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# IGUANA

CONSERVATION, NATURAL HISTORY, AND HUSBANDRY OF REPTILES

International Reptile Conservation Foundation

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JEFFREY W. ACKLEY

Dominican Anoles (*Anolis oculatus*) are ubiquitous on Dominica, but populations on different parts of the island vary consistently in color and pattern — to the extent that they were considered to be different species or subspecies until recently. See article on p. 130.





NELSON J. VELEZ ESPINET

Little is known about the biology of dwarf geckos, presumably because of their small size and secretive nature. The elevated head and tail of this male South Leeward Dwarf Gecko (*Sphaerodactylus fantasticus*) probably indicate arousal, triggered by concern over the presence of the photographer (see article on p. 130).



JOHN BINNS

Critically endangered Guatemalan Black Iguanas (*Ctenosaura palearis*) still are hunted for meat, eggs, and skins (see article on p. 142).



JOHN S. PARKERLEE, JR.

Mountains meet the sea on the Atlantic coast of Dominica, which bills itself as the “nature island” (see travelogue on p. 162).



SURESH CHAUDHARI

About 800 Gharials (*Gavialis gangeticus*) hatch each year in the Katarniaghat Wildlife Sanctuary in India, but many were washed away by monsoon floods this year (see article on p. 150).



JEFFREY W. ACKLEY

Dominican Racers (*Alsophis antillensis siboniensis*) are locally abundant on Dominica. Three short notes (beginning on p. 154) describe a failed foraging attempt, nocturnal activity, and color changes.



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## Notice!

### 2008 Guatemalan Fieldtrip and Excursion 10-17 October

Visit the IRCF website for details:  
[www.IRCF.org/projectheloderma/Fieldtrip2008.php](http://www.IRCF.org/projectheloderma/Fieldtrip2008.php)





NATALIE N. WYCZYNSKI

Populations of Lesser Antillean Iguanas (*Iguana delicatissima*) have declined or disappeared on many islands. Those on Dominica are doing well and may serve as a model for developing management strategies for other islands (see *IGUANA* 14(4), p. 222).



# An Annotated Checklist of the Amphibians and Reptiles of Dominica, West Indies

Esther A. Daniells<sup>1</sup>, Jeffrey W. Ackley<sup>2</sup>, Ruth E. Carter<sup>3</sup>, Peter J. Muelleman<sup>4</sup>, Seth M. Rudman<sup>5</sup>,  
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Travel writers have suggested that if Christopher Columbus were to take a Caribbean cruise today, Dominica might be the only West Indian island he would recognize. In an age when an ideal tropical paradise must include golf courses, five-star restaurants, towering hotels, cruise-ship berths, manicured white beaches, and swimming pools adjacent to the ocean, the drastic changes to which other destination islands have been subjected are understandable. However, an accident of geology spared Dominica from that fate. The island is a complex of volcanic peaks, the highest of which (Morne Diablotin) reaches 1,446 m above sea level, resulting in an intimidating terrain that has slowed the seemingly inevitable march of “progress.” Because level lowlands suitable for sugarcane plantations during the colonial era do not exist and tourism-oriented development is minimal, the inevitable consequences of deforestation and declining biodiversity are largely absent.

In sharp contrast, the potential for effective conservation is considerable, and Dominican authorities have taken steps to preserve two unique natural treasures: The forests, which still cover more than 60% of the island, and the animals that live in the largely natural habitats that remain. The amphibians and reptiles in particular comprise what may well be the most “natural” herpetofaunal community in the entire Lesser Antillean archipelago.

Although conserving forests and their inhabitants might not be a selling point for the vacationers to whose interests developers cater, Dominica benefits by promoting ecotourism, and markets itself as the “Nature Island.” By not competing for visitors whose sole interest is reclining in the lap of luxury, Dominica provides the chance to experience natural habitats, increasingly rare commodities that more intensely developed islands are about to lose entirely. However, in order to place a value on natural resources such as the herpetofauna, authorities must have access to reliable information about its distribution, natural history, and conservation status. Herein we present a summary of our observations on Dominica’s diverse herpetofaunal communities with the hope that it will remain relevant to coming generations.



JOHN S. PARMERLEE, JR.

Dominica (754 km<sup>2</sup>) is one of the volcanic Windward Islands in the Lesser Antilles. The rugged topography and lack of flat lowlands spared the island from the alterations (typically associated with sugar plantations) to which most other West Indian islands were subjected during the colonial period.

### Frogs (Amphibia: Anura)

*Eleutherodactylus amplinympha* (Kaiser, Green, and Schmid 1994). Anura: Eleutherodactylidae. Local name: Dominican Gounouj. English common names: Dominican Frog, Dominican Rain Frog, Dominican Whistling Frog. Endemic. These relatively small frogs (maximum male SVL 26 mm, maximum female SVL 50 mm) occur at elevations >300 m in montane rain forest, where they perch on trees, palm brakes, moss mats, epiphytes, and ferns. This species has a pointed snout and relatively large toepads. Males have bi-lobed glandular vocal sacs and produce a three-note call. Dorsal color varies from brownish to greenish to reddish, and, as in other frogs in the genus, pattern elements are highly variable. These largely nocturnal frogs are known to call by day in wet forests during or after heavy rains. The species is included on the IUCN Red List as “endangered,” primarily due to its restricted range, high likelihood of habitat loss attributable to human expansion, volcanism, or hurricanes, and the potential threat posed by chytridiomycosis, a fungal infection to which upland amphibians in the tropics appear to be particularly vulnerable.



The endangered Dominican Frog (*Eleutherodactylus amplinympha*) is restricted to moist forests at higher elevations.

*Eleutherodactylus johnstonei* (Barbour 1914). Anura: Eleutherodactylidae. No local name. English common names: Lesser Antillean Frog, Johnstone's Whistling Frog, Johnstone's Robber Frog. Lesser Antillean endemic, introduced on Dominica, other West Indian islands, and the South American mainland. These frogs are thought to have been introduced on Dominica after Hurricane David in 1979, probably with relief supplies from neighboring islands. Throughout their extended range, these small frogs (maximum male SVL 25 mm, maximum female SVL 35 mm) thrive in artificial sites such as residential gardens, agricultural areas, roadsides, and buildings from sea level to elevations of ~1300 m. This species has a rounded snout and relatively small toepads. Males have a single-lobed glandular vocal sac and produce a two-note call. Dorsal ground color usually is some shade of brown; other markings are highly variable. Where the two species occur together, *E. johnstonei* often is confused with closely related *E. martinicensis*. *Eleutherodactylus johnstonei* is a nocturnally active sit-and-wait predator with a diet composed primarily of small arthropods. Documented predators include Turnip-tailed Geckos (*Thecadactylus rapicauda*) and snakes. Recent surveys have failed



The Lesser Antillean Frog (*Eleutherodactylus johnstonei*) has been recorded from Dominica. Although it has successfully colonized other islands, where it has displaced native species, it has not been found during recent surveys, suggesting that the colonization of Dominica has failed. This frog was photographed on St. Vincent.

to document the presence of this species on Dominica and it is no longer included in the list of Dominican amphibians. This species is included on the IUCN Red List as being of “least concern,” largely attributable to its colonizing ability, which is unusual among amphibians, which generally have little tolerance for exposure to saltwater. Introduced populations on some islands compete successfully with native species, and often displace them, especially from altered habitats.

*Eleutherodactylus martinicensis* (Tschudi 1838). Anura: Eleutherodactylidae. Local name: Tink Frog. English common names: Martinique Frog, Martinique Robber Frog. This Lesser Antillean endemic is presumably native on Dominica, although it may have been imported inadvertently by early European settlers. These small frogs (maximum male SVL 32 mm, maximum female SVL 47 mm) occur from sea level to at least 1,250 m in varied natural and altered habitats that include rain forests, dry woodlands, banana and coconut plantations, and gardens. This species has a pointed snout and relatively small toepads. Males have a bi-lobed glandular vocal sac and produce a two-note call. Dorsal color is brownish to reddish; other markings are highly variable. These nocturnal frogs may call by day during or after



Like many relatives, patterns of Martinique Frogs (*Eleutherodactylus martinicensis*) are highly variable. This individual has a faint middorsal line, but others may be unicolorous, blotched, or have very distinct dorsal “racing” stripes.

heavy rains. They feed on a variety of small arthropods, and have been observed foraging at night for insects attracted to lights. Predators include snakes and larger frogs. Fungal infections (chytridiomycosis) have been documented. This species is included on the IUCN Red List as “near threatened,” due to a known range of less than 5000 km<sup>2</sup> and potential habitat loss due to human expansion, volcanism, and hurricanes.

*Leptodactylus fallax* (Müller 1926). Anura: Leptodactylidae. Local names: Crapaud, Kwapo, Mountain Chicken. English common name: Giant Ditch Frog. Native. This species currently is restricted to Dominica and Montserrat, although it may once have occurred on neighboring islands. These large frogs (maximum male SVL 159 mm, maximum female SVL 200 mm) are found in association with streams from sea level to elevations of ~400 m. In addition to natural habitats, they can be found in deforested areas, gardens, and plantations. Dorsal ground color is olive-brown, with highly variable pattern elements. They are sit-and-wait predators, feeding primarily on small arthropods, but they occasionally take vertebrates such as small rodents, bats, frogs, lizards, and even snakes (one attempt on a small *Boa nebulosa* has been documented). Activity is almost exclusively noc-



ARLINGTON JAMES

Mountain Chickens (*Leptodactylus fallax*) are large frogs that have been extensively exploited as a delicacy. Other factors that have contributed to population declines are predation by invasive mammals (pigs, cats, rats, and dogs), habitat loss attributable to human development, volcanism, hurricanes, and fungal infections.



ARLINGTON JAMES

Dominican populations of the critically endangered Mountain Chicken (*Leptodactylus fallax*) have declined by 70% since 2002 as a consequence of the chytrid fungus.

turnal, although some foraging and calling may occur on rainy days. The species is included on the IUCN Red List as “critically endangered,” largely due to excessive exploitation as a delicacy. Other factors that have contributed to population declines are invasive predators (pigs, cats, rats, and dogs), habitat loss by human expansion, volcanism, hurricanes, and fungal infections. Chytridiomycosis was first recognized as a threat in December 2002; between 2002 and 2004, the disease is thought to have reduced populations on Dominica by 70%.

### Lizards (Reptilia: Squamata)

*Ameiva fuscata* (Garman 1887). Squamata: Teiidae. Local name: Abòlò. English common name: Dominican Ground Lizard. Endemic. These large ground lizards (maximum male SVL 200 mm, maximum female SVL 154 mm) occur in lowland habitats such as coastal scrub, plantations, and open forests, but also may range to moderate elevations along road edges and in artificial clearings. Lizards have elongated pointed snouts and long, stocky tails. Smaller individuals are a mottled brown with light blue spots dorsally; large males have a black, slate-gray, to dark blue ground color with light blue spots. These lizards may run on their hindlimbs (bipedal) when engaged in chases or when frightened. *Ameiva fuscata* is a dietary generalist that feeds opportunistically, usually employing an active-foraging strategy, often in groups. It typically consumes arthropods, but will eat fallen fruit and small vertebrates, and is known to prey on *Iguana delicatissima* eggs and hatchlings. Lizards are most active at high temperatures and under direct sunlight, although they avoid the extreme mid-day heat. The conservation status of the species has not been assessed, but it is locally abundant and one of the most frequently seen lizards on Dominica.



JOHN S. PARKER JR.



ROBERT POWELL

Male Dominican Ground Lizards (*Ameiva fuscata*) often are strikingly blue (top), whereas females (bottom) retain the juvenile brown color well beyond maturity.



ROBERT POWELL

Because Dominica was historically forested, sun-loving Dominican Ground Lizards (*Ameiva fuscata*) had to take advantage of very small patches of sunlight. This juvenile had been actively foraging in the leaf litter before pausing in a patch where a bit of light penetrated the canopy.

*Anolis cristatellus* (Duméril and Bibron 1837). Squamata: Polychrotidae. No local name. English common name: Puerto Rican Crested Anole. Endemic to the Puerto Rico Bank; introduced on Dominica (where first discovered in 2000) and in the



ROBERT POWELL



ROBERT POWELL

Puerto Rican Crested Anoles (*Anolis cristatellus*) were first discovered on Dominica in 2000. They are displacing native *A. oculatus* along much of the dry leeward (western) coast of the island.

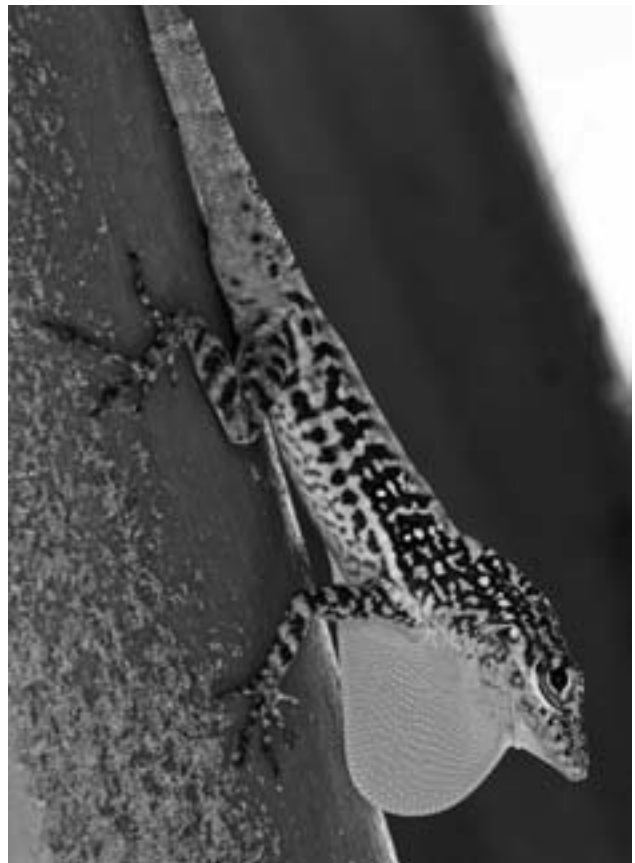


ROBERT POWELL

In areas where they occur together, males of native *Anolis oculatus* (bottom in top photograph, top in bottom photograph) and recently introduced *A. cristatellus* are strongly antagonistic toward one another.



Dominican Republic, southern Florida, and Costa Rica. These moderately sized anoles (male SVL to 77 mm, female SVL to 73 mm) typically exploit edge habitats in heavily disturbed areas along roadsides and in open fields and woodlands from sea level to elevations of ~980 m on the Puerto Rico Bank. Females and juveniles often forage on the ground. Lizards usually are light to dark brown and even greenish gray, often changing color depending on mood. Pattern elements include small dark spots, saddle-shaped markings, or distinct cross-bands. A light longitudinal middorsal stripe bordered by narrow dark lines is common in females but can be found on some, especially smaller males. Although primarily diurnal, they are known to extend activity to after dark, exploiting insects attracted to artificial lights. These sit-and-wait foragers eat mainly small arthropods, but may consume fruits, flowers, or nectar. On Dominica, they have been observed eating fruit flies on fallen mangos as well as ingesting the mango pulp. The conservation status of the species has not been formally assessed. As an invasive species on Dominica, the principal concern is its potential effect on endemic *A. oculatus*, which apparently is being displaced in dry lowland coastal habitats along the western (leeward) coast. One possible means of displacement might be intraguild predation, in which one related species exploits another as food, with large adults eating young *A. oculatus*. At one coastal site where both species occurred, juvenile *A. cristatellus* were abundant, but no juvenile *A. oculatus* were observed.



JEFFREY W. ACKLEY



RUTH E. CARTER

Dominican Anoles (*Anolis oculatus*) vary considerably in color and pattern in different parts of the island. For many years, biologists treated these populations as separate species or subspecies, but today they usually are considered to be ecotypes (populations with habitat-specific color and pattern adaptations). However, males (top) all have bright yellow dewlaps, which are used to deter other males and advertise for females. Anoles that live in cool, moist uplands, such as this female (bottom) often are distinctly green, whereas lowland anoles have a tan to brown ground color.



PETER J. MUELLEMAN

Like many relatives, Dominican Anoles (*Anolis oculatus*) exhibit sexual size dimorphism, with males much larger than females. This is generally seen in species in which males compete with one another for mates.

*Anolis oculatus* (Cope 1879). Squamata: Polychrotidae. Local name: Zandoli. English common name: Dominica Anole. Endemic. These anoles (maximum male SVL 96 mm, maximum female SVL 64 mm, although sizes vary considerably in different areas of the island) are essentially ubiquitous on Dominica, occurring in natural to extensively altered habitats that include roadside vegetation, dry forest, banana, mango, and coconut groves and plantations, artificial sites along walls, fences, and paved areas, and essentially all vegetation types except elfin

woodland from sea level to elevations of ~900 m. Populations are quite variable on different parts of the island. Once considered to be subspecies, these color variants now usually are treated as ecotypes (populations with habitat-specific color and pattern adaptations). Ground color may range from light to dark brown, although individuals in upland forests may be dark green. Females usually are unicolored or have a few black and beige spots. Males are more distinctive, ranging from largely unicolored animals with a few light specks to those having prominent black and beige spots. These sit-and-wait foragers eat small arthropods, and may in some instances “specialize” in concentrated resources such as social insects (e.g., ants and termites). They may occasionally consume plant material, including the pulp of fallen mangos. Although primarily diurnal, like many other West Indian anoles, *A. oculatus* readily exploits insects attracted to lights at night. The conservation status of these lizards has not been assessed, but at least some populations are vulnerable to displacement by *A. cristatellus*.

*Mabuya mabouya* (Lacépède 1788). Squamata: Scincidae. Local names: Kléwant, Zannoli Kléwant, Soud. English common name: Lesser Antillean Skink. Native; however, the taxonomic status of West Indian populations currently assigned to the genus *Mabuya* is poorly resolved, and populations on each island bank should be considered endemic to that bank until detailed studies have been conducted. These diurnally active lizards (maximum male SVL 87 mm, maximum female SVL 93 mm) occur in dry coastal woodlands, littoral woodland, dry shrubs,

and coconut plantations, where they occupy leaf litter and take refuge in holes in trees and stumps or in and under boulders. Skinks are shiny, with very smooth scales. Ground color is bronze or coppery, with a cream-bordered darker brown band on each side and very dark brown or black specks on the back. These lizards bear live young that are very large compared to maternal size. The conservation status of this species has not been assessed.

*Gymnophthalmus pleii* (Bocourt 1881). Squamata: Gymnophthalmidae. No local name. English common names: Rough-scaled Worm Lizard, Keeled-scaled Worm Lizard. Lesser Antillean endemic; the subspecies *G. p. pleii* occurs on Martinique, Dominica, and Guadeloupe, other subspecies occur



Like their relatives, Rough-scaled Worm Lizards (*Gymnophthalmus pleii*) occur primarily in leaf litter, where they are adept at “swimming” through the leaves, making them difficult to find and study.



The taxonomic status of West Indian populations currently assigned to the Lesser Antillean Skink (*Mabuya mabouya*) is poorly resolved, and populations on each island bank should be considered endemic to that bank until detailed studies have been conducted.

on St. Lucia and the Maria Islands. These small lizards (maximum SVL 48 mm) inhabit dry leaf litter with relatively high amounts of sunlight along the leeward (western) coast, and are particularly abundant in Cabrits National Park. Ground color is golden with darker lateral bands and golden-yellow canthal stripes that continue over the eyes and fade near the hindlimbs. Worm Lizards often are thought to be juvenile skinks. Unlike some other species in the genus, *G. pleii* is bisexual. Lizards presumably feed on small arthropods. The species' conservation status has not been assessed.

