public education opportunities about dragons were significantly enhanced. Specimens have been sent to 16 institutions in the U.S., Mexico and Europe. The majority of these zoos had not exhibited dragons previously. Thus untold numbers of zoo visitors were able to see this species for the first time and learn about the natural history, ecology, uniqueness and threats facing wild dragons. Likewise educational opportunities were expanded at Miami MetroZoo. A hatchling display was created that included the skull (reproduction) of an adult for size comparison and an eggshell. A video was also produced which shows the hatching of an egg from slit stage to complete emergence. This took approximately eight hours of video footage and condensed it into a 30 second loop shown continuously at the exhibit. One of the hatchlings was moved to the amphitheater area where animals used in the zoo's wildlife show are housed. Show staff worked closely with this individual to develop tameness and handleability. Close-up interaction with this animal and the thousands of show visitors, has helped instill in them a greater appreciation for dragons.



Portrait of a juvenile Komodo Dragon. Photo by Jim Pether.

Zoos which received offspring were asked to make a contribution to the Miami Metrozoo Conservation and Research Fund. Resources generated from these moves went to support a variety of projects involving wildlife conservation, but special attention has been given to in situ projects involving dragons. Specifically, Miami Metrozoo has been a major supporter of Dr. Claudio Ciofi and his work on genetics of the different island populations (Ciofi and Bruford, 1999). More funds are dedicated to future dragon work. The Komodo Dragon Species Survival Plan (SSP), a conservation program of the American Zoo and Aquarium Association, has also begun fundraising for dragon conservation work.

To learn more about how both these sources of funding could aid projects in the field, the author and Donal Boyer, Curator of Herpetology at the San Diego Zoo and Komodo Dragon SSP Coordinator, traveled to Komodo National Park to see conditions there first hand. We were fortunate to be able to accompany Dr. Tim Jessop (Millenium Postdoc, San Diego Zoo Center for Reproduction of Endangered Species) and his team who are in the process of performing an intense population survey/monitoring study of the dragons using mark and recapture. Morphometric data is collected on each animal, nest sites are located, mapped and monitored and prey species are identified (Jessop et. al., 2004). This work, which seeks to develop a long term management strategy for the dragons, is being undertaken through an agreement with the Nature Conservancy and the Indonesian Forestry Department. Major funding is provided by the San Diego Zoo. A high number of captures (500+) and, depending on the site, a 40-80% recapture rate, is providing the most accurate population estimates to date. Within the park proper, the population is believed to number about 2,000 animals. This was an excellent opportunity for a couple of "zoo guys" to assist in fieldwork, and also learn about other ways we can aid Komodo dragon conservation. Some needs which were identified included capacity building through the sponsorship of Indonesian students, equipment purchase and infrastructure development. There is much work to be done to insure the long term survival of dragons. Miami Metrozoo and the zoos which hold Komodo dragons will undoubtedly figure prominently in this effort.

Conclusion

The successful breeding of Komodo Dragons at Miami Metrozoo was the result of close monitoring of behavior patterns and the ability to easily introduce and separate adult lizards.

The provision of a semi-natural nest site may have contributed to timely oviposition and perhaps increased hatchability. Close monitoring of the eggs and incubators during incubation also contributed to the high

hatch rate. Successful rearing of these lizards was aided by the ability to provide access to quality artificial lighting and natural sunlight resulting in normal levels of Vitamin D3.

This breeding event has contributed to the conservation of this species in captivity and in the wild. By diversifying the genetics of the captive population through reproduction of these additional founders, the chances of its future survival are enhanced. Public education opportunities were also amplified through other zoos adding these lizards to their collection. The chance to behaviorally condition young dragons has also increased interactive learning experiences. Funds generated have been and will continue to be used to support *in situ* conservation, research and capacity building to facilitate conservation of Komodo dragons in their natural habitat.

Acknowledgements

I would like to thank Tom Condie and Linda Cunningham for their dedication to dragon care. Also thanks to Johnny Arnett of the Cincinnati Zoo and Trooper Walsh, formerly of the National Zoo for their advice and encouragement regarding Komodo dragon reproduction.

