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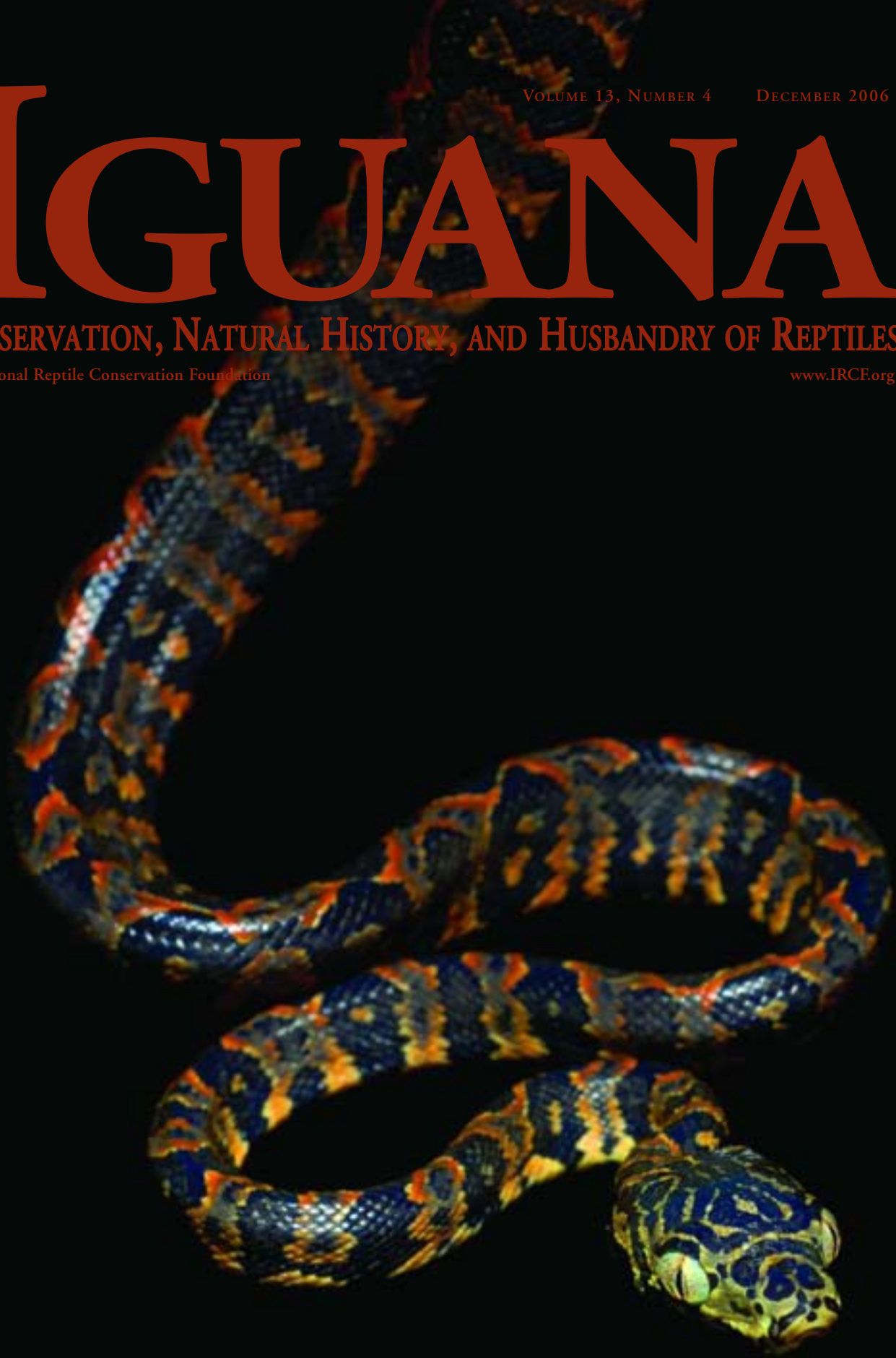
DECEMBER 2006

# IGUANA

CONSERVATION, NATURAL HISTORY, AND HUSBANDRY OF REPTILES

International Reptile Conservation Foundation

[www.IRCF.org](http://www.IRCF.org)



Cook's Treeboa (*Corallus cookii*) is endemic to St. Vincent in the Lesser Antilles. See article on p. 252.

ROBERT POWELL



GAD PERRY

Puerto Rican Ground Lizards (*Ameiva exsul*) readily dove into the sea and swam both under and on the surface (see article on p. 272).



BROCKEL TALLEY

The recently described bromeliad-dwelling frog *Hyla melacaena* is the only species of frog known to occur in the dwarf forests of Cusuco National Park, Honduras (see article on p. 242).



ROBERT POWELL

Cosmopolitan House Geckos (*Hemidactylus mabouia*) are human commensals that have become established throughout the tropics as a consequence of this close association (see article on p. 252).



JOHN BINNS

*Ctenosaura similis* may be an invasive species on Isla Utila, Honduran Bay Islands, where it could threaten the genetic integrity of the endemic *C. barkeri* population (see article on p. 264).



BRETT BALDWIN

Green Tree Monitors (*Varanus prasinus*) have been successfully bred at the San Diego Zoo. Hatchlings are quite active and ready to disperse (see article on p. 283).



MARILEE PASKER

*Goniurosaurus luyi* was described from southern China in the late 1990s. Within months, these geckos were demanding high prices in the pet trade (see commentary on p. 288).



JOHN BINNS

Exuma Island Iguanas (*Cyclura cyclura figginsi*) populations are increasingly affected by a growing number of tourists visiting the islands (see related reports on p. 278).



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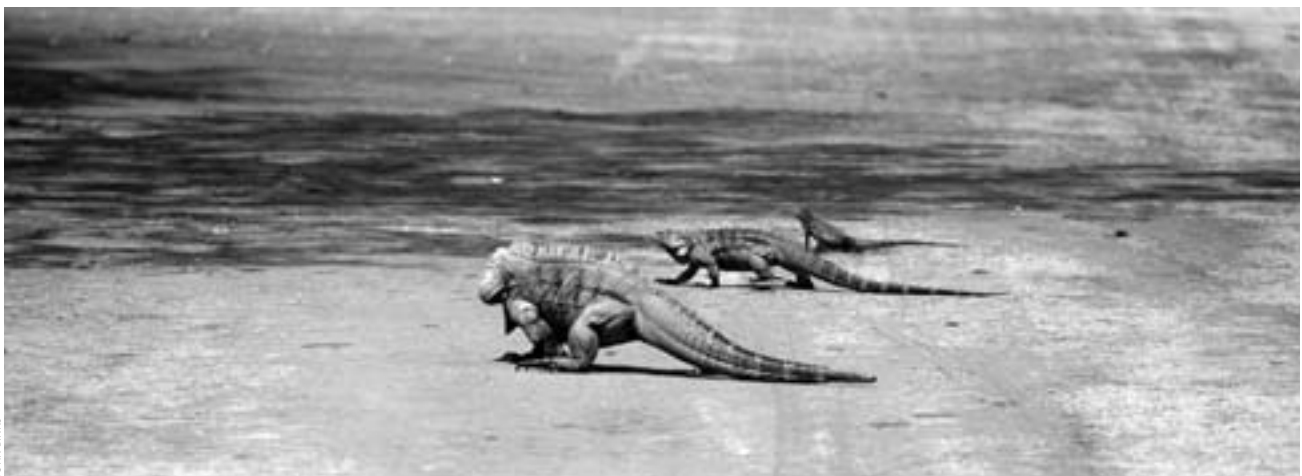
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JOHN BINNIS

Sister Isles Rock Iguanas (*Cyclura nubila caymanensis*): Taken in August 2006 on Little Cayman’s West End on a residential street where iguanas bask and beg. The number of cats has increased in all areas of the island and fewer than the normal number of hatchlings were seen during this period.





KEVIN M. LENGE

*Anolis (Norops) johnmeyeri* is a large anole found in the elfin forests of Cusuco National Park, Honduras.

# Denizens of the Dwarf Forest: The Herpetofauna of the Elfin Forests of Cusuco National Park, Honduras

Josiah H. Townsend<sup>1</sup> and Larry David Wilson<sup>2</sup>

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*It is hard to explain this transition to what looks like an arid-land flora on these high peaks which receive a maximum of water supply through condensation of moisture from the nearly continuous winds, unless it be that the stronger winds augment the hazard in a temporary failure of the moisture supply. These scant-leaved, dwarfed, and wind-tortured trees are often little more than framework for the support of masses of air plants, and a tree that at first glance appears to be alive may be nothing but a corpse, completely enshrouded by the epiphyte flora that killed it.*

Archie F. Carr, Jr., 1953

With these words, Archie Carr introduced readers to a poorly known and intriguing vegetative formation that even he was rarely able to visit. Shrouded in mist, atop the highest peaks of the Sierra de Omoa, lies a unique form of forest akin to that described by Carr, a place as enchanting as it is mysterious. This forest is referred to by local residents as the *bosque enano*, meaning “dwarf forest” or “elfin forest” in Spanish. Those fortunate enough to experience it are forever enamored by the stunning vistas, crisp air, and the luxuriant carpet of epiphytic organisms that are characteristic of this unique mountaintop habitat. Whereas the dwarf forest is home to only a handful of herpetofaunal species, those amphibians and reptiles that have managed to gain a foothold there include some of the more unusual and specialized species found anywhere in Mesoamerica.

The Sierra de Omoa is an isolated mountain range found in the northwestern corner of the Central American republic of Honduras. Although one of Honduras’s largest and fastest grow-

ing cities, San Pedro Sula, sits in an alluvial plain at the foot of the mountains, the upper regions of this range support a sizable cool cloud forest that is protected within the boundaries of Cusuco National Park, seemingly a world away from the heat and commotion of the country’s financial capital.

Cusuco National Park is one of the herpetologically best-known cloud forest reserves in Honduras. Seventeen species of amphibians and 33 species of reptiles have been recorded. Of these, nine are found nowhere else in Honduras (or the world for that matter), and another nine are found only in the Sierra de Omoa and the associated northwestern highlands of Honduras and adjacent Guatemala. The high degree of endemism demonstrated by the herpetofauna of Cusuco National Park indicates the critical conservation value of these forests, and the importance of the park as a framework for protecting the unique biota of the Sierra de Omoa.

Perhaps the most distinctive habitat formation found in these mountains is the dwarf forest, which is restricted to the



Honduras is located in Central America; the general location of Cusuco National Park and the dwarf forests is marked with a circle.



Heather wind scrub formation, around 2000 m elevation, on top of Cerro Cusuco, July 2005.



JOSIAH H. TOWNSEND

Peak of Cerro Cusuco, about 2100 m elevation, as seen from Cerro Jilisco.



DAN RUPUS

Hepatic or mossy forest formation, around 2050 m elevation, Cerro Jilisco, September 2004.

windswept upper slopes of Cerro Cusuco and Cerro Jilincó, the highest peaks in the Sierra de Omoa, above around 1950 m elevation. The term “dwarf forest” has been used to describe a variety of mountaintop vegetation formations in the Neotropics. In the Sierra de Omoa, this term is used to refer to two formations: the hepatic or mossy forest and the heather wind scrub. These formations were broadly defined initially by Archie Carr in 1950 and later by D. Mejía V. Subsequent authors have applied the terms specifically to the dwarf forests of Cusuco National Park. Both the hepatic or mossy forest and the heather wind scrub are



JOSIAH H. TOWNSEND

Heather wind scrub formation, around 2060 m elevation, on top of Cerro Jilincó, March 2006.

typified by short vegetation (canopy <10 m high) and an overwhelming abundance of epiphytes, including giant ground-dwelling bromeliads, arboreal bromeliads, mosses, hepatics, lichens, orchids, mistletoe, and fungi.

The heather wind scrub is found on the highest peaks and exposed ridges of Cerro Cusuco and Cerro Jilincó. As the name indicates, this vegetation formation is dominated by heathers (Ericaceae), with the tallest vegetation rarely exceeding 2 m in height. Hepatic or mossy forest is found just below the heather wind scrub, and has more trees, which seem to have every available inch of their trunks and limbs occupied by epiphytic growth. These two formations occupy less than 1 km<sup>2</sup> within the park, yet are so distinctive from the cloud forests below as to deserve special attention from researchers and conservation practitioners alike.

Not surprisingly, such a restricted high-elevation habitat that is at least 100 m in elevation above any permanent water source is home to a relatively small number of reptilian and amphibian species. Studying the herpetofauna of the dwarf forest is rendered more complicated by the lack of suitable campsites and available drinking water, as well as by the remoteness and relative difficulty of accessing the peaks of these mountains. During 2004, 2005, and 2006, the authors or other herpetologists working as part of the Operation Wallacea Honduras Forests Conservation Project visited the Cusuco dwarf forests seven times. Most of these visits were made during the daytime and involved a two to four hour trek to a dwarf forest site, a few hours of searching for reptiles and amphibians, and the return trek. On two occasions, small campsites were set up below the dwarf forest to facilitate searches of the habitat at night. In addition to the results of our visits to the dwarf forest, two records were obtained by Mario R. Espinal during his work in Cusuco National Park.

Four species of lizards have been recorded in the dwarf forest: the anguid *Mesaspis moreletii*, the anoles *Anolis johnmeyeri* and *A. amplisquamosus*, and the spiny lizard *Sceloporus schmidtii*. The Alligator Lizard *Mesaspis moreletii* is a terrestrial, viviparous lizard found at intermediate and high elevations in isolated highland areas from Chiapas, Mexico, to northwestern Nicaragua. The ability to give birth to its young live rather than laying eggs



KENNETH L. KRYSKO

Flowers of an unidentified Ericaceae on Cerro Jilincó, a dominant plant in the heather wind scrub.



BINGORE L. TALLEY

Hepatic or mossy forest formation, just below 2000 m elevation on Cerro Cusuco.



DAN PURVIS

The senior author ducking through the dense vegetation at about 2000 m elevation, near the top of Cerro Cusuco, August 2005.



BROOKE L. TALLEY

Dougie Fraser (left) and the junior author at a remote campsite below the dwarf forest on Cerro Cusuco, about 1870 m elevation.

is a hallmark of lizards that are adapted for life at high elevations, where ambient temperatures may not be high enough to naturally incubate eggs. *Anolis (Norops) amplisquamosus* is an anole known only from intermediate elevations of Cusuco National Park in the Sierra de Omoa of northwestern Honduras, and is one of many species that are endemic to the park. It is easily recognized by having 8–10 rows of greatly enlarged scales along the middorsal line. *Anolis (Norops) johnmeyeri* is a large anole found only at moderate and intermediate elevations on the Atlantic versant in western Honduras. This striking species is unusual in that both males and females have large dewlaps with a blue central spot; males have the blue spot surrounded by red and in females it is surrounded by yellow. The Emerald Swift, *Sceloporus schmidti*, is a spectacularly colored Spiny Lizard distributed at low, moderate, intermediate, and high elevations from western Honduras to western Panamá. This species is a common cloud forest inhabitant throughout its range, and can be found in exposed areas that receive the most exposure to sunlight, making the short vegetation of the dwarf forest an ideal habitat for this species.

Only two snakes are known from the Cusuco dwarf forests, the colubrid *Ninia espinali* and the montane pitviper *Cerrophidion godmani*. *Ninia espinali* is a small, semifossorial snake found at intermediate elevations from northwestern Honduras southward to southwestern Honduras; it is also known to occur in extreme northwestern El Salvador. Named for the Honduran biologist Mario R. Espinal, a single specimen





KEVIN M. ENGE

in distribution to Cusuco National Park. This species demonstrates a high degree of sexual dimorphism with respect to its color pattern; males are typically dark gray, whereas females are mottled orange, red, yellow, and brown. *Cryptotriton nasalis* is endemic to moderate and intermediate elevations of northwestern Honduras, and it is known from localities outside of Cusuco National Park in the Sierra de Omoa. These tiny salamanders derive their name from their large nostrils, which can approach the size of their eyes. In the dwarf forest, this species is found inside bromeliads. Only one species of frog is known to occur in the dwarf forest, the recently described bromeliad-dwelling “*Hyla*” *melacaena*. This species is endemic to the Sierra de Omoa. An adult female was discovered as it hopped from a bromeliad as a field crew brushed past, and these frogs are suspected to breed in the water-filled axils of arboreal bromeliads.

Although the known herpetofauna of the Cusuco dwarf forests is extremely limited, it is also quite significant, inasmuch as five of nine species of amphibians and reptiles are endemic to Honduras (*Anolis amplisquamosus*, *A. johnmeyeri*, *Bolitoglossa diaphora*, *Cryptotriton nasalis*, and “*Hyla*” *melacaena*) and another species (*Ninia spinali*) is a near-endemic, having been otherwise found only in extreme northwestern El Salvador. These nine species represent 18.0% of the 50 species known to inhabit Cusuco National Park. That such territorially limited yet inter-



BROOKE L. TALLEY

The Alligator Lizard *Mesaspis moreletii* gives birth to live young rather than laying eggs, a hallmark of lizards that are adapted for life at high elevations.



BROOKE L. TALLEY

of *N. spinali* was collected by Mario near the peak of Cerro Jilincó. *Cerrophidion godmani* is a pitviper distributed at occasionally moderate to high elevations in disjunct populations in Oaxaca and Chiapas, México, Guatemala, El Salvador, Honduras, northern Nicaragua, central Costa Rica, and western Panamá. This species is another that is typical of cloud forest habitats throughout its range, and can be locally abundant in areas where it is not persecuted by humans.

Two salamanders have been recorded in the Cusuco dwarf forest, *Bolitoglossa diaphora* and *Cryptotriton nasalis*, both plethodontids. *Bolitoglossa diaphora* is endemic to intermediate elevations in northwestern Honduras and is another species restricted



KENNETH L. KRYSKO

*Anolis (Norops) amplisquamosus* is one of many species that are endemic to Cusuco National Park.



JOSHUA H. TOWNSEND



KEVIN M. BIGE

*Anolis (Norops) johnmeyeri* is a large anole that is unusual in that both males and females have large dewlaps with a blue central spot; males (top) have the blue spot surrounded by red and in females it is surrounded by yellow (bottom).



DAN FOPHUS



JOSIAH H. TOMLINSON

The Emerald Swift (*Sceloporus schmidti*) is a common cloud forest inhabitant throughout its range, and can be found in open areas that receive the most exposure to sunlight.



JOSEPH H. TOWNSEND

The colubrid *Ninia espinali* is a small, semifossorial snake found at intermediate elevations.



JOSEPH H. TOWNSEND



KEVIN M. ENGE

The Pitviper *Cerrophidion godmani* is another species that is typical of cloud forest habitats throughout its range, and can be locally abundant in areas where it is not persecuted by humans. The right-hand photo is a juvenile.

esting habitat contains an equally limited yet interesting herpetofauna is fitting. What other secrets might be hidden in the wind-swept, cloud-drenched world at the top of the Sierra de Omoa? Only further exploration of Cusuco's dwarf forests can provide any semblance of an answer to this question — but we can say with certainty that the dwarf forest is one of the most fascinating and endearing places in which we have had the privilege of working; a magical little world shrouded in clouds and mystery.

#### Acknowledgments

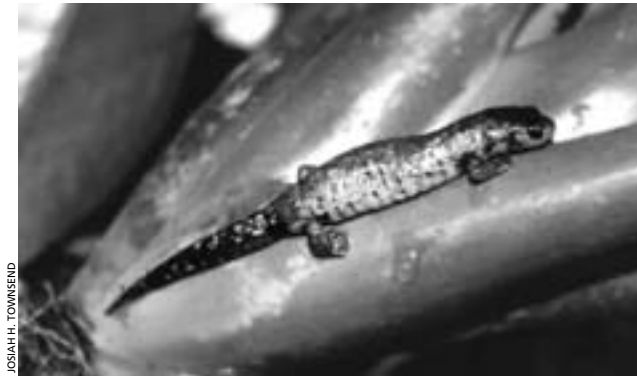
Makrín Ramírez, René Alvarenga, Danílo Alvarenga, Roger Alvarenga, Mino Cortés, Marina Alvarenga, Brooke L. Talley, T. Lynette Plenderleith, Dougie C. Fraser, Sara M. Hughes, Dan Pupius, Zia Lewindson, Kenney L. Krysko, and Kevin M. Enge

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JOSEPH H. TOWNSEND



KENNETH L. KRYSKO

*Bolitoglossa diaphora* demonstrates a high degree of sexual dimorphism in color pattern; males are typically dark gray, whereas females are mottled orange, red, yellow, and brown.



BROOKE L. TALLEY

Tiny *Cryptotriton nasalis* derive their name from their large nostrils, which can approach the size of their eyes.