*Gymnophthalmus underwoodi* (Grant 1958). Squamata: Gymnophthalmidae. No local name. English common name: Smooth-scaled Worm Lizard. Neotropical endemic, with populations on the South American mainland and a number of Lesser Antillean islands; the population on Dominica presumably is native (established by natural means), but the introduction may have been human-mediated. These small, diurnally active, ground-dwelling lizards (maximum SVL 43 mm) are associated with leaf litter in dry forests, beachside vegetation, and mixed agriculture with introduced orchard trees, usually at sites where sunlight penetrates for at least part of each day. Populations are known only from the leeward (western) side of the island from sea level to elevations of ~300 m. Body scales are smooth. The metallic brown back and silvery-white belly are separated by a dark brown lateral stripe. These lizards forage for small invertebrates in the leaf litter. Predators include cats, wild birds and chickens, and presumably snakes and larger lizards. This species is entirely female, reproducing by means of parthenogenesis (eggs developing without fertilization), enhancing the species' ability to colonize new areas, as only one individual is necessary to found a population. *Gymnophthalmus underwoodi* and *G. pleii* appear to be allopatric (do not occur together). The conservation status of the species has not been assessed.



ROBERT POWELL

Smooth-scaled Worm Lizards (*Gymnophthalmus underwoodi*) are all females, reproducing by means of parthenogenesis (eggs developing without fertilization), enhancing the species' ability to colonize new areas, as only one individual is necessary to found a population.

*Iguana delicatissima* (Laurenti 1768). Squamata: Iguanidae. Local name: Lèza. English common name: Lesser Antillean Iguana. Lesser Antillean endemic. These large lizards (male SVL to 434 mm, female SVL to 401 mm) occur in natural and altered habitats along cliff faces, in lowland forests, and often close to streams. Although the distribution is largely coastal, iguanas may be found at elevations to ~300 m. Concentrations may occur in the vicinity of communal nesting beaches to which females migrate from considerable distances. These lizards are largely arboreal but reg-

ularly venture onto the ground. Color varies greatly. Hatchlings are bright green, but this fades with age to dark gray with hints of green, blue, brown, and occasionally pink around the snout and facial features. Males tend to be darker than females, which frequently retain a primarily green coloration into maturity. Males have larger heads, prominent dewlaps, and conspicuous femoral pores on the undersides of their thighs. Individuals spend much of their time adjusting body positions and perch heights to regulate body temperatures. The diet includes flowers, fruits, and leaves of many plants. Iguanas are quick to exploit introduced ornamentals and appear to have a particular fondness for hibiscus. Juveniles are known to eat bird eggs, and iguanas of all ages may scavenge. Adults have few predators except humans and the occasional boa, but major predators on eggs and hatchlings include crabs, rats, and *Ameiva fuscata*. The species is included



JOHN S. PARNERLEE, JR.

Lesser Antillean Iguanas (*Iguana delicatissima*) are phenomenally abundant on the grounds of the Sunset Bay Club on Dominica's leeward (western) coast. The proximity of the Batali River and a communal nesting site, an abundance of forage, and the tolerance of the resort's owners account for population densities seen nowhere else in the world.



ROBERT POWELL

Male Lesser Antillean Iguanas (*Iguana delicatissima*) are very territorial. The proximity of adult males on the ground of the Sunset Bay Club resulted in overlapping home ranges and frequent agonistic interactions.



on the IUCN Red List as “vulnerable,” but some populations are “critically endangered.” The population on Dominica is faring much better than those on many other islands, where exploitation by humans, habitat destruction, or competition and even hybridization with introduced Common Iguanas (*Iguana iguana*) have resulted in extirpations and dramatic declines. Hunting iguanas is illegal on Dominica, although it still occurs. Many individuals, especially females migrating to coastal nesting sites, are killed on the roads.

*Hemidactylus mabouia* (Moreau de Jonnès 1818). Squamata: Gekkonidae. Local name: Mabouya Kai. English common names: Common House Gecko, Cosmopolitan House Gecko. These geckos, with populations in Africa and throughout the Neotropics, are human commensals. Whether the population on Dominica arrived by natural or human-mediated means is unknown. The nocturnal lizards (maximum male SVL 68 mm, maximum female SVL 61 mm) occur on walls and roofs of buildings and under loose concrete, logs, and rocks. They are pale but often change color in response to their habitat. Individuals found on the ground under loose bark and logs may be whitish gray to light brown, with bands on their backs. These lizards are frequently observed eating insects around lights at night. Their conservation status has not been assessed.



JEFFREY W. ACKLEY

Common House Geckos (*Hemidactylus mabouia*) are frequently observed eating insects around lights at night.

*Sphaerodactylus fantasticus* (Duméril and Bibron 1836). Squamata: Sphaerodactylidae. No local name. English common name: South Leeward Sphaero (Dwarf Gecko). Lesser Antillean endemic, the subspecies *S. f. fuga* is endemic to Dominica. These small diurnal geckos (female SVL to 29 mm, male SVL to 28 mm) occur in leaf litter of dry forests and beachside vegetation

along the northern leeward (western) coast. Population densities may be very high in some areas. *Sphaerodactylus fantasticus* is sexually dimorphic. Males have a dark blue head with light-blue and white spots, whereas those of females have two light stripes that begin as an inverted V and extend onto the body. Body ground color is usually brownish, dark orange, or maroon. Light blue rings often surround the eyes of both sexes. These geckos feed on a variety of small invertebrates. The conservation status of this species has not been assessed.



ROBERT POWELL



NELSON J. VIELEZ ESPINET

South Leeward Dwarf Geckos (*Sphaerodactylus fantasticus*) are sexually dimorphic. Males (top) have very dark heads with light spots, whereas females (bottom) are more distinctly patterned, but have striped heads.

*Sphaerodactylus vincenti* (Boulenger 1891). Squamata: Sphaerodactylidae. No local name. English common name: Windward Sphaero (Dwarf Gecko). Lesser Antillean endemic, the subspecies *S. v. monilifer* is endemic to Dominica. These small lizards (both male and female SVL to 40 mm, although the largest Dominican geckos reach only 32 mm SVL) occur in leaf litter of upland rain forests and habitats modified for agriculture to elevations as high as 900 m. These geckos are much less frequently encountered than *S. fantasticus*. *Sphaerodactylus vincenti* is sexually dimorphic. Dorsal ground color of both sexes is brown, but males have two black “eye-spots” (ocelli) on the shoulders, with the rest of the back variously marbled with dark brown. Two light lines outlined with black extend to between the ocelli. Females lack ocelli, but have spots on the shoulders lateral to the lines. The conservation status of this species has not been assessed.

*Thecadactylus rapicauda* (Houttuyn 1782). Squamata: Phyllodactylidae. Local names: Mabouya Hazyé, Mabouya ban-



ROBERT POWELL

Windward Dwarf Geckos (*Sphaerodactylus vincenti monilifer*) occur in leaf litter of upland rain forests and habitats modified for agriculture to elevations as high as 900 m. These geckos are much less frequently encountered on Dominica than *S. fantasticus*. *Sphaerodactylus vincenti* is sexually dimorphic. Males have two black “eye-spots” (ocelli) on the shoulders, whereas females lack ocelli, but have light spots on the shoulders.



JEFFREY W. ACKLEY



ROBERT POWELL

Throughout much of the species' range, Turnip-tailed Geckos (*Thecadactylus rapicauda*) are less likely to associate with humans than “house” geckos in the genus *Hemidactylus*. On Dominica, however, these large geckos frequently exploit insects attracted to lights at night and take advantage of the many cracks and crevices in buildings to seek refuge by day.

nann, Mabouya Hòtè. English common names: Thick-tailed Gecko, Turnip-tailed Gecko. Neotropical endemic; presumably native on Dominica. These geckos (male SVL to 125 mm, female SVL to 126 mm) occur in dry forests and are arboreal. They often exploit the night-light niche and can be common in artificial habitats, although they are less likely to function as human commensals than *Hemidactylus mabouia*. They are known to be nocturnal but have been found basking during the day. Ground color and pattern elements are highly variable, ranging from unicolorous pale to dark gray, brown, or even deep orange to having variable dark brown to slate gray or black markings. Color can change dramatically from day to night. Like many geckos, *T. rapicauda* is vocal, often producing a series of chirps decreasing sequentially in volume. The diet consists of insects, other small arthropods, and occasionally smaller lizards. The disproportionately swollen tail, especially when regenerated, is used to store fat. The conservation status of these widely distributed geckos has not been assessed.

### Snakes (Reptilia: Squamata)

*Boa nebulosa* (Lazell 1964). Squamata: Boidae. Local names: Tête-chien, Tèt-chyen. English common name: Clouded Boa. Dominican endemic. These large nocturnal snakes (maximum SVL ~3 m) occur in woodland and montane forests, scrub, and



ROBERT POWELL



PETER J. MUELLEMAN

Clouded Boas (*Boa nebulosa*) are the largest snakes on Dominica. Until recently, they were considered a subspecies of the wide-ranging *B. constrictor*.

on vegetated cliff faces. They can sometimes be found in more disturbed areas, such as along the edges of banana fields. They seek shelter by day in hollow logs, rock piles, tree roots, and under natural and human debris. Ground color ranges from tan

to grayish-brown to dark brown with 23–35 rectangular or irregular dark dorsal saddles. The pattern appears to be washed-out on much of the body, but becomes increasingly distinct near the tail. Like other members of the family Boidae, *B. nebulosa* gives birth to live young. The diet consists of small vertebrates such as agoutis, iguanas, and chickens. Adults have few natural predators, but humans hunt them for medicinal oil. The conservation status of the species is unknown, but all boids are included in CITES Appendix II.

*Alsophis antillensis* (Schlegel 1837). Squamata: Colubridae. Local names: Kouwès Nwè, Koulèv. English common name: Dominican Racer. Lesser Antillean endemic; the subspecies *A. a. sibonius* is a Dominican endemic (other subspecies occur on neighboring islands). These diurnal snakes (maximum female and male SVL 905 mm) occur in rain forest, rain forest edges, coastal scrub, mountain pastures, mangrove edges, deciduous forests, and orchards/plantations. Adult coloration is dark taupe through milk chocolate to very dark brown, dark slate gray, and jet black with white, cream, or light brown blotches. Juveniles have a distinct pattern that becomes obscured with age as a result of increased pigment deposition. These snakes are predominantly diurnal, with activity peaks at mid-morning and late afternoon. Species of *Alsophis* feed primarily on lizards (especially anoles), but may consume a variety of terrestrial vertebrates such as frogs, birds, rodents, and sometimes other snakes. They use a combination of active foraging and ambush foraging strategies, and may extend activity into the night to hunt anoles eating insects attracted to artificial lights. Their conservation status has not been assessed.



LAUREN A. WHITE

Dominican Racers (*Alsophis antillensis sibonius*) are predominantly diurnal, with activity peaks at mid-morning and late afternoon, but they may extend activity through midday on cloudy or rainy days.

*Liophis juliae* (Cope 1879). Squamata: Colubridae. Local names: Kouwès jenga, Kouwès zenga, Grove Snake. English common names: Dominican Ground Snake, Leeward Ground Snake. Lesser Antillean endemic; the subspecies *L. j. juliae* is a Dominican endemic (other subspecies occur on Guadeloupe and Marie-Galante). These diurnally active, ground-dwelling snakes (SVL to 458 mm) occur in rain forest, cut-over hardwoods, and dry forest. Ground color is typically black with a “salt and pepper” pattern of white to yellow spots. Communal nests have been found. These active foragers feed primarily on small vertebrates, including frogs, lizards (especially anoles), and lizard eggs. Less frequently encountered and presumably less abundant on Dominica than *Alsophis antillensis*, the conservation status of the species is unknown.



JEFFREY W. ACKLEY

Diurnally active, ground-dwelling Dominican Ground Snakes (*Liophis juliae juliae*) occur in rain forest, cut-over hardwoods, and dry forest.

*Typhlops dominicanus* (Stejneger 1904). Squamata: Typhlopidae. Local names: Kouwès dé-tèt, Koulèv, Coffin Borer. English common name: Dominican Blindsnake. Endemic. These burrowing snakes (maximum SVL 385 mm) occur in well-shaded areas under rocks and logs, but may be encountered on the surface after heavy rains. They have a small, blunt head with scales covering the rudimentary eyes and a short tail equipped with a ter-



JEFFREY W. ACKLEY

Dominican Blindsnakes (*Typhlops dominicanus*) are larger than most of their relatives. All blindsnakes are burrowers and are rarely encountered except when heavy rains bring them to the surface (much like earthworms). This individual was found on a trail in Cabrits National Park in northwestern Dominica.



minial spine that serves as an anchor when burrowing. Ground color is pale to very dark gray or dark brown. Little is known about these snakes, which, although rarely seen, are believed to be a numerically important component of the Dominican herpetofauna. The conservation status of this species is unknown.

### Turtle (Reptilia: Chelonia)

*Chelonoidis carbonaria* (Spix 1824). Chelonia: Testudinidae. Local name: Mòròkòy. English common name: Red-footed Tortoise. Neotropical endemic; whether turtles on Dominica arrived naturally via over-water dispersal or were introduced by humans is unknown. Many West Indian populations may include descendants of naturally occurring ancestors or of tortoises introduced by Native American or colonial-era Europeans for food or as pets by more recent island residents. These turtles (shell length in males to 60 cm, in females to ~40 cm) occur in forests as well as more open habitats. Despite their size, they are rarely encountered even where abundant. Almost never found on Dominica, the very existence of a wild population is questionable. The top of the shell is black with yellow markings; the underside of the shell is yellow with black markings. Some scales on the legs and tail are reddish orange. The diet consists primarily of plant material, but small arthropods and other invertebrates may be consumed. In many parts of their range, these tortoises are captured for food or for the pet trade. Although listed in CITES Appendix II, no formal assessment of conservation status has been completed.



ARLINGTON JAMES

Red-footed Tortoises (*Chelonoidis carbonaria*) are rarely encountered on Dominica and whether a wild population exists is questionable.

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The Guatemalan Black Iguana (*Ctenosaura palearis*) is one of five species of Spiny-tailed Iguanas found in Guatemala.

# Ecology and Traditional Use of the Guatemalan Black Iguana (*Ctenosaura palearis*) in the Dry Forests of the Motagua Valley, Guatemala

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Photographs by the authors.

The Semiarid Region of the Motagua Valley (SRMV) is one of the few regions of Mesoamerica in which the unique tropical dry forest and thorn scrub ecosystem still remains. One of the principal characteristics of this region is the presence of many endemic species (Nájera 2006), such as the Guatemalan Black Iguana (*Ctenosaura palearis*). The genus *Ctenosaura* is represented by five species in Guatemala: *C. alfredschmidti* (northern Guatemala), *C. flavidorsalis* (eastern Guatemala), *C. similis*

(general distribution), *C. acanthura* (Nentón Valley), and *C. palearis* (Köhler 2003, Acevedo 2006).

*Ctenosaura palearis* was described by Stejneger in 1899. Since then, few studies have addressed the species. Buckley and Axtell (1997) studied populations of *C. palearis* in Guatemala and Honduras, and described the Honduran population as *Ctenosaura melanosterna*. *Ctenosaura palearis* is believed to have a total distribution range of less than 100 km<sup>2</sup>. Total population size is unknown, but may consist of fewer than 2,500 mature individuals in the wild (Köhler 2004). The males of this species have been reported to attain a total length of 56.5 cm, and the females 48.5 cm (Köhler 2003).

*Ctenosaura palearis* is included in the IUCN Red List as Critically Endangered (CR), but the lack of ecological information makes developing conservation strategies difficult. To facilitate that process, we herein describe some ecological aspects and traditional uses of the Guatemalan Black Iguana in the dry forest of the Motagua Valley.

## Material and Methods

The SRMV is located in northeastern Guatemala. This region has the lowest average rainfall in Central America (500 mm) and comprises an area of about 200,000 ha, covering portions of the departments of El Progreso, Zacapa, and Chiquimula. Fieldwork was conducted in the mountains of El Arenal Village, Cabañas, and Zacapa. Cabañas is located 150 km from Guatemala City at the geographic coordinates 14°56'32" N and 89°48'24.9" W. The vegetation in this area is composed mainly of Mimosaceae, Cactaceae, Fabaceae, Euphorbiaceae, and Burseraceae. Representative species include Zacapan Oak (*Bucida macrostachya*), Quebracho (*Licania hypoleuca*), Palo de Jiote (*Bursera simaruba*), Yaje (*Leucaena* sp.), Zarza Blanca (*Mimosa platycarpa*), Manzanote (*Pereskia autumnalis*), Cactus Cabeza de Viejo (*Pilosocereus albocephalus*), *Stenocereus* spp., Subín (*Acacia spadicigera*), *Opuntia* sp., Naranjillo (*Jacquinia* spp.), and Piña de Coche (*Hechtia guatemalensis*) (Ariano-Sánchez 2003).



Hatchling *Ctenosaura palearis* observed in June 2007.



To determine the actual use of *C. palearis* by local villagers, we visited different areas of the Motagua Valley and surveyed inhabitants of the local communities.

We used the quadrant point method to determine if iguanas select any particular microhabitat. The quadrants were established in areas with known iguana shelters and each one was assigned a random replicate in a zone without known shelters. The location of random replicates was determined by using a computerized random number generator. Quadrants were 10 x 10 m in size and centered on the iguana shelter. In the random quadrants, the largest tree in the quadrant was designated as the center. Quadrants were oriented from north to south. We measured tree height and diameter at breast height (DBH). A Wilcoxon test was used to evaluate differences in DBH and tree height within areas with and without iguana shelters. We used JMP version 5 (SAS Institute, Cary, North Carolina) for statistical analyses.

The general location, exact position, and date were recorded for each iguana captured. Each iguana also was weighed and the following measurements were taken: snout-vent length (SVL), tail length (TL), head length, head width, and total length. We used a mark-recapture technique to determine the population size in the study area, using the Jolly (1965) method. Captures took place from May 2007 to March 2008. Iguanas were marked with bead tags (Binns and Burton 2007), using seven different colored beads in a unique identification code. The sequence for each iguana was recorded for the next capture. Also, we permanently marked each individual with PIT Tags, using AVID microchips.

To evaluate feeding habits, we collected fecal samples and stored them in 80% propanol. Contents of the samples were classified and identified using reference collections of plants and insects. We also considered direct observations of animals eating.

## Results

### Traditional Use

A large percentage (88%) of the people surveyed indicated that they had eaten iguanas in the past, but only 38.6% of them eat them currently. No preferred hunting season exists, but some people hunted preferentially in February–April during the egg-laying season. The number of iguanas killed ranged from two to five and as high as 60, depending on whether hunting is for consumption or trade. Twenty percent of people who make personal use of iguanas use them strictly for meat, 58% use the meat and egg yolks, and 22% use the meat, egg yolks, and skin. Locals have a marked preference for the consumption of *C. palearis* meat over that of *C. similis*. The Guatemalan Black Iguana is not used for any traditional handicrafts because of its small size.