Products Mentioned

Westron 100W bulbs. Westron Corporation, 3590-C Oceanside Rd., Oceanside, NY U.S.A. 11572

ReptiSun 5.0 UVB Fluorescent bulb. Zoo Med Laboratories Inc. 3100 McMillan Rd. San Luis Obispo, CA U.S.A. 93401

Lab Line ambi-hi-low chamber. Lab Line Instruments Inc. One Lab Line Plaza, 15th Bloomingdale Ave., Melrose Park, IL U.S.A. 60160

Humidaire Model 20. Humidaire Incubator Co. Wayne St., New Madison, OH U.S.A. 45346

Grumbach (Manufactured in Germany) Swan Creek Supply, 12240 Spencer, MI U.S.A. 48609

Bird of Prey Diet. Nebrask Packing Co

Provent-a-mite®. Pro Products, Mahopac, NY U.S.A. 10541

Sevin 5% Dust. Wilbur-Ellis Company, Fresno, CA U.S.A. 93715

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CHLAMYDOPHILOSIS IN RECENTLY IMPORTED EMERALD TREE BOAS (*Corallus Caninus*)

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Abstract

Over a 4-mo period, one hundred and five wild-caught emerald tree boas (*Corallus caninus*) were added to a collection of 15 others in Central Florida. Eighty-one boas (67%) developed repetitive regurgitation during the 23 mo period after the initial addition of wild-caught boas and 61 (75%) of these died. Prevalence of regurgitation in this population of snakes was 25% /mo (range 0 - 42%) and incidence was 3.52/mo (range 0 - 12/mo). The cumulative mortality, for those boas developing repetitive regurgitation (61/120), over the 23 mo epizootic was 51%. Histologic evaluation of gastrointestinal tracts showed positive immunohistochemical staining for chlamydial antigen characterized by multifocal to diffuse lymphoplasmacytic inflammation with the formation of granulomas. Electron microscopic evaluation of granulomas identified organisms consistent with *Chlamydophila* sp which were later identified as *Chlamydophila pneumoniae* by polymerase chain reaction (PCR) and sequence analysis.

Introduction

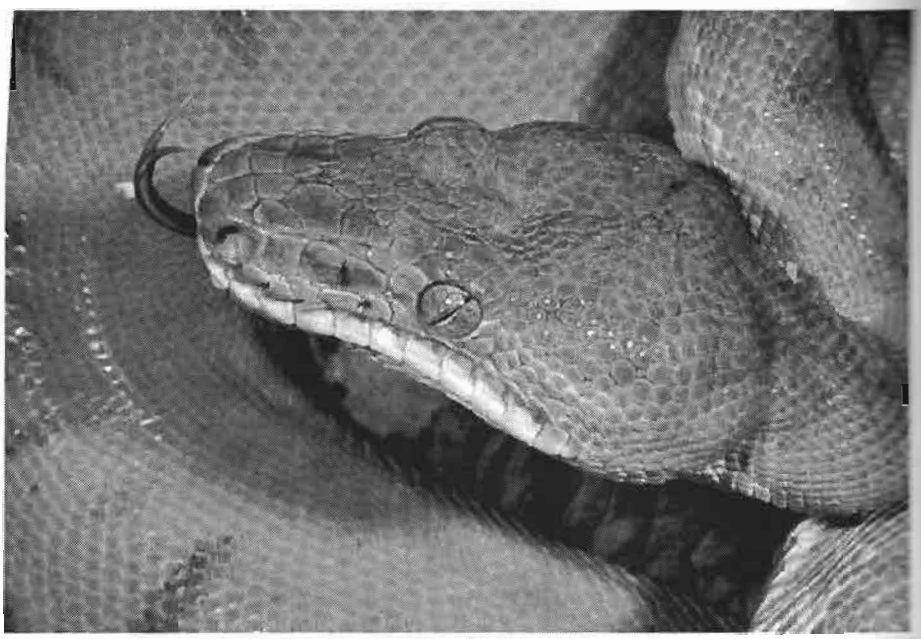
Deaths in many captive emerald tree boas (*Corallus caninus*) have been associated with "emerald regurgitation syndrome," characterized by repetitive episodes of regurgitation leading to weight loss and eventual death. A number of different etiologies have been proposed the failure of wild-caught emerald tree boas to acclimate to captivity. Reasons include inadequate husbandry (temperature and humidity), food items that differ from those encountered in the wild and exposure to various pathogens. This case report describes an epizootic of regurgitation in a group of wild-caught emerald tree boas similar to the previously described syndrome.

Case Report

A private collection of captive-born emerald tree boas (group I) consisted of 15 animals purchased between 12-8-94 and 10-21-98. Between 10-21-98 and 9-22-99, 105 wild-caught emerald tree boas from Guyana (group II; 71 "A" boas from an importer in Colorado and 34 "B" boas from a Florida importer) were added to the collection. Group II A boas were received in March, May and July 1999 and group II B boas arrived in May and June 1999.

The new animals were housed separately from, but within the same building as the original group of snakes. Sixty-five percent of the wild-caught boas ate within 14 days, and 89% had eaten by 30 days after introduction to the collection. Group II A snakes received in March 1999 began to regurgitate and started dying in April 1999 before group II B snakes were received. Seven of the 15 group I snakes (no previous regurgitation in this group) began regurgitating and died within 15 mo of introduction of group II A snakes. Eighty-one (67%) of the 120 emerald tree boas began to regurgitate within 15 mo, and of those snakes that regurgitated 61 (75%) died within 12 mo of acquisition. The mean time from introduction of group II AB boas to regurgi-

tation was 6 mo (range: 3 days to 21 mo). [8]



Portrait of an adult Emerald Tree Boa. Photo by Bill Love.