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DAN PURBUS

The recently described bromeliad-dwelling frog "*Hyla melacaena*" is the only species of frog known to occur in the dwarf forest. This species is endemic to the Sierra de Omoa. This adult female was discovered as it hopped from a bromeliad as a field crew brushed past, and this species is suspected to breed in the water-filled axils of arboreal bromeliads.



MARK DE SILVA

Relationships among West Indian skinks (*Mabuza* sp.) are poorly understood, and two or more species might occur in the Lesser Antilles. Skinks may always have been rare on St. Vincent, but diurnally active, ground-dwelling lizards are vulnerable to predation by mongooses. This lizard was photographed in the mongoose-free Grenadines, where the species is more abundant.

# An Annotated Checklist of the Amphibians and Reptiles of St. Vincent, West Indies

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## A Note on Conservation

Many of the world's species of reptiles and amphibians are threatened with extinction. Although most species discussed here remain abundant on St. Vincent, many conservation issues need to be addressed. The chytrid fungus is decimating frog populations throughout Central America, and at least some of the amphibians on St. Vincent would be susceptible to this epidemic, if it were to reach the island. Also, snakes on St. Vincent are routinely killed by local people who believe they are dangerous.

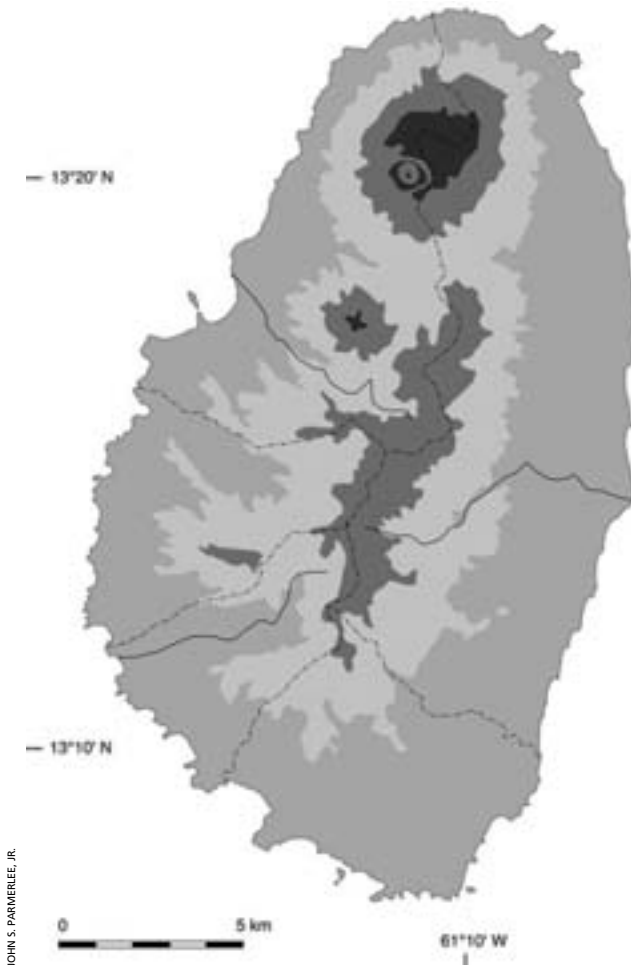
Finally, while the introduction of *Anolis sagrei* onto St. Vincent does not appear detrimental to the native species at this time, other invasions, such as that of the mongoose (*Herpestes javanicus*) have had dire consequences. Public education is the most important preventative measure against these problems: Travelers need to be taught about chytrid and how to avoid transporting it to uninfected areas; local people need to learn that all St. Vincentian snakes are harmless; and everyone needs to learn about the problems that almost invariably accompany invasive species, and how to prevent and minimize invasions.

*"In the end we will conserve only what we love; we will love only what we understand; and we will understand only what we are taught."*

Baba Dioum, 1968

## Frogs (Amphibia: Anura)

*Bufo marinus* (Linnaeus 1758). Anura: Bufonidae. Cane Toad (Marine Toad). Probably introduced. This large toad (maximum female SVL = 225 mm) is the only toad on St. Vincent. It has a brown dorsum and "warts" all over its body. It was probably introduced intentionally to control insect populations in sugarcane plantations, but it could have arrived as a natural migrant from the mainland. These toads have been introduced throughout tropical regions of the world, and have become pests and



JOHN S. PARMERLEE, JR.

St. Vincent (29 x 18 km, 344 km<sup>2</sup>) is one of the volcanic Windward Islands of the Lesser Antilles.



JOHN S. PARMERLEE, JR.

The Cane Toad (*Bufo marinus*) was probably introduced intentionally on St. Vincent to control insect populations in agricultural fields.

major threats to native frogs, with which they compete and on which they feed. *Bufo marinus* is found throughout the St. Vincentian lowlands in a wide variety of habitats that include urban situations and various moist to dry low-elevation forests. This species is a generalist predator, feeding on nearly any animal it can fit in its mouth. During daylight hours they are commonly found under cover, but at night they can be seen in the open, along or on roads and under streetlights, foraging and calling. All toads secrete toxins from skin glands, especially the parotoid glands on the backs of their heads, and persons handling *B. marinus* should wash their hands thoroughly to mitigate the chance of adverse reactions.

*Eleutherodactylus johnstonei* (Barbour 1917). Anura: Leptodactylidae. Johnstone's Frog (Lesser Antillean Frog). Introduced. These small frogs (maximum female SVL = 35 mm) have become established on many West Indian islands (and elsewhere), largely as a consequence of human-mediated transport. Dorsal coloration is generally some shade of brown, but other markings are highly variable. While generally occurring in mesic forests, *E. johnstonei* can be heard calling (a high-pitched whistle) throughout the night even in urban areas. During a three-week stay in June 2006, we were never out of earshot of calling males. These frogs are most abundant in the lowlands, although they reach the island's highest elevations, where they may pose a threat to endemic *E. shrevei*, which are absent from the lowlands (although we cannot say with any certainty whether or not *E. johnstonei* is responsible for their absence).

*Eleutherodactylus shrevei* (Schwartz 1967). Anura: Leptodactylidae. Saint Vincent Frog. Endemic. These small frogs (maximum female SVL = 40.1 mm; male = 28 mm) are morphologically similar to *E. johnstonei*, from which they can be readily distinguished by the presence of bright red color on the thighs and often on the belly. These frogs are generally found at higher elevations (> 300 m) and are abundant on the highest peaks (~980 m), even at the rim of La Soufrière, a volcano active as recently as 1979. Above the elevations where *E. johnstonei* is common, *E. shrevei* is nearly ubiquitous. It is primarily crepuscular and may be heard calling at dusk and into the early night. The call is comprised of short, loud clicks. Although the range



ROBERT POWELL



ALONDRA DIAZ

Introduced Lesser Antillean Frogs (*Eleutherodactylus johnstonei*) are ubiquitous in the lowlands, although they reach the island's highest elevations, where they may pose a threat to endemic *E. shrevei*. During a three-week stay in June 2006, we were never out of earshot of calling males.





ROBERT POWELL

Saint Vincent Frogs (*Eleutherodactylus shrevei*) may be particularly vulnerable to the chytrid fungus, if it becomes established on St. Vincent.



ROBERT POWELL

Windward Ditch Frogs (*Leptodactylus validus*) are endemic to the Lesser Antilles, where they occur on the Grenada and St. Vincent island banks.

of *E. shrevei* prior to the introduction of *E. johnstonei* is unknown, *E. shrevei* may be restricted to higher elevations by anthropocentric habitat alterations combined with competition from the more fecund, invasive *E. johnstonei*. This species, found nowhere else, may be particularly vulnerable to the chytrid fungus, if it arrives on St. Vincent.

*Leptodactylus validus* (Garman 1888). Anura: Leptodactylidae. Windward Ditch Frog. Native. This moderately sized frog (maximum female SVL = 51.5 mm; male = 42.9 mm) was recently

separated from the more widely distributed *L. wagneri* and is endemic to the Lesser Antilles, where it occurs on the Grenada and St. Vincent island banks. Considerably larger than the other anuran species on the island, it is easily distinguished from both species of *Eleutherodactylus* by the lack of expanded toe-tips. *Leptodactylus validus* is gray to brown with variable markings, and usually has a distinct fold of skin on either side of its back. As the common name suggests, these frogs often are associated with ditches (and small streams) throughout the lowlands, but its islandwide distribution is not well known.

#### Lizards (Reptilia: Squamata)

*Ameiva ameiva* (Linnaeus 1758). Squamata: Teiidae. Neotropical Ground Lizard. Origin unknown. The origin of these relatively large lizards (maximum male SVL = 149 mm; female = 141 mm) on St. Vincent is uncertain. They are native to the Grenada Bank (which includes the Grenadines) and much of the Neotropical mainland. They are habitat generalists throughout the range, with a strong preference for open areas, where they exploit abundant sunlight to maintain high body temperatures during active periods. *Ameiva ameiva* is known from only two sites on St. Vincent (Barrouallie on the leeward side of the island and Georgetown on the windward coast). The history of populations on the island is unclear, with the unusual distribution a possible consequence of extirpation from other lowland habitats (possibly attributable to mongoose predation) or the result of separate introductions, probably from one of the Grenadine islands, where the species is abundant.



MARK DE SILVA



ROBERT POWELL



JOHN S. PARMERLEE, JR.



JOHN S. PARMERLEE, JR.



DAVID STENBERG



JOHN S. PARMERLEE, JR.

Neotropical Ground Lizards (*Ameiva ameiva*) are known from only two sites on St. Vincent (Barrouallie on the leeward side of the island and Georgetown on the windward coast). The unusual distribution is a possible consequence of extirpation from other lowland habitats (possibly attributable to mongoose predation) or the result of separate introductions.

*Anolis griseus* (Garman 1888). Squamata: Polychrotidae. Saint Vincent Tree Anole. Endemic. These large anoles (maximum male SVL = 136 mm; female = 86 mm) are primarily arboreal and observed 2–8 m above the ground, with females and juveniles slightly lower than males. *Anolis griseus* is widely distributed throughout the island, but rare or absent where vegetation is sparse. Although habitats used by *A. griseus* overlap somewhat with those of the other native anole, *A. trinitatus*, it can be distinguished by its larger size. It is usually some shade of gray or gray-brown with a mottled dorsum and green or yellow tinges sometimes present on the limbs and face. The dewlap is dirty

white or light gray. The diet of *A. griseus* is highly variable, and includes berries, small invertebrates, and occasionally smaller anoles.

The diet of *A. griseus* is highly variable, and includes berries, small arthropods, and occasionally *A. trinitatus*.

*Anolis sagrei* (Dumeril and Bibron 1837). Squamata: Polychrotidae. Cuban Brown Anole. Introduced. These moderately sized anoles (maximum male SVL = 70 mm; female = 46 mm) are the only brown anole on St. Vincent (although *A. trinitatus* is dichromatic and occasionally may be brown). They have stocky bodies, and a diamond or mottled dorsal pattern is usually present. Dewlaps are a deep brick red. First documented on St. Vincent in 2005, *A. sagrei* was presumably introduced within

the previous two or three years with shipments of building materials from Florida, where it is well-established. Populations occur near the docks in Kingstown and Campden Park and in the Montrose neighborhood, where they presumably arrived with construction materials. All of these sites consist of dramatically disturbed, open habitats with sparse, generally low vegetation and rubble, which these lizards readily exploit. *Anolis sagrei* does occur with the similarly sized *A. trinitatus* in many of these areas,



ALEJANDRO SÁNCHEZ



CHRISTOPHER MALLERY

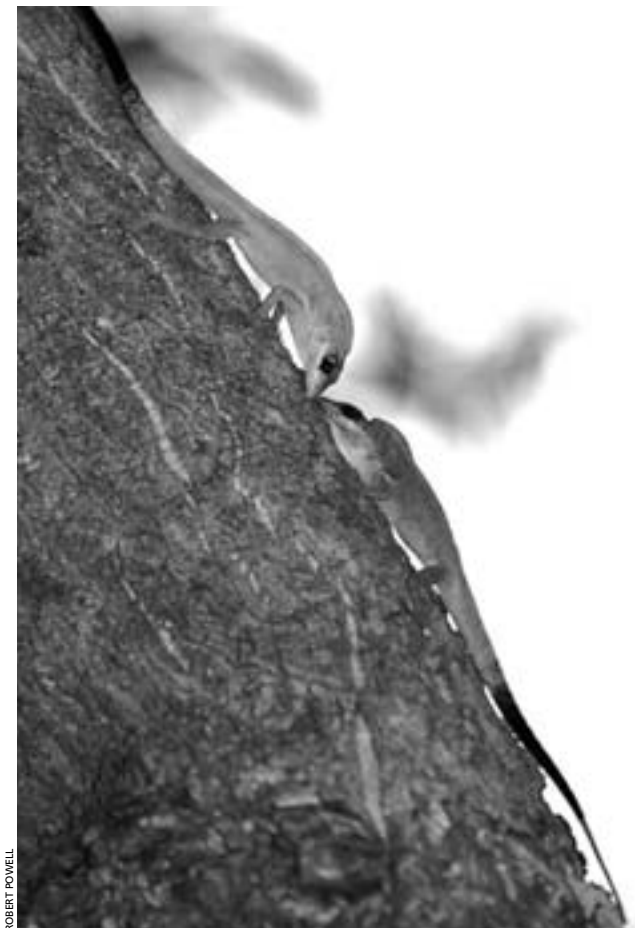
Recently introduced Cuban Brown Anoles (*Anolis sagrei*) currently are restricted to dramatically disturbed, open habitats with sparse, generally low vegetation and rubble.



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Male Saint Vincent Bush Anoles (*Anolis trinitatus*) are intensely territorial. The male (middle) responds to an intruder before the resident and intruder face-off (bottom).

but the presence of *A. sagrei* has had little observable effect on native species to date, although *A. trinitatus* may be forced to use higher perches in the presence of *A. sagrei* (similar to the effects on *A. carolinensis* in the southeastern United States). Long-term effects of the invasion of *A. sagrei* are not yet clear.

*Anolis trinitatus* (Reinhardt and Lütken 1863). Squamata: Polychrotidae. Saint Vincent Bush Anole. Endemic. These moderately sized anoles (maximum male SVL = 74 mm; females = 57 mm) are nearly ubiquitous throughout St. Vincent, found in all but the most heavily disturbed, sparsely vegetated habitats. Populations have become established on Trinidad, primarily in suburban or urban gardens and similar artificial habitats. Perches range from ground level to 2 m, with males often perching higher than females and juveniles. Coloration varies from bright green to yellowish green, or even blue with occasional grayish mottling. Dewlaps are usually yellow, but individuals at some locations have white dewlaps. These anoles primarily consume a variety of small invertebrates, often including a large number of ants.

*Gymnophthalmus underwoodi* (Grant 1958) Squamata: Gymnophthalmidae. Smooth-scaled Worm Lizard. Presumably native. These small, ground-dwelling lizards (maximum SVL = 43 mm) have smooth scales and are some shade of brown or grayish brown. They seem to prefer relatively dry, open habitats where they forage for small invertebrates in leaf litter. This is an all-female species, with eggs developing without fertilization (parthenogenesis). This reproductive mode can facilitate colonization of new areas, as only one individual is necessary to establish a population. Populations occur on the Neotropical mainland and are known from a number of Lesser Antillean islands. Although some of the latter are undoubtedly attributable to human-mediated transport, others may have been established as a consequence of natural over-water dispersal, presumably on flotsam. These lizards are abundant in suitable habitats throughout the island.

*Hemidactylus mabouia* (Moreau de Jonnés 1818). Squamata: Gekkonidae. Cosmopolitan House Gecko. Origin unknown, populations may represent a combination of animals that arrived naturally via over-water dispersal or human-mediated transport. These moderately sized geckos (maximum male SVL = 68 mm) function as human commensals, and are essentially ubiquitous in buildings and other artificial structures, including piles of debris. Because of their close association with humans, populations occur throughout the tropics as individuals accompany humans and their cargos. Ancestors of House Geckos originated in Africa; American populations range throughout the Neotropical mainland and the West Indies, and the species has become established in Florida and other regions. These nocturnal geckos feed on insects, and often forage around artificial lights (the "night-light niche"). The only species on St. Vincent with which *H. mabouia* might be confused is *Thecadactylus rapicauda*, which is much larger and generally lives in forested habitats.

*Iguana iguana* (Linnaeus 1758). Squamata: Iguanidae. Green Iguana (Common Iguana). Native. These large lizards (maximum SVL = 500 mm) are found in varied habitats that include





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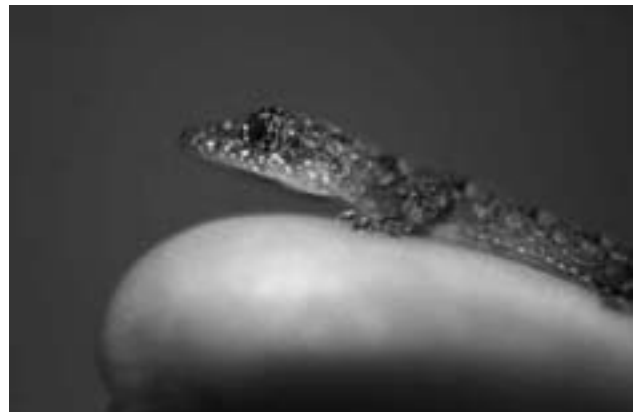
Smooth-scaled Worm Lizards (*Gymnophthalmus underwoodi*) are all females. Eggs develop without fertilization (parthenogenesis). This reproductive mode can facilitate colonization of new areas, as only one individual is necessary to establish a population.

xeric lowlands and mesic highlands, but their distribution is not well documented on St. Vincent. Where present, iguanas usually are found along forest edges that provide ready access to sunlight. Although commonly called “Green” Iguanas, these lizards are quite variable in color, ranging from bright green to grayish brown or brownish orange, often with dark transverse stripes or bars. Iguanas have large dorsal crests, and a dewlap that is typically green, but sometimes red or orange, or green with black streaks. Green Iguanas are hunted for food on St. Vincent, and a defined season exists. The apparently localized concentrations of animals may reflect differential hunting pressure.

*Mabuya* sp. Squamata: Scincidae. Lesser Antillean Skink (Slipperyback). Presumably native. Relationships among West Indian skinks are poorly understood, and two or more species might occur in the Lesser Antilles. Until genetic studies are available to clarify the status of populations on different islands, assignments to species are at best tentative. These moderately sized lizards (maximum SVL ~ 175 mm) have smooth, shiny scales, which are associated with small bones embedded in the skin. Primary ground color is brown. Little is known about St. Vincentian populations, but skinks are generally associated with leaf litter and assorted debris, but also may be found along rock



MARK DE SILVA



ROBERT POWELL

Cosmopolitan House Geckos (*Hemidactylus mabouia*) function as human commensals. Because of this close association with humans, populations occur throughout the tropics as individuals accompany humans and their goods.

walls and buildings. These lizards eat insects and other small arthropods. Their apparent rarity on St. Vincent may be a natural phenomenon, but diurnally active, ground-dwelling lizards are vulnerable to predation by mongooses, which have apparently caused the extirpation of some insular populations.



CARLOS RODRIGUEZ



MARK DE SILVA

Green Iguanas (*Iguana iguana*) usually occur along forest edges that provide ready access to sunlight. These lizards are hunted for food on St. Vincent, and a defined season exists. The apparently localized concentrations of animals may reflect differential hunting pressure.

*Sphaerodactylus vincenti* (Boulenger 1891). Squamata: Gekkonidae. Windward Dwarf Gecko. Native. These small geckos (maximum SVL = 40 mm) are locally abundant in leaf litter habitats that are generally moister than those occupied by *Gymnophthalmus underwoodi*. Primarily active by day, these diminutive predators feed on a variety of small invertebrates. Windward Dwarf Geckos have a brown dorsum, sometimes with a reddish cast and often with dark flecks. The venter is pale gray to purple. Light-blue rings often surround the eyes.

*Thecadactylus rapicauda* (Houttuyn 1782). Squamata: Gekkonidae. Turnip-tailed Gecko. Native. These large geckos (maximum SVL = 121 mm) acquired their common name because regenerated tails resemble turnips. They occupy diverse habitats ranging from dry and mesic forests and plantations to urban situations, although they are much less abundant in the latter than *Hemidactylus mabouia*. A mottled gray dorsum provides excellent camouflage against the lichens found on many forest trees. Although sometimes encountered by day, when they may emerge from refuges to bask, like most geckos, they are primarily active at night, when they forage for insects.

#### Snakes (Reptilia: Squamata)

*Chironius vincenti* (Boulenger 1891). Squamata: Colubridae. Saint Vincent Racer. Endemic. Little is known about these long, slender snakes (maximum SVL = 1070 mm). They appear to be associated primarily with rainforest habitats at moderate elevations (> 135 m), and are presumably semi-arboreal, which may provide some protection from predation by mongooses, which do not climb well. These snakes forage by day and presumably prey primarily on frogs and their eggs. This species is readily distinguished from others on the island by their uniform, slate black dorsum and a pale, dirty yellow venter. These snakes are rarely seen and may always have been rare, although predation by mongooses and habitat alteration may be responsible for their apparent scarcity.