Hunting is the primary method for obtaining iguanas (84%); some people buy iguanas (8%) or combine both methods (8%). Iguanas are hunted primarily for food for local families; however, we detected two areas in the department of El Progreso where *C. palearis* is hunted for the illegal pet trade. Local people will collect 60 or more animals and sell them to random buyers who then sell them to international illegal traders.

Guatemalan Black Iguanas, especially soup made from their meat, are believed to have medicinal properties. People say it is used to heal eye problems and cancer (especially if the meat is



The dry forests of El Arenal Village in the Motagua Valley of Guatemala.

consumed), and the fat is used to relieve swellings and for healing earaches.

### Habitat Characterization

Using 22 quadrants and their respective replicates, we sampled a total of 6,400 m<sup>2</sup> (0.64 ha). Trees in quadrants with *C. palearis* shelters are significantly larger ( $P = 0.0002$ ) and taller ( $P = 0.0001$ ) than trees in the replicates. Mean DBH of tree in areas with *C. palearis* shelters was  $8.84 \pm 6.68$  cm, whereas those in the randomly chosen areas had a mean DBH of  $7.84 \pm 6.37$  cm. Tree height averaged  $4.96 \pm 2.5$  m in areas with *C. palearis* shelters, whereas mean height in replicate quadrants was  $4.53 \pm 2.5$  m.

The range of *C. palearis* included areas of dry forest and thorn scrub at elevations of 350–700 m above sea level. The predominant species in areas with iguanas were tree cacti (*Stenocereus pruinosus*, *Ximena americana*, *Tecoma stans*, and *Licania hypoleuca*). For randomly defined replicates, predominant species were *Bucida macrostachya*, *Mimosa zacapana*, *Lonchocarpus rugosus*, *Psidium* sp., and *Stenmadenia obovata*.

### Population Size and Habitat Use

We captured 70 individuals (36 males and 34 females). The estimated total population size for the study area was 99 individuals. Maximum estimated population size for the entire study site (3,000 ha) was 651 individuals with a 95% level of confidence. This works out to an average density of one individual every 1.69 ha. Most iguanas were found in trees, confirming that this species is primarily arboreal. The tree cactus *Stenocereus pruinosus* was the species most frequently used by *C. palearis* ( $N = 33$ ), followed by *L. hypoleuca* ( $N = 4$ ), *T. stans* ( $N = 5$ ), *X. americana* ( $N = 3$ ), and a few other species selected only once. Three individuals used fallen logs. Actual shelters were usually hollow trunks or branches. Iguanas in shelters used their spiny tails to block the entrances. Lizards leave shelters as daytime temperatures rise. During the day, they use the crowns of trees and the highest parts of cacti for basking and displaying. They return to their shelters at 1600–1700 h.

Individuals demonstrate fidelity to a set of shelters, which are used as refugia. One adult male used five shelters covering an area of 475 m<sup>2</sup> (0.047 ha). A juvenile male used two sites



Hollow tree stumps and branches used by *Ctenosaura palearis*.



within a distance of 200 m. Two females were recorded making use of only two shelters.

### Feeding Habits

We examined 19 fecal samples (9 from females and 11 from males). The diet consists mainly of insects (47.83%) and plant material such as flowers (15.37%), fruits (7.69%), and leaves (26.92%). The most frequently represented insects were ants (19%) and crickets (15.38%). One fecal sample contained large numbers of fly larvae that may have been ingested adventitiously with fruit. Species recognized in the plant material were leaves of *Licania hypoleuca*, flowers of *Cochlospermum vitifolium*, and the fruits and seeds of *Stenocereus pruinosus*. We also found stones and resin.

We frequently have seen *C. palearis* feeding on fruits of *S. pruinosus*. Faces and forelimbs colored by the red pigment of this



A male *Ctenosaura palearis* on the branch of a Timboque tree (*Tecoma stans*) displays his dewlap.



JOHN BLINNS



Biologist Paola Coti with her first-ever captured *Ctenosaura palearis*. The male in the photo was the first marked with PIT tags for the project.



Evidence of the feeding habits of Guatemalan Beaded Lizards (*Heloderma horridum charlesbogerti*). The crushed eggshell on the right was found inside the nest of an iguana. Also found in the same nest were skin remnants from a Guatemalan Beaded Lizard.

cactus fruit are a common site. We captured three individuals with evidence of residual pulp and seeds stuck to their faces. These fruits are available from March through early May.

Food varied by season. The samples from May to September were composed mainly of leaves, fibers, and ants. In contrast, samples from November to December had smaller quantities of fiber and an increased number of leaf sprouts. Samples from February to March contained flowers, beetles, crickets, and ants (and other hymenopterans). Sample sizes were too small to determine if observed seasonal differences were significant.

### Reproduction

Female *C. palearis* have an annual reproductive cycle. Copulation occurs during January and February, and gravid females are found in February and March. Females dig sand tun-



Searching for *Ctenosaura palearis* inside a hollow trunk using a bore scope funded by the San Diego Zoo.

nels in which they lay their eggs. Nests were in banks of dry streams and gullies and in sandy patches within the dry forest. Six to twelve eggs are deposited from late March to late April. Eggs begin hatching in late May, which coincides with the beginning of the rainy season. Both males and females lose weight during the reproductive season. We also found evidence that Guatemalan Beaded Lizards (*Heloderma horridum charlesbogerti*) are predators of *C. palearis* nests.

### Discussion

#### Traditional Use

Local villagers use *C. palearis* primarily as a protein source. The species is heavily hunted in some areas, especially during the breeding season when the killing of gravid females has a substantial impact on the survival and viability of wild populations.

Although iguanas have been eaten by humans for many generations, the impact is exacerbated today by habitat loss, illegal trade, and non-sustainable hunting practices. Habitat loss is due primarily to the increasing amount of land used for watermelon cultivation and the construction of new residential zones

within the valley. Local people say they have seen a dramatic diminution in wild iguana populations compared to 20 years ago.

Hunting of gravid female iguanas is non-sustainable. Animals are consumed or hunters make an incision to remove eggs, sew the iguanas up and let them go free. These individuals soon die in the wild from bacterial infections and internal hemorrhages.

Illegal trade is proving to be a much more serious threat to the species than hunting. People who catch iguanas for meat usually catch six a month, while illegal traders often catch 50–60 iguanas a month. Web and market surveys have shown that this species is sold in countries such as Greece, Germany, and the United States for an average price of \$25.00 per individual. All *Ctenosaura palearis* sold outside Guatemala are illegal, as governmental biodiversity authorities in Guatemala have not issued any export permit for this species (CONAP 2008).

These factors seriously affect the viability of the extant populations of *C. palearis*. Subsistence hunting as currently practiced may cause long-term depletion of this species unless we develop a sustainable extraction plan accompanied by legislation that regulates the use of this species for such purposes. Farming iguanas may be a way of meeting the demand for iguana meat and eggs within the valley. The more important threat at this time is the illegal trade of this species on the international market. This may be diminished by incorporating *C. palearis* in Appendix II of the CITES convention. This iguana species certainly meets the criteria for inclusion.

#### Habitat Characterization

Habitat selection may be determined by the availability of food resources or the availability of trees providing suitable refugia and basking sites (Valenzuela 1981, Lara-Lopez and Gonzales 2002). Our results indicate that species composition, average height, and DBH of trees are important factors in habitat selection by *C. palearis*.

The tallest trees provide appropriate sites for males' territorial displays (Werner 1987). They also are used for thermoregulation. Trunk diameter is an important factor in shelter selection, mainly for the adults that require larger cavities for use as refugia. For example, in the cactus *Stenocereus pruinosus*, the species most frequently used by *C. palearis* as shelters, we have found



Evidence of the feeding habits of *Ctenosaura palearis* (from left to right): Fruits of the cactus *Stenocereus pruinosus*, iguana with seeds adhering to the throat, and fruit pulp of *S. pruinosus* staining the throat of another individual.





Researchers and the field vehicle (financed by the IRCF and Zoo Atlanta) used for the research project.

females, subadult males, and juveniles. However, in *Licania hypoleuca*, which is thicker, we have found only adult males. The composition of the vegetation also predicts the presence of *C. palearis*. In areas where iguanas occur, the more abundant species were *S. pruinus*, *Ximena americana*, *Tecoma stans*, and *L. hypoleuca*. The first three species provide food and the last one offers shelters for adult males.

### Feeding Habits

*Ctenosaura palearis* is omnivorous and this may be a function of the species' size. Unlike other ctenosaurs, such as *C. similis* or *C. pectinata*, that are large enough to feed on small vertebrates (Krysko et al. 2000, Alvarez del Toro 1960, Campbell 1998, Suazo and Alvarado 1994, Valenzuela 1981), we have not found any vertebrate remains in the fecal samples of *C. palearis*.

Fecal samples were taken only from adults, and these contained an abundance of insect remains. These data suggest that the consumption of arthropods corresponds to the dry season, when trees shed their leaves. At this time, adults must regain body mass lost during the breeding season, so the consumption of insects, flowers, and fruits contributes significantly to the rebuilding of body condition.

Evidence from fecal samples indicates that ants are the insects most commonly ingested. Iguanas presumably take opportunistic advantage of the abundance of social insects that are associated with the trees in which they live, similar to other lizards that consume large numbers of ants (e.g., *Phrynosoma* spp. and *Moloch horridus*; Pianka and Pianka 1970, Pianka 1966). Alternately, ants may be inadvertently ingested with fruit. However, the great frequency and quantity of ants consumed is strongly suggestive of intentional consumption.

### Ecological Role of *Ctenosaura palearis*

Iguanas are important pollinators and seed dispersers (Godínez 2004, Olsen and Valido 2003, Traveset and Riera 2005). *Ctenosaura similis* is one of the main seed dispersers for some plants in the deciduous forests of Costa Rica (Traveset 1990). *Ctenosaura palearis* is one of the most important species that feeds on fruits of the cactus *S. pruinus*, suggesting that it could serve as a seed disperser of this endangered cactus, and conse-

quently contribute to forest cover regeneration. Seeds of *S. pruinus* have been found in the feces and also attached to the gular region of iguanas.

Also significant is the fact that iguana eggs are an important food source for *Heloderma horridum charlesbogerti* (Ariano-Sánchez 2007). We have found a *C. palearis* nest with remnants of shredded *Heloderma* skin. The latter species is in extreme danger of extinction (Ariano-Sánchez 2006, Ariano-Sánchez and Salazar 2007). Therefore, maintaining a stable population of *C. palearis* might be important for conserving wild populations of *H. horridum charlesbogerti*. These data suggest that *C. palearis* might be a keystone species for the dry forests of the Motagua Valley (Mills et al. 1993). More detailed studies, especially on the diet of the iguana, are crucial in determining the role the species plays in seed dispersal and germination.

### Conservation Status

The conservation status of *C. palearis* is better than previously believed. However, threats to this endemic species are increasing, making the development of conservation strategies an imperative. The promotion of sustainable hunting practices should become part of the existing program of environmental education conducted in the region. Nest monitoring and further research into the demographic status and the effectiveness of the Guatemalan Black Iguana as a keystone species are also important. Data from such studies will provide more information about the ecology of *C. palearis* and might allow us to develop an ecologically sustainable harvest for local villagers. Other techniques, such as radio-tracking, could significantly help scientists learn more about the activities of these ctenosaurs.

No species of *Ctenosaura* is included in the CITES appendices. However, limited protection is provided by certain countries. For example, in Mexico, the majority of species of *Ctenosaura* are cataloged as threatened or under special protection (Alvarado and Suazo 1996). In Guatemala, *C. palearis* is considered a threatened species on the red list of endangered flora and fauna of the National Council of Protected Areas (CONAP). However, the lack of a regulatory entity for the international trade makes it difficult to control illicit commerce in this species.

Inclusion in the CITES appendices would provide a tremendous impetus for the conservation of these animals, both nationally and internationally. However, if this position is not supported by the countries with native populations of ctenosaurs, the inclusion of the Guatemalan endemic *Ctenosaura palearis* in Appendix II of CITES could still contribute to diminishing the threat of commercial trade on international markets.

### Acknowledgments

We thank Gilberto Salazar and Pedro Mejia for their invaluable field assistance. Zootropic, the International Reptile Conservation Foundation, and Zoo Atlanta provided financial and technical support for the present study. CONAP issued permits for the research. Special thanks to Luis Alvarado, John Binns, Brad Lock, Jack Schuster, Elfriede Pöhl, Cesar Castañeda, Mario Véliz, and Doris Carbonell. The present paper is part of the Biology degree thesis of P. Cotí at Universidad del Valle de Guatemala.

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Guatemala supports a phenomenally diverse flora and fauna, which we will feature in an upcoming issue. The Northern Tamandua (*Tamandua mexicana*) is a slow-moving anteater that inhabits the dry and tropical forests of Guatemala. It feeds exclusively on ants and termites. The prehensile tail is well-adapted to a semi-arboreal lifestyle, as are the claws, which also are used for defense and tearing open termite nests.



MATT VAUGHAN

The Gharial (*Gavialis gangeticus*) is a critically endangered species endemic to the Indian Subcontinent.

# Gharial Reproduction and Mortality

Suresh Chaudhari

Katerniaghat Foundation, Lucknow, India  
Photographs by the author except where noted.



In April of this year, 26 female Gharials (*Gavialis gangeticus*) laid eggs on an island in the Girwa River in the Katerniaghat Wildlife Sanctuary. In addition, a few Mugger Crocodiles (*Crocodylus palustris*) nested there. As in previous years, Mr. Ramesh Pandey, Divisional Forestry Officer at the sanctuary, facilitated nesting by providing a soft and secure sand bar. In March, grasses on the island were cleared and the sand softened by digging. Trial nesting by female Gharials was observed dur-

ing the last week of March. Actual nesting began on 1 April and hatchlings emerged in June. Two years ago, only 6–8 nests were located. This year about 1000 hatchlings were counted at one location along the river.

The Katerniaghat Wildlife Sanctuary is a secure refuge and the best hope for protecting Gharials from extinction. About 800 Gharials hatch each year. However, this year, monsoon rains during the last week of June led to flooding of the Girwa River,



Gharial nesting site on an island in the Girwa River in the Katerniaghat Wildlife Sanctuary, India.





Gharial hatchlings in the Katarniaghat Wildlife Sanctuary are vulnerable to monsoon flooding, necessitating the development of a conservation strategy to address this threat in future years.

and nearly all of the hatchlings were swept away. Additional protective measures will have to be developed in order to prevent a recurrence in future years.

Early this year, more than 100 Gharials died in the Chambal River Wildlife Sanctuary. Investigators have ruled out the possibility of any infection or parasite as the cause of the deaths. Dead Gharials were diagnosed with kidney damage and failure, significant gout within the body cavities and around internal organs (visceral gout), and gout within the joints (articular gout). A toxin is suspected of causing the kidney damage

and failure, although neither a toxin nor a potential source has been identified. Further investigations will focus on fish inhabiting the river, as well as industrial and other human activities in the region. For more information, see [www.gharials.org](http://www.gharials.org).

The recently established Katarniaghat Foundation is working for conservation of Gharials and other wildlife species in the sanctuary. These include Bengal Tigers, Leopards, Asian Elephants, Indian Rhinoceros, deer, pythons, Gangetic Dolphins, various turtles, and many species of resident and migratory birds.



An adult Gharial patrolling a sandy area where hatchlings are basking.



Early this year, more than 100 Gharials died of unknown causes in the Chambal River Wildlife Sanctuary.

Gharial Conservation Alliance  
an international organization committed to conserving gharials



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



ROBERT POWELL

Dominican Racers (*Alsophis antillensis sibonius*) may use either active foraging or sit-and-wait foraging strategies.

# A Predation Attempt Gone Awry: Defensive Constriction of a Predator by a Dominican Racer

Adam Mitchell<sup>1</sup> and Lyndon Prince<sup>2</sup>

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<sup>2</sup>Salisbury Village, Commonwealth of Dominica, West Indies

*Alsophis antillensis* is a diurnally active snake found on the Islands of Guadeloupe, Monserrat, and Dominica in the Lesser Antilles. The subspecies *A. antillensis sibonius* is found on Dominica, the most southerly of the three islands, where it is widely distributed, particularly in dry forests on the leeward slopes and coast (Malhotra and Thorpe 1999).

*Buteo platypterus* (Broad Winged Hawk) is a small (ca. 34–45 cm tall), forest-dwelling hawk found throughout eastern North America, northern South America, and the Caribbean

Basin, where it feeds on a wide variety of small vertebrates (BirdLife International 2004).

While radio-tracking *Iguana delicatissima* on Dominica in June 2008, we encountered a *B. platypterus* struggling on the forest floor in the Batali River Valley. Upon closer inspection, we discovered a large *A. antillensis sibonius* defensively constricting the bird's neck, right leg, and right wing. After several minutes of watching, the hawk's struggles became weaker and it could no longer stand. In an attempt to observe the head of the snake,



ADAM MITCHELL

A large *Alsophis antillensis sibonius* defensively constricting the neck, right leg, and right wing of a young Broad Winged Hawk (*Buteo platypterus*).



which was hidden under the litter, we moved a leaf and accidentally startled the *Alsophis*, which struck at us several times before releasing the hawk and moving into the litter, revealing a superficial head wound as it fled.

After release, the hawk stumbled on an apparently numbed right leg and seemed unable to flex its right wing; upon returning to the site approximately three hours later, however, we observed the bird, seemingly unharmed, flying between trees.

#### Acknowledgements

We thank Bob Powell and Bob Henderson for providing com-

ments on this note. This observation was made while conducting research on *Iguana delicatissima* in Dominica. That project is funded through the Center for Conservation and Research for Endangered Species (CRES) at the Zoological Society of San Diego.

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## Exploitation of the Night-light Niche by a Dominican Racer

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Normally diurnal West Indian anoles (Polychrotidae: *Anolis*) are known to exploit insects attracted to artificial lights well into the night (e.g., Perry and Fisher 2006, Henderson and Powell 2009). Secondary exploitation of nocturnal anoles by a typically diurnal predator, the Puerto Rican Racer (*Alsophis portoricensis*), has been reported on hotel grounds on Guana Island, British Virgin Islands (Perry and Lazell 2000).

At 1915 h (transition to full dark) on 18 June 2008, we observed a male Dominican Racer (*Alsophis antillensis sibonius*; SVL 525 mm, tail 247 mm) in a foraging position at the base of a light frequently used by a nocturnally active Dominican Anole (*Anolis oculatus*). The observation occurred on the grounds of the Sunset Bay Club at Batali Beach, on the leeward coast of Dominica, Lesser Antilles.

Based on our experiences, exploitation of the night-light niche has become commonplace among West Indian anoles associated with urban areas and other situations in which artificial lighting is prevalent at night (e.g., hotels, resorts). However, both situations in which snakes have been observed exploiting the night-light niche (Guana Island, Batali Beach) have been "snake-friendly"; that is, guests and personnel of the hotels are instructed not to harm snakes that enter areas frequented by humans. Under more typical circumstances (i.e., where snakes would be killed or, at least, removed from the area), we doubt that snakes would have the opportunity to learn to exploit this potentially productive trophic niche.

#### Acknowledgements

Marcella and Roger Dutrieux Cools, owners of the Sunset Bay Club tolerated our eccentricities. Mr. Arlington James, Forest Officer, Forestry, Wildlife, and Parks Division, Ministry of



A Dominican Anole (*Anolis oculatus*) exploiting the night-light niche on the grounds of the Sunset Bay Club at Batali Beach, Dominica.

