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# IGUANA

CONSERVATION, NATURAL HISTORY, AND HUSBANDRY OF REPTILES

International Reptile Conservation Foundation

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Flying Dragon (*Draco volans*) (see related article on p. 86).



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Gliding Lizards in the Genus *Draco* use wings for “flight” and also to facilitate species recognition and intra-species communication (see article on p. 86).



JOHN BINNIS

Exploitation of the Pacific Spiny-tailed (Black) Iguana, *Ctenosaura pectinata*, was a major topic of discussion during the VIII National Meeting on Iguanas in México (see article on p. 130).



JOHN BINNIS

*Ctenosaura bakeri* lives an unusual life in the mangrove forests on Isla de Utila, Honduras; both the mangrove forests and nesting beaches are threatened by development (see article on p. 108).



JOHN BINNIS

The conservation status of the Exuma Island Rock Iguana, *Cyclura cyclhura figginsi*, was one of many discussed during the IUCN Iguana Specialist Group Meeting in November 2005 (see article on p. 116).



AARON Z. SAVIT

*Chironius monticola* is a terrestrial snake most often seen basking in warm, open areas of the Santa Lucia cloud forest reserve (see article on p. 94).



JOSEPH M. POLANCO

Nose-rub, clearly evident in this Emerald Treeboa (*Corallus caninus*), is indicative of being kept in an inappropriate enclosure. This may reflect neglect in other aspects of care (see article on p. 133).



PHOTO COURTESY OF STEPHANIE SCANLIN/ZOO ATLANTA

**IMPORTANT NOTICE:** Please support the August 2006 National Reptile Breeder’s Expo Auction to benefit the critically endangered Guatemalan Beaded Lizard, *Heloderma horridum charlesbogerti* (see p. 176). For details visit [www.IRCF.org](http://www.IRCF.org).





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Gliding Lizards in the Genus *Draco* use wings for “flight” and also to facilitate species recognition and intra-species communication.

# The Flying Reptiles of Peninsular Malaysia

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Photographs by the author except when otherwise indicated.

Standing on the peak of Gunung Kajang on Tioman Island after a miserable, leech-infested, three-day climb to the summit, I was looking across a deep valley toward the twin peaks of Nenek-Semukut wishing I could spread my wings, glide between the peaks across the valley, land on the beach at Mukut, and crack open a nice, cold drink — anything to keep from hiking back down that mountain. As it turns out, I'm not alone. Flying has been a preoccupation of humans for time on end. Sadly, however, humans will never acquire the capability of unassisted flight and we'll have to continue appeasing and teasing ourselves with everything from hang-gliders to space shuttles.