*Corallus cookii* (Gray 1842). Squamata: Boidae. Saint Vincent Treeboa. Endemic. These arboreal snakes (maximum SVL = 1374 mm) are active at night and rarely seen during the day. A



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Windward Dwarf Geckos (*Sphaerodactylus vincenti*) are locally abundant in leaf litter habitats that are generally moister than those occupied by *Gymnophthalmus underwoodi*.



ROBERT POWELL



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The mottled gray dorsum of Turnip-tailed Geckos (*Thecadactylus rapicauda*) provides excellent camouflage against the lichens found on many forest trees.

bright red reflection is elicited from their eyes when caught in a beam of light at night. Dorsal ground color is variable, but generally ranges from reddish in juveniles, to taupe, gray, or dark brown in adults. An hourglass-shaped pattern is evident in nearly all individuals. The diet of small *C. cookii* consists almost exclusively of anoles, with larger snakes shifting to rodents. These snakes remain widely distributed in lowlands and to elevations of about 450 m. Treeboas appear to have adjusted remarkably well to many human-mediated habitat alterations, and are very common in suburban gardens. One essential habitat feature is that tree canopies be contiguous.

*Mastigodryas bruesi* (Barbour 1914). Squamata: Colubridae. Windward Racer. Native. These long, slender snakes (maximum



AMOS GLASGOW, SVG FORESTRY DEPARTMENT

Saint Vincent Racers (*Chironius vincenti*) are rarely seen and may always have been rare, although predation by mongooses and habitat alteration may be responsible for their apparent scarcity. This is the first published photograph of a live animal.

SVL = 830 mm) are semi-arboreal, and generally are found in relatively dry habitats, which include forests and plantations. They are not infrequently encountered in gardens and other urban/suburban situations. Active by day, these snakes eat frogs and lizards, and sleep at night in trees and bushes to heights of about 5 m. The dorsal ground color is generally bluish-gray to brown, with light lateral stripes and dark eyelines. Ventral color is much lighter, but varies from white to dirty yellow. Their arboreal tendencies may protect these harmless snakes to some extent from mongoose predation, to which they are nevertheless vulnerable due to their diurnal activity.

#### Turtle (Reptilia: Chelonia)

*Geochelone carbonaria* (Spix 1824). Testudines: Testudinidae. Red-footed Tortoise. Origin unknown, populations may represent a mixture of animals that trace their ancestry to individuals arriving via natural over-water dispersal, human-mediated transport by Amerindians or early European colonists, and recently escaped or released pets. Tortoises are exploited for food and for the pet trade throughout much of their native range, which encompasses large portions of northern South America and many Lesser Antillean islands. These turtles (maximum shell length = 512 mm) are diurnal, and generally inhabit forests, although they may venture into adjacent grasslands. Their high-domed shells are characteristic of terrestrial turtles (they seem to deter many predators and also serve to reduce surface areas through which moisture is lost to the environment). Front limbs are powerful, spade-like, and capable of digging extensive burrows. Hindlimbs are columnar. Males have indented lower shells to facilitate mating. Red-footed Tortoises feed on a wide variety of plant matter, insects or other small invertebrates, and carrion. Even on islands where tortoises are common, they are rarely encountered, rendering the determination of their abundance difficult.

#### Acknowledgments

Students and faculty of the 2006 Avila University REU Program helped in the field and shared insights and data. Robert Powell and Robert W. Henderson commented on earlier versions of the



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Saint Vincent Treeboas (*Corallus cookii*) remain widely distributed in lowlands and to elevations of about 450 m. They appear to have adjusted remarkably well to many human-mediated habitat alterations.

manuscript. Permits to conduct research on St. Vincent were issued by the Department of Forestry, St. Vincent and the Grenadines. Brian Johnson, Director, Department of Forestry, Cornelius Richards, Amos Glasgow, and especially FitzGerald Providence facilitated our efforts. Fieldwork was funded by a grant from the National Science Foundation (U.S.A.) to Robert Powell (DBI-0242589).

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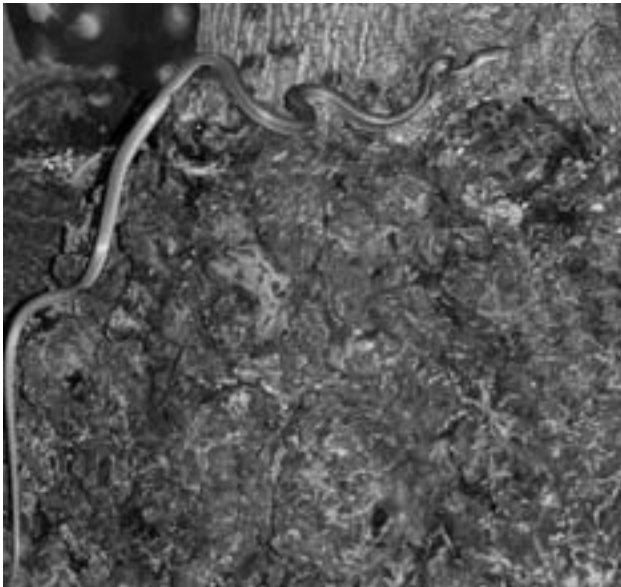
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The arboreal tendencies of Windward Racers (*Mastigodryas bruesi*) may protect these harmless snakes to at least some extent from mongoose predation.



MARK DE SILVA



ROBERT POWELL

Lesser Antillean populations of Red-footed Tortoises (*Geochelone carbonaria*) may represent a mixture of animals that trace their ancestry to individuals arriving via natural over-water dispersal, human-mediated transport by Amerindians or early European colonists, and recently escaped or released pets. The individual in the lower photograph is a hatchling.

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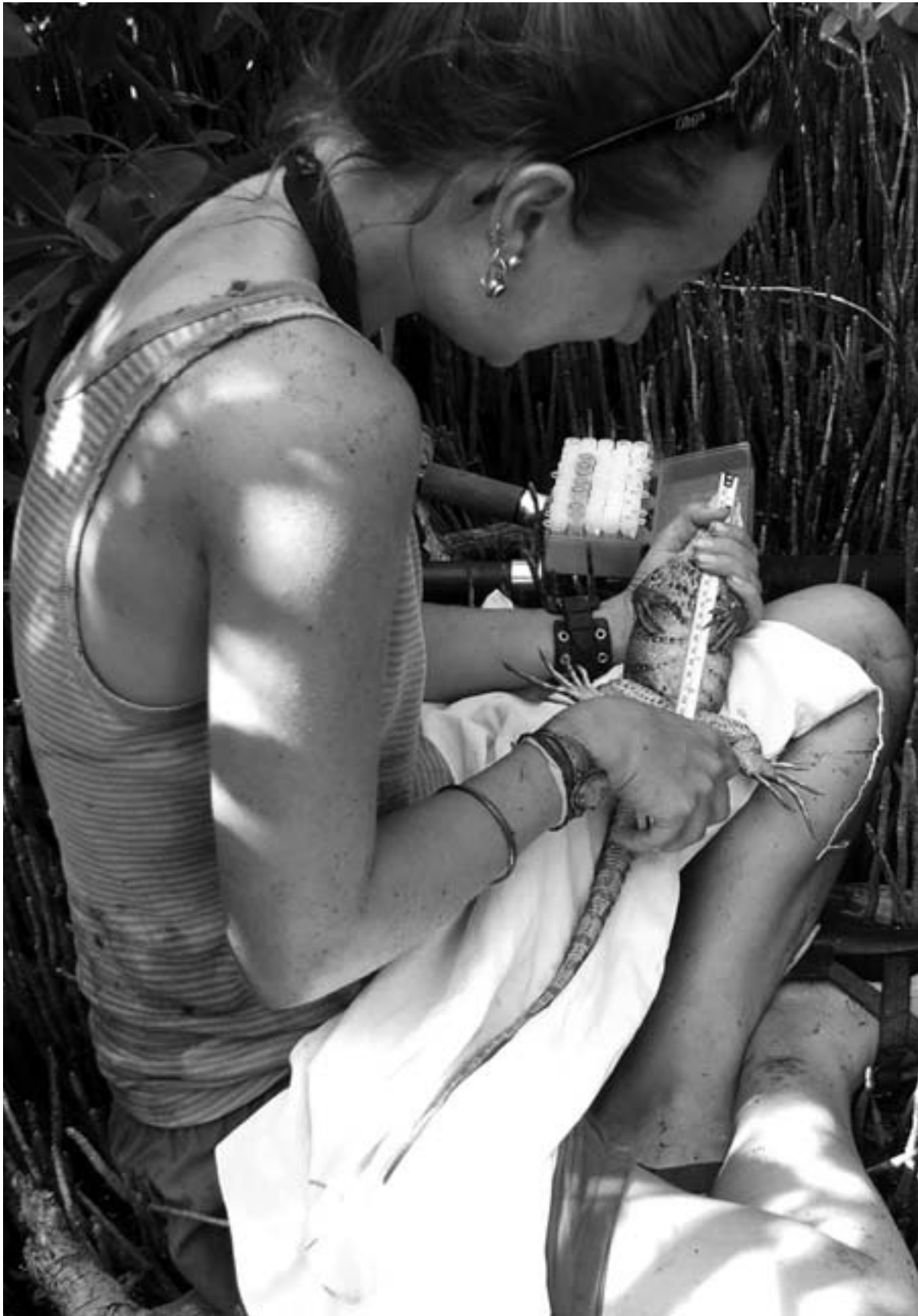
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DENNIS BAULECHNER

The author processing a crocodile in the mangrove swamp on Utila.

# Ctenosaurs of Honduras: Notes from the Field

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Photographs by the author except where noted.

Mesoamerica is one of the most biologically diverse areas in the world. Iguanid lizards comprise a conspicuous component of this diversity, largely due to the species-rich genus, *Ctenosaura*. This genus encompasses 17 distinct species (more than twice as many as the second most diverse genus, *Cyclura*). These lizards are threatened with extinction by habitat destruction and fragmentation, over-harvesting, pollution, and exportation for an illegal pet trade (four of the five largest threats to biodiversity). In 2004, ten species in this genus were Red-listed by the IUCN. Four of five species listed as critically endangered form the *Ctenosaura melanosterna* clade. In order to address the high degree of intra-generic diversity, gain an understanding of the threats faced by these critically endangered species, and aid in their protection, I plan to do a multi-scale molecular evaluation of the clade and its wide-ranging and sympatric congener, *C. similis*.

One principal goal of my research is the construction of a molecular phylogeny of the *Ctenosaura melanosterna* clade, which occurs along the Caribbean versant of Honduras and Guatemala and on the Honduran Bay Islands. When added to recent studies of the southern sister clade, the *C. quinquecarinata* complex, this work will complete the phylogenetic analysis of ctenosaurs in southern nuclear Mesoamerica.

A second component of this project will address the threat that habitat destruction poses to *Ctenosaura bakeri*, endemic to



Destruction of what had been a mangrove stand southeast of the canal on Utila.



DENNIS BAULECHNER

The author (left) and Hadas Grushka, a volunteer from Israel, noosing ctenosaurs from an incomplete foundation.

the Bay Island of Utila, by evaluating the degree and direction of genetic introgression with *C. similis*. These hybridization events may result from a novel overlap in the ecological distributions of these species that resulted from habitat destruction. A detailed management plan will recommend methods of preserving the genetic integrity of *C. bakeri*.

The third portion of this investigation concerns the colonization by *Ctenosaura bakeri*, *C. similis*, *C. melanosterna*, and *C. oedirhina* of the Bay Islands, Cayos Cochinos, and various islets in the Caribbean Sea bordering Honduras. This will allow for insight into evolutionary rates and patterns within this clade. Additionally, due to ecological and hybridization threats that *C. similis* poses to *C. bakeri*, dating the arrival of the former on Utila will be necessary to determine if it is an invasive species.

During the spring and summer of 2006, I spent six months collecting data on *Ctenosaura melanosterna*, *C. bakeri*, *C. oedirhina*, and *C. similis* populations throughout their respective ranges in Honduras. The goal of this preliminary report is to discuss the success of collecting DNA samples and the current status of the populations of these species. Later reports will discuss my molecular findings.

## Southern Honduras (March)

Department of Choluteca.—Along the main highway, we encountered children selling *C. similis* and *Iguana iguana* and

were able to obtain tissue samples from four *C. similis*. These children told us that, in an effort to be sustainable, they only catch males. We could not confirm that contention, but I see no reason for them to lie, since hunting iguanas at all is illegal. In an area locally called La Bonanza, we again encountered children selling *C. similis* and *I. iguana*. We obtained tissue samples from three more *C. similis*, before traveling north along a dirt road toward the town of El Triunfo, where we caught a juvenile ctenosaur. Given the locality, this should have been *C. similis*, however, it looked strikingly like *C. flavidorsalis*. A genetic sample and subsequent molecular analysis should resolve this mystery. Inspired by a photo of what looked like *C. quinquecarinata* from this area (sent to me by Dr. Thomas Akre), I asked locals about this possibility. Apparently, *C. quinquecarinata* did and may still occur in this area, although we found no individuals.

Department of Valle.—In an area known as San Juan Pali, we encountered a man carrying a bag of ctenosaurs. We obtained tissue samples from four *C. similis*, but were unable to determine the sex of these individuals due to their condition. Locals at Playa Blanca helped us catch two additional lizards, one of which appeared to have been poisoned, a local technique for ridding gardens of iguanas. In San Pablo we hired a boat to take us to Isla del Tigre and Isla Expositon. Although we saw many *C. similis* on Isla del Tigre, we were unable to catch any. Our visit to Isla Expositon proved more successful. Aided by four local teenagers, we caught three male *C. similis*. Apparently, all of the sizable islands in the Golfo de Fronseco support ctenosaurs.

Hunting pressures on ctenosaurs in these southern departments are intense. Hunters have little fear of being caught. Additional molecular work from this area is desperately needed to determine if the *C. similis* in the area represent a unique gene pool. Intense field and molecular work also are needed to determine if either *C. flavidorsalis* or *C. quinquecarinata* are present.

#### Northern Honduras

Department of Cortez (July).—Locals in San Pedro Sula told us that ctenosaurs are not sold in markets due to the presence of law enforcement. We did, however, encounter both *I. iguana* and *C. similis* being sold along the highway north of the city. We obtained a tissue sample from one adult female *C. similis*. In Puerto Cortez, we searched for ctenosaurs in areas where they are normally sold, only to be told that it was the wrong season. However, one roadside “store” had “iguana” meat for sale. We could not determine what type of iguana this was due to its condition. Traveling west along the coast toward Omoa, we encountered many *C. similis*, but were able to obtain tissue from only one individual. In the small Garifuna village of Travesia, locals told us that they normally have many iguanas for sale, but it was not the right season for hunting iguanas.

Department of Atlantida (June and July).—In the towns of Miami and Tornabe, we obtained tissue from seven *C. similis*. Along the road from Tornabe to Miami and in the village of Miami, we saw many hatchlings, indicating that this is a very stable population, despite the presence of local hunters. In



*Ctenosaura oedirhina* from Barbareta, Roatan.



*Ctenosaura oedirhina* from along the Mangrove Canal on Roatan.

Miami, a grove of large Red Mangroves (*Rhizophora mangle*) provides habitat for many adult *C. similis*.

We hired a small boat to take us into the Punta Sal National Park, where we visited the areas of Puerto Carib and Cocolito. We caught seven hatchlings in Puerto Carib and six more in Cocolito. Additional molecular work is needed, but the population in the park seems to be reproducing well. The lack of encounters with adults was probably attributable to the very dense vegetation, although we cannot rule out hunting pressure.

Department of Colon (July).—Our time here was split between the coastal regions, where *C. similis* occurs, and the Valle de Aguan, where both *C. melanosterna* and *C. similis* occur. We obtained eight *C. similis* tissue samples from Sambo Creek, between La Ceiba and Trujillo. We stopped in many different towns and asked about ctenosaurs in markets, but were told each time that selling iguanas is illegal. *Ctenosaura similis* appears to be thriving in the gated area at Puerto Castillo. Guards, most likely representing the Standard Fruit Company, apparently provide protection for the ctenosaurs in this area. We easily caught three individuals. We then entered the Naval Base, where *C. similis* was similarly abundant, although catching them was impossible. My impression was that they are harassed but not hunted.

Along the road from Puerto Castillo and around Casa Kiwi, we found a good number of juvenile *C. similis*, the latter

a result of protection provided by the New Zealand owners. We asked to collect tissue samples, but were told that no iguana could be harmed for any reason. Although disappointing for our study, such an attitude should help preserve *C. similis* in the area. We acquired two tissue samples west of Trujillo, one subadult female in the town of San Antonio and one sample retrieved from the tail of a *C. similis*, lost as it escaped into a hole.

*Ctenosaura similis* appears to be much less threatened in these northern coastal areas than in the south. Northern populations seem to be reproducing at good rates, and individual property owners seem to be taking an active interest in their preservation. However, illegal hunting does occur, but populations seem to be handling this threat.

In the Valle de Aguan, we acquired genetic samples from eight *C. melanosterna* and seven *C. similis*. Four *C. melanosterna* (two juveniles and two hatchlings) and six hatchling *C. similis* were captured north of the Río Aguan in an area known as Agua Caliente, and four additional *C. melanosterna* (three sub-adult males and one hatchling) and one hatchling *C. similis* were captured south of the river in the area around Arenal. The situation in this area is dire. Hunting pressure is greater than I have seen anywhere else, with the possible exception of southern Honduras. The threat is aggravated by the fact that this is the only continental area where *C. melanosterna* occurs. I did not see a single adult *C. melanosterna* and saw very few hatchlings. Hatchling *C. similis* were abundant, and the timing was such that hatchling *C. melanosterna* should also have been prominent — if they are indeed breeding. Given the reduced range of *C. melanosterna* and the anthropogenic factors involved, this population could be extirpated within a few years if action is not taken immediately. The Honduran government in past years was working on a reserve for endemic species. This effort, headed by Paul House, was to include a breeding program for *C. melanosterna*. This project is no longer funded and is at a standstill. The only alternative is a coordinated effort by international organizations and the COHDEFOR office in Olanchito, which recently has established a protected area in the Valle de Aguan, and is in the process of building a visitor/research center on site. At present, guards watch over this area, and I strongly recommend that a breeding program be implemented within that reserve.

#### Cayos Cochinos (June)

The Cayos Cochinos Archipelago is protected by the Honduran Coral Reef Foundation (HCRF), which has set up a National Marine Reserve that encompasses all of the islands in the archipelago. We spent approximately one week on both Cayo Pequeno and Cayo Grande, the only islands of the archipelago where ctenosaurs are found. Although both islands are technically protected under Honduran law, Cayo Pequeno has increased protection due to the presence of a research station, founded by the HCRF. This allows *C. melanosterna* to thrive, because both hunting and habitat destruction have stopped. We caught eleven individuals from this island. Cayo Pequeno is extremely small and has no obvious physical barriers, so I consider animals from the entire island as one population. Work on Cayo Grande proved to be much more difficult. Lizards were very skittish and the island itself is much larger. We nevertheless caught nine animals, all from one area. Based on the lizards'



behavior and the absence of large individuals, we concluded that *C. melanosterna* probably is being hunted regularly on Cayo Grande by the Garifuna people living on this island. Locals who helped us came equipped with dogs and slingshots, tools typical of mainland iguana hunters. Mainland Hondurans also may hunt on the island and return to the mainland to sell their catch, as the *C. melanosterna* on the island are much easier to catch than *C. similis* on the mainland.

#### Isla de Roatan (June)

We caught 25 *C. oedirhina* at six sites that were spread fairly evenly throughout the island. Five individuals were caught from the West Bay area. This area is the site of ongoing development, where clearing in the past has opened up a rocky area in which ctenosaurs seem to thrive. We saw no physical evidence of hunting in this area, although a local, intrigued by our efforts to dig ctenosaurs out of the rocks, quickly jumped in and caught one for us. Additionally, we saw very few adults, which could be indicative of hunting. We caught six individuals at the Paya Bay Resort on the northeastern half of the island. Interestingly, ctenosaurs are abundant on the open rock faces abutting the ocean, and locals have told us that they often see them in the ocean, although I was unable to confirm this with my own observations. Four individuals came from Arch's Iguana Farm. Although this "farm" is dedicated to the preservation of Green Iguanas (*Iguana iguana*), a few *C. oedirhina* can be found in the area. Through the efforts of one of the farms caretakers, ctenosaur breeding may be incorporated into the farm's objectives. This would be of great benefit to the species, and considerations should be given to helping him with such an effort.