ROBERT POWELL



ROBERT POWELL

Agriculture & the Environment, Commonwealth of Dominica, was instrumental in issuing permits to conduct research in Dominica and facilitated our efforts in myriad ways. Fieldwork was funded by a grant from the National Science Foundation (USA) to Robert Powell (DBI-0242589).

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A Dominican Racer (*Alsophis antillensis sibonius*) in a foraging position at the base of a light such as that illustrated on the facing page. This foraging posture, with the anterior portion of the body elevated at the base of the light, is essentially similar to that observed in snakes at the bases of tree trunks in more “natural” habitats (L.A. White and P.J. Muellemann, pers. comm.).

## Juvenile Pattern and Ontogenetic Pattern Changes in Dominican Racers

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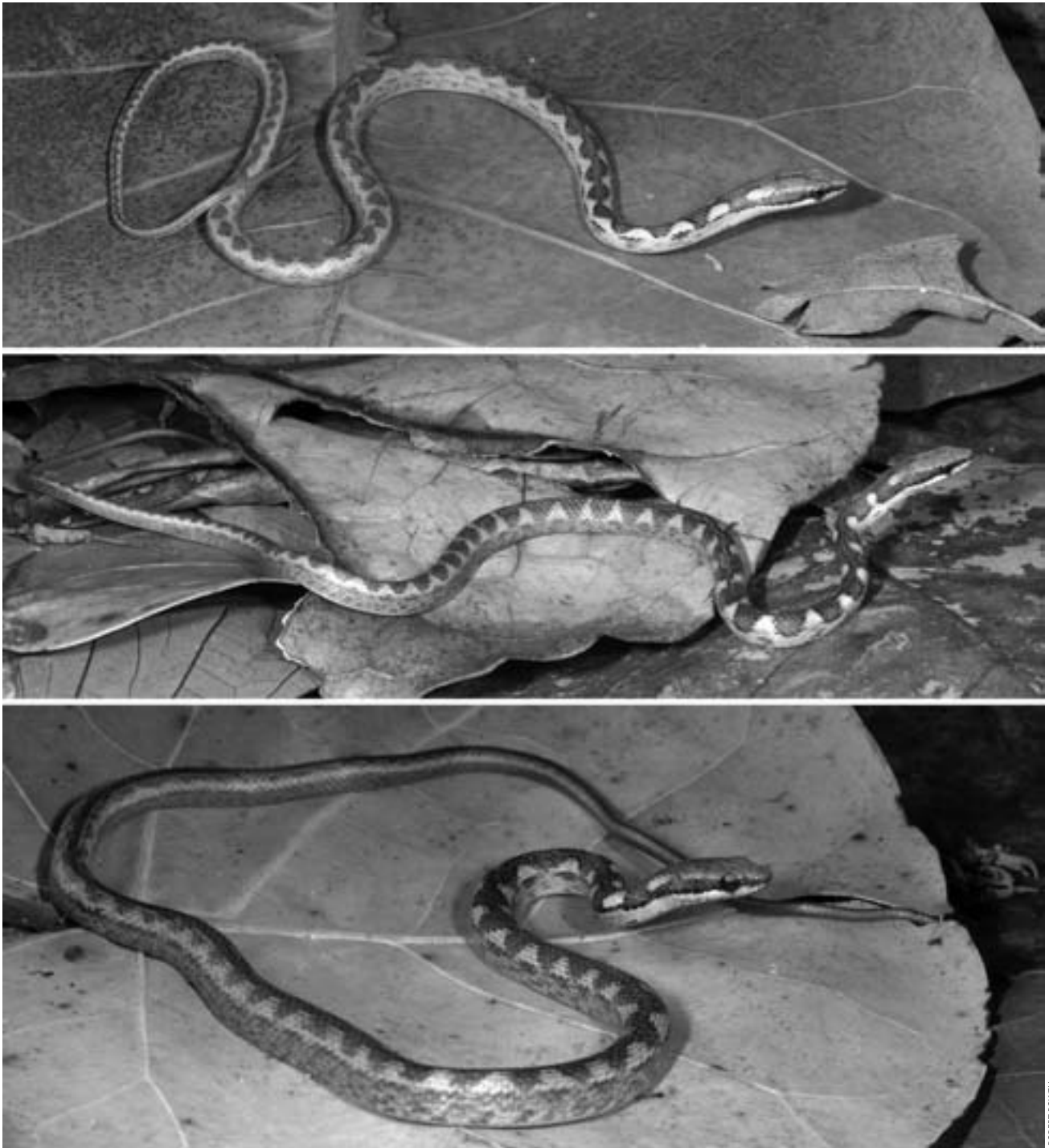
<sup>2</sup>Department of Biology, Truman State University, Kirksville, Missouri 63501, USA (pjm563@truman.edu)

*Alsophis antillensis sibonius* is endemic to Dominica, Lesser Antilles. Although Schwartz and Henderson (1991) described adults, thorough descriptions of juveniles have not been published. During a June 2008 study conducted primarily at Cabrits National Park, we made >160 observations of an undetermined number of snakes. Included in the observations were five juveniles, for four of which we collected and recorded pattern data. The only previous description of the juvenile pattern was by Parker (1933): “... an undulating dark vertebral stripe, a narrow lateral line, and dark spots on the flanks and hinder parts of the belly.”

The top of the head in juveniles is uniformly brown, darkening laterally, with very dark brown to black lines extending

from the snout and through the eyes before blending into the darker elements of the body pattern. Supralabials are white, sometimes with faint specks of light brown or gray. Faint to moderately distinct stippling occurs on infralabials, chin, and throat.

Juveniles have distinct brown middorsal “saddles” faintly outlined in black on a white to pale gray or tan ground color. Most saddles on any one individual are in contact, forming a continuous middorsal line with paired lateral extensions. These saddles may be obliquely situated or offset, forming a wavy (“zigzag”) line along at least portions of the dorsum. At least a few saddles on each animal are isolated by pale ground color extending across the middorsal line. On all juveniles examined,



ROBERT POWELL

Juvenile Dominican Racers (*Akophis antillensis sibonius*) (186 mm SVL, ~230 mm SVL, and 290 mm SVL, respectively) with the distinct pattern characteristic of small snakes.

the dorsal saddles are most distinct anteriorly, where they alternate laterally with patches of light ground color. Saddles become progressively less sharply outlined posteriorly and onto the tail, where the lateral patches of light ground color fuse to form vague lateral stripes that disappear completely on the tail. Faint ventrolateral brown or gray blotches alternate with the dorsal saddles anteriorly and fade into vague stippling posteriorly. The venter is white with faint tan to gray stippling increasing in density and becoming darker toward the vent.

As snakes grow, the dark elements of the pattern expand and fuse (= abundism), to the extent that the light ground color is increasingly obscured, in many instances leaving as remnants only light lateral patches. The smallest juvenile examined (186 mm SVL) had 65 pairs of distinct dorsolateral light patches between saddles. These were more obvious, even posteriorly on the body and on the tail, than in larger snakes. Two juveniles of intermediate length (240 mm SVL and a slightly smaller individual that was released before measurement, although the pat-





JEFFREY W. ACKLEY

Lesser Antillean Iguana (*Iguana delicatissima*) are almost exclusively herbivorous (the yellow color on the iguana's face is from eating mangos) and largely arboreal, descending to the ground to forage or defend territories for only short periods each day. Dominican Ground Lizards (*Ameiva fuscata*) are almost entirely terrestrial and are opportunistic foragers that feed mostly on small invertebrates, but will eat fruits when available. These two individuals came into close proximity to bask in a small patch of sunlight. See article on p. 130.



ROBERT POWELL

Martinique Frogs (*Eleutherodactylus martinicensis*) are ubiquitous on Dominica. This individual has an unusually distinct middorsal "racing" stripe, a pattern element sometimes seen in the Dominican Frog (*E. amplinympha*), which is restricted to higher elevations on the island. See article on p. 130.





JEFFREY W. ACKLEY

Male Lesser Antillean Iguanas (*Iguana delicatissima*) avidly defend territories. On the grounds of the Sunset Bay Club on Dominica's leeward (western) coast, the population density is very high, resulting in frequent contact between males with neighboring territories. The beads are permanent markers allowing for individual recognition in a long-term study of Dominican iguanas (see *IGUANA* 14(4), p. 222). See article on p. 130 and travelogue on p. 162.





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OLIVIER BORN

The Katarniaghat Wildlife Sanctuary is a secure refuge and the best hope for protecting Gharials (*Gavialis gangeticus*) from extinction. In April of this year, 26 females laid eggs in a soft and secure sand bar on an island in the Girwa River where nesting had been facilitated by clearing grasses and softening sand by digging. About 1000 Gharials hatched this year at one location along the river, but many were swept away by monsoon floods, for which protective measures will have to be developed in the future. See article on p. 150.



SURESH CHAUDHARI

In sharp contrast to the successful reproduction in the Katarniaghat Wildlife Sanctuary, more than 100 Gharials (*Gavialis gangeticus*) died in the Chambal River Wildlife Sanctuary this year. An unidentified toxin is suspected of causing kidney damage and failure. See article on p. 150.



JOHN S. PARMERLEE, JR.

An adult Dominican Racer with an abundistic pattern in which the dark pattern elements have expanded, with only a few light patches remaining of the juvenile ground color.

tern was recorded in photographs) had 33 and 52 distinct dorsolateral light patches, with darker pattern elements blending posteriorly. The largest of the three juveniles (290 mm SVL) had 50 distinct pale dorsolateral light patches and the darker dorsal saddles were discontinuous near midbody, where 3–4 pale blotches extended middorsally through the saddle pattern. Posteriorly, the darker elements condensed into a middorsal stripe, and virtually all indications of the anterior pattern of saddles and patches were lost.

When juveniles are compared with larger adults and subadults, the head pattern may be retained essentially unchanged in some individuals or the tops of heads may become increasingly dark to the extent that the distinct juvenile ocular lines are subsumed into the uniformly dark dorsal and lateral head coloration. The light labial line is variously invaded by darker pigment. In larger snakes that retain some vague semblance of the juvenile pattern, the line may extend posteriorly onto the body. The darker elements of the body pattern expand, often become darker, and outlines become increasingly indistinct, resulting in what appears to be a dark ground color with a series of variously defined white, cream, or yellowish lateral patches that vary in number and in how far posteriorly they extend onto the body. Parker (1933) described the adult pattern as "... posterior part of the body is almost entirely black, but anteriorly the dorsal stripe is broken up into a series of large oval spots narrowly separated from one another; the light interspaces

may be fused on the sides of the neck to form a fairly distinct light stripe." Schwartz and Henderson (1991) described it as "anteriorly large white to tan blotches on brown to black ground, sometimes alternating to form lateral zigzag, posterior solid black." We observed adult "ground colors" ranging from dark taupe through milk chocolate to very dark brown, dark slate gray, and jet black. "Blotches" of adults ranged from a few lateral light spots restricted to the anteriormost portion of the body to series of patches extending to midbody and, in a few individuals, the full extent of the body. The chin, throat, and anterior portion of the venter remain light, but variously stippled. Stippling becomes increasingly prominent posteriorly. The posterior ventrals and subcaudals are uniformly dark brown or slate gray. The transition from stippling to uniform dark color may occur as early as one-fourth the length of the body to well beyond midbody. The apparently ontogenetic changes in pattern are suggestive of progressive but variable abundism (= pseudomelanism).

#### Acknowledgements

We thank our mentors, Bob Henderson (Milwaukee Public Museum) and Robert Powell (Avila University), for guidance and support. They and John S. Parmerlee, Jr. made invaluable comments on earlier drafts of this manuscript. We thank Adam Mitchell, Ruthie Carter, and Seth Rudman for their help in the field. Mr. Arlington James, Forest Officer, Forestry, Wildlife, and Parks Division, Ministry of Agriculture & the Environment, Commonwealth of Dominica, was instrumental in issuing permits to conduct research in Dominica and facilitated our efforts in myriad ways. Fieldwork was funded by a grant from the National Science Foundation (USA) to Robert Powell (DBI-0242589).

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ROBERT POWELL

An adult Dominican Racer showing the white labial line extending onto the body.





KEITH BINNS

Black Iguanas (*Ctenosaura similis*) range from southern Mexico through Central America to Panama. The species was not known to occur in South America until now. Other introduced populations are known from Florida and the Colombian islands of Malpelo and San Andres.

# Spiny-tailed Iguanas (*Ctenosaura similis*) in Venezuela: A Preliminary Report

César Luis Barrio-Amorós and Gilson Rivas-Fuenmayor

Fundación AndígenA, Apartado Postal 210, 5101-A Mérida, Venezuela (cesarlba@yahoo.com)

*Ctenosaura similis* is a large iguanid (see the excellent description in Savage 2002) that ranges from southern Mexico through Central America to Panama. The species is unknown in South America, but has been introduced in Florida (Krysko et al. 2003) and the Colombian islands of Malpelo and San Andres (Forero-Medina et al. 2006).

Around 1998, Eduard Asens (pers. comm.) noticed large iguanids in the Barcelona area. Only two large lizards with distinctly different shapes, *Tupinambis teguixin* and *Iguana iguana*, are known from coastal Venezuela. These lizards were identified from photographs as *Ctenosaura similis*. Because the area is a port, the assumption is that the species arrived with cargo shipped from Central America.

The area where the iguanas occur is heavily developed, and is centered around a storage and market center named Lecherías along the road from Barcelona to Puerto La Cruz in the state of Anzoátegui, where they occur in gardens, parking lots, and parks, but the population has expanded into adjacent natural dry habitats. Because only a few adult males have been seen, the sex ratio of this population appears to be female-biased, or perhaps composed largely of subadults. In the developed areas, they are quite tolerant of people. No specimens have been collected; consequently, the photographs presented herein are the only vouchers for the presence of *C. similis* in Venezuela.

*Ctenosaura similis* is known to produce clutches of 12–88 (mean 43) eggs (Fitch and Henderson 1978). This species is mainly herbivorous but may feed opportunistically on invertebrates and small vertebrates such as lizards, birds, eggs, and mammals. On Central American Caribbean islands, *C. similis* is known to prey on beach-nesting birds and marine turtle hatch-

lings (Krysko et al. 2003). If the Venezuelan population expands to the east toward Mochima National Park or reaches the Paria Peninsula, it might pose a threat to nesting sea turtles (*Chelonia mydas* and *Dermochelys coriacea*). Although presumably subject to the same predators as Green Iguanas in the region, the population appears to be reproducing effectively.

A study investigating the extent and impact of *C. similis* in Venezuela is necessary to identify the possible threat this species poses to native plants and animals. The Venezuelan Ministerio del Ambiente, with the assistance of Venezuelan and international herpetologists with expertise in invasive populations of iguanas, should address the situation before control measures are no longer possible.

## Acknowledgments

We thank Eduard Asens Pagés, Diego Flores Padrón, Piero Abbondanza, and Jose Alfredo Iglesias for sharing data. Gunther Köhler identified the species based on photographs.

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EDUARDO ASENS PAGÉS

Ctenosaurs in the Barcelona area occur in heavily modified habitats such as gardens, parking lots, and parks, but the population has expanded into adjacent natural dry habitats. This is one of the few adult males observed.



EDUARDO ASENS PAGÉS

Females are difficult to distinguish from subadult males. Most individuals fall into one of these classes, suggesting that the Barcelona population either is composed largely of adult females or is reproducing rapidly, and the rising cohort of young males has yet to fully mature.



Lauren White (Oklahoma State University) was quick to find an *Anolis oculatus* exploiting the complex structural habitat on the grounds of the Sunset Bay Club.

## TRAVELOGUE

# Most by Land, Some by Sea: Photographing the Obscure in Dominica

Jeffrey W. Ackley

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Photographs by the author except where noted.

We go through life with all kinds of things covering our eyes. Although some are self-imposed, many can be attributed to outside sources. Time is a prime example, and I was never more aware of just how little was available than during a three-week trip to Dominica. Nine students from across the U.S. and Puerto Rico had been accepted to the Avila University Research Experiences for Undergraduates (REU) program. These National Science Foundation funded programs last about 10 weeks, and most are based in labs at U.S. universities. Needless to say, fieldwork on a tropical island was an attractive perk of the Avila program.

Spending the entire three weeks fixated on a subset of the fauna or even a single species, collecting data for projects that we were expected to complete and submit for publication, often interfered with commonplace activities like showers and sleep. It certainly got in the way of exploring one of the most well-

regarded diving and ecotourism destinations in the West Indies. This issue of *IGUANA* includes several articles about the Dominican herpetofauna, and at the risk of offending those researchers with the dedication required to ignore much of what surrounds them, the following is devoted to aspects of the island experience that might otherwise have eluded my attention.

Our first day in paradise held several surprises. The most notable was that our accommodations at Sunset Bay were far more civilized than those that field biologists usually experience. Also, our immediate surroundings, a complex of ornamental plants in a well-maintained garden, provided a diverse assortment of cover and perching sites that was readily exploited by a number of Dominican lizards (along with occasional frogs and snakes). Amazingly, during my survey, I found that the hotel grounds were home to the highest herpetofaunal diversity we encountered on the island — no doubt facilitated by the hotel



This sunset at the Sunset Bay Club heralded our arrival.





High elevations, rugged topography, and hundreds of streams produce myriad waterfalls. Here, the students enjoy some downtime beneath Trafalgar Falls.



These pillars support the grandstands of Windsor Park Stadium in the capital of Roseau. Although usually host to cricket matches, we took a very rare night off to experience the national military band and a steel drum group playing everything from hip-hop to Mozart and the theme from Snow White. Such intensely developed areas are rare on Dominica, and are largely limited to the very centers of Roseau and the larger villages on the island.



Ruthie Carter studied microhabitat associations of frogs. Because we shared a need to cover much of the island, she became my travel partner. While searching for *Eleutherodactylus amplinympha* on Morne Macaque a kilometer above the ocean, she looks out over what would have been Freshwater Lake had the cloud forest not been, well, cloudy.



This dead bat had been hanging unnoticed from a branch during much of our stay; its discovery on our last day was attributable to the smell.

management and staff, who thoroughly enjoyed (or at least tolerated) the animals, not to mention putting up with us and our antics.

The area was densely planted with exotic vegetation, lacked a full tree canopy, and despite omnipresent humans and a great deal of concrete, we saw as many reptilian species here as at any other single place on the island. This situation is not unique, and is actually predicted by the intermediate disturbance hypothesis. For example, if you build a swimming pool in the middle of the forest, it will probably not prevent any of the previous inhabitants from living nearby. Meanwhile, however, aquatic species, which normally would not live in a dry forest, now have suitable

habitat and may occupy a new niche that was previously unavailable, thus increasing the local diversity.

Of course, the risk exists that the magnitude, frequency, or type of disturbance may make an entire area uninhabitable for some or all of the species currently present. The seemingly optimal environment offered at Sunset Bay was certainly a local phenomenon. However, the ubiquity of *Iguana delicatissima* was approached only at another moderately altered environment at Champagne Bay (where we went snorkeling). The characteristics of habitats that promote diversity could exist or be emulated elsewhere, and conservation by coexistence with tolerant humans should not be overlooked as an option. This is particularly true in areas where patches of human habitation are smaller than the natural areas surrounding them, and invasive species are less of an issue. For those of us who do not live in a tropical paradise, “going herping” certainly should not be limited entirely to arduous treks through secluded areas — we might just encounter more animals and species near human habitation.