Prevalence of regurgitation, defined as the total number of boas regurgitating during a 1-mo time period without distinction between old and new cases, averaged 25% throughout the 23-mo epizootic with peak prevalence (40% or greater) 16-19 mo after the introduction of group II A snakes. [7] Incidence of new regurgitation cases averaged 3.5/mo and the cumulative incidence of regurgitation (proportion of non-diseased snakes that became diseased during the 23-mo epizootic) reached 51%. Peak incidence of new regurgitation cases (13) occurred 16 mo after group II A introduction. [8]

Mortality averaged 1.2/mo through 1999 and 3.57/mo through 2000. Cumulative mortality, the proportion of individuals alive at the beginning of a month that die during the month, averaged 3.7%/mo with peaks at 16(9.6%) and 20 (10.3%) mo after addition of group II A boas. [8]

The majority of snakes continued to have normal appetites. Regurgitation was observed within 3-4 days of feeding. Regurgitating snakes lost weight, became cachexic, and eventually died.

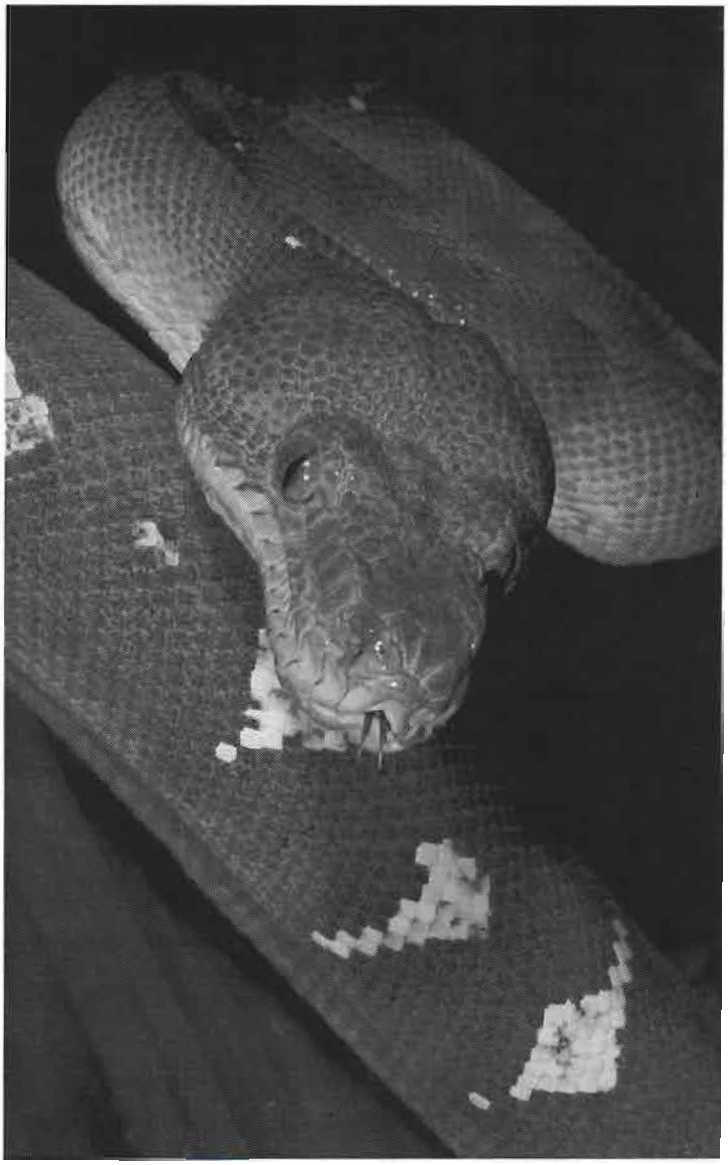
Electron microscopy, histopathology, immunohistochemistry and polymerase chain reaction

Twelve snakes were necropsied and tissues were collected from all major organs and processed for light microscopy. Histologic examination demonstrated histiocytic granulomas in the small intestine and heart of one boa and in the esophageal tonsils of a second animal. Within the center of these granulomas, small basophilic punctuate organisms were demonstrated using H&E staining. [8] Transmission electron microscopic examination of an intestinal granuloma demonstrated developmental stages of an organism consistent with members of the family Chlamydiaceae. Using an immunoperoxidase staining technique and two different commercially available monoclonal antibodies against Chlamydia LPS antigen, positive staining was seen within histiocytic granulomas. [6] Additionally, macrophages and enterocytes within diffuse infiltrates of lymphoplasmacytic cells in the colon, small intestine, liver, spleen and esophageal tonsils of three additional emerald tree boas contained antigen. [6] Tissues stained with Zieh-Nielsen acid-fast technique showed no evidence of cryptosporidial or mycobacterial organisms. [8]