We hired a dory to take us through the Red Mangrove Canal. This is a tourist route, and was recommended as a place to find ctenosaurs. We were able to catch four individuals from this area in about one hour. Hunting pressure appears to be low, at least in part because the ctenosaurs are a tourist attraction. We took a second dory trip to the far eastern end of the island and to the two small islands of Morat and Barbareta. Barbareta is a private island that is heavily guarded against local poachers of Green Iguanas, ctenosaurs, and sea turtles. The owner of the resort on this island seems to be very concerned with protecting the wildlife. With the assistance of two guards, he allowed us to collect samples from five individuals. Our trip to Morat was unsuccessful. We examined the entire southern side of the island, but saw no signs of any kind of iguana. We saw no tail drags, evidence of nesting or hatching, or fecal matter. We also saw no clear signs of hunting, although branches had been cut off the mangrove trees, the pattern was not typical of ctenosaur hunting. Santa Elena, located on the far eastern side of Roatan, also proved unsuccessful, although we did see one individual. We stopped farther west at Rocky Point and saw many ctenosaurs, but were unable to catch any as they were extremely skittish. Hunting pressure on the far eastern side of the island appears to be high.

The situation for *C. oedirhina* on Roatan seems to be fairly good, although the fact that hunting is occurring was no secret. The island seems to be big enough and contain enough protected areas to conserve this species. *Ctenosaura oedirhina* also seems to be able to exploit many different environments, from

Red Mangrove stands to dry scrub forest, indicative of its ecological versatility, a characteristic that should help this species as habitats change or are destroyed. I propose that conservation efforts focus on the populations on Barbareta and at Arch's Iguana Farm.

#### Isla de Utila (March–May)

On Utila, I continued and expanded work initiated in 2005, which included mark-recapture, collection of DNA samples, and ongoing evaluations of the status of *C. bakeri* and *C. similis*, with particular efforts aimed at assessing the possibility of hybridization between the two species. In addition to sites visited last year, I discovered many new sites, some of which support only *C. bakeri* or *C. similis*, whereas others have both species. In all, I identified 26 sub-sites located throughout the island. These sub-sites can be grouped into three main geographic regions based on both anthropomorphic and natural barriers and useable habitat connections.

Geographic region one (GR1) encompasses the most easterly portion of the island and is divided from geographic region two (GR2), which encompasses the middle section of the island, by the presence of Utila Town in the south and uninhabitable savannah through the interior of the western part of the island. These barriers may be more of a problem for *C. bakeri* than for *C. similis*. GR1 includes five sub-sites, of which one is occupied solely by *C. similis*, one solely by *C. bakeri*, and three have both species. We captured a total of 71 *C. bakeri* (30 males, 32 females, 9 juveniles) and 31 *C. similis* (five males, 15 females, 11 juveniles) in GR1.



Typical locally made noose found near the Tradewinds properties.



*Ctenosaura bakeri* from northwestern Utila.

Geographic region two encompasses the middle section of the island on both the eastern and western sides of the canal and is separated from geographic region three (GR3) by the presence of uninhabitable savannah running essentially north-to-south through the western section of the island. Although a man-made canal runs north-to-south through the middle of GR2, it is not a geographic barrier for ctenosaurs, because it is extremely shallow in many areas and trees occasionally form a contiguous canopy over the water. This barrier, however, may affect *C. similis* more than *C. bakeri*. GR2 includes 17 sub-sites, two occupied solely by *C. similis*, 12 solely by *C. bakeri*, and three support both species. We captured a total of 271 *C. bakeri* (118 males, 114 females, 39 juveniles) and 20 *C. similis* (six males, nine females, five juveniles) in GR2.

Geographic region three is the largest region and encompasses the most westerly portion of the island. GR3 includes eight sub-sites, five occupied solely by *C. bakeri* and three include both species. We captured a total of 40 *C. bakeri* (14 males, 15 females, 11 juveniles) and five *C. similis* (1 female, 4 juveniles) in GR3. We spent substantially less time collecting in GR3 due to the difficulty of reaching the area.

I can now conclude that *C. bakeri* can be found in nearly all areas of the island, with the sole exception of the savannah. Although traditionally thought to be a mangrove specialist, *C.*

*bakeri* may actually be more of a generalist. Although they thrive in mangroves, I also found them doing well in dry areas that were once thought to be occupied solely by *C. similis* or to be entirely ctenosaur-free. This may be an artifact attributable to habitat destruction, but occupied areas on the northwestern side of the island, which are virtually free of people, argue otherwise. Additional observations from the eastern shore indicate that *C. bakeri* often exploits dry beaches far from mangrove stands, even during periods other than the breeding and nesting seasons. Similar to *C. oedirhina* on Roatan, I suggest that *C. bakeri* can be considered a habitat generalist that is adept at exploiting mangrove swamps. However, on Utila, *C. bakeri* shares the island with a congener (*C. similis*) that appears incapable of surviving in the mangroves.

I also visited many of the small cays off the southwestern and western coasts of Utila, and found no evidence of iguanas. My purpose on these cays was to check for the presence of ctenosaurs and evaluate them for the possible introduction of *C. bakeri* rescue populations. The only cay that might be able to support iguanas is Bird Cay, which offers suitable habitat and is free of human visitation. However, the island is very small and could support only a small population of lizards.

I was unable to recapture enough individuals to estimate accurately population or subpopulation sizes. This may reflect



*Ctenosaura similis* from a new development on the eastern side of Utila.



Cleared area on the eastern side of Utila at the Blue Bayou lagoon.



Dead *Ctenosaura similis* hit by a four-wheeler on the road near Annie Marelli's Hotel.

the fact that only 100 individuals were marked in 2005 or it may be attributable to the recent increase in iguana hunting on the island. Although questions regarding hybridization between the two species will be addressed more conclusively once molecular evidence can be taken into account, I found no obvious morphological evidence suggesting that hybridization occurs more than very rarely, supporting tentative conclusions based on molecular work in 2005.

Although populations of *C. similis* and *C. bakeri* on Utila seem stable at this time, hunting, development, and traffic on the island have increased dramatically in just the past year. In 2005, I rarely saw hunters or signs of hunting. In sharp contrast, I rarely had a day in the field this year during which I did not encounter hunters, find evidence that people had been hunting, or hear people hunting with guns. Additionally, habitat destruction continues to threaten the wildlife of Utila, particularly the illegal destruction of mangrove forests. Utila's roads and associated traffic also are expanding. This year, for the first time, I found road-killed ctenosaurs. I strongly recommend support of the habitat action plan being developed by the Utila Iguana Research and Breeding Station to buy land, give land owners incentive to be ecologically friendly, and hire guards to protect wildlife.

### Summary

Honduran ctenosaurs face many threats. In the south, the greatest threat is illegal poaching. In the north and on the islands, in addition to illegal hunting, the greatest threats are habitat destruction and a growing human population. Throughout the country, the sporadic or total lack of law enforcement that should have been protecting these animals since 1994 leaves

them vulnerable. In 2004, the IUCN listed all of these ctenosaurs, except *C. similis*, as "critically endangered," indicating the severity of the situation. Without local protection, their future is questionable at best. Only those individuals and institutions that feel a moral obligation to protect the diversity of nature can postpone the seemingly inevitable extirpation of at least many populations.

### Acknowledgements

The success of this field season would have been impossible without the help of many amazing volunteers: Dennis Baulechner, Corey Shaffer, Jeff Liechty, Wendy Naira, Melissa Issis Medina, Sammy Nuñez, and Hadas Grushka, my thoughtful mentors Drs. Arthur Echternacht, John Iverson, and Tom Near, The Utila Iguana Research and Breeding Station, The Overseas Research Station on Roatan and Dr. David Evans, The Cayos Cochinos Foundation, Dr. Gustravo Cruz, Jorge Ferrari, and the many offices of AFE-COHDEFOR. Additional thanks go to Oscar Maccio, Colin Meeks, and Martin Nuñez for aid in translating the report on which this article is based.

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ROBERT POWELL

Puerto Rican Bank endemic species like this Saddle Anole (*Anolis stratulus*) are found on nearly all of the islands in the region. However, transporting even native species from island to island may dilute unique gene pools that have evolved on individual islands that have been separated for thousands of years.



# Keeping Invasive Species Off Guana Island, British Virgin Islands

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Only habitat loss is a bigger threat to native species than invasive species, which are found in increasing numbers in both terrestrial and aquatic habitats and cause over \$100 billion in estimated economic damage every year in the United States alone (Pimentel et al. 2000). Such species often arrive via the transportation network (reviewed in Ruiz and Carlton 2003), whether voluntarily (intentional introductions) or involuntarily (accidental immigrants). That has been the case of the Cuban Treefrog (CTF), *Osteopilus septentrionalis*, which has been spreading in the Caribbean, primarily as a stowaway in ornamental plants and construction materials (e.g., Townsend et al. 2000, Powell et al. 2005, Powell 2006). In recent years, one of us has documented its ongoing expansion in the British Virgin Islands (BVI), where it is now known from breeding populations on Tortola, Virgin Gorda, Beef Island, and Peter Island (Owen et al. 2005, 2006). Single individuals have been documented on Necker Island and Guana Island, but searches of both in 2006 revealed no breeding populations, adults, or tadpoles. This frog is of concern for several reasons: It appears to cause the decline of native frogs, at least partially by direct predation; it also feeds on lizards, snakes, birds, and — primarily — invertebrates. In addition, it invades the water cisterns that are the main source of drinking water for many BVI residents, raising human health concerns.

Even before the collection of a CTF on Guana Island, a private wildlife preserve, the owners and management have been committed to keeping these frogs off the island. Over the years, they have fumigated plants and construction materials with vehicle exhaust, but the frogs appear remarkably resistant to long exposures to the toxic fumes, and this practice has been stopped. Nursery staff is supposed to inspect all plants for frogs before loading. In addition, all arriving nursery and construction materials are individually inspected before they are allowed onto the island. So far, these searches have resulted in the capture and destruction of three CTFs, two in a single shipment in 2005 (S. Western, pers. comm.) and one in 2004 (H. Watson, unpublished). Here, we report on one such search.

On 12 October 2006, the barge Deriece-W, normally based on Beef Island, delivered over 220 potted plants to Guana Island: *Ficus microcarpa*, *Clusia guttifera*, *Bougainvillea* “Helen Johnson,” *Pandanus utilis*, *Jatropha integerrima*, *Suriana maritima* (Bay Cedar), and *Coccoloba wifera* (Seagrape). As with many ornamental plants used throughout the Caribbean, they originated in Florida, USA, which is inundated with invasive reptiles and amphibians (e.g., Meshaka et al. 2004). Prior to being loaded on the barge, plants were housed at Minine’s Plants, a nursery on Beef Island that is heavily infested with CTFs (Owen, 2005). Some of the material (*Clusia* and *Jatropha*) had arrived from Florida 10 days previously, while other plants had been on Beef Island for up to 18 months. In addition to the plants, the barge carried soil and several vehicles, including a truck loaded with additional plants. Thus, we were concerned about both frogs (either arriving directly from Florida or acquired at the nursery) and other organisms that might have arrived from either location. One species of particular concern was the Brown Anole, *Anolis sagrei*, which also has invaded Florida and is spreading in the Caribbean (e.g., Greene et al. 2002, Henderson and Powell 2005), often to the detriment of native species (Kolbe et al. 2004). So far, it has not been found in the BVI. The search was conducted by a team of eight, including the authors, and lasted approximately one hour. Each plant was individually searched, with both foliage and soil being sifted for invasive organisms. Those found were recorded and removed.

We removed from the plants inspected five juvenile anoles, later identified as the native Crested Anole (*Anolis cristatellus*),



BRIAN WHITE

A Cuban Treefrog (*Osteopilus septentrionalis*) on an ornamental plant at the Beef Island nursery.



BRIAN WHITE

A cistern on Beef Island, the source of water for a household, is teeming with dozens of Cuban Treefrogs (*Osteopilus septentrionalis*).



ROBERT POWELL

Guana Island, like the many other islands of various sizes that comprise the British Virgin Islands, is separated from other islands only by short distances across intervening channels. As part of the Greater Puerto Rico Bank, these islands were once connected when sea levels were much lower than today. At least those populations of plants and animals with limited abilities to disperse across water have evolved separately on individual islands, and efforts should be made to avoid diluting potentially unique gene pools by transferring even common species from island to island.

and sighted at least one other that was not recovered. In the soil of the planters, we collected one dwarf gecko, later identified as a native *Sphaerodactylus macrolepis*. In addition, we recovered one immature spider (an unidentified member of the genus *Selenops*, catalog number TTU-Z 31,098) and three individual snails, *Zachrysis provisorio* (MCZ 356974). This species originates in Cuba, but has been reported in Florida and elsewhere in the Caribbean, including the U.S. Virgin Islands (A. Baldinger, pers. comm.; Kraus 2005). The soil in two pots contained nests of the imported Red Fire Ant (*Solenopsis invicta*), and had to be fumigated. This species is not listed among those



JOHN S. PARMERLEE, JR.

The Cuban Brown Anole (*Anolis sagrei*) is an aggressive invader originating in Cuba. These lizards thrive in habitats altered by human activity.



GAD PERRY

The barge, with its gate down, is ready to discharge its load of plants and soil on Guana Island.



GAD PERRY

James Lazell and Howard Watson inspecting the leaf axils of *Pandanus utilis* for stowaways.

located by Miller (1994), who searched a similar barge at the same location, but looked for invertebrates.

In addition to these cargo-related species, we recovered two juvenile ground lizards, later identified as the native *Ameiva*



GAD PERRY

A juvenile Crested Anole (*Anolis cristatellus*) on a nursery plant on top of a truck loaded on the barge. The animal escaped before it could be captured.

*exsul*, which appeared to have been resident on the barge. When chased, the lizards behaved in a manner we have never previously encountered or seen described. Both lizards used a drain hole on the edge of the deck to launch themselves into the sea, about 3 meters below. Once in the water, they swam as a crocodile or marine iguana would, tucking their limbs against their bodies and undulating the body and tail. Swimming occurred both under and on the surface of the water and lasted about 1 minute in each case. The lizards then swam back to the boat and climbed up its side. This ability may help explain why ground lizards are found on so many islands. We are happy to report that the owners of Guana Island, in keeping with their long-term policy of protecting the island, have now decided to suspend such shipments.

None of the reptiles collected were invasives, nor were CTFs found during our search, but some of the invertebrates collected were, similar to the findings of Miller (1994). Both the number of organisms discovered on this barge and their diversity is alarming for two reasons. First, they indicate that a broad range of organisms can and is transported in such shipments, which are not uncommon. In the last few years, Guana Island, which is not a major consumer of nursery plants, typically received 2–3 shipments of similar magnitude a year, as well as several smaller ones (H. Watson, unpublished). The potential for arrival of invasive species, such as the Fire Ants (already established on Guana) or CTF (which has not been noted this year, despite repeated surveys of all freshwater locations on the island) is alarmingly high. Second, transporting native species between



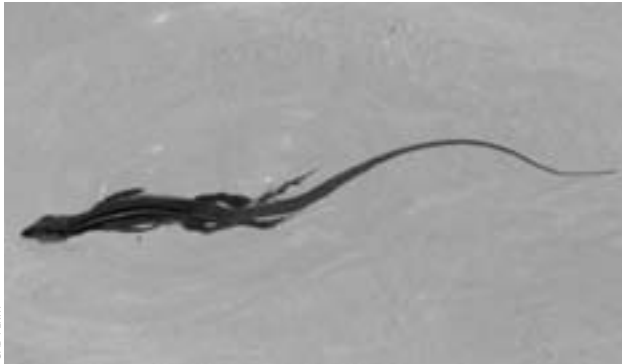
ROBERT POWELL

This dwarf gecko, *Sphaerodactylus macrolepis*, is common in the British Virgin Islands.



GAD PERRY

One of two juvenile ground lizards (*Ameiva exsul*) encountered on the barge.



GAD PERRY

*Ameiva exsul* swimming in the sea after leaping from the deck of the barge.

islands is not a benign activity. It swamps local genetic specializations that have evolved after the islands separated, leaving populations less well-adapted to local conditions. For example, water loss rates vary among islands in a manner related to their aridity (Dmi'el et al. 1997), and this variation has at least some genetic basis (Perry et al. 2000). Bringing in foreign genetic material could make an island population less capable of surviving a drought. In addition, such translocations make research into the biological history of the islands much more difficult. For example, an ongoing study of the genetic differences among Crested Anole populations and their relationship to other biogeographic patterns would be severely hampered if animals are regularly transported among islands.

BVI law offers little guidance about inspecting and sanitizing shipments arriving from other locations, such as Florida. We support the recommendation of Perry and Gerber (2006) that additional measures are needed to prevent the arrival of invasive species and eradicate those already in the BVI. In addition, however, we also recommend that internal biosecurity measures be established to reduce the risk of native species being accidentally moved among islands. Such measures are clearly needed to reduce the spread of invasives already found in the BVI, such as the Fire Ant or CTF, to new locations. We are not aware of such

regulations being in effect in any island-based nation. Attempts at quarantines of mainland invasives, such as the Fire Ant in the USA, often have failed because the volume of transport is high and inspection is lax, but the isolation provided by an island-based system offers some hope of success.

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# West Indian Iguanas: An Update<sup>1</sup>

## Anegada Island Iguana (*Cyclura pinguis*)

In order to determine the genetic suitability of the San Diego Zoo's six adult (3.3) Anegada Iguanas for a captive breeding program, relatedness within the captive population was examined by comparing their microsatellite variation to that observed for two groups of wild Anegada Iguanas, one known to be closely related (clutchmates from marked nests) and one presumed to be randomly related (haphazardly captured adults and juveniles).

A *Cyclura pinguis* DNA microsatellite library was constructed using 23 of 48 candidate loci screened for polymorphism and found to be useful for analysis. DNA was extracted from a total of 178 Anegada Iguanas: 12 captives at the San Diego Zoo (the six adult founders and their six offspring) and 166 wild individuals (68 haphazardly captured animals assumed to be randomly related, and 98 hatchlings from eight nests assumed to represent eight sibling groups). Genotypes were obtained for all individuals and the average number of alleles observed across the 23 loci in the captive and wild populations was 2.8 and 4.3 respectively, with observed heterozygosity determined to be 0.61 in the captive group and 0.53 in the wild population.

A maximum likelihood statistical approach, using the six captive founders and most of the wild individuals sampled, was used to infer relatedness among the captive adults. Results of this

analysis suggest the six captive adults contain three related pairs (one pair of males, one pair of females, and one male and female pair) and that each related pair is unrelated to the other pairs. The statistical approach used requires more markers to estimate specific relationships, such as determining whether two iguanas are likely to be siblings, half-siblings, parent-offspring, etc. For this reason, we can only generally state whether each pair is likely to be related or not.

The molecular data compiled to infer relatedness of the six adult founders was also used to correctly assign parents to a captive offspring with a questionable pedigree. The adults that were believed to be the parents of the offspring were excluded at 7 out of 23 loci. Of the four other possible adult candidates, microsatellite allele data revealed that only one male and female qualified as parents of the offspring at all 23 loci.

The microsatellite data have also provided important information about the genetic diversity of the wild population on Anegada. Although population estimates suggest that the wild population contains fewer than 300 individuals, the microsatel-

<sup>1</sup> Reprinted with permission from the *IUCN Iguana Specialist Group Newsletter* 9(1), Summer 2006.



GLENN GERBER

To determine the genetic suitability of the San Diego Zoo's adult Anegada Iguanas (*Cyclura pinguis*) for a captive breeding program, relatedness in the captive population was compared to that observed for two groups of wild iguanas.

lite data suggest that the population is genetically healthy (observed heterozygosity is 0.53) and that subpopulations are not significantly subdivided ( $F_{ST}$  is 0.153).

The genetic data also support the presence of partial sibling relationships across multiple field seasons for hatchlings captured on the tiny islet of Windberg Cay (0.26 ha) in Red Pond, suggesting that females return to this cay year after year to lay their eggs.

This work was jointly undertaken by the Genetics and Applied Conservation Divisions of CRES and was funded by a grant from the Institute for Museum and Library Services and with a Van Ness Research Fellowship at CRES.

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#### Allen Cays Iguana (*Cyclura cychlura inornata*)

Two separate research trips were made to the Allen Cays area in the northern Exumas, Bahamas, one from 18–26 March 2006 and one from 16–21 July 2006. The March trip consisted of an alumni team that surveyed cays in and around the Allens Harbour for potential migrant iguanas and for the collection of blood samples. This expedition replaced the normal May trip for current Earlham College students that involves intensive mark-recapture work on Leaf and U cays. The July trip focused on nesting activity on Flat Rock Reef Cay (FRRC) just northeast of Leaf Cay. We hoped to compare nesting parameters in this rapidly growing population with those observed in 2001 and 2002 on Leaf and U cays, where populations are presumed to be at or near carrying capacity.