Less enchanting was getting around the island. On the drive from the airport on day one, we encountered a tourist who was forced off the road by an oncoming vehicle on a stretch of road reduced to barely one lane by the island’s rugged topography. Although I was told that “traffic” on Dominica is not at all com-



PJ Muelleman (Truman State University) and a school of fish at Champagne Bay, a Dominican national marine sanctuary.



Named by the French for a 1674 killing of Carib Indians by the English, Massacre is a coastal town north of the capital Roseau. A member of our group commented on how this would read if “vandals” were to add an “s” after Christian...

parable to that on more developed islands, searching for appropriate field sites was occasionally problematic. My specific project involved traveling across much of the island at all elevations and times of day to evaluate the herpetofaunal diversity at eleven sites. These areas were characterized by varying degrees of human activity, and formed a gradient from natural forests to bustling towns. Considerable travel was involved, and our limited time frame and Dominica's lack of superhighways led to an appreciation for why local residents regularly ignore posted speed limits.

In many ways, Dominica has remained the island it was when Europeans first arrived. Intimidating mountain ranges and near total absence of intervening flatlands that precluded the development of extensive sugar plantations during the colonial era are largely responsible. The roads to several of our study sites, which were at elevations over 500 m, alternately revealed expansive ocean vistas and views of the extensive old-growth forests that still cover much of the island. In sharp contrast, the frogs, lizards, and snakes we sought were often quite miniscule. Being a bit of a camera nut who dabbles in underwater photography, I was well-equipped with a wide-angle lens for the vistas and a macro lens for the critters.

The blessings and curses of carrying a camera abound. Leaving behind this piece of steal-able, bulky, breakable, temperamental, and valuable scientific equipment is almost guaranteed to result in missed photographic opportunities — yet the burden is not unlike that of taking responsibility for a child in the field. Another curse is the almost inevitable reality that you'll

have the wrong lens in place when faced with a fleeting image you wish to preserve. However, when properly wielded, a good camera allows you to record memories of one-time experiences like no other tool.

For example, we were walking under the majestic 20-m forest canopy along the trail to Kachibona Lake, and I had my fish-eye lens attached when a small frog scampered across the path.



JOHN S. PARNERLEE, JR.

The sea and shore on the windward (eastern) coast of Dominica is framed by banana leaves. Although spared the ravages imposed on most islands by the sugar industry during the colonial era, banana plantations proliferated during the 20<sup>th</sup> century and, unlike sugar, these extend high into the mountains. However, with falling banana prices in recent years, forest is reclaiming some former plantations.



Turning around when we ran out of passable road was a common occurrence. This foreboding sign required us to back down 50 m of steeply pitched asphalt. The entrance we eventually used to access the trail to Kachibona Lake was just to our left, although we took another two days to discover it.



Few living things can make you feel smaller or younger than old-growth forests. This open semi-dry region was near the beginning of a treacherous three-hour hike to Kachibona Lake.

This lens has a viewing angle wider than a human eye, and distorts straight lines into curves (note the trees in wide angle shots). However, small objects can be emphasized against a large background, and thus given a context that a normal lens would not allow.



A Martinique Frog (*Eleutherodactylus martinicensis*) and Craig Berg's intimidating hands are only a few centimeters from the fisheye lens. This was taken without a flash, using only the patchy light filtering through the canopy.

Much of my work was done at night, and operating a camera while dodging raindrops and attempting to take field notes became quite a challenge. Flashes operate just fine without ambient light, but that's not true for the autofocus feature. Thankfully, we had solutions strapped to our heads. Our nighttime activities were all conducted with headlamps. Usually, a colleague was available to shed enough light on a subject to give our cameras a chance to focus, but working alone required more appendages than the number typically allotted to people (admittedly, a tripod would have helped, but data collection almost invariably precluded its use). A solution was to frame a picture, then move my head away from the camera to angle the light on a subject just in front of the lens. Autofocus makes a distinctive noise when it stops "hunting" for the subject and finds a focal point. Depressing the shutter immediately after this happens without looking at the viewfinder is hardly a foolproof method, but was sometimes the only option. Fortunately, most of the animals we encountered at night were asleep or happily ensconced on a stable perch and could be readily approached. Some of these provided a wonderful excuse to take off the blinders we wore to anything not related to amphibians or reptiles. Unfortunately, many of these creatures were mobile, and some insect pictures were possible only because biological urges (sex and food) kept them from scuttling out of the frame. Because I too was fixated on frogs and lizards, I often needed a few moments to realize what I was seeing when encountering insects at night.

One of our first nocturnal hikes involved a narrow trail along a 45° slope in the midst of organic plastic-wrapped banana trees. What first seemed to be a walking stick a few feet from my head turned out to have considerably more than the usual number of legs and antennae. After counting more than 12 appendages, I eventually located two heads of animals engaged in an aerial ballet of significant sexual dexterity.

Cannibalism was another activity well suited to macro photography. After completing an uneventful survey along a trail behind the Syndicate Nature Centre, we again encountered an animal with too many legs. This time, however, only enough limbs to account for one and a half insects were present. A large



This grasshopper is feasting on another of its species. The genders involved and what events led to this macabre spectacle are unknown. Sexual cannibalism is rare in insects outside of mantids, but is known to occur in crickets.





These walking sticks were engaged in midair coitus. The insect on top is hanging onto a leaf with two feet (top of frame), whereas the lower individual is hanging onto the head of the first.

grasshopper was cannibalizing another, and we arrived after most of one creature had been ingested by the other.

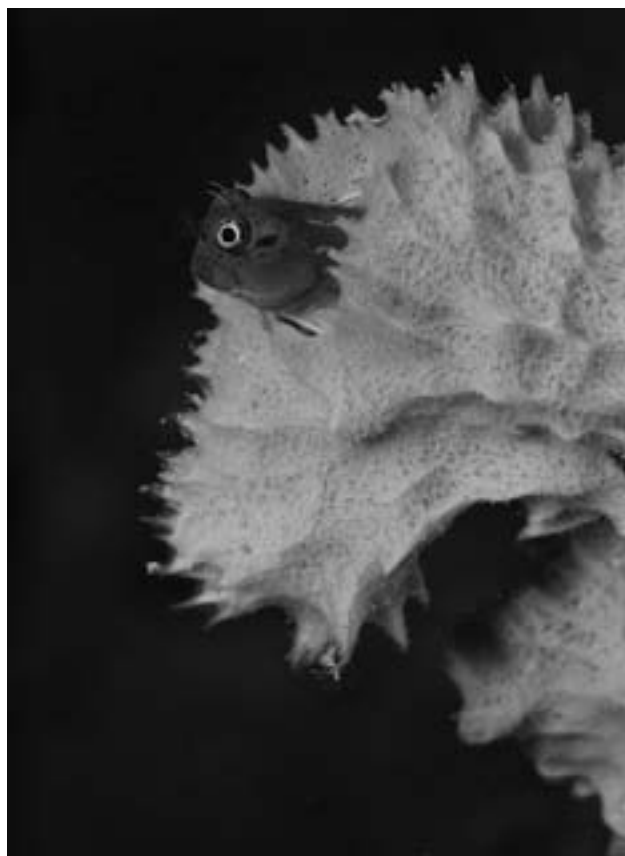
For those of us with a penchant for water, an investment in an underwater housing adds another weight-limit-grazing bag — but also can provide opportunities for tripling the difficulty of land-based photography (along with boatloads of fun). Considering Dominica's reputation for diving, I found myself carrying my total body weight in equipment, and had to resort to washing my limited clothing supply by swimming. When I could sneak in the two hours required to set up, dismantle, and clean the aluminum housing, I spent much of my time freediving with a snorkel.

The housing and external strobe are about the size and weight of a toddler, although they achieve near-neutral buoyancy in the ocean with the aid of foam floats and displaced water. Towing the bulk with flippers is not difficult. However, like approaching land animals with a camera, sea creatures capable of fleeing are far more inclined to do so when presented with a clunky light emitting black object. On land, the solution is to use zoom lenses that allow the photographer to capture a subject from a distance, but that's impractical underwater. Color is distorted by wavelengths of light absorbed by the water, and distant objects often have a drab, flat blue appearance. The solution is in the words of a war photographer named Robert Capa

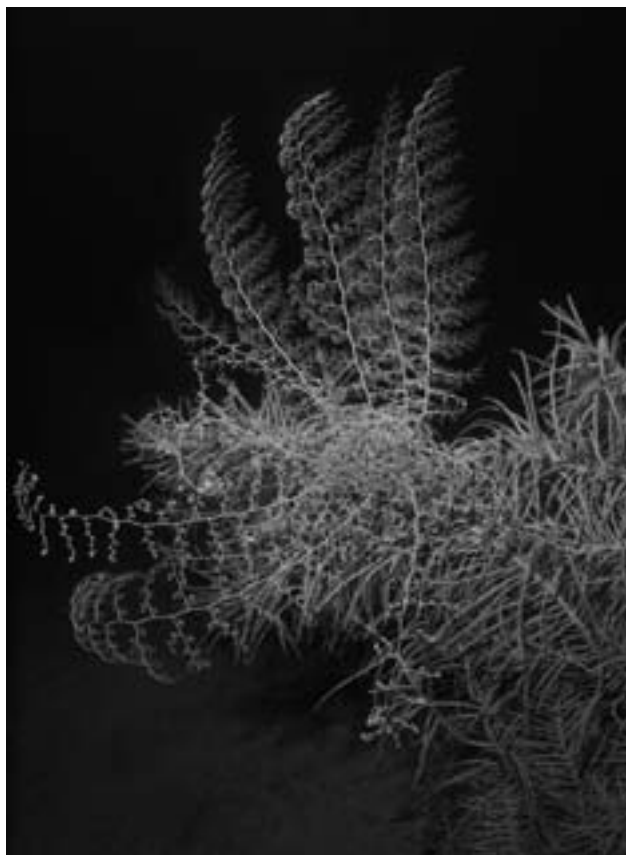


A trumpetfish is camouflaged amid the limbs of a feather duster worm, blown back by the swells from which the feathers sift food particles. The polychaete worm is actually the more skittish of the two, and responds to any disturbance by quickly withdrawing into the mineralized cylinder it secretes.

(who, incidentally, died by stepping on a landmine): "If your pictures *aren't* good enough, *you're* not close enough." The need to be close to the target results in many shots of fish posteriors, and stalking anything that can move underwater will often include the childhood games of hide-and-seek or sit-and-wait. Wandering through a forest of spiky soft corals in the midst of an untouched rocky patch reef, I encountered a number of evocatively named creatures including Gold Spotted Snake Eels, Flying Gurnards, and Bearded Fire Worms.



Never more than a few inches long, blennies sit atop corals next to holes no larger than themselves, into which they all-too readily disappear.



A two-meter high starburst of soft coral rises above the ocean floor at night.

Dominica has much to offer a naturalist, not only in terms of diversity, but in sheer quantity of flora and fauna. A national park system is in place, and a mix of international and indigenous conservation efforts have established public education programs. However, new threats, such as an outbreak of the chytrid fungus among amphibian populations, are of increasing concern. Development on the scale of that on many other



A "hairy" crustacean retreats under the swaying arms of a protective sea anemone.



"Boa" Bob Henderson demonstrated his snake-wrangling skills to the displeasure of this *Boa nebulosa*.



One visible sign of the nation's commitment to conservation consists of educational signs posted along many of the major roads.

Caribbean islands is certainly within the realm of possibility. Economic needs may yet trump the "nature isle." However, the current level of coexistence between the flora and fauna and humans and their needs has resulted in a unique destination for those of us who enjoy a natural experience.

### Acknowledgements

Marcella and Roger Dutrieux Cools and their staff at the Sunset Bay Club Beach Hotel were gracious hosts. Our mentors, Robert Powell (Avila University), Robert W. Henderson (Milwaukee Public Museum), John S. Parmerlee, Jr. (Johnson County Community College), and Craig S. Berg (Milwaukee County Zoo), provided transportation and guidance. Mr. Arlington James, Forest Officer, Forestry, Wildlife, and Parks Division, Ministry of Agriculture & the Environment, Commonwealth of Dominica, was instrumental in issuing permits to conduct research in Dominica and facilitated our efforts in myriad ways. Fieldwork was funded by a grant from the National Science Foundation (USA) to Robert Powell (DBI-0242589).

## HISTORICAL PERSPECTIVES

Snake Eats Snake<sup>1</sup>

C.W. Kempton

Oro Blanco, Arizona

While walking over a dry mesa, yesterday, I noticed a small snake slowly crawling to the shelter of a mesquit bush. On capturing it, I found it to be of a very dark olive-green color, in large, square pattern, the lines between the plaids being of lighter green; underneath, white, with very dark-green blotches. Its head was very dark green, and rather small; it had small fangs. The length of the snake was nineteen inches. Noticing that the body seemed much distended, I opened it, and found, nicely

packed away inside, the body of an ordinary, brown, striped "grass snake," as we call them here, twenty-two inches long. This green snake may be a new species of snake-eating serpent. The grass snake is very swift, and I am puzzled to know how the green snake caught it; it was swallowed head-first.

<sup>1</sup> Originally published in *Science*, Vol. 20, No. 498 (19 August 1892), p. 107.

Snake Story<sup>2</sup>

Mrs. W.A. Kellerman

Columbus, Ohio

At propos of the interesting notes on snakes, lately published in your columns, I would like to relate the following:—

I think it was about the middle of last June that our little boy, who is interested in collecting various natural history objects, brought home a full-grown water-snake. He procured a box of generous dimensions, one whole side of which he covered with wire-screen, such as is used in windows. A small slide was made in the top of the box, so that the porcelain tray (such as photographers use for developing trays), which he placed within, could be kept filled with water, and also for the introduction of food.

This box was thenceforward "the snake den," and here the snake passed the remainder of its existence. A small frog, several grasshoppers, and various insects were dropped through the opening in the top of the box from time to time, but we are not sure whether the snake ever deigned to taste a morsel during her entire captivity; certain it is, however, that if she did finally taste the frog, she did not find it a very appetizing meal, for the little frog hopped about in the box for days and days without any food itself. It was just as apt to rest upon the body of the snake as anywhere else, each seemingly indifferent to the presence of the other. The grasshoppers also were entirely ignored. The snake was left in the box, in the back-yard, during the months of July and August, with no care whatever, we being absent during that time, and the little boy who had agreed to look after it having deserted it.

What was our surprise, after our return early in September, to find one day that Mrs. Snake had giv[en] birth to thirteen little ones. Such a little, writhing, squirming, snaky mass! The little snakes were about five inches long, and soon became quite active. In the course of a few weeks they were much more ready to take their own part than their mother seemed to be. She had

probably learned by experience that it was of little or no avail to "fight back," and contented herself with running out her forked tongue when irritated, and then trying to creep out of harm's way. The little ones, on the contrary, would crawl up the screen as far as possible, and when pushed off, with a straw or wire introduced through the screen, they would at once crawl up again, run out their little tongues, and show all the rashness of youth.

Wondering how far the maternal instincts were developed in the mother snake, whether she would try to defend or protect them, the young snakes were frequently irritated, in order to arouse, if possible, her defensive propensities; it was all to no purpose; she seemed a heartless mother, ignoring wholly that her offspring were in danger. A long wire was often thrust into the box, and under a little snake, which could thus be dangled before the old snake in a most irritating manner. But, whether from fear on her own part, or utter indifference to the welfare of her young, she paid no attention whatever to the provocation.

The mother snake lived until the middle of October, when she succumbed to the white frosts of autumn.

A few weeks later two of the young snakes fell asleep; one of them was given to a little schoolmate, who put it in his pocket and took it to school, when, lo! and behold! the warmth from his body resuscitated it, and the "bad boy" played with it in school. To the teacher's question as to what he had, he replied, "A shoestring!"

Learning thus that possibly the remaining little snakes might sleep (hibernate) through the winter, soil, small stones, dead leaves, etc., were placed in the box, and they crept away out

<sup>2</sup> Originally published in *Science*, Vol. 21, No. 520 (20 January 1893), pp. 36–37.

## Editor's comments: Three Snake Stories

Those of us living in the age of the Internet often forget how fast and far science has come. The journal *Science* is published by the American Association for the Advancement of Science and was established in 1848. The journal has come out weekly since 1880, leaving a record of what was considered noteworthy for the past 130 years. Among other topics, the current issue (Vol. 320, No. 5877) discussed climate change, quantum dots, nanotubes, and DNA extracted from fossilized feces left by pre-Clovis humans — none of which would have made sense to the original authors and readers of the journal.

Organismal biology has been featured in *Science* throughout its existence. Here we feature three short pieces that discussed snake biology. The oldest and shortest, from 1892, described a snake found in the stomach of another snake. The descriptions of the animals are so vague that we have been unable to determine what species are described. We know a lot more about snake diets today, yet notes such as this still appear and convey new information. For example, a report due to be published soon in *Herpetological Review* describes, for the first time, cannibalism in *Alsophis portoricensis*. Although the lack of specific information would make the Kempton piece unacceptable in any journal today, we still need good natural history observations.

The second piece, published a year later, also is anecdotal: the author's son got a snake, which gave birth. The author, clearly a layperson, was astounded by how long it took the poor animals to die in the absence of food, and how lacking in maternal instincts the mother was in the face of continued harassment of her offspring. Today, none of this would be news. At the time, it was deemed worthy of publication.

The final piece, now just over 100 years old, is the only one penned by a scientist, albeit a geologist. Clinton Hart Merriam, named in the article, was one of the giants of natural history during his lifetime (1855–1942). Although his focus was on birds and mammals, his many contributions are still recognized in scientific names such as the Canyon Lizard (*Sceloporus merriami*), found in Texas and Mexico. The other professional mentioned, Leonhard Hess Stejneger, was Curator of Herpetology and later the Head Curator for Biology at the Smithsonian. In the late 1800s, another herpetological giant, Edward Drinker Cope, described in his honor *Zamenis stejnegerianus* (now included in *Coluber constrictor*, the Black Racer) and *Eleutherodactylus stejnegerianus*, Stejneger's Rain Frog, a name still recognized today.

Gad Perry



GAD PERRY



APRIL BATES

Apparent cannibalism in Puerto Rican Racers (*Alsophis portoricensis*). This snake (top) died in an effort to cannibalize another individual and this apparent effort to kill and consume another snake ended with humans “rescuing” the intended victim (bottom).

of sight. Whether they are dead, or only sleeping, we do not know. They lived, however, some seven or eight weeks, were active, seemed well and happy and, as far as we know, never ate a mouthful of anything during the entire time. I neglected to mention that the old snake shed her skin once during her cap-

tivity, unfortunately, it was during our absence, and we did not witness the operation.

It certainly seems strange that, with so much fasting, they none of them should look thin and poor, but should apparently grow and increase when having consumed nothing.



# A Salamander-Snake Fight<sup>3</sup>

J.S. Diller

U.S. Geological Survey  
Washington, D.C.

While studying the geology of Buck Peak, twelve miles west of Riddle, Douglas Co., Oregon, last September, I saw a mortal combat that interested me very much because so anomalous. James Storrs, a mountaineer and trapper of California, well acquainted with the habits of wild animals, was with me at the time and remarked that it was "the first ring engagement he had ever seen in which the salamander showed any sand." In these strenuous days of nature faking it is after all not surprising that even the salamanders are beginning to take an active part in affairs.

We watched the progress of the fight for a few moments each time at intervals of about forty-five minutes for three hours.