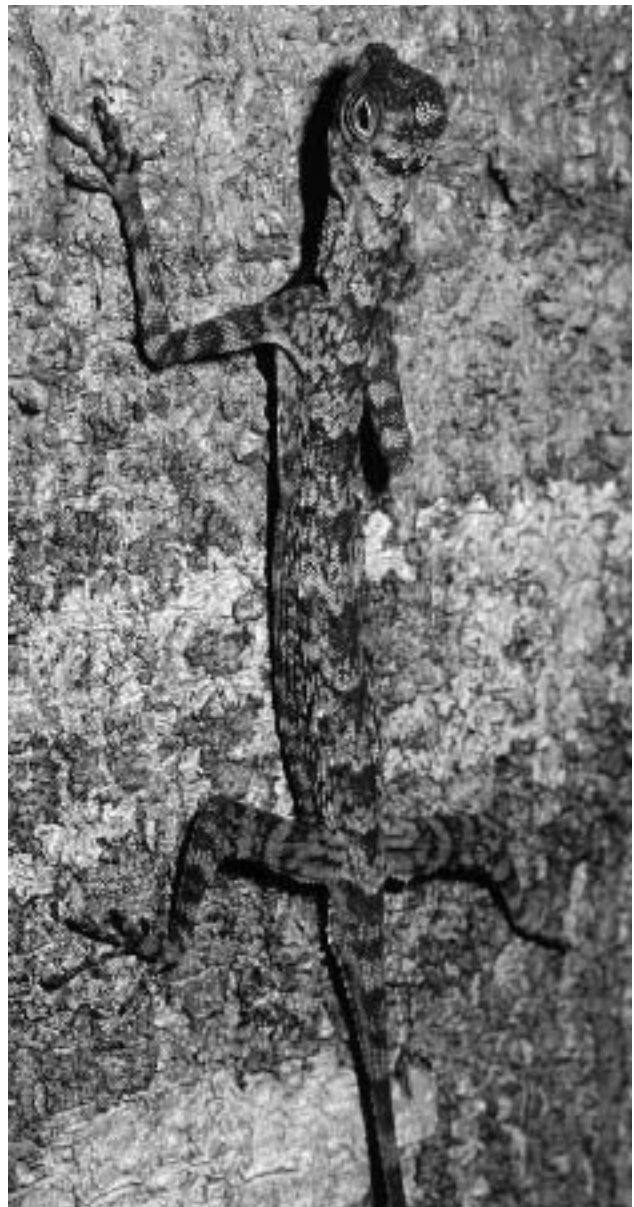
In other vertebrates, however, flying is really no big deal. Some fish leap out of the water to escape predators, extend their enlarged pectoral fins, and glide for hundreds of meters. Many frogs have extensively webbed, elongate fingers and toes that function as parachutes when they leap from the leaves and branches of trees to glide across the forest. Several groups of mammals, ranging from bats to rodents to colugos, have evolved many different ways to move through the air. Reptiles have been flying for millions of years. The earliest fliers were the Frigate Bird-like pterosaurs. They were also the first reptiles capable of powered flight and ranged in size from chickens to giants having wingspans of over 16 m. However, the most successful flying reptiles of all time are (not were) the dinosaurs and their modern-day representatives — birds.

In southeastern Asia, modern, non-avian reptiles have gone crazy and flight of some sort has evolved independently at

least three, maybe four times in lizards, and once in snakes — but why flight, and why in southeastern Asia? Although a number of hypotheses have been proposed, the overarching theme



The Bronzeback Snake (*Dendrelaphis cyanochlorus*) is an adept climber that frequently preys on arboreal lizards.



Black-bearded Gliding Lizards (*Draco melanopogon*) have light bodies with big wings and can attain lift immediately after leaving the tree, even at slow speeds, and are capable of considerable in-flight maneuverability.



Spotted Forest Skinks (*Lipinia vittigera*) often forage on trunks of trees, but lack the escape capabilities of gliding lizards.

throughout all of them is predator evasion. Think about it: You're less than 15 cm in body length, you have no formidable defenses, and you're living in a jungle. By default, that makes you one of nature's "fast-food" entrées. So, if you want to avoid becoming the next McLizard in the Rainforest Happy Meal, you had better develop an effective escape mechanism.

This always seemed logical to me, but it really hit home one afternoon while I was taking a break along the banks of the Sungai Mentawak on Tioman Island. I was just about to resume my hike when I noticed a Bronzeback Snake (*Dendrelaphis cyanochloris*) crawling up the trunk of a large tree. This snake's ability to climb on flat, vertical surfaces had always fascinated me, so I decided to watch for a while. Its coils were purposely looped in just the precise way necessary for gaining purchase on the irregularities of the tree's surface as it continued to effortlessly push itself upwards. Then I noticed it was ever so slightly moving its head from side to side and rapidly flicking its tongue — the telltale signs that it was following a scent-trail. At that very moment, I saw a Black-bearded Gliding Lizard (*Draco melanopogon*) leap from the tree and glide through the green, filtered light of the forest to land on a different tree. Then, suddenly, the snake struck and grabbed a Spotted Forest Skink (*Lipinia vittigera*), which I hadn't seen, right off the side of the tree. While the Bronzeback Snake gnawed and manipulated the Forest Skink in its mouth, to position it just so before swallowing, I realized that this particular little skink and I had something in common; we both wished that we could fly.