*March Survey Trip.*—As early as 1995, JBI (author) began hearing reports that iguanas were seen on islands around Leaf and U cays, where they had not been previously observed. By 2001, populations had been confirmed on Allen Cay and FRRC (ca. 1 km NE of Leaf Cay), both of which contained individuals pre-

viously marked on Leaf or U cays. Our assumption was that people were relocating iguanas. In 2005, two iguanas and a carcass, none of which were marked, were discovered on a tiny islet just north of Leaf Cay that had yielded no sign of iguanas when surveyed in 2001. In order to better understand the issue, 13 Earlham alumni and associates spent six days in March 2006 in the Allen Cays area to survey islands and to collect blood samples for future DNA work.

A total of 12 cays were visited during this trip. U Cay and Leaf Cay were visited long enough to collect blood samples, but no other work was conducted on either cay. Allen Cay and FRRC were extensively sampled and blood was collected at each location. Total population estimates for each now stand at 20 (total marked) and 100 (based on 38 captures this trip that included five recaptures and a total of 45 marked for the island), respectively. To date, neither juveniles nor adequate nesting sites have been observed on Allen Cay.

FRRC, which had no evidence of iguanas in 1994, now has a thriving, growing population and the estimate of 100 iguanas includes a subjective count of 30 elusive juveniles. Eight other cays between the Allen Cays and Robert's Cay just south of Ship Channel Cay, most of which had never been surveyed before, were also visited during this trip. A total of seven iguanas was seen on three of these islands and a fourth island had iguana scat and tail drags. Of the observed iguanas, two were captured and blood was collected from each. One of these iguanas was unmarked and the other was a female originally from U Cay that had clearly been relocated sometime after 2001, when it had been included in our nesting study on U Cay.

*July Nesting Study.*—JBI and KNH returned to FRRC for five days after the presumed nesting season (mid-June to mid-July on Leaf and U cays). A total of ten potential nest sites were identified based on mound presence, soil and vegetation disturbance patterns, and female attendance. All ten sites were excavated and egg clutches were uncovered at seven of the sites. Unlike on Leaf



KRISTEN JAINES

An adult female Allen Cays Iguana (*Cyclura cychlura inornata*) in the northern Exumas, Bahamas.

and U cays, female nest defense was minimal and it took some time to determine which nests had associated females. Nonetheless, seven nesting females were identified and six were matched with precise clutches. One female was associated with a potential nest site, but the eggs were never uncovered. At one nest where eggs were found, no female was observed. Two of the identified sites yielded no eggs nor associated females, indicating that our initial nest identification may have been incorrect for those sites.

In addition to a lack of strong nest defense, the most important differences between the young population on FRRC and the older populations on Leaf and U cays tentatively appear to be a higher clutch frequency (40–50% on FRRC; ~33% on Leaf and U cays) and more rapid growth rate (32 cm SVL = 10 years on FRRC; 32 cm SVL = 18–23 years on Leaf and U cays) on FRRC. The latter apparently results in female sexual maturity being attained in less than a decade on FRRC rather than the 12 or more years necessary on the other cays. Other nesting parameters, including clutch size, egg size, and distance between closest nests, do not appear to differ significantly between FRRC and Leaf and U cays.

As a follow-up to the March survey, JBI and KNH revisited one of the cays where four iguanas had been observed and the previously unmarked individual had been captured. We observed a total of five individuals and captured two. As with the March capture, these were unmarked, adult females. The captured females demonstrated site fidelity suggestive of nesting, and digging was observed, but soil appeared to be too sparse for

actual nest construction. No juveniles were observed, reinforcing the notion that these individuals may be unable to nest on this island.

*Conclusions.*—Our research this year leads us to wonder whether this might be an optimal time for the Bahamian government to formally protect the Allen Cays Iguana area. The discovery of a U Cay female as far away as Robert's Cay (6 km to the north) verifies that unauthorized persons are relocating iguanas from Leaf and U cays. The presence of unmarked adult iguanas on at least two new cays also suggests a wider natural distribution than previously known. For example, at least three of the five iguanas on the newly surveyed cay appear to be long-term natural inhabitants. Aside from Leaf, U, and FRR Cays, however, the other cays appear to lack nesting habitat, potentially rendering the iguana populations there biologically dead.

Results of DNA analyses from collected blood and future survey work should help clarify relationships among these island-separated populations. In the meantime, preliminary nesting results from FRRC verify that populations can establish quickly given appropriate nesting habitat. In addition, the island with five iguanas offers a potential experimental site to study the demographic effects of adding nesting soils to an island.

Launching an educational campaign that includes informational kiosks on Leaf and U cays is essential to the long-term well-being of the Allen Cays Iguana. Leaf Cay and its iguanas support a booming tourist industry, but the latter depends on a vulnerable species that is made even more so by increased



KRISTEN HINES

John Iverson exhumes an Allen Cays Iguana (*Cyclura cyclura inornata*) nest in the northern Exumas, Bahamas.

human involvement. Well-meaning tourists may be creating some of these biologically dead populations. Too many islands support only single sex individuals or may not have sufficient nesting soil. Furthermore, preliminary observations suggest that tourist feeding has dramatic effects on a subset of the populations. We have yet to understand the implications this may have on the health of individuals and the population as a whole. Education, combined with a cooperative agreement among the owners of Leaf and U cays and the Bahamian government, could go far in ensuring the long-term existence of the Allen Cays Iguana, the indigenous endangered Audubon's Shearwater, and other flora and fauna in that area of the Exumas.

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#### **Exuma Island Iguana (*Cyclura cyclura figginsi*)**

Surveys in the Exuma Island chain were conducted from 6–11 April 2006. The surveys were part of the John G. Shedd Aquarium's citizen-scientist iguana research program and included the islands of Leaf (northeast of Normans Pond), White Bay, North Adderly, Noddy, and Pasture cays. Objectives for 2006 were to: (1) survey iguana populations in the south-

central Exuma chain because they have not been visited since 1998, (2) translocate iguanas from Leaf Cay (northeast of Normans Pond) to Pasture Cay in the Exuma Cays Land and Sea Park to augment the initial colony that was translocated in 2002, and (3) collect preliminary diet and body condition data for comparative studies of iguana populations inhabiting Exuma cays visited by tourists versus un-visited cays.

In addition to the April surveys, Gaulin, Bitter Guana, and Pasture cays were visited by CK (author) between 26 May and 4 June 2006. The surveys were part of a Bahamas Ecology course that included undergraduate students to help collect data from each cay (Gaulin: 27, 28 May and 4 June; Bitter Guana: 27 May; Pasture: 26 May and 2, 3 June). Research on Gaulin and Bitter Guana cays is part of an annual monitoring project initiated in 1998. Approximately 2.5 days were spent on Gaulin Cay, one day on Pasture Cay, and three hours on Bitter Guana Cay.

*General Surveys and Morphometrics.*—During the April surveys, we captured and processed 123 iguanas from five cays (Leaf,  $n = 19$ ; North Adderly,  $n = 33$ ; Noddy,  $n = 14$ ; White Bay,  $n = 51$ , Pasture,  $n = 6$ ). This was the first year that iguanas were all marked with PIT tags on these cays (except Pasture Cay) for long-term identification. During the May/June surveys, we captured an additional two founder iguanas from Pasture Cay, one iguana from Bitter Guana, and 51 iguanas from Gaulin Cay. Of the 51 Gaulin captures, 27 were recaptures dating back as long ago as 1998. No differences existed in body mass, snout-vent length, or ectoparasite load between the North Adderly, White



JOHN BINNS

Exuma Island Iguanas (*Cyclura cyclura figginsi*) populations in the south-central Exumas were surveyed for the first time since 1998.

Bay, and Gaulin cay iguana populations (all  $P > 0.05$ ). Leaf and Pasture cays were excluded from statistical analyses because they represent translocated populations with low densities and thus exceptional large body sizes. Noddy and Bitter Guana cays also were excluded from analyses because of small sample sizes. The southern end of Bitter Guana Cay was surveyed by CK and L. Roth on 27 May. Twelve iguanas representing multiple age classes were observed, but only one large male was captured because of the extreme wariness of the iguanas and our short time on the island. Additionally, while at anchor on 26 May off of Bitter Guana Cay, four iguanas were observed foraging on the north beach. These observations represent an increase in recorded iguanas over the past nine years. Although speculative, annual increases in observations coincide with the informative/protective signs posted on the island in 1998.

On 10 April, we set Sherman live rat traps on White Bay ( $n = 28$  traps) and Leaf Cays ( $n = 30$  traps). We trapped six rats from White Bay and none from Leaf Cay. To date, rats have been confirmed from White Bay, Gaulin, Bitter Guana, and Pasture cays. North Adderly, Noddy, and Guana cays (not visited in 2006) still need to be surveyed for rats.

*Translocation.*—The original translocation from Leaf Cay [northeast of Normans Pond] to Pasture Cay in the Exuma Cays Land and Sea Park was conducted as a necessity because of a land sale dispute that required the removal of as many lizards as possible in two days. The translocated colony was heavily male-biased (11.5) resulting in an initial loss of large males. Since December 2002, three male iguana carcasses have been recovered, while the fate of four (2.2) iguanas remains uncertain. One of the male carcasses was discovered in December 2002 washed up on Compass Cay located approximately 5 km south of Pasture Cay. Interestingly, two large iguanas have been spotted this year on the north beach of a private cay (Little Halls Pond) located 1.5 km north of Pasture Cay (Tom Barbernitz, personal communication). We were not granted permission to land on the island, so we were unable to determine if those iguanas came from Pasture Cay. However, no iguana-inhabited islands are in the area, so, if the iguanas did not originate from Pasture Cay, they were purposely put on the island from a distant iguana-inhabited cay.

Seven (5.2) of the founder iguanas remaining were recaptured on Pasture Cay and all appeared healthy and had gained body mass since last capture. Two additional founder iguanas (1.1) were observed but not captured. One subadult that hatched on the island was recaptured and increased its body mass by 302 g and SVL by 5.9 cm (BM = 420 g; SVL = 19.6 cm) since it was last captured in 2004. Two other subadults were observed but not captured.

Evidence of exploratory dig activity was observed on the north beach, and two iguanas appeared to have nested. One female was aggressive toward male and female conspecifics in her nesting area and chased iguanas away from the area if they approached too closely. A snake (*Alsophis vudii*) was captured on the island in April. High predation rates of iguana hatchlings by these snakes on Andros Island warrant future investigations concerning predation effects on Pasture Cay.

*Dietary Comparisons.*—Visitor traffic in the Exuma Cays has been increasing significantly over the past decade. Many of these tourists land on cays inhabited by iguanas. For example, the Allen Cays in the northern Exumas experience up to 600 people each week from one-day Nassau excursions. The islands in the southern Exumas also receive high-impact visitors from Great Exuma aboard one-day excursion tourist trips. Previously undisturbed populations in the more remote central Exumas also are becoming subjected to more frequent visits by tourists due to increased traffic from the Staniel Cay Yacht Club. Consequently, few iguana populations remaining in the Exumas are free from visitor impact. Visitors purposely feed the iguanas, thus altering their natural behavior and potentially their health. In order to assess the impact of tourist feeding on populations of Rock Iguanas in the Exumas, general dietary data were collected for comparative analyses between disturbed and undisturbed islands. We collected 131 scat samples from six cays in the central and southern Exumas (White Bay, North Adderly, Pasture, Noddy, Leaf [northeast of Normans Pond] and Guana). In March 2006, KH (with John Iverson) collected 84 scat samples of *C. c. inornata* from seven cays in northern Exumas (Leaf [east of Allens], Southwest Allens, Flat Rock Reef, Roberts, and three unnamed cays just north of Allens). Scat samples were collected in different habitats and areas that included wooded interior, rocky areas, and beach habitat. Preliminary results indicate that prolonged, high rates of feeding do alter iguana diets. Of the islands sampled, Leaf Cay (Allens) has by far the longest history and greatest rate of food provisioning by tourists. Scat samples from the main tourist beach on Leaf Cay contained high levels of ooid sand grains (six of 19 samples), remnants of grapes (seven of 19), and fresh samples with more of a loose/liquid consistency than fresh samples found on other parts of the island (sand in two of 17 samples; grapes in one of 17; no loose/liquid samples). To a much lesser extent, other sampled iguana populations experience food provisioning by tourists (e.g., White Bay Cay, Southwest Allens Cay), but no distinct differences were evident between samples from these islands and samples from populations with minimal or no food provisioning by tourists. More data are needed to make meaningful conclusions, but we now have a working hypothesis for future studies. Future work will also focus on blood chemistry and behavioral comparisons.

Further reinforcing the timeliness of this work, we documented an increase this year in tourists visiting Gaulin and Pasture cays, thereby stressing the need for signs advertising the protected status of the iguanas. Additionally, dialogue needs to be initiated to prohibit the feeding of iguanas on selected cays to prevent potential perturbations or preserve selected “natural” populations.

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## HUSBANDRY

# Successful Care and Reproduction of Green Tree Monitors (*Varanus prasinus*) at the San Diego Zoo

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Photographs by the author except where noted.

## Natural History

*Varanus prasinus*, commonly known as the Green Tree Monitor, is a gracile lizard reaching a total length of less than 1 m. Ground color is light to emerald green with some black markings from nape to tail base, usually as lines or chevrons across the back. First described by Schlegel in 1839, this member of the family Varanidae is native to the Cape York Peninsula of Australia, most of New Guinea, and some surrounding islands. Green Tree Monitors lay 2–5 eggs that hatch after 150–190 days. They are notorious for consuming their own eggs in captivity. In the wild, they inhabit the canopies of remaining lowland forests at elevations to 500 m. Little is known of their habits in the wild. Although highly arboreal, these animals are excellent swimmers with keen eyesight. *Varanus prasinus* is reported to lay its eggs in arboreal termite nests. Wild hatchlings probably eat termites or termite eggs. Green Tree Monitors are very wary, nervous animals, fleeing for cover at the slightest disturbance. The prehensile tail is nearly twice the snout to vent length and is used for balance and as a stabilizer or fifth limb when moving through trees, on the ground, or in water. They will curl their tail tightly and flatten their necks dorsally and ventrally to appear larger when in defense mode. The tongue is long and forked, and is used to gather scent molecules, which are interpreted by using the Jacobson's organ in the upper palate. *Varanus prasinus* has very sharp teeth that are used for subduing prey such as invertebrates, mice, lizards, frogs, birds, and bird eggs. Teeth also are used for defense, as is the expulsion of fecal material.

## Captive Husbandry

In 1998, the San Diego Zoo acquired a pair of unrelated *V. prasinus*. Following two parasite treatments and two clean fecal checks in quarantine, the pair was brought into the zoo's main reptile building. Lizards are maintained at an ambient temperature of 24–29 °C (75–84 °F), with basking site temperatures reaching 35–38 °C (95–100 °F), using 250-w spotlights (PHILIPS® 250w REFLECTOR) above their enclosures. UV-fluorescent (PHILIPS® F40T12/C50 COLORTONE) and black fluorescent lights (SYLVANIA® BLACKLIGHT F40/350BL) also are used above the enclosures. The ambient lights are on from 0600–1800 h and basking lights from 0700–1700 h. The relative humidity averages 50–75%, and misters above the cages are on 3–4 times per week for 1–2 hours.

The monitors are offered 5–10 gut-loaded and vitamin dusted crickets 2–3 times each week, 3–4 neonatal (pink) mice are offered 2–3 times per week, and ground turkey with supplemental vitamins mixed occasionally with a crushed, boiled egg also is provided 3–4 times a week. The San Diego Zoo has just recently switched from turkey to Dick Van Patten's Natural Balance Zoo Carnivore Diet™ (Pacoima, California). Ovulating females are offered food daily. Males feed very readily and can become obese if their diets are not carefully regulated.



Rows of cages in the section of Klauber-Shaw Reptile House where individual Green Tree Monitors (*Varanus prasinus*) are housed.



A subadult male Green Tree Monitor (*Varanus prasinus*) signals defensive behavior by inflating its throat.

Enclosures are sink cages (plastic sinks without the detachable legs are designed and built by Ed Snow, Naturally Exotic, Valley Center, California). Our versions are custom designed by the author. They have thin plastic walls with screen fronts and tops. The top half opens independently of the bottom half. Dimensions are 220 x 57.6 x 63.5 cm in height, width and depth. The height allows for appropriate heat gradients and security. The cages have nest boxes attached to the sides that are 71.1 x 12.7 x 64.8 cm in size and 105.4 cm above the ground. Access to the box is through a hole 8.9 cm in diameter. Supersoil™ brand potting soil filled to a depth of 30.5–40.6 cm



A juvenile Green Tree Monitor showing defensive posturing.

is used as nest box substrate. The door for outside access to the nest box is hinged and opens down with two latches on each top corner of the door, which is situated near the top and measures 25.4 x 64.8 cm. Long branches are placed at angles from bottom to top of the cage, and another branch is screwed into the sides near the nest box opening. Basking on this perch, the female can attain temperatures of up to 33 °C. During the day, temperatures at the bottom of the cage are around 24–26 °C (75–78 °F). At 61 cm above the bottom, temperatures climb to 26–29 °C (78–81 °F), and at 122 cm, temperatures range from 27–29 °C (81–84 °F). The highest temperatures (46–47 °C (114–117 °F)) are attained in the top corner under spotlights.

The section of the building in which the monitors are housed has built-in skylights situated directly above the enclosure where the two males are on exhibit; the females have no direct access to the skylights. Three of the skylights are opened during cool, rainy months and intermittantly throughout the year. The heating in the section is set at 29 °C (84 °F) at 0600 h and 27 °C (80 °F) at 2200 h. Cooling is set at 30 °C (86 °F) at 0500 h, 31 °C (88 °F) at 0900 h, and 30 °C (86 °F) at 2200 h.

#### Reproductive History

On 6 February 2003, a captive-bred male was introduced to the female and copulation was observed on the same day. Four desiccated eggs were found in the enclosure on 10 March 2003. Two were inside the nest box on top of soil and two were on top of the nest box. These eggs were incubated for two weeks but did not rehydrate. No further eggs were found and the female showed no obvious weight gain until 11 January 2004, when

one egg was found in the nest box; it went bad early in the incubation. Another two desiccated eggs were removed from the top of the soil in the nest box on 25 April 2004; these did not rehydrate. Four eggs were removed from the bottom of the soil in the new nest box on 24 October 2004. A tunnel was dug down one side to the bottom and across to the other side of the nest box. These eggs went bad 2–3 weeks into incubation. On 5 July 2004, this female was moved into a new cage with the dimensions listed above. In 2005, she laid four eggs on 30 January, four eggs on 11 May, five eggs on 15 August, and five eggs on 11 November. On 27 February 2006, she laid two eggs in the water bowl. More soil was added to the nest box, increasing the depth from 10 in to 16 in. She laid two more eggs in the nest box the next day. On 17 May 2006, this female laid another clutch of five eggs that quickly went bad and displayed no signs of fertility. She had been with the male for only three days (23, 24, and 25 March) between 17 May 2006 and the last clutch. In August 2006, she laid one egg on the top of the soil in the nest box. The following day, she laid four more eggs in the bottom of the soil of the nest box. These eggs also were infertile. She had been with a male seven days in total since the last clutch on 17 May (11 and 12 June, and 16, 17, 25, and 26 July). Copulation was observed on 25 July 2006. The male was introduced to her again on 22 and 23 August 2006. He still showed interest in her, chasing her around the cage. She laid the last

clutch on 25–26 August 2006. The days between laying from March 2003 and May 2006 were 251 days, 105, 182, 98, 101, 96, 92, 104, 79, and 100 days.



San Diego Zoo captive-hatched adult male Green Tree Monitor feeding on Carnivore Diet.



Captive-hatched male Green Tree Monitor (*Varanus prasinus*) copulating with a wild caught female.



When the time is right, male Green Tree Monitors aggressively chase females, which quickly submit.



JENNA RAMBEY

Green Tree Monitor (*Varanus prasinus*) egg #1 slit just a few hours before fully emerging.

All *Varanus prasinus* are kept separately. Other institutions report housing groups of two or more animals together, including more than one male with no problems. During 2005, a captive-bred male was introduced to the female at certain times during the year for no more than a week at a time, sometimes for only 1–2 days: 15 and 28 February, 15 March, 23 May, 26 July, 10, 17, and 23 August, 25 September, 23 November 2005, and 14 February 2006. On several occasions, the female ate 2–4 of her eggs.