Electron microscopic examination of intestinal tissue with granuloma formation demonstrated structures consistent with chalmydial elementary, intermediate and initial bodies.[6] Subsequent examination of tissues, from 5 affected boas, using polymerase chain reaction (PCR) amplification of 23SrRNA gene and PCR sequence analysis showed that these emerald tree boas were infected with *Chlamydophila pneumoniae*. [5]

Treatments

Approximately 50 snakes with repetitive regurgitation were treated with oxytetracycline (Maximum, 200 mg/ml, Phoenix Pharmaceutical Inc., St. Joseph, Missouri 64503, USA, 10 mg/kg i.m., every 3-5 days for 6 wk). These boas showed reduced frequency of regurgitation for a variable period of time and were able to digest small food items. [8] Thirty-four of the 50 snakes with reduced regurgitation eventually died; 22 were found dead and 12 died from a hyperthermic episode due to a malfunctioning space heater. [8] The remaining 16 snakes stopped regurgitating for an average of 6 mo (range 1-8 mo), were fed one to seven meals (average 4.3), with no regurgitation, and were still alive when transferred to another collection, when they were lost to follow up.



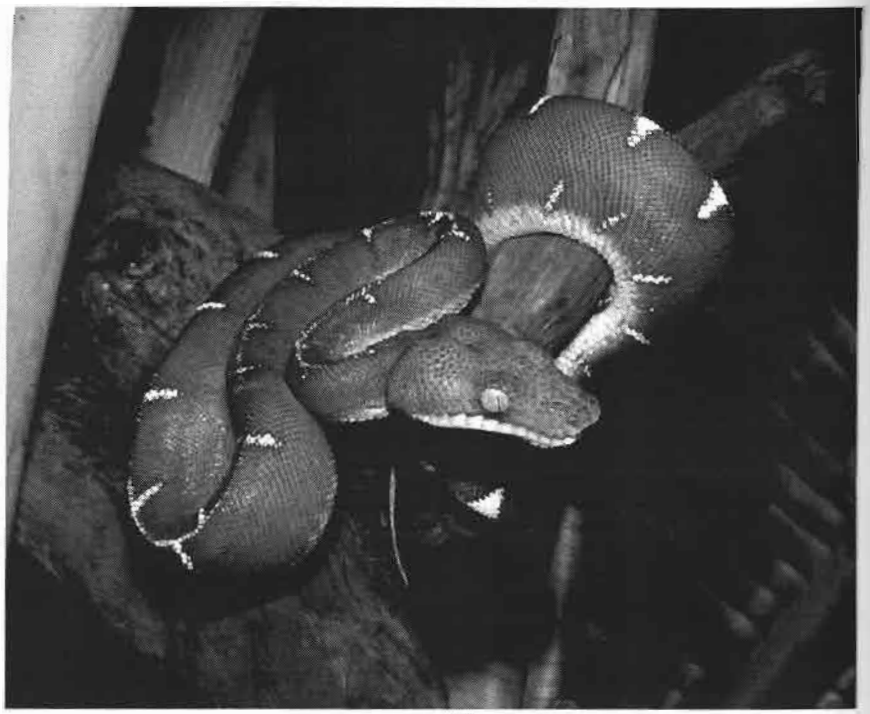
The face of the Emerald Tree Boa, *Corallus caninus*. Photo by Bill Love.

Discussion

A disease characterized by regurgitation and wasting has been observed in wild-caught emerald tree boas in captivity. There is extremely limited information in the literature to implicate a causative agent. Differential diagnosis for regurgitation in snakes include infections due to bacteria (chlamydophilosis), fungi, viruses (inclusion body disease) and parasites (cryptosporidiosis, trichomoniasis, coccidiosis, cestodiasis and nematodiasis), improper husbandry and handling. Although gram-negative bacteria were isolated from gastric lavage samples in regurgitating snakes none were found consistently. [8] Intracytoplasmic inclusions characteristic of inclusion body disease were not found in any examined tissue. [7] Organisms consistent with cryptosporidial or mycobacterial species were not identified in acid-fast stained gastrointestinal tissues. [8]

Nine of 12 necropsied emerald tree boas had histologic evidence of gastroenteritis including three with histiocytic ganulomas that had distinct central basophilic inclusions similar to those reported in puff adders with chlamydiosis. [6] Evaluation of granulomas from the small intestine of an emerald tree boa contained developmental stages of an organism consistent with members of the family Chlamydiaceae. [6] The gastrointestinal tracts of 5 emerald tree boas demonstrated positive staining for chlamydial antigen using two different antichlamydial monoclonal antibodies. [6] The presence of gastrointestinal lesions, positive immunohistochemical staining for and demonstration of *Chlamydophila* spp. by electron microscopy suggest that the organisms may have contributed to regurgitation and death of these snakes.