Thinking that the occurrence might be familiar to herpetologists, I sent a brief account of it to my friend Dr. C. Hart Merriam for information. In his reply he regarded the observation as important and expressed a request that the account be published in *SCIENCE* as a matter of permanent record.

The combatants were a salamander and a garter snake. The salamander was about eight inches in length, of a rather dark brown color above and lighter below. On the back and sides including the tail were irregularly elongated roundish darker spots. His smooth skin was naturally moist and being plump and chunky he seemed to be a bull-dog of his kind. Judging from the specimens kindly shown me by Dr. Stejneger in the National Museum the salamander was probably an *Ambystoma* [= *Ambystoma*].

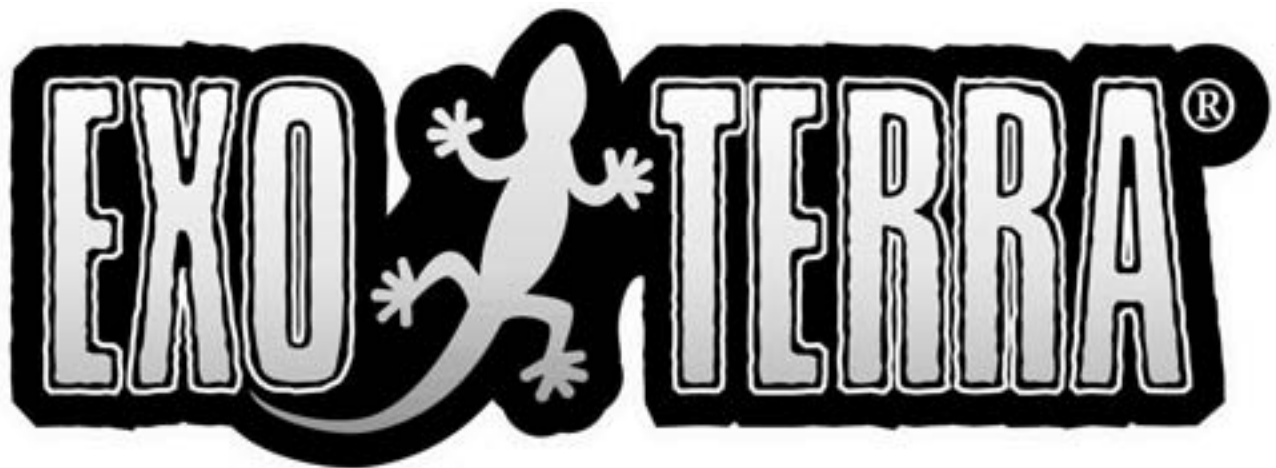
The garter snake was of good size, about two feet in length, and with other stripes had reddish-brown markings on the sides. Both animals seemed to be in perfect condition for a hard fight.

When first seen in a narrow dry water course I supposed that the snake was swallowing the salamander, but the squirming of the snake attracted closer attention and the salamander was found to have a firm grip on the snake at the base of the right jaw and neck. The snake could not bite the salamander but writhed so as to turn him over and over and drag him along on his side or back without affecting the grip of the salamander. His whole attention seemed to be given to holding on without caring whether he was right side up or not.

This moderately active writhing in which the snake furnished all the energy continued for over two hours with gradually waning strength on the part of the snake. In the course of the struggle they passed beneath a bank and out of sight, but when last seen, half an hour later they were out again at the old place. This time all was quiet. The salamander was now in control. He had changed his grip. He was directly in front of the snake and had a deep hold on its upper jaw covering its nostrils. The lower jaw of the snake was hanging limp. The salamander seemed fresh in the enjoyment of his victory, while the snake was nearly dead.

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<sup>3</sup> Originally published in *Science*, New Series, Vol. 26, No. 678 (27 December 1907), pp. 907–908.



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## C O M M E N T A R I E S

# A Burmese Python Could Be More Than A Pest<sup>1</sup>

J. Whitfield Gibbons

Savannah River Ecology Lab, Aiken, South Carolina

How would you like to find out that a 15-foot-long Burmese python was a permanent resident in your neighborhood? Add to this report that someone has found a clutch of 50 recently hatched python eggs, which means that pythons are breeding and that the juveniles have dispersed into the area. This exact scene has not been documented yet in suburban areas of south Florida, but the possibility exists. A recent book (*The Exotic Amphibians and Reptiles of Florida*, 2004, Krieger Publishing Company, Malabar, FL) by Walter E. Meshaka, Jr., Brian P. Butterfield, and J. Brian Hauge gives cause for the human residents of Florida to address the issue of introduced species of herpetofauna that have now become their new neighbors in the state.

The book provides an account of 40 species of reptiles and amphibians that are now believed to be established residents in

the state. In other words, they have breeding populations that will continue to persist, often to the detriment of native species. Most of the exotic reptiles that now thrive in Florida are lizards and include species from Asia, Africa, India, and tropical America. Introduced species often do well in a new region because their population sizes are no longer controlled by natural predators. One of the ways that exotic species can eliminate native species is by outcompeting them for food, or in many cases just by eating them. For example, the Knight Anole from Cuba will eat other lizards and reaches twice the size of most native lizard species.

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<sup>1</sup> Reprinted with permission from the author and Partners in Amphibian & Reptile Conservation (<http://www.parcplace.org/>).



ROY WOOD, BERGLADES NATIONAL PARK

Most Burmese Pythons (*Python molurus bivittatus*) encountered in southern Florida are adults, presumably former pets released by owners when they become too large to accommodate easily in captivity.



LOUI GERNIGER

Interactions between introduced and native species are unpredictable. However, in southern Florida, both a native (American Alligator, *Alligator mississippiensis*) and an invasive species (Burmese Python, *Python molurus bivittatus*) may pose a risk to pets and small children.

Many of the exotic reptiles in Florida have been introduced as a consequence of the pet trade. Pet snakes are notorious for escaping from cages, even from professional herpetologists, and then getting out of a building. Pet trade facilities can be damaged or destroyed by high winds or trees, resulting in the escape of animals. For example, the book notes that the Brown Mabuya skink, a lizard from Southeast Asia, became noticeably more abundant around Coconut Grove in Dade County after Hurricane Andrew. But some releases have been intentional. For example, in 1985 people living around a golf course in Ft. Myers released Jamaican Giant Anoles, which now have an established colony.

One of the paradoxes of the invasive plant and animal problem is that intuitively a person might think that adding new species increases biodiversity. If biodiversity is a good thing, why would it not be good to add more species to the ones already present in a region? One of the simple explanations is that when an introduced species becomes dominant in an area, native species can decline in numbers and eventually disappear.

Although the animal pet trade is the ultimate source of most introduced exotic species, the majority of the specimens themselves are released into the environment by pet owners who

are ordinary citizens. Getting a baby python that is only a couple of feet long may seem like a good idea until you notice that you have to feed it a full-grown chicken every couple of weeks. The size differential would be like getting a red setter puppy and realizing a few months later that it was the size of a cow. Not much smarter, but a lot bigger.

According to the book, the largest Burmese Python found wild in Florida so far was less than 8 feet long, slightly smaller than the largest indigo snakes native to Florida. But these pythons are known to reach a length of 20 feet, which is more than twice the size of any snake native to the United States. With a warm climate and the availability of plenty of food, pythons should do well in south Florida. Young pythons will eat rats, mice, and small birds, and larger ones will fare well on possums, raccoons, dogs, cats, and larger birds. Burmese Pythons can swim, climb trees, and creep through thick underbrush, so they should find plenty to eat. We may soon hear Floridians complaining that a resident species other than native alligators is eating pets and is perceived as a threat to children. Ironically, in contrast to alligators, which lived in the state long before people, pythons were brought to Florida by the people themselves.

# The Decline of the Natural-History Museum<sup>1</sup>

Thomas H. Benton<sup>2</sup>

Sometimes I wonder whether I have chosen the wrong profession. How many English professors, after all, have a 6-foot-long reproduction of Rudolph Zallinger's "The Age of Reptiles" mural from Yale's Peabody Museum hanging in their home office above cabinets full of fossils, butterflies, and seashells? As a child, I was, like many kids, fascinated by dinosaurs. One of my most powerful early memories is of visiting the great hall of Philadelphia's Academy of Natural Sciences: an enormous 19<sup>th</sup>-century gallery decorated, as I recall, with wrought iron, entablatures, oak, and marble. I remember my footsteps echoing as I walked toward the polished railing behind which stood the *Hadrosaurus*, more than 20 feet tall and impossibly ancient. The mounted skeleton — brown, lacquered, and cracked, like a Rembrandt painting — revealed itself gradually as my eyes adjusted to the light. Dinosaur Hall was a temple dedicated to the wonder of creation, the aspirations of science, and the smallness of humanity in the context of geologic time.

I kept that faith, earning top grades in science courses, until my junior year of high school, when the rigors of trigonometry and physics — the empirical fetish — more or less put an end to my scientific ambitions, if not to my love of science. It surprises some people when I say that the closest cousin to science, for me, was English, because it, too, was about the cultivation of wonder and imagination.

Nowadays, when a scholarly conference brings me to Philadelphia, New York, Chicago, or Washington, I try to make a trip to their natural-history museums. But I rarely find what I am looking for. I suppose I am trying to relive my childhood. I know the past is easy to glorify, but I do not think my disappointment comes only from my tendency toward nostalgia and old-fogeyism. I think natural-history museums have changed for the worse in the last 30 years. The solitude, silence, and quasi-religious awe that I remember have been banished by throngs of screaming, barely supervised children on school trips, who pay less attention to the exhibits than they do to the gift shops and food courts. No doubt, the museums were forced into that situation by economic necessity and political demands that they cater to the broadest possible segment of the public. That means museums simplify their exhibitions rather than expect visitors to aspire to a higher level of appreciation for something outside the normal range of experience.

I remember, even as a 10-year-old, not liking the new children's annexes that were first installed back in the 70s. I felt a lit-

tle insulted, as if I was being made to watch *Sesame Street*, or spend time in a day-care center. Clearly, these "Please Touch" museums have to cater to a wide age range, but, just as it often does in the classroom, that seems to mean aiming at an ever-lowering median of knowledge, interest, and common civility.

My 7-year-old daughter also loves natural history. She likes being able to handle real fossils and touch exotic animals, but she does not like being crowded and trampled by other children who often reduce museums to something approximating life in the Hobbesian state of nature. So we have learned to avoid the so-called children's sections, even though the behavior they encourage seems to have spilled out to the rest of the museum.

Unfortunately, the Academy of Natural Sciences was a victim of the imperialism of the juvenile back in the mid-80s. Dinosaur Hall, no longer a chapel, is now brightly lit and painted in "kid-friendly" colors. The architectural details are concealed beneath wall-to-wall carpeting and plaster board.



The *Barosaurus* at the American Museum of Natural History, rearing up and defending its young from an advancing *Allosaurus*, is perhaps the greatest mounted dinosaur exhibit in the world.

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<sup>2</sup> Thomas H. Benton is the pseudonym of an associate professor of English at a Midwestern liberal-arts college. He writes about academic culture and welcomes reader mail directed to his attention at [careers@chronicle.com](mailto:careers@chronicle.com).



Toward the back of the hall, a dated “high tech” video installation inserts kids into a picture with dinosaurs in it, as if they were starring in *Jurassic Park*, a movie that today’s children are no more likely to have seen than the old TV show, *Land of the Lost*. The kids make ugly faces and dance while watching themselves on screen until the next group comes in and shoves them out.

Never mind that Dinosaur Hall was one of the most important sites in the institutional history of paleontology. Discovered in 1858, the academy’s *Hadrosaurus* was the first mounted dinosaur skeleton in the world. Dinomania started in Philadelphia. Now the towering *Hadrosaurus* is hunched over — in deference to current theory — and banished to an inconspicuous corner to make room for a gathering of fossil replicas designed as photo-ops. Instead of gazing up at a relic of the heroic era of Victorian science, people ignore the *Hadrosaurus* and get their picture taken with their head beneath the jaws of the scary *Giganotosaurus*, a sort of *Tyrannosaurus rex* on steroids, before going to the gift shop to buy a “sharp toothed” plush toy. See, kids, science can be fun!

But programmed “fun” is not necessarily pleasure, nor is entertainment the only means of sparking an interest in science. The people who run museums these days seem to think that children cannot enjoy quiet reflection. I suppose they think that would be elitist. As a result, decorum — once one of the key lessons of the museum for children — is replaced by the rules of the schoolyard, the serious is usurped by the cute, and thought is banished by the chatter of last decade’s high-tech gizmos.

In *Stuffed Animals & Pickled Heads: The Culture and Evolution of Natural History Museums* (Oxford, 2001), Stephen T. Asma quoted one curator from the Field Museum in Chicago: “The sad fact is that many quieter people, who put in years of good work at the Field Museum, have recently lost their jobs to more dynamic but less educated competitors. The nature of the work, hunched over tiny bugs or fossils in a hidden-away cubicle, for example, traditionally drew introverts to the curator and staff jobs. And the museum nurtured them.” Instead, the curator laments that “the current trend is for museum trustees and administrators to ignore the internal, albeit quirky, talent when staffing positions of power and go outside for M.B.A.’s who frequently don’t know anything about the nuances of the subject matter.”

Fortunately, it is still possible in some of the larger museums and the more obscure ones to find older exhibits — silent corridors of glass cases filled with specimens — that have not been ruined by the addition of push-button TV sets, cuddly mascots, and other contemporary affectations. In particular, I enjoy the animal dioramas created from the 1920s through the 1940s. Those are not mere scientific displays; they are among the most interesting and underrated art works of the 20<sup>th</sup> century. Some of them are the three-dimensional equivalents of Audubon’s *Birds of America*. Successful museum installations need not always require huge expenditures for blockbuster attractions like the Field Museum’s \$8-million *T-rex*, “Sue,” the most expensive fossil in the world (the conspicuous cost being the real attraction).

I remember that the second-best thing about the Academy of Natural Sciences, back in the 70s, was something called the “Trading Post.” It was a large display counter full of rocks, fossils, and bones. Kids could bring in specimens from their own collections and trade them for something new. I once brought in a box of ordinary seashells from the Jersey shore and exchanged them for two skulls: a cat and a rabbit, as I recall. The Trading Post always gave kids the better end of the bargain, and it kept me exploring the creeks and vacant lots in my neighborhood, discovering that nature even existed inside the city. (Those specimens are still in my cabinets, and my daughters are starting to add their own findings to the collection.)

There are also a few museums that have been preserved by benign neglect, such as the Wagner Free Institute of Science, also in Philadelphia, and the Harvard Museum of Natural History. And, I think, foremost in the United States, the American Museum of Natural History in New York has preserved, expanded, and updated itself without sacrificing too much of its history and grandeur.

In the American Museum, for example, the curators took the risk of having their enormous *Barosaurus* rear up, with its head 50 feet in the air, defending its young from an advancing *Allosaurus*. Set amid the marble columns of Roosevelt Memorial Hall, the display is awe-inspiring, perhaps the greatest mounted dinosaur in the world. The museum’s *Barosaurus* is probably bad science, but it is also an important work of public art that expresses the obligations of one generation to another in a medium that a child can appreciate as well as an adult.

Natural-history museums are not just about science. Why couldn’t the academy in Philadelphia leave Dinosaur Hall alone? Were the memories associated with that setting not worth anything to the curators? No doubt for the hard pressed natural-history museum, an alliance between science and business — i.e., entertainment, tourism, and merchandising — seems more sustainable than the old linkage between science and the humanities — i.e., art, history, and even religion, and their combined power to cultivate wonder and imagination.

On the other hand, I do admire the efforts of many natural-history museums — in particular, the American Museum in New York and the Smithsonian Institution’s National Museum of Natural History in Washington — to challenge their visitors, to stand up against the pressure to expunge evolution, and to defend the ideas that led to their founding.

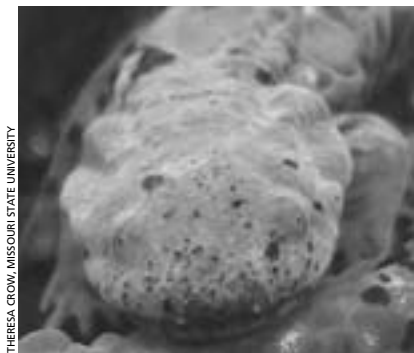
If museums could keep in the foreground their complex, contentious, and interdisciplinary histories — while avoiding the tendency to turn themselves into theme parks and shopping malls — they might rediscover a way to honor the past and embrace the complexity of science as a social institution in a manner that respects the intelligence of visitors, old and young, from every kind of background. In the process, they might make some political enemies, jeopardize some corporate donations, and sell fewer plush toys. They might also demand more from their current audience of captive schoolchildren. And that might be a good thing, if they aren’t bankrupted in the process.

From the perspective of a long-time lover of natural history, it’s a risk worth taking.

## CONSERVATION RESEARCH REPORTS

### Non-native Fishes Threatening Hellbenders in Missouri

The introduction of non-native fishes often results in the local extinction of native amphibians due to a lack of evolutionary history and resultant minimally-adapted antipredator behaviors toward the introduced fishes. Populations of Hellbenders (*Cryptobranchus alleganiensis*) in Missouri have declined considerably since the 1980s, coinciding with a rapid increase in non-native trout introductions for recreational angling. GALL (2008. Unpubl. M.S. Thesis, Missouri State University, Springfield) examined Hellbender and fish predator-prey interactions by: (1) examining the foraging behavior of predatory fishes in response to a Hellbender secretion; (2) comparing the number of secretion and control-soaked food pellets consumed by trout; and (3) comparing the response of larval Hellbenders to chemical stimuli from introduced (trout) and native fish predators. Brown Trout, Walleye, and large Banded Sculpins responded to Hellbender secretions with increased activity, whereas small Banded Sculpins responded by decreasing activity. In addition, Brown Trout ingested more Hellbender secretion-soaked food pellets than control pellets, whereas Rainbow Trout expelled secretion-soaked food pellets. Finally, larval Hellbenders exhibited weak fright behavior in response to chemical stimuli from nonnative trout relative to their responses to native predatory fish stimuli. These combinations of responses indicate that predation by non-



THERESA CROW, MISSOURI STATE UNIVERSITY

Populations of Hellbenders (*Cryptobranchus alleganiensis*) in Missouri have declined considerably since the 1980s, coinciding with a rapid increase in non-native trout introductions for recreational angling.



ROBERT POWELL

*Ameiva undulata* (illustrated) and *Sceloporus utiformis* were the only two sampled species of lizards that were disturbance-sensitive. Both are terrestrial and forage in the leaf litter. Reduction of the litter may be responsible for the decline of these species in disturbed forests.

native fishes may be a plausible hypothesis for the decline of Hellbender populations in Missouri.