On 28 February 2005, the male showed interest, tongue-flicking with jerky motions over her back and along her side, and pushing his vent area close to hers. On 23 May, he displayed similar behavior. On 26 July, the male chased the female around the cage while tongue-flicking and trying to copulate. On 27 July, the pair was observed in copula during both morning and afternoon. On 30 August, he also chased her, but both were observed later in the day basking on separate branches. On 23 November, the female was put on exhibit with a wild-caught male and removed the next day. On 11 January 2006, she was placed with a wild-caught male on exhibit, and they were observed copulating in the afternoon and on the following day. She was removed 16 January and placed back into her enclosure. This female has bred with a male and had clutches of eggs periodically beginning in 2000. Successful hatches did not occur with this female until 2004, when two of four eggs laid 24 October 2004 hatched on 1 April 2005. The incubation period for this clutch was 151 days. The second successful clutch was five eggs laid 15 August 2005. These eggs hatched 14–17



JENNA RAMBEY

All *Varanus prasinus* successfully hatched at the San Diego Zoo have slit and fully emerged from their eggs within 24 hours.

January 2006 with an incubation period of 153–156 days. The third successful clutch consisted of four eggs laid 27 February 2006. Two eggs arrested 2–3 weeks into incubation, but the other two hatched on 28 and 29 July 2006 with incubation periods of 152 and 153 days.

A female *V. prasinus* no longer in the zoo's collection laid three eggs in a log in her enclosure on 8 April 2000. One egg went bad, one went full-term but died, and one hatched on 10 September 2000 with a 153-day incubation period. This animal is the father of two successful clutches. He is an aggressive feeder of Natural Balance Zoo Carnivore Diet™ and crickets, but refuses pink mice.

Eggs are incubated at 30 °C (86 °F) in a substrate with a 1:1 ratio of water to vermiculite. Average mean egg weight is 9.8 g. Average weight of the female over the last year was 238 g and average weight for the male was 414 g.

#### Husbandry of Juveniles

Average mean weight for hatchlings is 8.5 g. About one week after hatching, juveniles can be enticed to eat two-week-old crickets by either releasing 2–3 into the cage or by tong-feeding. Some individuals are more difficult to feed than others during the first 2–3 weeks. During the third week, they are offered Natural Balance Zoo Carnivore Diet™ with vitamin supplements. They also may need to be tong-fed turkey or the carnivore diet if they are not taking it from a plate. In the third or



JENNA RAMSEY

Day-old Green Tree Monitors are very quick and ready to disperse.



JENNA RAMSEY

Newly hatched Green Tree Monitor (*Varanus prasinus*).



JENNA RAMSEY

Neonate Green Tree Monitors at the San Diego Zoo have had well-absorbed yolk sacs and few remnants of an umbilicus.

fourth week, a pinky mouse chopped into four pieces is added to the turkey plate. This is offered about 2–3 times a week. Three or four crickets are offered twice a week. Once the hatchlings start eating regularly, they can gain from 0.25–0.50 times their body weight each month.

All juveniles are maintained separately. The substrate in juvenile enclosures is wet sphagnum moss. Branches are angled from top to bottom of the enclosure, a piece of bark is provided for cover, and a bowl of water, which is just large enough to accommodate the animal, is used. A 50-w spotlight (PHILIPS™ Indoor Flood), and fluorescent UV- and black lights (SYLVANIA™ BLACKLIGHT F40/350BL) are situated above each cage. Cages are custom glass tanks that are 45.7 x 25.4 x 50.8 cm in size and have sliding screen tops and fronts.

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## COMMENTARY

# Endangered by Research: Poachers Mine the Scientific Literature for Locations of Newly Discovered Animals<sup>1</sup>

Lila Guterman

## *The Chronicle of Higher Education*

The gecko could have sprung from the mind of Dr. Seuss: It had black spots. It had white spots. It had stripes upon those spots. The nine-inch-long lizard with bright-orange eyes was new to science in the late 1990s, when L. Lee Grismer, a professor of biology at La Sierra University, first encountered it — but now, doing nothing more than research, he may have indirectly wiped out the gecko species from its home range in southern China.

Dr. Grismer simply described the lizard in a scientific journal, the *Journal of Herpetology*. He named it *Goniurosaurus luii* and recalls thinking, “If we’re going to protect these animals, we need to describe them and get them on the books.” To his dismay, “Within months of the description, these things hit the pet trade with a bang,” he says. “These things were going for \$1,500 apiece.”

Dr. Grismer has not returned to the site, but other scientists have. “They say when you go to this place in southern

China, it looks like a bomb hit it,” he says. “The rocks are overturned, they’re smashed, you don’t have geckos anywhere.”

While poaching exotic animals is not new, Dr. Grismer thinks that smugglers have become more clever in that they are using scientists’ research papers to find newly described animals. He is not alone in that concern. Three other scientists joined him in a letter to the journal *Science* in May, telling the glum stories of three new species, all quickly decimated by poachers after their scientific description appeared in print. The letter warns fellow taxonomists that their activities may actually harm the animals they intend to study or to conserve.

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Dr. L. Lee Grismer described *Goniurosaurus luii* from southern China in the late 1990s. Within months, these geckos were demanding high prices in the pet trade.



JAMIE PLAZA

When the Wollemi Pine (*Wollemia nobilis*) was discovered in 1994, scientists kept its location a closely guarded secret.

The problem may not yet be widespread for new animal species, but the researchers urge their colleagues to debate solutions before it grows in scope. The issue is even forcing biologists to consider withholding information from publication — a solution anathema to some researchers. “Science is a free flow of information,” says Dr. Grismer. “I’ll be damned if I’m going to have these criminals dictate how I’m going to do my science.”

### Plants in Peril

The wildlife trade is a multibillion-dollar industry, but it seems to have branched into newly discovered animals only recently. Botanists, by contrast, have faced the problem for longer. “That’s the unfortunate thing of discovering and publishing a new species — it obviously brings with it the need for collectors to have one,” says Geoff Bailey, a scientific consultant in Manchester, England, who studies cacti as a hobby.

When scientists discover a new animal or plant, they normally collect one or more — legally, they point out, often going through a lengthy permit process — to deposit in an institutional collection. That animal or plant becomes the “type” specimen, the representative of its species.

As hobbyists or poachers hunt for plants, says Michael Chamberland, collections manager of the herbarium at the U.S.

National Arboretum, the area where the type specimen was found often becomes the “sacrificial locality.” “One has to hope that there are satellite locations elsewhere and that those are not going to be revealed as widely,” he says.

Some botanists have concluded that to preserve species of commercial interest — like orchids, cacti, and carnivorous plants — they should publish only general geographical information, rather than precise locations. For example, when the Wollemi Pine (*Wollemia nobilis*) was discovered in 1994, in a national park near Sydney, Australia, scientists kept its location a closely guarded secret. Just a few dozen of the trees live in the wild, and before their discovery, the species was known only from fossils millions of years old. The Australian government restricts visits to the site, and some scientists were even brought there blindfolded.

Researchers rarely go to such extremes. However, botanists often play it coy in their publications. Mr. Bailey says, “Nowadays people are very guarded as to giving location other than a very generalized statement.” Other researchers object to withholding information in articles. W. John Kress, a research scientist and chairman of the department of botany at the Smithsonian Institution’s National Museum of Natural History, points out that habitat loss threatens far more plant species than does poaching. “One hundred years down the line,” he says, “when these habitats are destroyed anyway, having the records of where these things were scientifically will be very important.”

The animal scientists who published the letter in *Science* concur. “I believe very strongly that the conservation benefits far outweigh the potential detriment,” says Bryan L. Stuart, the lead author of the letter, who defended his Ph.D. thesis last month at the University of Illinois at Chicago. He described a new salamander that quickly appeared in the exotic-pet trade. In most countries, legislation to protect a rare species requires that it have a scientific name and that the government know where the species occurs.

What’s more, even if they don’t plan to sample the organism, scientists studying the species need to know where it lives (or lived) to determine how it evolved and adapted to its environment, among other things. Rogerio Bertani, a tarantula expert at the Butantan Institute, a biology and biomedicine organization in São Paulo, Brazil, agrees, even though Brazilian officials once caught smugglers with copies of his papers.

Dr. Grismer, who discovered the gecko, imagines taking matters into his own hands. “I fantasize that just one time I’m going to find one of these guys” taking a rare animal, he says, “and I’m going to make an example of him. I may end up in jail, but it would be worth it.” Of course, he realizes that violence would not solve the wildlife-smuggling problem — and neither would policing the areas, which costs too much for even the United States to eliminate poaching from its national parks. “The best thing I can come up with is an imperfect solution,” says Dr. Stuart. He recommends that taxonomists delay publishing their finds until they have worked with the government of the country where the animal was found to develop laws to protect it.

### Internet Insecurity

Once researchers describe a species, the information often goes into online databases, which provide an even bigger security risk.



RICHARD L. PYLE

*Centropyge boylei* occurs at depths of nearly 100 m near the Cook Islands in the South Pacific. Unlike other species featured in this article, it is not in any way threatened by commercial harvesters, and indeed was brought to the attention of scientists with the help of a commercial harvester. Fortunately for the fish, its habitat is out of reach of most divers.

Finding articles in obscure research journals takes some hunting by poachers, but anyone with an Internet connection can check the online archives at many institutions, finding the origins of the plants and animal species in their collections.

Scientists treasure that kind of easy access. For instance, combining data from an entire region with past records of plant ranges should help scientists predict how climate change could affect plant populations, says Zack E. Murrell, an associate professor of biology at Appalachian State University and director of a database organization called the Southeast Regional Network of Expertise and Collections. But curators of herbaria are debating how much data to reveal online. "It's very ad hoc," says Richard L. Pyle, an associate zoologist in ichthyology and the database coordinator for natural sciences at the Bishop Museum, a museum of natural and cultural history in Honolulu. "Every scientist and institution makes up their own approaches as they go."

Arthur D. Chapman, an independent scientist in Queensland, Australia, hopes to get more scientists talking about the issue. This spring, under the auspices of the Global Biodiversity Information Facility, an international organization trying to provide online access to biodiversity data, he conducted an online survey of people who worked at botanical and zoological collections. He found that most of the 102 who responded said they did restrict access to sensitive data in their publicly accessible data sets, using a variety of methods. He plans to publish the results of the survey and hold a workshop about them.

### Working Together

While many scientists fight commercial collectors, some researchers have taken a more cooperative approach. Dr. Pyle has found collectors in his field friendly and useful. He studies coral-reef fish. When an aquarium-fish collector finds an unusual animal, he says, "in almost every case they've deferred to science instead of making a quick buck" by selling their specimen. The money is no small potatoes: "Some collectors spend literally \$10,000 for a single fish," he says.

In the late 1980s, a collector named Chip Boyle described to Dr. Pyle two rare species that he had seen while scuba diving off Rarotonga in the Cook Islands. He invited Dr. Pyle to see them, stay in his house, and use his boat. The brightly colored species turned out to be new to science, and Dr. Pyle described them in the scientific literature, naming one *Centropyge boylei* after the aquarium-fish collector. He also discovered a third species while visiting Mr. Boyle.

With all three fish, Mr. Pyle had no qualms about describing their location. "You have to have high-tech equipment to go to that depth," he says, since the fish live some 300 feet below the surface. Besides, he says, "they're the most abundant species down there." But he acknowledges that terrestrial species are another matter. When people discover new fish species, he says, they usually reside in an unexplored area or deeper in the ocean than taxonomists had looked before. "Usually the species is very abundant wherever it lives," he says. On dry land, different rules



BRYAN L. STUART

*Paramesotriton laoensis*, known only from two streams in Laos, is being exploited before we have any idea how abundant it is.

apply. For both animals and plants, says Dr. Kress, of the Smithsonian museum, “99 percent of the common stuff has already been found, so it is going to be things that are inherently endangered and rare that are discovered and described now.” And unfortunately, that very rarity can drive the exotic pet or plant trade. “It’s like rare art collectors,” says Dr. Stuart. “The rarer a piece is, the more desirable it is.”

#### Too Much Information

Scientists who find a new species of plant or animal face a difficult choice. If they follow scientific procedures and publish the precise location of their find, that new species may soon be snatched up by collectors, who are always looking for rare organisms. Here are tales of three newly discovered species.

Bryan L. Stuart was horrified this year to find that a large, colorful, warty salamander, which he had first described in the scientific literature in 2002, was for sale online. He eventually



HANS-JÜRGEN BRÄUER, WWW.THEAMATELURSDIGEST.COM

A “living rock” cactus (*Ariocarpus bravoanus*) survived unmolested for a decade after its discovery in 1992. Poachers since discovered where the species grew. Today, these cacti are virtually extinct.

found out that German and Japanese collectors had hired local people in Laos to collect the salamander, called *Paramesotriton laoensis*, from the two streams where the amphibian lives. “It has a very restricted range,” says Dr. Stuart, a research assistant at the Field Museum in Chicago. “It’s being exploited before we have any idea how abundant it is.” Dr. Stuart fears his paper in the *Journal of Herpetology* led the smugglers to their treasure. “All that’s been published is what’s contained in the original description,” he says. The collectors may take so many animals that the species will be in danger. “It’s very sad for the salamander,” he says.

A “living rock” cactus species survived unmolested by thieves for a decade after its discovery. The cactus, *Ariocarpus bravoanus*, which blends in with its rocky surroundings in Mexico, was described in 1992 in a scientific journal, with only vague details of its location. But poachers later discovered the site and by 2002 had removed almost all of the plants. Scientists discovered two new sites where the cacti grew and did not publish their locations, but when Geoff Bailey, a cactus enthusiast from Britain, visited in 2003, he and two others could not find a single plant. “To all intents and purposes,” he says, “it’s virtually extinct.”



ENICA MORON

A new “slipper orchid” (*Phragmipedium kovachii*) was first brought to light by a commercial dealer, who smuggled it into the United States and made it available to scientists. Within a year of its formal description, signs of poaching were prevalent throughout the species’ habitat.

The 2002 discovery of a new “slipper orchid,” *Phragmipedium kovachii*, in Peru set the orchid world buzzing — the deep-reddish flower was twice the size of most other slipper orchids, which feature flowers with pouches. But that was not all that got people talking. The plant was first brought to light by a commercial dealer, who smuggled it into the United States and made it available to scientists at the Marie Selby Botanical Gardens, in Sarasota, Florida. The dealer and the gardens were eventually fined for illegally importing and possessing the rare flower. A year later, an orchid expert visited the region where it lived and saw signs of substantial poaching. Four locations were totally stripped of the plants, and at one site, he found seven large sacks stuffed with the orchids.

## BOOK REVIEW

# Sea Turtles: A Guide for the General Public

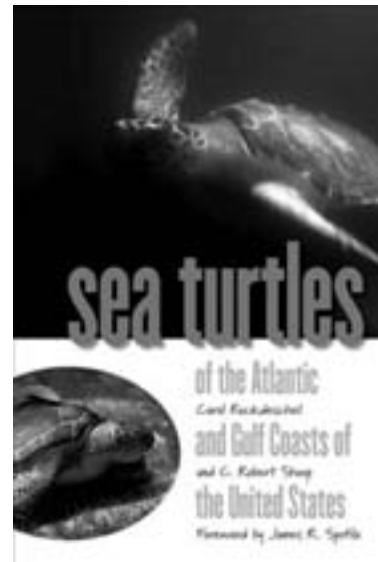
*Sea Turtles of the Atlantic and Gulf Coasts of the United States*. 2006. By Carol Ruckdeschel and C. Robert Shoop; foreword by James R. Spotila. The University of Georgia Press, Athens, Georgia, USA. vii + 136 pp. Paperback – ISBN: 0-8203-2614-3 – \$19.95.

Anyone who has ever walked along a beach and seen a sea turtle emerge from the ocean will never forget the experience. Although these marine reptiles have roamed the oceans for over a hundred million years, in the past few centuries their populations have declined toward extinction at the hands of humans. Today, all sea turtles are listed as endangered or critically endangered by the IUCN Redlist (2006) and are protected under the U.S. Endangered Species Act. Whether the conservation efforts of governments or NGOs around the world are able to repair the damage remains to be seen, but the galvanization of public support through education is a necessary part of conservation work if we are to have any hope of success. This book is an excellent introduction for the general public to some of the seas' most beautiful animals.

The first chapter gives a broad introduction to sea turtle biology and includes general life history stages, diets, diseases, and predators. A brief section on conservation talks about some of the threats facing sea turtles living in the coastal waters of the eastern U.S. and some of the efforts being used to address them, such as turtle excluder devices (TEDs) installed on fishing nets. No mention was made of head-starting programs, such as that on Padre Island. These have had mixed results and have become quite controversial in recent years (see references). A set of brief guidelines for people who wish to observe nesting turtles concludes the introduction.

The bulk of the book (pp. 35–106) is devoted to accounts of each of the six species found along the eastern coast of the United States: Leatherbacks (*Dermochelys coriacea*), Loggerheads (*Caretta caretta*), Kemp's Ridleys (*Lepidochelys kempii*), Olive Ridleys (*L. olivacea*), Greens (*Chelonia mydas*), and Hawksbills (*Eretmochelys imbricata*). Each account follows the same format, starting with the species' status and its distribution, which is illustrated with color maps, followed by extensive descriptions that include photographs, sections on life history and behavior, and ending with summaries of conservation threats and work specific to that species.

A one-page epilogue emphasizes the importance of further conservation work, and gives a list of ways for the public to help. Concluding the book is an appendix, which contains useful and easy-to-follow keys and a glossary. The key uses numerous illustrations to clarify the written descriptions. In addition to a key for identifying living turtles, another helps identify carcasses that may have washed ashore. The latter is based on different body parts, in case the turtle has begun to decompose. The glossary



provides clear and simple definitions for all technical and turtle-specific terms and a short list of books and websites that provide further information on sea turtles.

Taken as a whole, this book summarizes a great deal of information, although it is a bit dry and tedious at times. Each account differs in only a few species-specific details, which becomes repetitive. The authors have amassed a large collection of photographs, which add immensely to the appearance and utility of the book. The photographs and the keys are this book's strongest points. Diagrams and illustrations generally were quite good, although some (e.g., Fig. 1, p. 14, which shows the relative sizes of eggs produced by different species) seemed less than professional in quality. Overall, however, Ruckdeschel and Shoop did an excellent job of compiling an easy-to-understand guide to sea turtles for the general public.

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# CONSERVATION RESEARCH REPORTS

## Timber Rattlesnake Population Extirpated

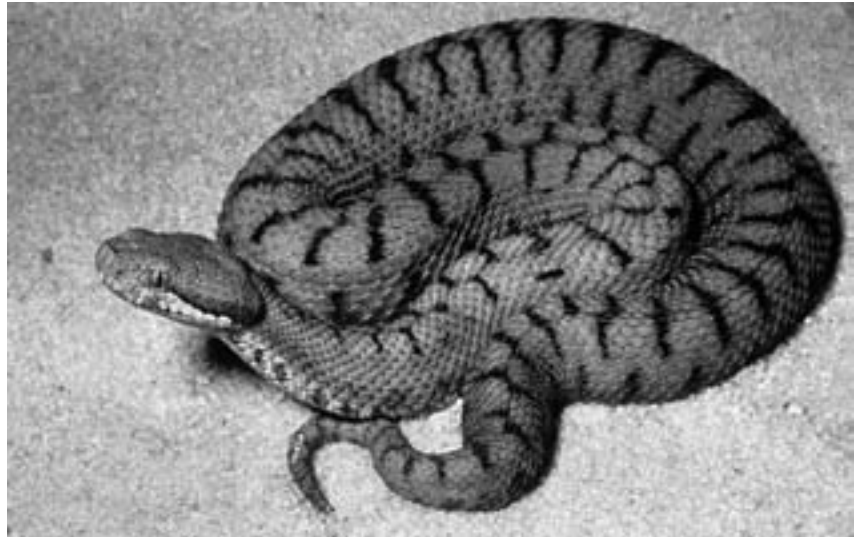
Timber Rattlesnakes (*Crotalus horridus*) are long-lived and slowly maturing snakes. Populations throughout the distribution of the species in the eastern United States have been negatively impacted by habitat alteration, poaching, and vehicular traffic. Over a three-year period, FOSTER ET AL. (2006. *Bulletin of the Chicago Herpetological Society* 41:147–148) surveyed habitats and potential hibernacula at a site in Clark County, Illinois where numerous recent, credible reports of Timber Rattlesnakes had occurred. Finding no rattlesnakes, the authors concluded that the population had been extirpated. Because snakes encountered in the area in the past had been killed despite laws protecting this species in the state, education must be an integral part of conservation strategies in Illinois and throughout the species' range.



Populations of Timber Rattlesnakes (*Crotalus horridus*) throughout the eastern United States have been negatively impacted by habitat alteration, poaching, and vehicular traffic.