Emerald tree boas exposed to others with chlamydial organisms appear highly susceptible to developing chronic regurgitation. In one report the probability of boas developing regurgitation during an outbreak was high. [8] The cumulative incidence of regurgitation in that report reached 51% during the epizootic. [8] Cumulative incidence can be used to predict an individuals change in health status and is an indicator of the probability of development of a disease during a specified time period. [8] Snakes developing repetitive regurgitation died over a prolonged period of time (average 5.3 mo) as shown by the increasing prevelance of regurgitation with time. The animals that developed chronic regurgitation early in the epizootic did not die but continued to contribute to the overall prevalence of regurgitation. Total mortality reached 51% (61 of 120) for the total population of boas and 75% (61 of 81) snakes that developed chronic regurgitation died. [8] The highest cumulative mortalities per mo occurred 16, 17 and 20 mo after arrival of group II A snakes. [8] These finding are consistent with the fact that the snakes were not recovering from disease and that additional snakes were developing disease with time.



A young Emerald Tree Boa. Photo by Bill Love.

The order Chlamydiales consists of four families. Of these, the family Chlamydiaceae contains members that are known to be pathogens in humans and other animals. Recently, a reclassification of Chlamydiaceae has resulted in the recognition of two genera: *Chlamydia* and *Chlamydophila*. *Chlamydia psittaci*, which formerly consisted of numerous strains, having a wide host range, has been reclassified as *Chlamydophila psittaci*. Currently, this organism is only known to infect birds. *Chlamydophila pneumoniae* was identified by PCR in the emerald tree boas described in this recent die-off. [5]Chlamydophilosis has been reported in several species of reptiles. Puff adders (*Bitis arietans*) developed severe granulomatous myocarditis, pneumonia and enteritis. [4] A die-off of green turtles with chlamydia (*Chelonia mydas*) had necrotizing myocarditis and histiocytic splenitis. [2] Both Chlamydia and a pox virus were identified in circulating monocytes and macrophages in the spleen and liver of a flap necked chameleon (*Chameleo dilepis*). [7] Chlamydia was found in the liver of Nile crocodiles (*Crocodylus niloticus*) with hepatitis[3] and *Chlamydia psittaci* was isolated from a captive Moorish tortoise (*Testudo graeca*) with pneumonia. [9]

A recent report using amplification of chlamydial 16S RNA from paraffin-embedded tissues of reptiles documented the presence of multiple species of Chlamydiae: *C. abortus* and *C. pneumoniae* (puff adder, green turtle, Burmese python); *C. felis* and *C. pneumoniae* (green iguana); *C. pneumoniae* (chameleon). [1] This report demonstrates the *C. pneumoniae* is not restricted to humans but also occurs in reptiles.

In the emerald tree boas the predominance of lesion were gastro-intestinal suggesting an oral route of transmission. [8] *It was suggested that contamination of water bowls, handling equipment and the immediate envi-*

ronment of the snakes contributed to spread of the disease. The contribution of mites to the spread of disease were not investigated. Whether the emerald tree boas in this die-off acquired the pathogen from humans or other animals or whether humans can be infected with the strain in these snakes is yet to be determined.

Chlamydophilosis should be considered as a diagnosis for repetitively regurgitating snakes and snakes with respiratory disease. Oxytetracycline has been used to treat chlamydophylosis in emerald tree boas with some degree of success.

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SCIENTIFIC NOMENCLATURE

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Why do so many people have a phobia about scientific names of animals? One hears "Oh that's all Greek to me" or "Only the pope speaks Latin," etcetera. Heck, the word "PHOBIA" itself is Greek and "ETCETERA' is Latin.