What made that crucial life-or-death difference between the skink and the gliding lizard was a wing. In fact, gliding lizards (genus *Draco*) are southeastern Asia's most adept flying reptiles, and their wings have clearly contributed to their widespread distribution (India to eastern Indonesia) and radiation (over 40 species). Oddly enough, the *Draco* wing is just a marvelously rearranged rib cage. The opposing ribs, the ends of which normally meet in the center of the body to form a bony basket (i.e., the rib cage) to protect the heart and lungs, have become disconnected. The ribs have lengthened and now lie bunched up alongside the body when not flexed. Muscles in the chest that normally lift and elevate the rib cage to draw air into the lungs now pull the ribs forward and outward, opening the wing. The amount of skin along the sides of the body has

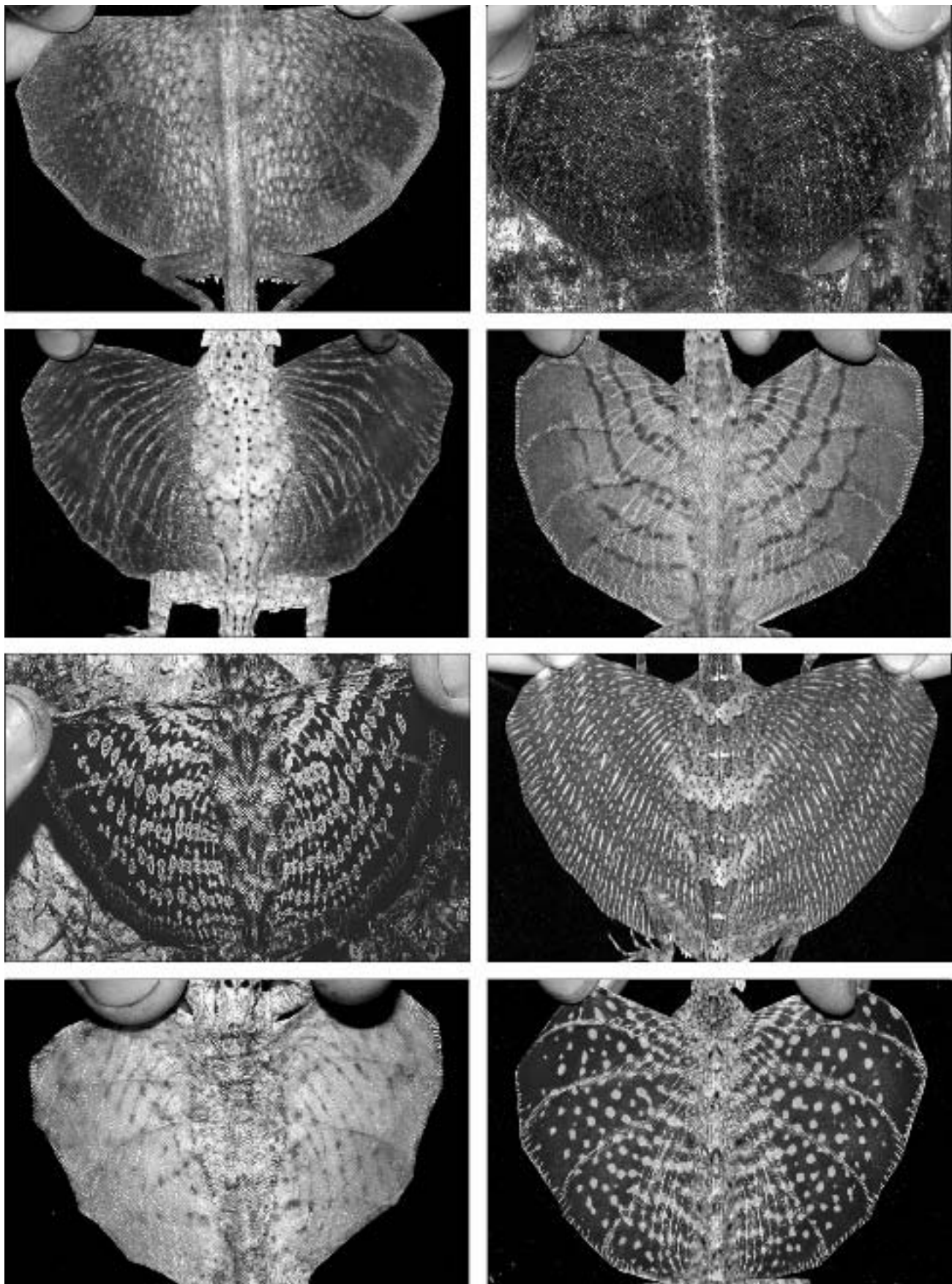
increased and now functions as the flying surface that the lengthened ribs support. Although this wing is not capable of generating power, it does provide enough lift to extend the length of the glide and provide considerable in-flight maneuverability.