## Changes in an Italian Snake Fauna

Eight species of snakes have been recorded from a protected area in central Italy. FILIPPI AND LUISELLI (2006. *The Herpetological Journal* 16:29–36) compared recent survey data with those collected 10 years previously. Although more species (8 vs. 6) were found during the recent survey and a slight rise in the species diversity index was recorded, the species dominance index increased dramatically. This was largely due to a relative increase in the most abundant species (*Coluber viridiflavus*) and a



The European Asp (*Vipera aspis*) was one of two species negatively affected by clearing of brush at an archaeological site in central Italy.

decline in the relative abundance of other species. Two species (*Elaphe longissima* and *Vipera aspis*) apparently were affected negatively by clearing of brush at an archaeological site. Documenting such declines is particularly relevant in Europe, where many protected areas are set aside for archaeological or historical rather than biological reasons.

## Unsuccessful Reintroduction

Eighteen years after 29 Mugger Crocodiles (*Crocodylus palustris*) were reintroduced into the Neyyar Wildlife Sanctuary, Kerala, India. JAYSON ET AL. (2006. *The Herpetological Journal* 16:69–76) indicated that the effort was a failure. Although fishes provided ample prey for smaller crocodiles, large mammalian prey was insufficient for larger animals. Crocodile attacks on livestock were reported within two years of rein-



Efforts to reestablish a population of Mugger Crocodiles (*Crocodylus palustris*) into the Neyyar Wildlife Sanctuary, Kerala, India, failed.

roduction, and 35 attacks on humans (two of which were fatal) have occurred. Nine crocodiles were removed to reduce conflicts, but the local population does not support the conservation of crocodiles under existing conditions.



Lesser Earless Lizards (*Holbrookia maculata*), such as this individual from Sumner County, have all but disappeared in Kansas.

## Earless Lizards Disappearing in Kansas

Although once abundantly (albeit spottily) distributed throughout the western two-thirds of Kansas, Taggart (2006. *Kansas Journal of Herpetology* 19:10) noted that the Lesser Earless Lizard (*Holbrookia maculata*) has all but disappeared in Kansas within the past 10 years. Causes are unknown.

BARNEY OLDFIELD, WWW.LIZARDSANDLANDSCAPES.COM

JOHN TASHJIAN

SUZANNE L. COLLINS, CMNH

RUCHIRA SOMANVEERA

## NEWSBRIEFS

**Snake-spotting May Have Helped Humans Evolve**

Snakes may make people jump for a good reason — human close-up vision may have evolved specifically to spot these reptiles. Humans, monkeys, and other primates have good color vision, large brains, and use their vision to guide reaching and grasping. Although some scientists believe these characteristics evolved together as early primates used their hands and eyes to pick fruit and other foods, Lynne Isbell, a professor of anthropology at the University of California–Davis, believes they may have evolved to help primates evade snakes.

“A snake is the only predator you really need to see close up. If it’s a long way away it’s not dangerous,” said Isbell, who has published her theory in the *Journal of Human Evolution*. Neurological studies show that the structure of the brain’s visual system seems to be well connected to brain structures involved in vigilance, fear, and learning, she said.

Mammals evolved about 100 million years ago and fossils of snakes with mouths big enough to eat those mammals appeared at about the same time, she pointed out. Other predators, such as big cats, hawks, and eagles, evolved later. Venomous snakes evolved about 60 million years ago, which forced primates to

get even better at detecting them. “There’s an evolutionary arms race between the predators and prey. Primates get better at spotting and avoiding snakes, so the snakes get better at concealment, or more venomous, and the primates respond,” Isbell said. No dangerously venomous snakes occur on Madagascar, and lemurs, which only live on that large island and which have poor eyesight, have not evolved much in other ways in the past 60 million years, either, Isbell added.

*Reuters News Online*  
20 July 2006  
Washington, D.C.

**State Wildlife Agent Targets Black Market for Turtles on Internet**

Box turtles are known for their lethargic pace and tough shells. But lately the Alabama-native reptiles are becoming a fast-moving commodity on an illegal black market. Experts say the animals are going to need more than shells to protect themselves from unlawful turtle-catchers. Lt. Michael Bloxom is an Alabama Wildlife and Freshwater Fisheries Division officer who is designated to help them. He spends part of every workday looking for turtles, deer, snakes, and

other Alabama animals for sale on the Internet. Recently, his efforts paid off, leading to the arrest of two couples in Wedowee.

According to Randolph County Assistant District Attorney Amy Newsome, Porsha and Wayne Price and Daniel and Rebecca Smith of Wedowee were arrested and convicted of possessing protected animals for sale earlier in July. Police say the four had been selling endangered Eastern Box Turtles (*Terrapene carolina carolina*) online and mailing them to buyers around the country and possibly abroad. The two couples had no connection to each other that police can find and claimed they did not know selling the turtles is illegal. All four spent a short time in jail before being released to 24 months of probation, paying \$100 fines, and forfeiting money they earned in the sales.

The two Wedowee couples are not the only people involved in the illegal capture and sale of turtles in Alabama. Bloxom said Eastern Box Turtles mostly are being sold as pets at flea markets or shipped to “turtle farms” in Louisiana and Arkansas. Farmers who want to breed the reptiles pick up other turtles. Some farmers breed turtles to sell the eggs or hatchlings as pets, Bloxom said. Others breed the turtles for food.<sup>1</sup> In Louisiana and parts of Asia, Bloxom said, farmers inject the turtles with hormones and slaughter them like chickens every year. Turtles are a traditional source of meat in Cajun cuisine. “Within a year they’ve got an eating-sized turtle,” Bloxom said.

For the farmers, capturing turtles in the wild makes economic sense. “When you want to start a turtle farm, where do you start?” Bloxom asked. “You can get these little hatchlings and wait five or 10 years for them to mature or go into the wild and catch some breeding-sized turtles.”

But turtle catching can create a strain on the environment, especially



ROBERT POWELL

The evolution of snakes with mouths big enough to eat mammals may have forced primates to develop close-up vision to detect them.

<sup>1</sup> Editor’s note: Box Turtles (genus *Terrapene*) frequently consume poisonous fungi and may retain toxins that could be passed to anyone eating the meat.



SUZANNE L. COLLINS, GWAP

Populations of Eastern Box Turtles (*Terrapene carolina carolina*) in Alabama have been declining due to illegal collection for sale at flea markets or to turtle farms in Louisiana and Arkansas.

when the turtles are endangered like the box turtles, which have been on the federal endangered species list since 1973. Bloxom said that in the late 1990s, the number of turtles in Weiss Lake declined dramatically because of turtle-catchers. Turtle populations haven't recovered, Bloxom said.

State lawmakers set a catch limit of 10 turtles per day after seeing the declining numbers in Weiss Lake. Turtles can provide an important part of the ecosystems where they live, eating insects and decaying organic material, said Kevin Jenne, a biologist at the Anniston Museum of Natural History. "They're another link in the food chain," he said. "If you get rid of them, there may be too many worms here or too many bugs there."

Said Bloxom: "Just think if everyone thought 'Hey I can get on the computer and make a hundred bucks a turtle.' There wouldn't be any turtles left." Jenne said the reptile trade took off in the 1990s and has not slowed since.

Snakes and lizards have been imported into the U.S. from all over the world, leaving other areas with greatly reduced numbers of indigenous animals. "If something becomes a fad, some local will say 'Hey I can make some money off of this' and go catch and sell native animals," Jenne said. Turtle catchers typically bait partially submerged boxes or small, round fishing nets with dead fish and collect the turtles. Once the turtles are caught, they usually are placed in burlap sacks with 30 or 40 other turtles

and put on trucks to be hauled as far away as Arkansas. "When you get them in there in June or July, it becomes like an oven in there for them," Bloxom said.

Box turtles first were placed on the federal list of endangered species in 1973 because the numbers of young turtles being found was lower than expected. Since turtles often live much longer than humans, the plentiful numbers of adults still may be seen in 20 years. But when that generation dies out, biologists like Jenne fear the younger turtles may not be able to replace them.

All turtles have a "4-inch rule," Jenne said. Turtles whose shells are less than 4 inches around cannot be bought or sold. This is to protect turtles that have not reached sexual maturity, Jenne added.

Bloxom said box turtles are not the first species in Alabama that the demands of the retail market have threatened. In the 1990s, freshwater mussels, which can be used for the production of cultured pearls, and paddlefish, sought for their caviar, were in such high demand that laws were passed to keep the species from being wiped out. Recently, Bloxom and his agents have learned of truckloads of bullfrogs and crawfish being shipped out of the state. "That's not illegal, but it's our job to find out if that is going to cause a problem," he said.

Even deer have become a popular export for some traffickers. People in neighboring states will pay good money for live deer to stock their hunting

reserves, Bloxom said. "We may be worrying about turtles today and deer tomorrow," he said.

Andy Johns

*The Anniston Star*

(<http://www.annistonstar.com/>)

2 August 2006

### First Successful Breeding of Released Blue Iguanas in the Salina Reserve, Grand Cayman

In December 2004, thirty-two Grand Cayman Blue Iguanas (*Cyclura lewisi*) were released into the National Trust Salina Reserve, inland from the Queen's Highway. The iguanas had been reared in captivity to two years old.

A year later, an additional 73 two-year-olds were released in the same areas of the Salina Reserve. In the summers of 2005 and 2006, these released iguanas were monitored by teams of local and international volunteers, and this year, three females from the 2004 release were seen digging nests to lay their eggs.

On 8 September, one of those nest sites had developed a hole, indicating that the eggs inside may have hatched, and the hatchlings dug to the surface. The nest has now been carefully excavated, and three perfect, hatched eggshells were recovered from the nest chamber a foot underground. The hatchlings have probably dispersed in search of safe retreats, and have not yet been sighted.



FRED BURTON

Blue Iguanas (*Cyclura lewisi*) bred successfully for the first time in the Salina Reserve since the Blue Iguana Recovery Program began restoring the population.

This landmark event is the first time successful reproduction of Blue Iguanas in the Salina Reserve has been seen, since the Blue Iguana Recovery Program began restoring a population there. The other two nests, which were laid later in the summer, are still being monitored.

### Butler's Garter Snake and Endangered Species Acts

#### Threatened by Wisconsin Legislature

The Wisconsin Legislature, usually known for protecting the state's natural resources, has recently taken significant action in regards to the Butler's Garter Snake (*Thamnophis butleri*). In Wisconsin, this species is listed as "Threatened," and is protected against take in areas where it is found. Its very small range in the state exists primarily in the rapidly developing greater Milwaukee area. The majority of existing habitat for the Butler's Garter Snake is on private land. Efforts to protect and preserve the snake on these lands has resulted in a growing conflict with regional developers, supported strategically and politically by the Milwaukee Builder's Association and to a lesser degree by the real estate industry. Two major efforts have been made to delist the snake, the second of which is pending. Wisconsin's legislative Joint Committee for the Review of Administrative Rules (JCRAR) voted to delist the snake as of 1 October 2006 if the Department of Natural Resources (DNR) does not take significant steps to reduce the impact of protection on the development community. In their decision, the committee put forth no scientific evidence that the Butler's Garter Snake should have its Threatened status removed. Furthermore, the steps they required of the DNR were unreasonable and cannot be met in the time allotted.



GARY CASPER

A committee of the Wisconsin legislature has voted to delist Butler's Garter Snake (*Thamnophis butleri*), currently listed as threatened in the state.



Some of the participants at the Horned Lizard Working group meeting at the Windmill Ranch in Texas. Representatives of universities (Texas Tech University, University of Texas), the military (Texas Army National Guard, Moody Air Force Base in Oklahoma), the state (Texas Parks and Wildlife), and a zoo (Fort Worth Zoo) are shown, demonstrating the diversity of groups interested in the conservation of Texas Horned Lizards (*Phrynosoma cornutum*).

If the delisting takes effect, it will be the first time in the nation's history that a listed species has been delisted for economic reasons and without sound scientific data driving the decision. Such an action would set a dangerous precedent for species protected under both state and federal Endangered Species Acts.

#### Horned Lizard Working Group

The Horned Lizard Working Group met 15–17 September 2006, at the Windmill Ranch, west of Snyder, Texas. The working group was formed in 2005 to bring together regional biologists and land managers and to discuss research priorities for the conservation of Texas Horned Lizards (THL: *Phrynosoma cornutum*). This year's program expanded to include Flat-tailed Horned Lizards (FTHL: *P. mcallii*). We hope to see further expansion in the future.

Eleven speakers from Texas, Oklahoma, Colorado, and Arizona presented recent and ongoing research related to Horned Lizards (*Phrynosoma*). Topics included life history, seasonal and daily activity patterns in wild and urban populations of THL, effects of burning

and grazing management regimes on THL, citizen monitoring program for THL, and captive care and husbandry of THL at the Ft. Worth Zoo, conservation genetics of the FTHL, GIS model of niche evolution in Horned Lizards, and management of Red Harvester Ants (*Pogonomyrmex barbatus*). A round-table discussion of the importance, necessity, and difficulties of reintroducing THL to parts of its former range completed the primary activities of the meeting. Abstracts for the 2006 meeting can be read online at the HLCS Webpage: [www.hornedlizards.org](http://www.hornedlizards.org).

Attendees noted that service and support by the staff of the Windmill Ranch was impeccable. Next year's meeting was discussed with board members of the Horned Lizard Conservation Society to coincide with a larger national meeting in Fort Worth, Texas, in mid to late summer. Next year's meeting will strive to include research efforts on additional species of *Phrynosoma* and management and conservation issues related to these lizards. The HLCS also intends to provide small research grants for the 2007 field season, and an announcement should appear on the Society's web site in the near future.

### Conserving One of the Rarest Reptiles in North America: The Louisiana Pine Snake

The Southeast and Southwest Regions of the U.S. Fish and Wildlife Service are collaborating with several partners to conserve the Louisiana Pine Snake (*Pituophis ruthveni*), which inhabits longleaf fire forests in Louisiana and Texas. The species produces the largest egg (7.5–12.5 cm) and hatchling (46–56 cm) of any North American colubrid snake. A 2004 Candidate Conservation Agreement provides a framework that is being used to develop a comprehensive cooperative plan for recovery, so that the species may not need to be listed. Specific goals, strategies, and success metrics will be established for each conservation category, which includes: (1) ecosystem conservation; (2) habitat management; (3) monitoring and trapping; (4) captive-breeding; (5) research; (6) outreach and education, and (7) integration of public and private-land conservation efforts. Based on the foundation established by the Agreement, the 2006 Annual Louisiana Pine Snake meeting in early August fostered growing interagency and private-land owner cooperation. It provided an active forum that stimulated lively debate and discussion. The meeting was hosted by the U.S. Forest Service in Nacogdoches, Texas with strong support from Arlington, Texas and Lafayette, Louisiana field offices. Participants

included state wildlife agencies in Louisiana and Texas, the National Forest of Louisiana and Texas, the U.S. Forest Service Southern Research Station, the Department of Defense at Fort Polk, Louisiana, the Natural Resource Conservation Service, The Nature Conservancy, the Texas Department of Transportation, Stephen F. Austin University, Texas A&M University, the Ellen Trout Zoo of Lufkin, Texas, and private landowners that included Temple-Inland, International Paper, and TimberStar. Video footage taken at the meeting of this multi-partner, two-state CCA will be one of three agreements featured in a video on candidate conservation agreements that is in production by the U.S. Fish and Wildlife Service's National Conservation Training Center in Shepherdstown, West Virginia.

### Bolson Tortoise Returns to Its Historic Range

The endangered "Tortuga Grande," as its known in the southern Mexican states of Chihuahua, Coahuila, and Durango, last week returned to its historical northern range on the Armendaris Ranch in eastern Sierra County. "You have been invited to celebrate the return of the Bolson Turtle (*Gopherus flavomarginatus*) to its native Chihuahuan grassland; this is its habitat," Ladder Ranch manager Steve Dobrott told a couple



The Bolson Tortoise (*Gopherus flavomarginatus*) has returned to its native Chihuahuan Desert grassland habitat in New Mexico.

dozen visitors who gathered at the Armendaris on 15 September to witness the reintroduction.

The Ladder Ranch in western Sierra County was originally identified as the reintroduction site, but the Armendaris more closely resembles the turtle's natural habitat. Both ranches are owned by media tycoon and conservationist Ted Turner. The Turner Endangered Species Fund is spearheading the reintroduction, as it has for many an endangered species, including most recently the Aplomado Falcon (*Falco femoralis*) last month at the Armendaris.

Myles Traphagen, biologist for the Turner Endangered Species Fund, said the Bolson Turtle enjoys the highest designation of endangered species internationally, but it has been a challenge keeping the species viable. For one, the scientific community didn't identify the species until 1958, when a group of biologists from the University of Illinois were visiting Mexico on an unrelated project and encountered some locals who were using the turtle's shell, or carapace, as a chicken feeder. Asked about the shell, the villagers said it came from "la tortuga grande."

According to scientific documentation provided by Traphagen, the Bolson Tortoise is the largest terrestrial turtle in North America. It is capable of obtaining carapace lengths between 14 and 16 inches, with undocumented reports of them reaching 39 inches in length and weighing 77 to 100 pounds.

Several factors contributed to the species' decline. High on the list is their status as a food source. "It's a big, slow-moving piece of meat," Traphagen noted, adding climate change and urbanization also are responsible for their declining numbers. The species also has a low suc-



Louisiana Pine Snakes (*Pituophis ruthveni*) inhabit longleaf fire forests in Louisiana and Texas. A 2004 Candidate Conservation Agreement provides a framework that is being used to develop a comprehensive cooperative plan for recovery, so that the species may not need to be listed.



cess rate when it comes to reproduction. Although a female tortoise is capable of laying about 10 eggs per year, the young are susceptible to a long list of predators, including rats, ravens, and snakes. On the plus side, turtles can live up to 100 years and can survive for up to a year without water.

An initial population of seven tortoises will inhabit the eight-acre pens, which are enclosed by a knee-high fence. Each pen contains 14 burrows that were constructed by cutting 18-inch plastic sewer pipes in half, digging a trench and building a Quonset-hut-style enclosure angled into the ground.

While the turtles are being reintroduced on the Armendaris, a hatchery will be built on the Ladder, according to Traphagen. "This is a pretty historic event," Armendaris Ranch manager Tom Waddell noted at the outset of the release. While biologists are certain that the Bolson Tortoise's historical range extended all the way to the northern edge of the Chihuahuan Desert, no traces of the species have been uncovered at the Armendaris. "I like to think they lived here at one time, but were buried by the sands of time and the ever-blowing winds of the Jornada (del Muerto)."

Tony A. Archuleta

HERALD Reporter

TorC Times, Truth or Consequences,  
New Mexico

### Rare Finds: Expedition Uncovers Caribbean Plants

A team of scientists from Fairchild Tropical Botanic Garden embarked on an expedition to Jamaica's rugged Cockpit Country to find some of the Caribbean's rarest plants, some of which have not been seen for 100 years. In three weeks of searching, the team rediscovered eight plants, found two species new to science, and began cataloging the rich biodiversity of the Caribbean island, home to plants not seen anywhere else in the world. The remote area, with bowl-shaped valleys surrounded by deceptively benign-looking hills, aside from its concentration of plant diversity, is the source of 40 percent of the water in Jamaica. Its tapestry of plants includes more than 1,000 species within 500 square miles. The entire Florida Peninsula — at

66,000 square miles — holds only about 4,000.

Among the targets of the six Fairchild biologists and horticulturists: the eight-foot *Euphorbia alata*, a poinsettia relative that hasn't been viewed since 1906. Rugged conditions have protected these hills, creating a refuge for ferns, *Lypanthes* orchids, birds, the endangered Jamaican Boa, Black-billed Parrots, and a swallowtail butterfly with wings up to eight inches across. Relatively isolated and without roads, the area nevertheless is coming under pressure as tons of sapling trees are cut every year for growing yams, weeds follow people who are pushing in from the edges, and aluminum companies prospect for bauxite mines.

One of the team's resources was botanist George Proctor, who has lived in Jamaica since 1949 and is the resident expert on the island's plants. Proctor, 86 and still working, surveyed the region 30 to 40 years ago. He accompanied the team for a few days and has a contract with Fairchild to write a checklist of the plants of the Cockpit Country. Although unable to climb with the team, Proctor was able to tell the scientists exactly where to look.

Fairchild is working with Florida International University, the University of Puerto Rico, the Smithsonian Institution, and the U.S. Department of Agriculture to catalog the Caribbean's plant diversity. Through their research, Fairchild scientists tallied 169 endemics in this biodiversity hot spot; Cockpit Country claims 64 of these. Information collected on this expedition will assist Jamaican environmental and forestry agencies with planning environmental protection policies.

Georgia Tasker

gtasker@miamiherald.com

18 October 2006

### Farmers Lobby FDA for Overturn of Long-time Turtle Ban Citing New Study on Salmonella

The Food and Drug Administration is the target of a lobbying campaign by a handful of farmers to reverse a three-decade U.S. ban on selling baby turtles. The agency prohibited sales in 1975, after the then-popular pets were blamed for causing as many as 280,000



DARRELL BEMERE, WORLD CHELONIAN TRUST

Turtle "farmers" are lobbying the Food and Drug Administration to reverse a 1975 ban on the sale of turtles with shells less than four inches long. Their efforts center on Red-eared Sliders (*Trachemys scripta elegans*).