### Effects of Converting Dry Tropical Forest to Agricultural Mosaics

SUAZO-ORTUÑO ET AL. (2008. *Conservation Biology* 22: 362–374) explored the impact of forest conversion to agricultural mosaic on anuran, lizard, snake, and turtle assemblages in Neotropical dry forests. Over two years, the authors sampled six small watersheds on the western coast of Mexico, three conserved and three disturbed. The disturbed watersheds were characterized by a mosaic of pastures and cultivated fields (corn, beans, squash) intermingled with patches of different successional stages of dry forest. In each watershed, they conducted 11 diurnal and nocturnal time-constrained searches in ten randomly established plots. We considered vulnerability traits of species in relation to habitat modification. Eighteen anuran, 18 lizard, 23 snake, and three turtle species were recorded. Thirty-six species (58%) occurred in both forest conditions, and 14 (22%) and 12 species (19%) occurred only in the conserved and disturbed sites, respectively. Assemblages responded differently to disturbance. Species richness, diversity, and abundance of lizards were higher in disturbed forests. Anuran diversity and species richness were lower in disturbed forest, but abundance was sim-

ilar in both forest conditions. Diversity, richness, and abundance of turtles were lower in disturbed forest. The structure and composition of snake assemblages did not differ between forest conditions. Species were considered disturbance-sensitive if their abundance was significantly less in disturbed areas. Four anuran (22%), two lizard (11%), and three turtle (100%) species were sensitive to disturbance. No snake species was sensitive. The decline in abundance of disturbance-sensitive species was associated with the reduction of forest canopy cover, woody stem cover, roots, and litter-layer ground cover. Anuran species with small body size and direct embryonic development were especially sensitive to forest disturbance. An important goal for the conservation of herpetofauna should be the determination of species traits associated with extinction or persistence in agricultural mosaics.

### Reptilian Road Mortality in Illinois

Roads have numerous negative ecological effects on terrestrial fauna, and vehicular mortality can have significant demographic consequences for some species. SHEPARD ET AL. (2008. *Copeia* 2008: 350–359) studied road mortality of reptiles around Carlyle Lake, Clinton County, Illinois, USA, from April 2000 through November 2002, to assess the impact of vehicular traffic and identify



DON SHEPARD



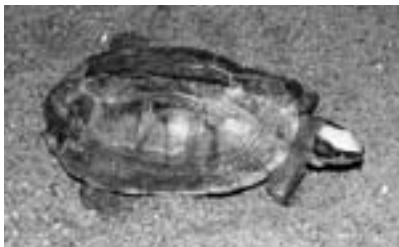
MICHAEL REDMER

Road mortality of the endangered Eastern Massasauga (*Sistrurus catenatus*) was biased toward adult males, which show an increase in movement in August, coinciding with the peak of the mating season and a period of high tourist visitation.

influential factors. Carlyle Lake, a popular tourism/recreation area, is situated in a larger agricultural landscape and is home to the largest Illinois population of the endangered Eastern Massasauga (*Sistrurus catenatus*). The authors documented 321 cases of reptilian road mortality (84 individuals of six turtle species and 237 individuals of nine snake species) while driving the approx. 46-km study route roundtrip daily. Turtle road mortality was highest in May and June, and positively associated with precipitation and minimum daily temperature. Colubrid snake road mortality was highest in April and October, and positively associated with minimum daily temperature. We recorded 42 cases of road mortality of *S. catenatus*, with the highest number occurring from mid-August to mid-September. Road mortality in *S. catenatus* was biased toward adult males, which show an increase in movement in August, coinciding with the peak of the mating season and a period of high tourist visitation. The traffic intensity on a road segment did not significantly affect the level of road mortality, but segments through high-quality habitats had higher levels of mortality than segments through lower quality habitats.

### Refutation of Traditional Chinese Medicine Claims about Turtles

The Chinese turtle trade is the primary threat to endangered turtle populations throughout Asia, primarily because of the long tradition of consuming turtles in China. Practitioners of Traditional Chinese Medicine (TCM) promote nutritional and medicinal benefits from eating turtles, especially hardshell species. MEILING ET AL. (2008. *Applied Herpetology* 5: 173–187) tested these claims by determining the nutritional value of turtle products (meat, fat and shell) in five species of geoemydid turtle, *Cuora trifasciata*, *C. mouhotii*, *Mauremys mutica*, *M. sinensis*, and *Geoemyda spengleri*. The authors analyzed nutritional variables such as the composition of amino acids, fatty acids, and mineral elements to determine the relative nutritional quality of turtle products. Their study refutes TCM claims about products made from hardshell turtles. Alternative animal products should be substituted to obtain similar minerals, amino acids and fatty acids. Balancing the cultural use of turtles with their conservation status remains a major challenge.



TORSTEN BLANCK, WILDLIFE

Analysis of turtle meat from five species of Chinese turtles, including *Cuora trifasciata*, refuted claims about the nutritional value of eating hardshell turtles.

### A Sixth Mass Extinction?

Many scientists argue that we are either entering or in the midst of the sixth great mass extinction. Intense human pressure, both direct and indirect, is having profound effects on natural environments. The amphibians — frogs, salamanders, and caecilians — may be the only major group currently at risk globally. A detailed worldwide assessment and subsequent updates show that one-



JEFF LEWIN

Amphibian population declines, extirpations, and extinctions may be the first sign of an impending mass extinction. The status of the critically endangered Mountain Yellow-legged Frog (*Rana muscosa*) may be a harbinger of other declines in the United States.

third or more of the 6,300 species are threatened with extinction. This trend is likely to accelerate because most amphibians occur in the tropics and have small geographic ranges that make them susceptible to extinction. The increasing pressure from habitat destruction and climate change is likely to have major impacts on narrowly adapted and distributed species. WAKE AND VREDENBURG (2008. *Proceedings of the National Academy of Sciences* 105: 11466–11473) showed that salamanders on tropical mountains are particularly at risk. A new and significant threat to amphibians is a virulent, emerging infectious disease, chytridiomycosis, which appears to be globally distributed, and its effects may be exacerbated by global warming. This disease, which is caused by a fungal pathogen and implicated in serious declines and extinctions of >200 species of amphibians, poses the greatest threat to biodiversity of any known disease. The authors' data for frogs in the Sierra Nevada of California show that the fungus is having a devastating impact on native species, already weakened by the effects of pollution and introduced predators. A general message from amphibians is that we may have little time to stave off a potential mass extinction.

## NATURAL HISTORY REPORTS

### Morphology and Diet of Two Sympatric Snakes

PINTO ET AL. (2008. *Amphibia-Reptilia* 29:149–160) described the morphometry and diet of two sympatric species of *Chironius* (*C. flavolineatus* and *C. quadricarinatus*) from Brazilian Cerrado. The two species differ in external morphology, with *C. flavolineatus* longer and *C. quadricarinatus* heavier. Each species also showed marked sexual size dimorphism. Both species feed exclusively on frogs with a heavy preference for hylids, and may have a tendency to eat small prey. These two species have brownish ground colors and exhibit no ontogenetic variation, suggesting that juveniles and adults use similar substrates. *Chironius flavolineatus* and *C. quadricarinatus* are semi-arboreal, forage actively, and usually feed on the ground. *Chironius flavolineatus* uses higher vegetation for resting and, based on morphological results, seems to be more arboreal than *C. quadricarinatus*.

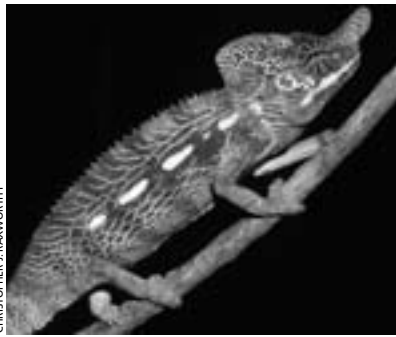


LAURE J. VITT

Both *Chironius flavolineatus* (top) and *C. quadricarinatus* (bottom) are semi-arboreal, forage actively, and usually feed on the ground, but the former is more slender and elongate, suggesting that it is more arboreal.

### A unique life history among tetrapods: An annual chameleon living mostly as an egg

The ~28,300 species of tetrapods (four-limbed vertebrates) almost exclusively have perennial life spans. KARSTEN ET AL. (2008. *Proceedings of the National Academy of Sciences of the United States of*



CHRISTOPHER J. RAXWORTHY

*Furcifer labordi* from Madagascar spends most of its life inside an egg.

*America* 105:8980–8984) discovered a remarkable annual tetrapod from the arid southwest of Madagascar: The chameleon *Furcifer labordi*, with a posthatching life span of just 4–5 months. At the start of the active season (November), an age cohort of hatchlings emerges; larger juveniles or adults are not present. These hatchlings grow rapidly, reach sexual maturity in less than 2 months, and reproduce in January–February. After reproduction, senescence appears, and the active season concludes with population-wide adult death. Consequently, during the dry season, the entire popula-

tion is represented by developing eggs that incubate for 8–9 months before synchronously hatching at the onset of the following rainy season. Remarkably, this chameleon spends more of its short annual life cycle inside the egg than outside of it. A review of tetrapod longevity (>1,700 species) found no others with such a short life span. These findings suggest that the notorious rapid death of chameleons in captivity may, for some species, actually represent the natural adult life span. Consequently, a new appraisal may be warranted concerning the viability of chameleon breeding programs, which could have special significance for species of conservation concern.

### World's Smallest Snake

Islands are viewed as natural evolutionary laboratories for terrestrial organisms because they have boundaries that limit dispersal and often reveal evolutionary patterns and mechanisms. One such pattern is that the smallest and largest species of different types of tetrapod animals are frequently found on islands. HEDGES (2008. *Zootaxa* 1841: 1–30) described two new diminutive species of



S. BLAIR HEDGES

The Barbados Threadsneak (*Leptotyphlops carlae*) may be the world's smallest species of snake.



JENNIFER DALTRY

The Antigua Ground Lizard, *Ameiva griswoldi*, affected habitat use and abundance of *Anolis wattsi* on small islands near Antigua.

snakes of the genus *Leptotyphlops* from the Lesser Antilles: One from Saint Lucia (*L. breuili*) and the other from Barbados (*L. carlae*). The species from Barbados is the world's smallest snake, with a total adult length of approximately 100 mm. Limited evidence indicates a clutch size of one and a greatly elongated egg shape. Comparison of egg shapes in snakes indicates that the shape is a packaging phenomenon, related primarily to the shape of the available body cavity and clutch size. The body shape of snakes also varies and influences the shape of snake eggs. The smallest snakes are typically stout-bodied, whereas the longest snakes usually are more slender. The allometry of organ size also affects clutch size and shape, because the smallest snakes have the smallest proportion of body cavity space available for reproduction. The best explanation for the observation of body size extremes on islands is that colonizing species have adapted to open ecological niches that would otherwise be occupied on the mainland. Island colonists encounter novel environments and reduced interspecific competition, allowing species to evolve physical traits, including extremes in size, not normally seen on continents. However, the lower limit of adult size appears to be constrained by the allometry of morphology, physiology, and reproduction. The smallest tetrapods have small clutches, usually one egg or young, and offspring that are relatively large. In the smallest snakes, offspring are one-half of the length of adults, compared with 10% adult length in the case of large species of snakes. Thus the evolutionary tradeoff between number and size of offspring appears to have reached a size boundary in these

species, limiting the evolution of yet smaller species.

### Niche Relationships and Interspecific Interactions in Antigua Lizard Communities

*Anolis* lizards are the focus of most Caribbean lizard community ecology studies, with few studies including other common species that might influence community structure. To study niche relationships and interspecific interactions in Antigua lizard communities, KOLBE ET AL. (2008. *Copeia* 2008: 261–272) used five offshore islands with varying combinations of three diurnal lizards: *Ameiva griswoldi*, *Anolis leachii*, and *Anolis wattsi*. The authors collected data on perch height, substrate, thermal microhabitat, body size, head length, daily activity, and abundance to characterize the ecological niche of each species. *Ameiva griswoldi* was more similar to *A. leachii* in size and daily activity, but more similar to *A. wattsi* in perch height, and *A. leachii* and *A. wattsi* were more similar in thermal microhabitat. This pattern of niche differentiation was consistent with niche complementarity, where species are

similar on some niche axes but differ on others. Using the same niche characteristics as in species comparisons, we tested for a niche shift among islands for *A. wattsi*. In the absence of *A. griswoldi*, *A. wattsi* used lower perches, sunnier microhabitats, and was found more often on the ground. In contrast, with *A. leachii* absent, *A. wattsi* perched higher, more often in the shade, and on trunks. Furthermore, *A. wattsi* was most abundant when with *A. leachii* only, but least abundant when alone with *A. griswoldi*. These results suggest interspecific interactions, most likely due to competition and intraguild predation, are important for structuring Antiguan lizard communities.



CARLOS A. RODRIGUEZ GÓMEZ

The Barbuda Bank Tree Anole (*Anolis leachii*) also affected habitat use by smaller *Anolis wattsi* on Antiguan satellite islands.

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## NEWSBRIEFS

### Canada's Roadkill Hot Spot

The fourth deadliest road in the world for turtles just got a little safer. Work crews finished laying 2,500 meters of temporary fencing this week to prevent turtles and other creatures from wandering out of their marshlands onto the Long Point (Ontario) Causeway. "It's just an attempt to stop the carnage right now," said reptile biologist Scott Gillingwater, shortly after finding a Midland Painted Turtle (*Chrysemys picta marginata*) squashed into the pavement on which 10,000 animals die each year.

Long Point, extending into Lake Erie south of Brantford, defines one of the most biologically diverse regions in Canada. The United Nations recognizes the peninsula and its neighboring wetlands as one of the country's 13 World Biosphere Reserves, with multitudes of birds, animals, and reptiles, including eight types of turtles and 18 kinds of snakes — but the wetlands lie between the mainland and the peninsula. In 1927, authorities built a 3.5-km causeway to allow car access to cottages, fishing spots, and public beach areas that later developed into a provincial park. They created a killing field.

"My father and his dad often talk about their trips to their cottage on Long Point ...," area biologist Paul Ashley wrote two years ago in *BirdWatch Canada*. "My grandfather reminisces that back then the turtles and snakes were so thick that you couldn't help but run over a few." Now population numbers are dropping noticeably.

"The Northern Map Turtle [*Graptemys geographica*] is a species of special concern," reptile biologist Gillingwater said, as he stepped through

the marshes to examine nesting sites. "The Blanding's Turtle [*Emydoidea blandingii*] is threatened, and the Eastern Fox Snake [*Elaphe gloydi*] has recently been upgraded ... from threatened to endangered."

With warm weather, turtles begin roaming widely in search of mates or places to lay eggs. Skunks, foxes, and possums will eat most of the eggs. Birds and bullfrogs will go after hatchlings. Only a few turtles will survive to adulthood. Several years ago, Canadian Wildlife Service researchers estimated that between April and October the causeway handles 2,250 car trips a day. On summer weekends the number quadruples. The same study found that 10,000 animals a year die on the road — mostly Leopard Frogs (*Rana pipiens*), but 99 other species as well. Another Canadian Wildlife Service study showed that some drivers run over turtles and snakes for sport. "Working from existing literature, U.S. conservationist Matthew Aresco of northern Florida named Long Point Causeway the world's fourth-worst road for turtle mortality after three U.S. roads. Area residents decided enough was enough.

Two years ago, some 20 local groups came together to rebuild the causeway. They decided that permanent barriers to the roadway and underground passages must be created for animals. Waterways must be opened for spawning fish. A \$40,000 feasibility study by a Kitchener, Ontario, firm recently put renovation costs at \$14–20 million. Provincial and national bodies would need to get involved. In the meantime, the Ontario

Species at Risk Stewardship Fund has paid \$30,300 to erect 2,500 m of plastic fencing toward the south end of the causeway. Sand is also being dumped inside the fences as temporary turtle nesting areas. A modest start, perhaps, but the efforts should save a few turtles.

*John Goddard, Toronto Star*

### Snake-handling Pastor Arrested

The pastor of a Kentucky church that handles snakes in religious rites was among ten people arrested by wildlife officers in a crackdown on the venomous snake trade. Undercover officers purchased more than 200 illegal reptiles during the investigation. More than 100 snakes, many of them deadly, were confiscated in the undercover sting after Thursday's arrests, said Col. Bob Milligan, director of law enforcement for Kentucky Fish and Wildlife. Most were taken from the Middlesboro home of Gregory James Coots, including 42 Copperheads (*Agkistrodon contortrix*), 11 Timber Rattlesnakes (*Crotalus horridus*), three Cottonmouth Water Moccasins (*A. piscivorus*), a Western Diamondback Rattlesnake (*C. atrox*), two cobras and a Puff Adder (*Bitis arietans*).

Handling snakes is practiced in a handful of fundamentalist churches across Appalachia, based on the interpretation of Bible verses saying true believers can take up serpents without being harmed. The practice is illegal in most states, including Kentucky.

Coots, 36, is pastor of the Full Gospel Tabernacle in Jesus Name in



GLENN LOWSON, TORONTO STAR

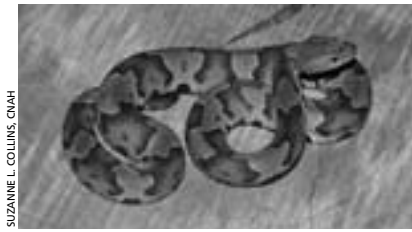
A Midland Painted Turtle (*Chrysemys picta marginata*) makes the trek across the treacherous causeway.

## DANGER ZONES

The top five sites for turtle roadkill per mile are:

1. U.S. Highway 27 at Lake Jackson near Tallahassee, Florida.
2. U.S. Highway 441 at Payne's Prairie Preserve State Park near Gainesville, Florida.
3. U.S. Highway 93, Mission Valley, Montana.
4. Long Point Causeway, Ontario.
5. Cape May, New Jersey.

*Matthew Aresco, Lake Jackson Ecopassage Alliance*



SUZANNE L. COLLINS, ONAH

Copperheads (*Agkistrodon contortrix*) are frequently handled in a small number of fundamentalist churches who trust that true believers can take up serpents without being harmed.

Middlesboro, where a Tennessee woman died after being bitten by a rattlesnake during a service in 1995. Her husband died three years later when he was bitten by a snake in northeastern Alabama. Coots was charged Thursday with buying, selling, and possessing illegal reptiles. He had no listed telephone number and could not be reached for comment.

The snakes, plus one alligator, were turned over to the nonprofit Kentucky Reptile Zoo in Slade. Most appeared to have been captured from the wild, with some imported from Asia and Africa. Zoo Director Jim Harrison said some of the animals would likely have become exotic pets had they not been seized. "There's been a large trade in exotics for years," he said. "Some people are just fascinated with them." "You can purchase anything off the Internet except common sense," Harrison said. "A venomous snake isn't a pet. You don't play with it. If you do, you're an idiot."

### Butler's Garter Snake in Trouble

The Wisconsin Department of Natural Resources (DNR) is changing the way it interprets its authority and definition of "Take" under the Wisconsin Endangered Species Law, and is proposing a new "regulatory framework" for the Butler's Garter Snake (*Thamnophis butleri*). These changes would remove most protections for habitat utilized by endangered and threatened species, substantially reducing the Department's regulatory jurisdiction. The new Butler's Garter Snake "framework" would allow unregulated development of most upland habitat utilized by the snake for its life cycle. The Department has begun implementing these changes without public notice.