Gliding lizards use their wings for more than just flight, however. These expansive surfaces also function as prime advertising space for communicating to other gliding lizards. Each of Malaysia's 11 species has its own, unique wing pattern.

When not flying or displaying, gliding lizards are commonly seen sitting head-up on the trunks of trees with their wings inconspicuously folded against their bodies. They spend many of their daylight hours running up and down trees feeding on ants, which make up the vast majority of their diet. However, when it's time for a change of scenery, they simply leap from the tree, extend their ribs to open the wings, and glide to the next tree. The extent and speed of the glide depends on a couple of factors: Height of the lizard on the tree and the surface area of the wing relative to the weight of the body. As it turns out, not all *Draco* are created equal. The smaller, frail Black-bearded Gliding Lizard, with its pencil-neck and light bulb-shaped head, has a light body with big wings, attains lift immediately after leaving the tree, even at slow speeds, and is capable of considerable in-flight maneuverability. In stark contrast, the Orange-bearded Gliding Lizard (*D. fimbriatus*), with

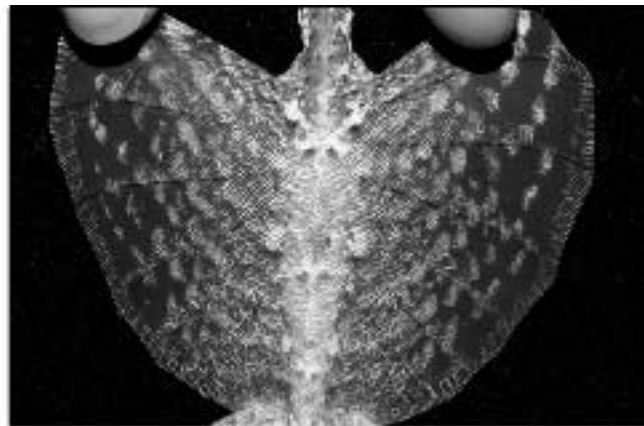
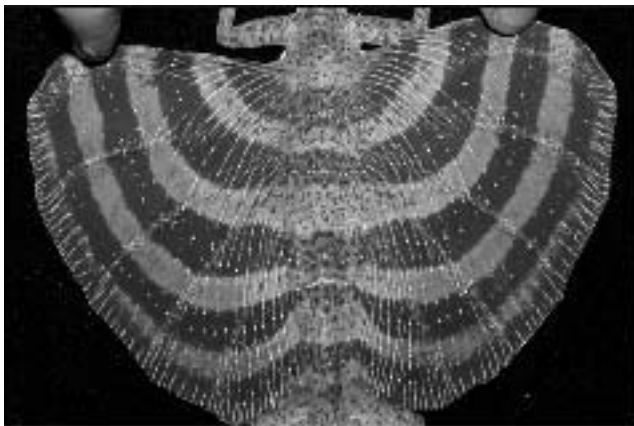


Orange-bearded Gliding Lizards (*Draco fimbriatus*) have thick necks, heavy, robust bodies, and relatively small wings; consequently, in-flight maneuverability is poor, but glide speed is very fast.