Our language and most other European languages are derived from Greek and Latin. There are still some unchanged Greek and Latin words in our vocabulary that we use quite often:

LATIN		GREEK	
E Pluribus Unum	= One out of many	Pentagon	= Five cornered
Habeus Corpus	= Produce the body	Octopus	= Eight legs
Ad Hoc	= After this	Arthritus	= Joint pain
Anno Domini	= The year of our Lord	Microscope	= See small things
Quid Pro Quo	= This for that	Teloscope	= See far
Ad Lib	= For free	Dichotomy	= Dividing In two
Circa	= Around or Approximately	Astronomy	= Naming stars
Non Compos Mentis	= Mentally incompitant	Melanistic	= Blackish
Et Cetera	= And so forth	Thermometer	= Heat Measure

This will not be an argument at you to learn Greek and Latin but, rather, to step up to the next level, of a little more precise nomenclature of herps. *Herp*, by the way, is a Greek word. This is a HERPETOLOGICAL SYMPOSIUM (= a group of people gathered together to study reptiles and amphibians). I'm from California, one of the centers of US herpetology. We proudly descend from some of the pioneers in the study of reptiles and amphibians such as Van Denbergh, Slevin, Klauber, Perkins, Stebbins, Shaw, Drewes, Etheridge, and others so, if we are going to take our heritage seriously and continue calling ourselves HERPETOLOGISTS rather than pet snake cuddlers, we ought to consider educating ourselves a little above pet shop terminology, in my opinion.

Scientific names aren't all Greek just to confuse you, nor are they all Latin either, even though they're often called "Latin names". They are simply an attempt to give some consistency to the names of animals and plants as well as rocks and minerals and usually, or rather ideally, tell us something about the species that they describe and tend to standardize the names of species for biologists as well as hobbyists all over the world no matter what the local or currently popular name may be.

At first, those who spoke of animals gave them names in their own language. In England a small venomous snake is called an adder while in Germany the same species is called an otter. That's close, but in English an otter is not a snake at all but a fur-bearing mammal. So, how does an English-speaking herpetologist communicate with one from Germany without confusing scales and fur?

Well, in the 1700s a Swedish botanist by the name of Carl von Linné came to the rescue. He had been plagued by the same problem with plants. Who else spoke Swedish? So, being trained in Latin and Greek, as were all scholars of his time, he devised a binomial system of nomenclature using Latin and Greek which are

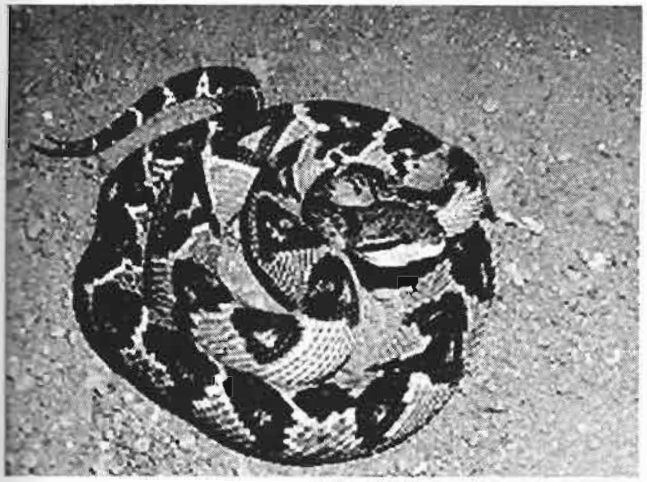

Fig. 1. *Lachesis* is one of the three fates in Greek mythology, who assigned to man his term of life.

Fig. 2. *Vipera berus*. The common name of this snake is adder in English while in German it is called otter.

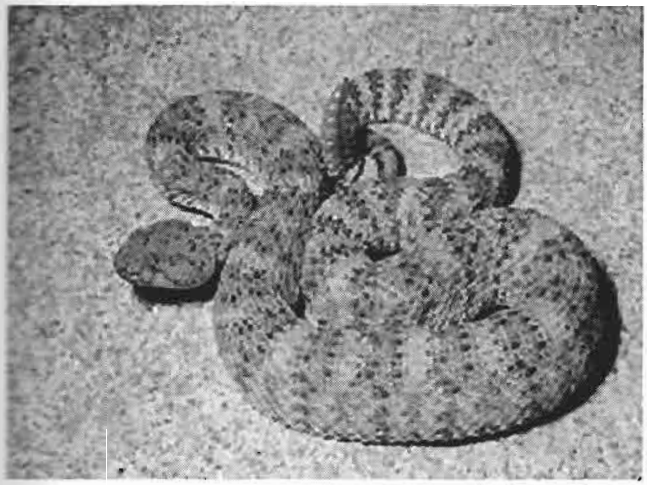

Fig. 3. *Crotalus mitchelli* is pronounced differently in America and Europe, the emphasis being on the first syllable of the names in the U.S. with the specific name pronounced "Mitchell" with an "eye" at the end while in Europe the emphasis is placed on the penultimate, the next to last syllable with a short "i" at the end.