The proposed "regulatory framework" is based on a new legal interpretation of "Take" and the Department's jurisdiction, which suggests that if no animals are immediately and obviously killed by an action, a "Take" is avoided and the Department has no authority, even if the actions result in significant harm to the resource, or deaths that are not immediately observed. This new interpretation does not acknowledge that destroying a species' habitat harms individuals of the species, and does not acknowledge that a "Take" occurs when mortality results when individuals return to a lost habitat area and cannot find food or shelter, and through loss of reproductive potential and increased mortality from overcrowding in remaining habitat (if any remains). Such mortality would be a direct result of the unregulated habitat loss. The Department also takes no account of cumulative harm, jeopardy, or viability of the resource resulting from these habitat and population losses. This new interpretation essentially removes protections for all endangered and threatened species in many, if not most, situations. It allows a person to simply shoo an animal off, or wait for it to walk, crawl, or fly away, perhaps to get a drink of water, and then destroy the habitat upon which it depends. For the Butler's Garter Snake, which feeds almost exclusively on earthworms (which do not occupy saturated wetland soils), upland habitat is crucial for obtaining food and shelter, and incubating embryos. The snakes depend on grasses and other vegetation for shelter from predators. Pregnant females seek warm upland sunlit areas adjacent to grasses (to which they flee when disturbed). Such basking sites are crucial to embryonic development in this ectothermic species so proper temperatures can be achieved. Loss of upland habitat would crowd snakes into wetlands, where many would succumb to lack of food and shelter from the elements, overcrowding, and increased predation. Snakes hidden within upland soil and duff retreats at the time of grading, where they take shelter for the night, sit out periods of hot dry weather, and hibernate, would simply be crushed by heavy equipment.

The DNR has issued a "regulatory framework" for selected (stakeholder

public review. They are holding meetings about it with stakeholders, and state they will develop a new broad authorization based on it after comments are received. The new broad authorization will be public noticed and vetted by the Natural Resources Board (NRB). If similar to the "framework" being distributed, this broad authorization will automatically approve the "Take" that results from projects that follow certain minimization measures, such as snake fencing, snake removals, and staying 300 feet away from wetland boundaries. However, the Department, by a form letter being distributed to parties currently in the Butler's Garter Snake approval process, appears to be implementing the substance of the proposed new broad authorization before it is public noticed or reviewed by the NRB.

The "regulatory framework" lists a number of measures that minimize "Take" of snakes. The draft regulatory framework correctly refers to these as avoidance measures that minimize "Take," but the form letter contradicts this and states that these measures actually avoid "Take." As a point of fact, these measures do not avoid "Take," they only minimize it. The Department's own research, for example, documented that snakes occupy habitat more than 300 ft from a wetland boundary (Joppa and Temple, 2005. Use of upland habitat by Butler's Garter Snake (*Thamnophis butleri*). *Bulletin of the Chicago Herpetological Society* 40:221-227), and ample evidence exists of snakes crossing fence lines and over-wintering in uplands. The incorrect portrayal of minimization measures as complete avoidance is the basis for the removal of protections, and unsupported by science.



GARY CASPER

The Wisconsin Department of Natural Resources (DNR) is proposing a new "regulatory framework" for the Butler's Garter Snake (*Thamnophis butleri*) that would remove most protections for habitat utilized by this and other endangered and threatened species.

If any of these measures are implemented, the draft framework allows the project to proceed with no further review, ceding its authority to require conservation measures to avoid cumulative harm and jeopardy. This will result in nearly complete loss of the upland habitats on which the species depends, with no mitigation required.

The “regulatory framework” uses an unsupported definition of “over-wintering habitat,” essentially equating it with wetlands. This is repeated in the form letter. However, ample evidence indicates that snakes hibernate in certain upland situations, such as crayfish burrows, rotted tree root channels, loose fill, and old foundations. The Department acknowledges this by claiming that they will study the matter. The assertion that Butler’s Garter Snakes only hibernate in wetlands is not supported by a single scientist, and the “Take” associated with developing upland overwintering sites is being allowed without regulation.

The “regulatory framework,” if approved as a new broad authorization, would provide a path leading to essentially no protections for the upland habitat portion of Butler’s Garter Snake critical habitat (in most cases), clearly resulting in significant harm to the resource, with no jeopardy analysis performed. The current “regulatory framework” does not acknowledge this, takes no account of cumulative harm, and cedes the Department’s authority and obligation to protect the resource.

### **The San Francisco Airport Aims to Boost the Population of Endangered San Francisco Garter Snakes**

The Peninsula’s most tenacious population of endangered San Francisco Garter Snakes (*Thamnophis sirtalis tetrataenia*) is about to make a major comeback in a little-known urban canal system steps away from a concrete jungle of airport runways, highway on-ramps, and railroad tracks. San Francisco International Airport’s team of planners and environmental engineers is in the final stages of preparing for a 10-year, \$4 million project to redesign two urban storm water canals that also happen to be prime habitat for the San Francisco Garter Snake. The construction project, beginning in mid-August, is designed to dredge four miles’ worth of canals that

provide flood control for the airport while creating a veritable snake paradise of burrows, swimming holes, and hunting sites for prey.

Motorists southbound on Highway 101 would never suspect they were speeding by this little oasis of willow and acacia plants along the banks of a channel that stays wet through the summer. This is the place — Cupid’s Row Canal in San Bruno, along with the South Lomita Canal in Millbrae — to which San Francisco Garter Snakes have been restricted for the last 50 years as the surrounding land has been filled with malls and subdivisions.

The habitat enhancement project, which is seeking an environmental permit from San Francisco and several state agencies, evolved out of an incident in 2003 when a storm flooded the neighborhood around the Cupid’s Row Canal. Both canals suffer from silt buildup and require regular dredging, but dredging can be tricky because of potential impacts to the garter snake and the California Red-legged Frog (*Rana aurora draytonii*), its main source of food.

The solution on which airport officials settled was to re-engineer the canals, creating sediment traps that would minimize the need to dredge as often, and widening the canals to create still pools where the frogs could lay their eggs. The next time they have to maintain the canal a decade hence, officials hope the snake and frog populations will have rebounded so strongly that getting a permit won’t be quite so complicated. “It’s like expanding their subdivision. There’s more space for them to set up their burrows close to the water,” said Ernie Eavis, deputy airport director and chief engineer.

The San Francisco Garter Snake has been listed as endangered since 1967, its wetland habitat threatened by develop-

ment while its prey, the Red-legged Frog, became correspondingly rare (it is now listed as a threatened species). By 2004, the snake was so scarce that state officials were asking the public to help find the remaining population so it could be protected. In 2005, five pairs of snakes were transported from the Netherlands to San Francisco.

A few pockets of the distinctive blue-and-brown snake remain, mostly in coastal areas, such as Mori Point in Pacifica, and in parts of coastal Santa Cruz County. Scientists believe they originated in the flatlands around what is now Highway 280. However, the largest known population in the Bay Area now exists in the narrow “West of Bayshore” area owned and maintained by San Francisco International Airport. The U.S. Fish and Wildlife Service has been aware of their presence there since the 1970s, but was under the impression that their numbers had dwindled in recent years. The Service was proven wrong by a study, conducted this spring, that found between 400 and 500 San Francisco Garter Snakes. “It’s hard to tell how long the snakes have been there. It’s completely surrounded by development, so it’s like a little island population. That population is going to be isolated from all the others, but at one time they were probably able to go up the watershed and communicate with all the others,” said David Kelly, a Fish and Wildlife Service biologist familiar with the project.

The snakes’ survival becomes even more impressive considering how close they came to being wiped out by development. Only the fact that the airport bought the land in the 1920s spared their habitat.

*Julia Scott, Bay Area News Group*



The largest known population of endangered San Francisco Garter Snakes (*Thamnophis sirtalis tetrataenia*) in the Bay Area exists in an area owned and maintained by San Francisco International Airport.

### **The Bush Administration Seeks to Kill the Endangered Species Act**

Parts of the Endangered Species Act may soon be extinct. The Bush administration wants federal agencies to decide for themselves whether highways, dams, mines, and other construction projects might harm endangered animals and plants. New regulations, which do not require the approval of Congress, would reduce the mandatory, independent reviews government scientists have been performing for

35 years, according to a draft first obtained by *The Associated Press*.

Interior Secretary Dirk Kempthorne said late Monday that the changes were needed to ensure that the Endangered Species Act would not be used as a "back door" to regulate the gases blamed for global warming. In May, the Polar Bear became the first species declared as threatened because of climate change. Warming temperatures are expected to melt the sea ice on which the bear depends for survival.

The draft rules would bar federal agencies from assessing the emissions from projects that contribute to global warming and its effect on species and habitats. "We need to focus our efforts where they will do the most good," Kempthorne said in a news conference organized quickly after AP reported details of the proposal. "It is important to use our time and resources to protect the most vulnerable species. It is not possible to draw a link between greenhouse gas emissions and distant observations of impacts on species."

If approved, the changes would represent the biggest overhaul of endangered species regulations since 1986. They would accomplish through rules what conservative Republicans have been unable to achieve in Congress: Ending some environmental reviews that developers and other federal agencies blame for delays and cost increases on many projects. The chairman of the House Natural Resources Committee, which oversees the Interior Department, said he was "deeply troubled" by the changes. "This proposed rule ... gives federal agencies an unacceptable degree of discretion to decide whether or not to comply with the Endangered Species Act," said Rep. Nick Rahall, D-

WV. "Eleventh-hour rulemakings rarely if ever lead to good government."

The new regulations follow a pattern by the Bush administration not to seek input from scientists. The regulations were drafted by attorneys at both the Interior and Commerce Departments. Scientists with both agencies were first briefed on the proposal last week during a conference call, according to an official who asked not to be identified. Last month, in similar fashion, the Environmental Protection Agency surprised its scientific experts when it decided it did not want to regulate greenhouse gases under the Clean Air Act. The rule changes unveiled Monday would apply to any project a federal agency would fund, build, or authorize that the agency itself determines is unlikely to harm endangered wildlife and their habitat. Government wildlife experts currently participate in tens of thousands of such reviews each year.

The revisions also would limit which effects can be considered harmful and set a 60-day deadline for wildlife experts to evaluate a project when they are asked to become involved. If no decision is made within 60 days, the project can move ahead. "If adopted, these changes would seriously weaken the safety net of habitat protections that we have relied upon to protect and recover endangered fish, wildlife, and plants for the past 35 years," said John Kostyack, executive director of the National Wildlife Federation's Wildlife Conservation and Global Warming initiative.

Under current law, federal agencies must consult with experts at the Fish and Wildlife Service or the National Marine Fisheries Service to determine whether a project is likely to jeopardize any endangered species or to damage habitat, even if no harm seems likely. This initial review usually results in accommodations that better protect the 1,353 animals and plants in the U.S. that are listed as threatened or endangered, and determines whether a more formal analysis is warranted. The Interior Department said such consultations are no longer necessary because federal agencies have developed expertise to review their own construction and development projects, according to the 30-page draft obtained by the AP. "We believe federal action agencies will err on the side of caution in making these determinations," the proposal said. The direc-

tor of the Fish and Wildlife Service, Dale Hall, said the changes would help focus expertise on "where we know we don't have a negative effect on the species but where the agency is vulnerable if we don't complete a consultation."

Responding to questions about the process, Hall said, "We will not do anything that leaves the public out of this process." The new rules were expected to be formally proposed immediately, officials said. They would be subject to a 30-day public comment period before being finalized by the Interior Department. That would give the administration enough time to impose the rules before November's presidential election. A new administration could freeze any pending regulations or reverse them, a process that could take months. Congress could also overturn the rules through legislation, but that could take even longer. The proposal was drafted largely by attorneys in the general counsel's offices of the Commerce Department's National Oceanic and Atmospheric Administration and the Interior Department, according to an official with the National Marine Fisheries Service, who spoke on condition of anonymity because the plan hadn't yet been circulated publicly. The two agencies' experts were not consulted until last week, the official said.

Between 1998 and 2002, the Fish and Wildlife Service conducted 300,000 consultations. The National Marine Fisheries Service, which evaluates projects affecting marine species, conducts about 1,300 reviews each year. The reviews have helped safeguard protected species such as Bald Eagles, Florida Panthers, and Whooping Cranes. A federal government handbook from 1998 described the consultations as "some of the most valuable and powerful tools to conserve listed species." In recent years, however, some federal agencies and private developers have complained that the process results in delays and increased construction costs. "We have always had concerns with respect to the need for streamlining and making it a more efficient process," said Joe Nelson, a lawyer for the National Endangered Species Act Reform Coalition, a trade group for home builders and the paper and farming industry.

Sen. Barbara Boxer, D-CA, chairwoman of the Environment and Public Works Committee, called the proposed



Current proposals to alter regulations regarding enforcement of the Endangered Species Act would have undermined efforts to protect endangered species, such as the Gray Whale (*Eschrichtius robustus*).

changes illegal. "This proposed regulation is another in a continuing stream of proposals to repeal our landmark environmental laws through the back door," she said. "If this proposed regulation had been in place, it would have undermined our ability to protect the Bald Eagle, the Grizzly Bear, and the Gray Whale."

The Bush administration and Congress have attempted with mixed success to change the law. In 2003, the administration imposed similar rules that would have allowed agencies to approve new pesticides and projects to reduce wildfire risks without asking the opinion of government scientists about whether threatened or endangered species and habitats might be affected. The pesticide rule was later overturned in court. The Interior Department, along with the Forest Service, is currently being sued over the rule governing wildfire prevention. In 2005, the House passed a bill that would have made similar changes to the Endangered Species Act, but the bill died in the Senate. The sponsor of that bill, then-House Natural Resources chairman Richard Pombo, R-CA, told the AP that allowing agencies to judge for themselves the effects of a project will not harm species or habitat. "There is no way they can rubber stamp everything because they will end up in court for every decision," he said. However, internal reviews by the National Marine Fisheries Service and Fish and Wildlife Service concluded that about half the unilateral evaluations by the Forest Service and Bureau of Land Management that determined that wildfire prevention projects were unlikely to harm protected species were not legally or scientifically valid. Those had been permitted under the 2003 rule changes. "This is the fox guarding the hen house. The interests of agencies will outweigh species protection interests," said Eric Glitzenstein, the attorney representing environmental groups in the lawsuit over the wildfire prevention regulations. "What they are talking about doing is eviscerating the Endangered Species Act."

For more information see the Fish and Wildlife Service ([www.fws.gov/endangered](http://www.fws.gov/endangered)), National Marine Fisheries Service ([www.nmfs.noaa.gov/pr/laws/esa/](http://www.nmfs.noaa.gov/pr/laws/esa/)), and the National Wildlife Federation ([www.nwf.org/news](http://www.nwf.org/news)).

Dina Cappiello, Associated Press

### Man Bitten by Gila Monster

On 25 June, a 24-year-old homeless man who had wandered into the Saguaro National Park found a Gila Monster (*Heloderma suspectum*) and picked it up because — as he later told rangers — "it wanted to be friends." The man then placed the lizard on his shoulders, whereupon it promptly bit him on the neck. While trying to shed the animal, it bit him once more on the hand. He then picked it up and wrapped it in a piece of clothing. A park volunteer encountered the man walking on a roadway adjacent to the park and asked if he needed help. The man told the volunteer what had happened, then showed him the lizard.

Rangers were summoned; when they arrived, they found the man vomit-

ing and complaining of difficulty breathing. He was transported by ambulance to a Tucson area hospital, where he was admitted for treatment of the bites, heat exhaustion, and severe dehydration. The Gila Monster appeared uninjured, and was returned to the park.

This was the park's second Gila Monster incident this year. Gila Monsters are native to the American southwest and northern Mexico, and are the only venomous lizard native to the United States. These heavy, slow-moving lizards can grow to two feet in length and can weigh up to three pounds. Because of their slowness, they rarely present a threat to humans.

Bob Love, Chief Ranger, Saguaro  
National Park



Gila Monsters (*Heloderma suspectum*) are the only venomous lizard native to the United States, but they rarely present a threat to humans.



## IRCF ON THE MOVE



MICHAEL KERN

Many of us had exactly this same facial expression when we saw our first *Cyclura*. This is one of the younger attendees at the Extreme Green Reptile Show in San Jose, California, on 9–10 August 2008. The IRCF secured 25 new members. The show was manned by Sandy Binns, Mike Kern, and John Binns.



JOHN BINNS

The IRCF booth at the San Diego Reptile Super Show, 28–29 June 2008. This show generated a record 54 new members. Seated is Sandy Binns, talking with Dr. Russell Pearl of Park Ridge, Illinois.



UNKNOWN

The IRCF booth at the San Diego Reptile Super Show was manned by (from left): Mike Kern, John Binns, Sandy Binns, Desiree Wong, Limey, and Izzy.

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**Michael Ripca**, the Art Director for *Iguana*, has been “the hands behind the journal” since the early days of the *Iguana Times*. He joined the International Iguana Society in March 1992 to learn more about his newly acquired Green Iguana. Mike and his wife offered to redesign *Iguana Times*, and to take over layout, design, and print coordination. Over the years, they also contributed editorial, advertising, and promotional assistance. Mike sat on the IIS Board of Directors and helped bring the IIS into the computer age by converting the original paper membership list into a database and mailing list, and by building the original IIS website. He has worked for the American College of Physicians in Philadelphia for over 16 years as a Graphic Designer and Technical Administrator, and lives in southern New Jersey with his wife, Janet, and their 14-year-old daughter, Olivia. Besides an obsession with Macintosh computers, classic films, and rock concerts, Mike enjoys sharing his home-brewed beer with friends and family.



## 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.

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# FOCUS ON CONSERVATION

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## Conserving Southern California's Mountain Yellow-legged Frog (*Rana muscosa*)



According to the World Conservation Union, at least one-third of the world's estimated 6,000 amphibian species are threatened with extinction. Many of these amphibians reside in the United States, and two critically endangered species, the Mountain Yellow-legged Frog (*Rana muscosa*) and the California Red-legged Frog (*Rana draytonii*), reside in California.

In close partnership with the U.S. Fish and Wildlife Service, the U.S. Forest Service, the U.S. Geological Survey, and California Department of Fish and Game, the San Diego Zoo's Conservation and Research for Endangered Species (CRES) is participating in the recovery of the critically endangered Mountain Yellow-legged Frog (*Rana muscosa*). In August 2006, CRES received 82 Mountain Yellow-legged Frog tadpoles. These animals were salvaged from a drying streambed in Southern California's San Jacinto Mountains. The tadpoles were brought to the Applied Animal Ecology lab at CRES, where they were housed in spacious aquaria. As of August 2008, the remaining 62 frogs are all nearing adult size and are showing breeding behaviors. Some frogs will be moved to other AZA institutions for breeding, and all progeny will be released within the historical range of the species in a project designed to monitor the fate of released frogs and develop an optimal release strategy. The project will end when the conservation partners determine that captive propagation is no longer useful for recovery efforts, an outcome expected to be more than 10 years in the future.

California populations of the Mountain Yellow-legged Frog were listed as endangered by the U.S. Fish and Wildlife Service in 2002. Despite this protection, these frogs continue toward extinction, with only seven known populations remaining in southern California, each ranging in size from seven to no more than 75 adults. While habitat loss historically has been the leading cause of amphibian decline, the most immediate threat is from the chytrid fungus. In addition to recent fire and drought damage, the decline of the frog is further compounded by non-native predators such as bullfrogs and trout, and possibly by airborne and aquatic contaminants.

Jeff Lemm  
Research Coordinator  
Applied Animal Ecology Division  
CRES, Zoological Society of San Diego





ROBERT POWELL

Lesser Antillean Iguanas (*Iguana delicatissima*), such as this male, often assume what appear to be extremely awkward positions for access to prized morsels. The letter on the side of this individual facilitated individual recognition during a study on home ranges and activity periods. See article on p. 130.





ROBERT POWELL

South Leeward Dwarf Geckos (*Sphaerodactylus fantasticus*) are Lesser Antillean endemics, but the subspecies *S. f. fuga* is endemic to Dominica. These small diurnal geckos are sexually dimorphic. Males have a dark head with light spots, whereas heads of females have two light stripes that extend onto the body. See article on p. 130.