Wing patterns of gliding lizards serve to facilitate species recognition and intra-species communications. Patterns of western Malaysia's species of *Draco* are exceedingly variable. From left to right: (top row) *D. blanfordii*, *D. cristatellus*, (upper middle) *D. fimbriatus*, *D. formosus*, (lower middle) *D. haematopogon*, *D. maximus*, (bottom row) *D. maculatus*, *D. melanopogon*.





FRANS LANTING (BOTTOM)

More wing patterns of western Malaysian species of *Draco*. *D. quinquefasciatus* (top left), *D. sumatranus* (top right), *D. taeniopterus* (middle), and *D. melanopogon* (bottom; note the variation in the extent of stippling when compared to the individual illustrated in the previous figure).

its thick neck and heavy, robust body and relatively small wings, has poor in-flight maneuverability but a very fast glide speed. In fact, when this species jumps off a tree, it has to dive straight down with its wings folded against its body until it picks up enough speed to open them up and glide. When it does glide, it looks like a jet rocketing through the forest. Consequently, Orange-bearded Gliding Lizards often are found high in some of the forest's tallest trees, from which they can safely dive in order to gain the momentum necessary to initiate the glide. Black-bearded Gliding lizards usually are found on lower portions of trees.

As it turns out, this is one of the reasons these two species can coexist in the same forest and even on the same trees. Their flight anatomy helps separate them ecologically and keeps them from competing directly for some of the rainforest's resources. In certain areas of the forest, up to eight different species of *Draco* may occur together. Generally, when closely related species with unique, restrictive life histories (and being an arboreal, flying, anteater is pretty restrictive) live in the same area, the potential for competition is high and resources must be carefully partitioned. *Draco* do this in such a way that you rarely see more than two species in close proximity. For example, Common Gliding Lizards (*D. sumatranus*) and Spotted Gliding Lizards (*D. maculatus*) are common in open and disturbed areas; Five-banded Gliding Lizards (*D. quinquefasciatus*) are usually found in dense forest with relatively small, closely-spaced trees; Giant Gliding Lizards (*D. maximus*) are somewhat restricted to riparian areas; smaller Yellow-bearded Gliding Lizards (*D. haematopogon*) and larger Blanford's Gliding Lizards (*D. blanfordi*) occur at higher elevations than most other species; and Black-bearded Gliding Lizards and the larger Dusky Gliding Lizards (*D. formosus*) are habitat generalists in lowland forests.

However, Gliding Lizards aren't the only flying, reptilian denizens of Malaysia's rainforests. As if geckos weren't weird enough already, with their big heads, bulging lidless eyes, ability to vocalize, and elaborate hands and feet, some can add flight to their résumés. As exemplified by Flying Geckos (genus *Ptychozoon*), their wings lack the elaborate thoracic (chest) modifications of Gliding Lizards. Instead, they are composed solely of a large flap of skin along their flanks. These flaps remain folded across the belly until the lizard jumps from a tree. At that point, they become passively opened by air during the descent. Accompanying the body flaps are extended flaps along the sides



of the head, neck, and tail, backsides of the hind limbs, and extensive webbing on the hands and feet. During flight, when all the flaps and webbing are splayed and extended, they serve to provide more of a parachuting effect rather than generating lift as with the wing of a Gilding Lizard. Nonetheless, I have seen Kuhl's Flying Gecko (*P. kuhli*) display remarkable in-flight maneuverability and actually change directions 180° during flight.

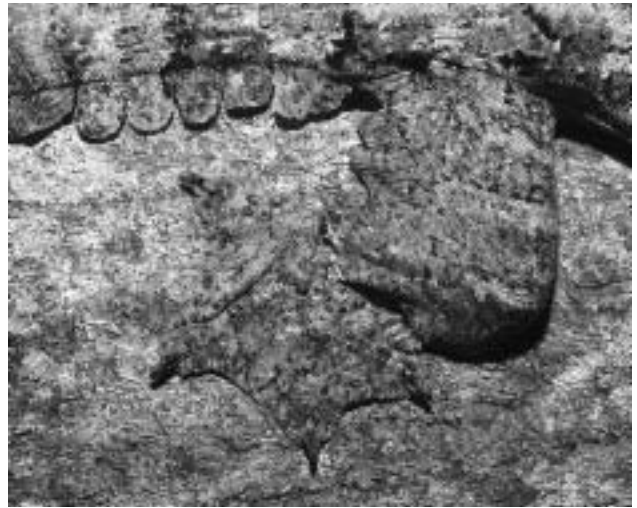


MARCUS NG



MARCUS NG

Nesting female *Draco sumatranus*.