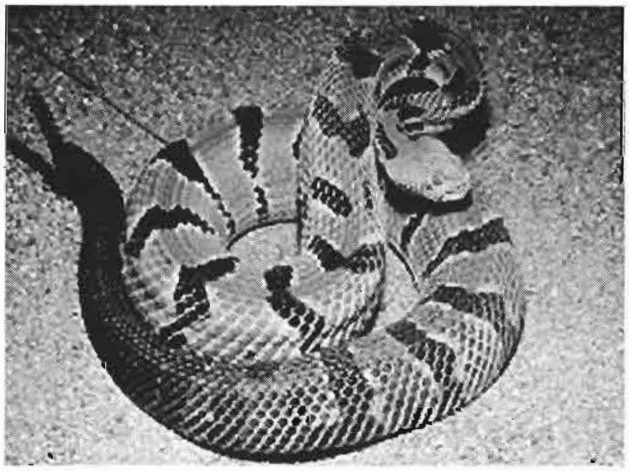

Fig. 4. *Crotalus horridus* is the true timber rattlesnake found in the eastern United States.

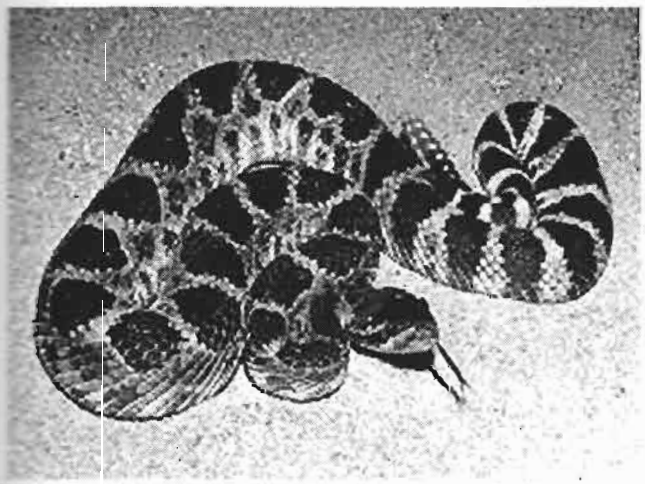

Fig. 5. *Crotalus viridus oreganus*, the northern Pacific rattlesnake is sometimes mistakenly referred to as a timber rattler, presumably, because it can be found in tall timber.

Fig. 6. *Boulengerina* is a patronym honoring a noted nineteenth century Belgian herpetologist at the British Museum.

dead languages used by scholars in all European countries.(He even latinized his own name to Linnaeus). The classical Latin and Greek, being extinct, didn't change anymore and were ideal for communication by scientists from all countries. The common folk spoke in the local dialects, changing the pronunciation and even the meaning of words and invented new words as needed in their localities over a period of time and, eventually, the dialects became languages. This has even been reported to occur in the songs of birds and whales. The classical languages, as we call them, that is, Latin and Greek, remain constant to this day ... sort of. Even here there may be slight differences because of linguistic accents. An American pronounces the scientific name of the speckled rattlesnake " CRO tal us MICH el eye" while a German says "Cro-TAL-oos mee-CHELL-ee" but we understand each other.

So, in other countries, when herpetologists get together do the Swedes and Italians use Greek or Latin? They usually refer to their animals by their scientific names, but how do they communicate? They generally use the "universal language of science" – broken English – and some of it is not so broken either. Many speak very good English.

The Indo-European languages have evolved into dozens of local tongues, starting as dialects then developing into complete languages in different subgroups such as Latin, Germanic, Slavic and others while, connected through Greek and Sanskrit in another direction, are Farsi, Pashtu, Hindi, Bengali, Nepali, and a whole host of other languages of the Indian subcontinent which are as diverse as those of Europe. These all comprise the Indo-European family of languages. And this is just one language family. Some others are Semitic, including Hebrew and Arabic, Sino-Tibetan, Malayo-Polynesian and many, many others in other parts of Asia, Africa, North and South America and some islands.

Closer to home, I've heard of a northern Pacific rattler, *Crotalus viridus oreganus* called a timber rattler which is an entirely different species, *Crotalus h. horridus* and, worst of all, when I was in a pet shop one day, two little boys, looking at lizards were overheard by the proprietor when one said to the other "Hey, Bruce, check this out!" When Bruce asked the proprietor, "What kind of a lizard is that?" He was told "Oh, that's a Bruce's lizard". If that kid bought that lizard how would he be able to learn what kind of care to give a "Bruce's lizard"?

Scientific nomenclature tends to standardize the names of plants and animals for biologists all over the world, no matter what the local or popular names and in whatever language. Scientific names may be based on description, geography, habitat, habits, patronyms (= named after somebody), onomatopoesis (= after a sound it makes) or other criteria, and can provide a clue to the care of an animal or, at the very least, make us a tiny bit smarter, and we can all stand some more of that.