*Salmonella* infections a year, mostly in children. The FDA edict almost completely barred U.S. commerce in "animals commonly known as turtles, tortoises [or] terrapins" with shells less than four inches long. The size was selected largely because bigger turtles couldn't easily be popped into children's mouths.

Their efforts center on the Red-eared Slider (*Trachemys scripta elegans*), a turtle native to areas that include the Mississippi Delta and watery central and southern Louisiana. As long ago as the late 1950s, growers began stocking man-made breeding ponds with adult turtles, which laid their eggs on the ponds' sandy banks. Farmers collected the eggs, hatched them, and, by the 1970s, were selling millions of quarter-size, green and yellow babies each year. The turtles, which can grow to a foot long and live for more than three decades, were typically sold in the U.S. as pets.

That's the problem, the FDA says. Turtles often carry *Salmonella* in their digestive tracts. Infected turtles can convey the bacteria to their eggs (the FDA also restricts the sale of turtle eggs in the U.S.). Although bacteria-carrying turtles may not show symptoms, they can spread *Salmonella* to their handlers. Ingesting it — typically after failing to wash hands after playing with a turtle — can lead to vomiting, fever, and cramps, even death in vulnerable patients. After the 1975 restriction, turtle-related infections nearly vanished.

Anna Wilde Mathews

Wall Street Journal

4 October 2006

## O B I T U A R I E S

*In Memoriam:*  
Ella “Marie” Poyner  
(1963–2006)



Marie Poyner and one of her beloved pet Green Iguanas.

Ella “Marie” Poyner was born Woo Mon Chue in Taiwan on 25 January 1963, and was adopted by the Poyner family in February 1963, moving with them to National City, California.

Marie’s dream of becoming a veterinarian went unfulfilled. Nevertheless, she never hesitated to help animals (and people) throughout her life. Marie cared for many iguanas, including Baby and Dragon, who came into her life in 1994. She read extensively on iguana husbandry and veterinary care in order to provide the best possible life for her charges. Marie touched the hearts of many people, sharing her knowledge through online forums and providing assistance to iguanas in distress, even going so far as to purchase and ship supplies to animals in need.

Marie was a longtime IRCF member who provided gift memberships for her friends in order to encourage them to become involved with conservation. She also was an enthusiastic supporter of the Blue Iguana Recovery Program. To make a donation honoring Marie, please contact [Des@IRCF.org](mailto:Des@IRCF.org).

Marie passed away in Cleveland, Ohio on Sunday, 10 October 2006. She is survived by family, many friends, and her three iguanas. She will be sorely missed by all, for her sharp wit, delightful personality, and extensive iguana knowledge. Rest in Peace, Marie.

*In Memoriam:*  
Margaret “Meg” Stewart  
(1927–2006)

Distinguished Teaching Professor Emerita of Biological Sciences Margaret “Meg” Stewart passed away on 2 August 2006 after battling pancreatic cancer. Stewart was known for a lifetime of dedication to science and biological conservation. An outstanding teacher, she was particularly interested in mentoring female students. Her graduate trainees are themselves a distinguished group of scientists and academics.

Known internationally for her studies of amphibians and reptiles, Stewart officially retired in 1997, although she continued to serve as founding director of the Graduate Program in Biodiversity, Conservation, and Policy. Associate Professor George Robinson of the Department of Biological Sciences said, “She spent a lifetime doing the difficult things that others shirked, and her fierce Scots integrity stands out in all her accomplishments.”

Stewart’s first love was frogs. An African frog was named for her (*Phrynobatrachus stewartae*) and is known as Stewart’s Puddle Frog. She also studied the Mink Frog (*Rana septentrionalis*) of the Adirondacks, the frogs of Jamaica, and the Coqui (*Eleutherodactylus coqui*) of Puerto Rico. Her distinguished work on the Coqui led to an honorary doctorate from the University of Puerto Rico–Mayagüez in 1996.

In 1979, Stewart became the first woman to lead a professional herpetological organization when she was elected president of the Society for the Study of Amphibians and Reptiles (SSAR). In 2005, the American Society of Ichthyologists and Herpetologists (ASIH) awarded her its Robert K. Johnson Award for excellence in service to the society and the ASIH’s highest award, the Henry S. Fitch Award, for long-term excellence in herpetology.

Survivors include her husband, George E. Martin, mathematics professor emeritus at the University at Albany, and her brother, John M. Stewart, a renowned peptide chemist at the University of Colorado Medical School in Denver.



Margaret “Meg” Stewart in the mid-1980s at El Verde Field Station in Puerto Rico.

## IRCF ON THE MOVE

### IRCF Conservation Champion Award: Stesha Pasachnik

Stesha Pasachnik is the first recipient of the new IRCF Conservation Champion Award. Stesha received the award to allow her to travel to the IUCN Iguana Specialist Group Meeting in Puroto Rico to present critical information about the status of *Ctenosaura* and to generate conservation interest in the genus. Stesha spent six months in Honduras from February 2006 through July 2006 collecting data (see article on p. 264), and will return again next year to continue her efforts.



MARE RUNIT

Stesha Pasachnik, from the University of Tennessee, will be working with Zootropic collecting tissue samples of *Ctenosaura palearis* for genetic analysis in 2007. Stesha, the first recipient of the IRCF Conservation Champion award is shown here holding a *Ctenosaura similis* on the island of Utila, Honduras.

### Project Heloderma: Meeting in Guatemala City

A Project Heloderma meeting was held at the Zootropic office in Guatemala City, Guatemala on 26 September 2006 to discuss the next phase of the project and the distribution of funds collected from the Daytona Expo auction. Attending the meeting were Rodrigo Botran, Luis Alvarado, and Daniel Ariano from Zootropic, Brad Lock from Zoo Atlanta, and John Binns from the IRCF.

Action priorities discussed included: Environmental education, research, land acquisition, and the *in situ* breeding facil-

ity. Resolved were: (1) Continuing support for educational material, such as 1000 T-shirts to be distributed to local schools in the Motagua Valley, an awareness poster, school supplies, and other handout materials. Five hundred dollars was allotted, with additional funds covered by individual fundraising campaigns. (2) Support for research equipment needs through 2007; \$2,500–3,000 was allotted to purchase 15 radio-tracking transmitters, handheld GPS units, and AVID chips. Not funded but discussed as a potential independent campaign was the need for a field vehicle and compensation for a local field assistant. (3) The major decision from the meeting was approval to purchase a 285-acre plot of land (\$30,000) as a reserve and breeding facility site. The remaining balance of auction funds (\$12,500) was allocated toward this purchase. Project Heloderma partner San Diego Zoo has since contributed \$5,000, and Toronto Zoo and Jacksonville Zoo also have promised contributions. The remaining funds needed to purchase this critical property amount to about \$11,000. Please visit IRCF.org for more information. (4) The breeding facility was not discussed in any detail to avoid sidetracking the meeting's purpose. Some of the basic topics discussed were construction of the facility with the aid of local labor, facility location at the base of the property, on-going research to determine breeding strategies, long-term ideas about a visitor attraction such as the Grand Cayman Blue Iguana Breeding and head-starting facility.



JOHN BINNS

The Project Heloderma meeting ran late into the evening. Pictured from left are Brad Lock, Zoo Atlanta, Luis Alvarado, Zootropic, Rodrigo Botran, Zootropic, and Daniel Ariano, Zootropic. Not shown, John Binns, IRCF.

The IRCF, Zoo Atlanta, and Zootropic once again thank all the contributors and volunteers from the Daytona Expo auction as well as the San Diego Zoo for contributions; together these have already made a significant impact on Project Heloderma's progress towards saving the Guatemalan Beaded Lizard.

### Project *Ctenosaura palearis*: A Chance for Survival

While visiting Guatemala, John Binns, IRCF, opened a separate discussion about *Ctenosaura palearis* (the Paleate Spiny-tailed Iguana, also known as the Guatemalan Black Iguana), proposing the inclusion of a recovery action plan for this species under Zootropic's umbrella. *Ctenosaura palearis* appears on the IUCN Red List as Critically Endangered, and its known distribution range lies within the same area of the Motagua Valley as that of the Guatemalan Beaded Lizard. Specifically, the recovery action plan would involve the inclusion of *C. palearis* in Zootropic's educational program, the development of a research component with the aid of college students, and a primary focus on utilizing the breeding facility to raise animals for repatriation as soon as possible.

The proposal was unanimously accepted. Since returning from Guatemala, Daniel Ariano and field assistant Gilberto Salazar have located four males and one female *C. palearis*, and currently are monitoring these animals. Paola Coti, a Guatemalan undergraduate college student, has already taken the initial steps to develop her research program (Daniel Ariano is her advisor) to determine distribution, ecology, and the conservation status of *C. palearis*. Stesha Pasachnik, University of Tennessee, will be assisted by Zootropic to obtain permits to take *C. palearis* tissue-samples during her 2007 visit to the Motagua Valley. Stesha is working on *Ctenosaura* genetics.

Within a short few months, Zootropic has provided hope for this species' future, after an extended period during which no action was being taken

to save this species. Currently this is an unfunded project, and the ongoing work is being conducted without compensation. The IRCF website will soon have a section dedicated to the project in order to disseminate information and provide



DANIEL ARIANO

In their initial effort to locate the Guatemalan Black Iguana (*Ctenosaura palearis*), Daniel Ariano and Gilberto Salazar found four males and one female. The male depicted above is one of the individuals currently under observation.

a port to receive contributions. If you are interested in contributing to this effort, please contact John Binns (jfb@ircf.org).

**NARBC, Anaheim, California: Ingenuity**

On 8–9 September, with the entire staff committed elsewhere, IRCF didn't have the human resources necessary to man a booth at the NARBC in Anaheim, California. Improvising, Desiree Wong, IRCF Public Relations, loaded up her



Desiree Wong poses with new IRCF member, Nigel Marven.

messenger bag with IRCF material, armed herself with a camera, and headed for Anaheim. She secured five new members, including the well-known personality Nigel Marven, who praised IRCF's conservation efforts.

**Indy Reptile Expo: IRCF Makes its Debut**

Kacie and Joe Ehrenberger and Dee Asbury manned the IRCF booth at the Indy Reptile Expo in Indianapolis, Indiana, on 4–5 November 2006. Kacie, Joe, and Dee secured 15 new members and contributions towards our conservation programs. Thanks guys!



JOE EHREMBERGER

Kacie Ehrenberger, center and Dee Asbury, right, assist a new IRCF member in Indianapolis.



JOE EHREMBERGER

IRCF members Tell Hicks, left, Bob Ashley, center, and Joe Ehrenberger, right.

**San Jose Reptile Show: Teaming-Up**

Our first convention in the San Francisco Bay Area (San Jose, California, 11–12 November) was manned by the Binns family and Joel and Mason Friesch. This show was a joint venture with Michael Kern (The Gardens of Eden; www.TheKernFamilyZoo.com), who supported our efforts and donated the proceeds of his sales at the show to the IRCF. Thank you, Michael! Our *Cyclura* ambassador "Izzy" was on station for a total of 16 hours and drew massive



JOHN BINNS

Joel Friesch (behind the table at left) and Sandy Binns (right) are assisted by Joel's son, Mason (center).



JOHN BINNS

"Izzy" was on display each day for eight hours delighting visitors, including members of this family getting their first look at an adult Cuban Iguana.



JOHN BINNS

The IRCF booth attracted large crowds throughout the Show. Gang Chen, a photo-journalist and correspondent for the China News Service (far left), interviewed staff about IRCF conservation efforts.



JOHN BINNS

Sandy and John Binns's son, Don, and his fiancée Kim Claussen, took turns manning the booth. Don (facing forward) discusses the problems faced by wildlife today.

crowds. Sandy Binns gave two presentations on conservation awareness. The show resulted in 11 new members and contributions towards our conservation efforts.



JOHN BINNS

Sandy Binns gave two conservation presentations during the San Jose Reptile Show.

**Member Highlight:  
Jake Edmondson**

Jake Edmondson, an enthusiastic high school junior in Virginia, aspires to be a herpetologist one day. He has joined the IRCF and is promoting membership at his school and at reptile shows in his community. His passion for reptiles is matched by his energy to sign up new members. Armed with copies of the Journal, membership forms, and brochures, he has attended shows, made presentations to his class, and is trying to get the local paper to publish his IRCF promotion efforts.

**Going, Going, Gone?  
Animals on the Brink of Extinction  
and How You Can Help.**

The clock is ticking: Can it be stopped? Many scientists believe that we are on the brink of a new mass extinction, with at least one million species in danger of not surviving to the end of the century. Can we turn the tide, changing the way we



Jake Edmondson, IRCF member, displaying a recent issue of the journal and wearing the limited edition Project Heloderma T-shirt, has been actively promoting the Foundation at his school and at local shows.

live and giving these creatures a chance? In the very first book of its kind, 100 conservation organizations from around the world each nominate a species — animal or plant — that it believes is most threatened. Every one selected received a two-page spread, with magnificent photography, fascinating facts, details on why it is endangered, and information on how we can save it. The book provides complete contact details for all featured organizations (including IRCF, which featured the Blue Iguana Recovery Program). (Think Books, hardback, illustrated, 216 pp., ISBN:1845250273).

**IRCF Staff Announcement:  
Michael Kern, COO**

We are pleased to announce that Michael Kern has officially joined the IRCF as Chief Operating Officer. Michael has spent the last 24 years as partner with the global technology management and consulting firm Accenture, where he helped large Fortune 500 companies apply technology to create business advantages.

Michael is also an accomplished wildlife photographer and writer. He won the 2005 Nactus Award and two International Herpetological Symposium Best-in-Show Awards for his wildlife photography.



Additionally, his writing and photography have appeared in several leading nature and photography magazines. By adding Michael's fresh perspective, business acumen, ability to manage complex programs, and photographic and writing skills to the already strong team at IRCF, the organization will be able to address even more efficiently the conservation needs of reptiles and the ecosystems that support them. Michael, his wife Yuki, and their two boys Josh and Alex reside in Palo Alto, California.





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## Editors' Remarks

### The Need for Collaboration

During World War II, "collaboration" came to mean something very negative: Helping the occupying Nazis administer their reign of death. In science, too, the word used to have uncomfortable implications. Scientists were expected to be loners, working by themselves in glorious isolation to reduce distraction and intellectual pollution. Today, however, the pejorative meaning of the word is becoming less and less common. In science, collaboration is now typically seen as an essential component of successful research.

What has changed is the complexity of the projects with which we are dealing and the amount of knowledge needed to address each element. For example, zoos once dealt only with housing animals. Then, zoo personnel had to learn to breed them, which required an improved understanding of nutrition and behavior. In addition, modern zoo work involves endocrinologists, who monitor and interpret hormone levels, and veterinarians, who focus on health. In the meantime, however, we've noticed that breeding animals in captivity is a hollow success, unless a natural habitat remains to which they can be returned. Enter a team of experts who study the animal in the wild and work to protect its environment. Consequently, modern zoos employ biologists of all kinds, but also rely on policy experts, lawyers, bankers, landowners, and, to make the public understand why this is all happening, a cadre of education experts. Each person is essential for a successful conservation project.

Several stories in this issue show the importance of collaboration. When the Iguana Specialist Group met (p. 278), reports from various perspectives enhanced iguana conservation. Similarly, the Horned Lizard Working Group (p. 296) brought together people from diverse disciplines. Also, one of our articles is authored by two biologists and a landscape architect (p. 272), who worked in collaboration with private landowners to prevent the arrival of invasive species on a Caribbean island.

Rather than dilute scientific expertise, as people originally feared, collaborations foster better research and conservation. Teams of experts working together toward a single goal bring a diversity of tools, experiences, and thought processes to bear on the problem, often resulting in solutions no one scientist could have conceived. We are pleased to see abundant evidence of collaboration on the pages of *Iguana*.

## Statement of Purpose

**The International Reptile Conservation Foundation works to conserve reptiles and the natural habitats and ecosystems that support them.**

The International Reptile Conservation Foundation, Inc. is a non-profit 501 c(3) California corporation.

## Membership Information

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\*The Adobe PDF is optimized for web publishing and does not provide the quality and resolution of the archival printed version, especially noticeable in photographs and complex graphics.

**www.IRCF.org**

Join Online at: [www.IRCF.org](http://www.IRCF.org)

## Membership Questions?

Email: [info@IRCF.org](mailto:info@IRCF.org), or contact AJ at 860-236-8203, or write to: IRCF, 3010 Magnum Drive, San Jose, CA 95135

## Solicitations

The IRCF encourages contribution of articles, letters to the Editor, news items, and announcements for publication in *IGUANA*. General articles can deal with any aspect of reptilian biology, including conservation, behavior, ecology, physiology, systematics, or husbandry. Submission of photographs to accompany articles is encouraged. Manuscripts may be submitted via e-mail (send to [AJ@IRCF.org](mailto:AJ@IRCF.org)). Authors of one page or more of print will receive a free copy of the journal in which their contribution appears, and will receive a PDF file of their article for distribution.

## Donations

For any donations, please include your name, address, phone number, and e-mail address.

## Advertising Policy

We advertise only non-living products (except feeder insects). For advertising rates and options contact Sandy Binns, Advertising Director, at [SB@IRCF.org](mailto:SB@IRCF.org) or 3010 Magnum Drive, San Jose, CA 95135.

# FOCUS ON CONSERVATION

## The Gharial: Back on the Brink



MATT VAUGHAN

Touted as the most successful conservation story in India for decades, the Gharial (*Gavialis gangeticus*) conservation program is in the doldrums today. Gharials are specialists in choice of habitat (only deep rivers) and prey (only fish), limiting the species' ability to survive in disturbed and marginal areas. Only about 200 reproducing Gharials remain in the wild in India and Nepal. Formerly found in almost every river system in the northern Indian subcontinent, today these large crocodylians are found only in a few protected areas disconnected by hundreds of kilometers. Gharials have been extirpated in Pakistan, Bhutan, Bangladesh, and Myanmar.

Poaching is a major threat, and fishing depletes the prey base and Gharials quickly drown when enmeshed in nets. Fishermen are not sympathetic to the plight of Gharials, which they view as rivals. Many riverbanks are seasonally taken over by farmers to grow cucumbers and others are destroyed by sand mining. Either deprives Gharials of basking and nesting sites. Water siphoned from rivers for irrigation creates extensive shallow areas that Gharials will not use. Turtle poachers use longlines with up to 1000 fishhooks that ensnare young Gharials.

Once before, in the mid-1970s, the number of wild Gharials had approached 200, triggering the much-publicized Project Crocodile. A head-starting program was so successful that it was touted as the most successful conservation project ever conducted in India and one of the most successful in the world — but little was done to involve local communities and to secure wild habitats. Today we are reaping the results of that incomplete conservation strategy.

### How can you help?

The Gharial Taskforce at the Madras Crocodile Bank is lobbying for the resumption of the Gharial rehabilitation program and for the protection of riverine habitats, coordinating conservation and education efforts, and conducting surveys on thousands of kilometers of rivers. A donation to the Madras Crocodile Bank will be instantly acknowledged and will entitle you to receive periodically the Task Force's Gharial Conservation Update. The Gharial needs your help now!

You can support the Madras Crocodile Bank Trust through the IRCF ([www.IRCF.org/gharial](http://www.IRCF.org/gharial)).

NOTE: The Madras Crocodile Bank Trust is a registered charitable trust established in 1976 for the conservation of India's three species of crocodiles. It is also an international crocodile gene bank with 2500 crocodiles representing 14 of the 23 species. The Crocodile Bank has administered and operated numerous conservation programs throughout India and is highly regarded as the premier herpetological institution in India.



HELODERMA HORRIDUM.  
(YOUNG)  
(TEHUANTEPEC.)

R. Musters. del et lith.

Musters. Exec. sculp.

The Beaded Lizard (*Heloderma horridum*) is one of only two species of venomous lizards (the other is the Gila Monster, *H. suspectum*). Because of persecution motivated by fear of a dangerous animal and habitat alteration or destruction, Beaded Lizard populations are declining throughout the range of the species. This illustration of a juvenile appeared as a colored lithograph in some printings of Albert C. L. G. Günther's *Biologia Centrali-Americana* (reproduced with permission from the 1987 Facsimile Reprint in Herpetology by the Society for the Study of Amphibians and Reptiles, Ithaca, New York). See related information on p. 300.





*Anolis (Norops) johnmeyeri* is a large anole found in Cusuco National Park, Honduras, that is unusual among anoles in that both males and females have large dewlaps with a blue central spot; females, such as this individual, have the blue spot surrounded by yellow, whereas in males, it is surrounded by red. The bright red "dots" are ectoparasitic "chiggers" (larval trombiculid mites). See article on p. 242.