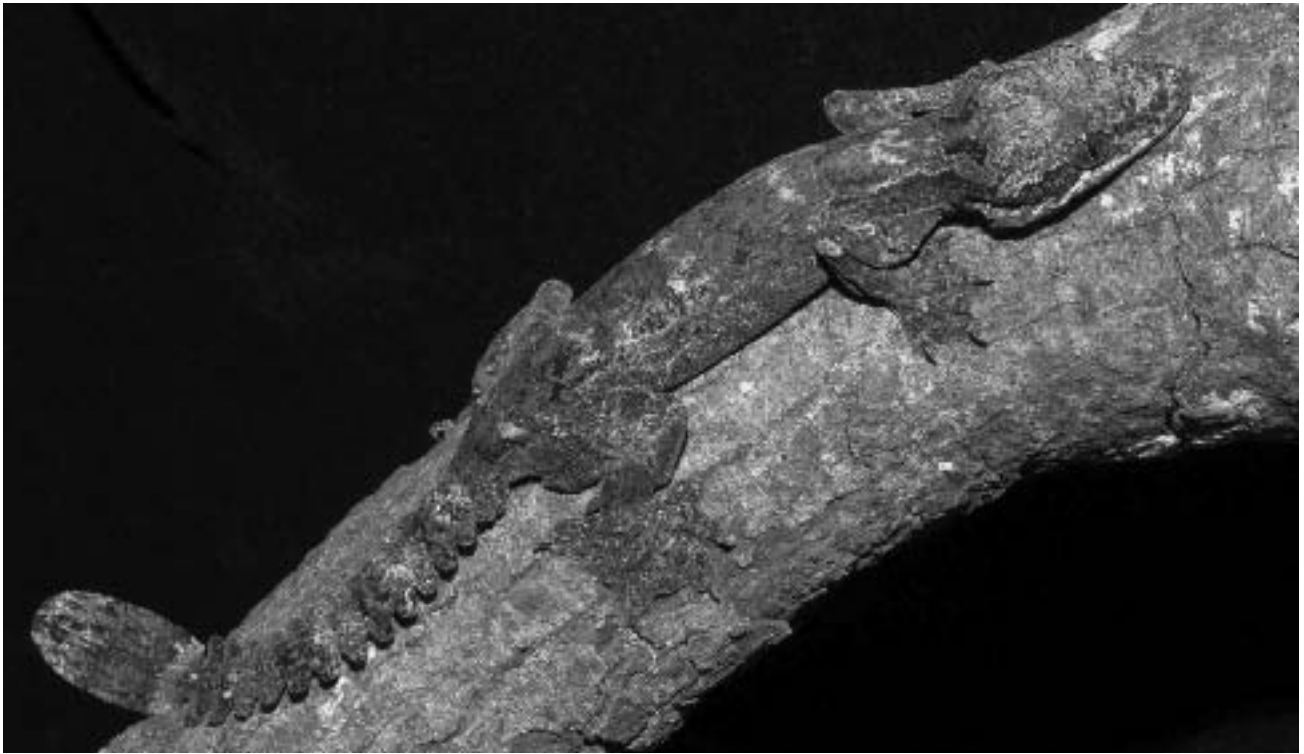


Tail and thigh flaps and webbed foot of a Flying Gecko (*Ptychozoon kuhli*).