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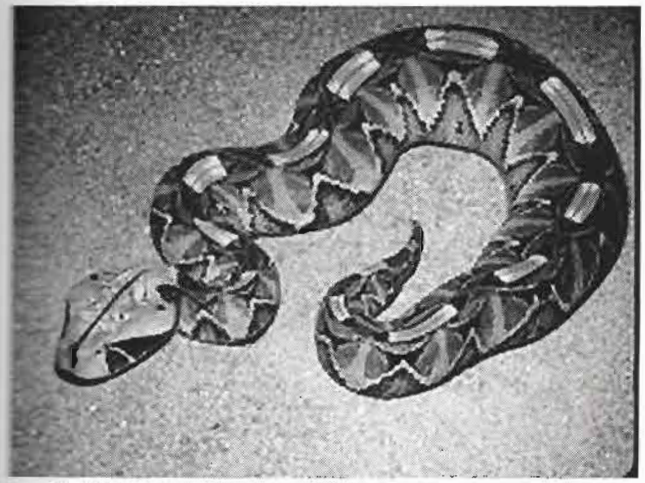

Fig. 7. *Bitis gabonica* was first described from Gabon, a country in Africa.

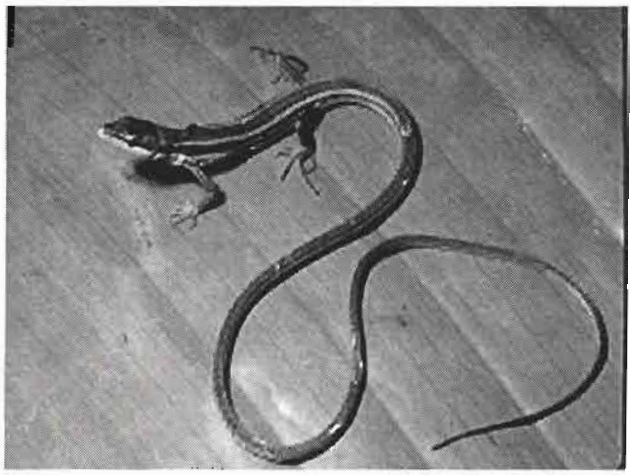

Fig. 8. *Takydromus* means swift runner in Greek, referring to its habit of disappearing swiftly in grass.

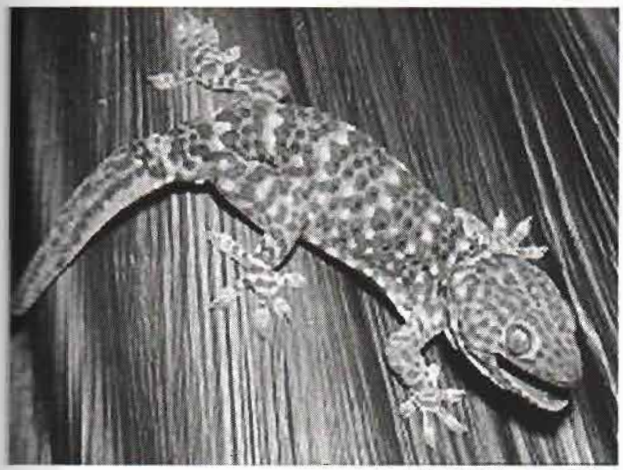

Fig. 9. *Gecko gecko* is an onomatopoeic name, an attempt to imitate the sound that the animal makes. When the generic and specific names are the same it is referred to as a tautonym.

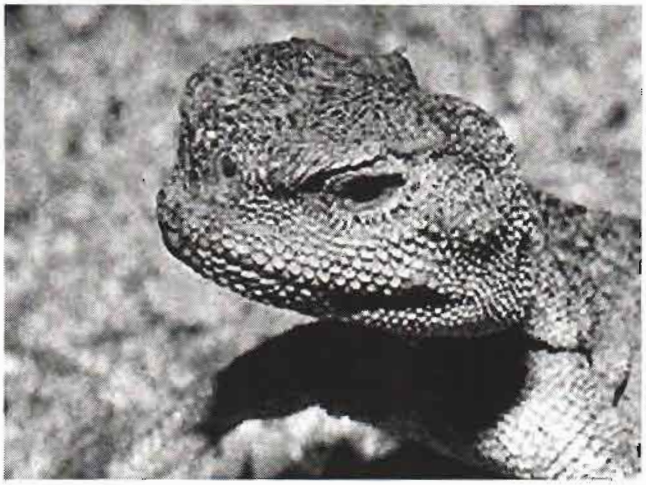

Fig. 10. *Phrynocephalus* is a descriptive name meaning "toad head" in Greek.

Fig. 11. *Dendrobates*, in Greek, is one who haunts trees, referring to its habitat.

Fig. 12. *Chitra* is an Indian name, originally chitraka in Sanskrit, meaning spotted. The name of the cheetah, a spotted cat of India and Africa is also a derivative.