Very similar flying surfaces have evolved independently in an unrelated species known as the Frilly Gecko (*Cosymbotus craspedotus*). The Frilly Gecko is smaller than most Flying Geckos and has not been observed demonstrating the same in-flight maneuverability or ability to glide from tree to tree. It usually uses its parachuting capabilities to glide from one portion of a tree to a lower section of the same tree in order to avoid predators.

The different means by which these distantly related groups of lizards have solved the same problem (making a wing to escape predators) beg an interesting evolutionary question. I mean, if you're a lizard and you're going to make a wing, why not do it the same way? Well, it probably has a lot to do with the general life styles of the members of their respective families to whom they are related. In southeastern Asia, the Agamidae, the family to which Gliding Lizards belong, are arboreal, diurnal, conspicuous insectivores that signal to one another by puffing out their throats and expanding their chests to display their brilliant color patterns. They also jump from branch to branch in search of prey and to escape predation. So, in a sense, they can already do everything necessary to fly — jump from one place to another and expand their rib cages. Now all that's necessary is to do them both at the same time and let natural selection run its course. In support of this hypothesis is a remarkably obvious intermediate condition in the Green Crested Lizard (*Bronchocela cristatella*), a common, arboreal agamid also native to southeastern Asia. When threatened, Green Crested Lizards will leap from one tree to next, splay out their limbs, and expand their rib cages during flight. Although they have no trace of a wing, the increased surface area resulting from the expanded rib cage and splayed limbs significantly decreases the angle of the drop and extends the length of the "glide." So, seeing how natural selection may again, within the same selection regime and same related group of lizards, be developing flight in the Green Crested Lizard is not hard to imagine.

Geckos (family Gekkonidae), however, are cryptic species that attempt to go undetected during the day and are active at night. All the displaying and leaping common to many agamids



Kuhl's Flying Geckos (*Ptychozoon kuhli*) display remarkable in-flight maneuverability and can change directions during flight.



When threatened, Green Crested Lizards (*Bronchocela cristatella*) will leap from one tree to the next, splay out their limbs, and expand their rib cages during flight. Although they have no trace of a wing, the increased surface area resulting from the expanded rib cage and splayed limbs extends the length of the "glide."



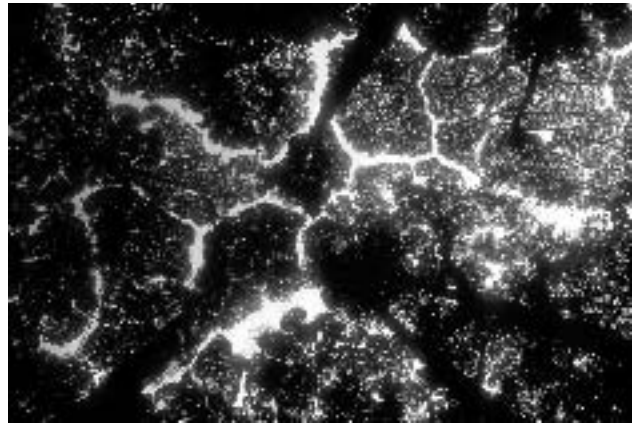
Frilly Geckos (*Cosymbotus craspedotus*) usually use their parachuting capabilities to glide from one portion of a tree to a lower section of the same tree in order to avoid predators.

do not happen in geckos. In fact, their color patterns generally match the substrate on which they reside, enabling them to go unnoticed. Interestingly, the Flat-tailed Gecko (*Cosymbotus platyurus*), a species closely related to the Frilly Gecko, presents us with another example of intermediacy. It has the same folds of skin along the head, body, limbs, and tail as the Frilly Gecko, but they're not nearly as well developed. These geckos lay these flaps out on the trunk of the tree to prevent the curvature of the body from casting a shadow where it contacts the trunk in order not to give away its location. If these flaps passively opened up like they do in other geckos when this gecko jumps from one branch to another, and this imparted even a small advantage by extending the length of the jump, natural selection will come into play. This is a likely example of what evolutionary biologists refer to as "preadaption" — a situation in which a structure evolves to be used in one context (camouflage) and becomes modified later to be used in a completely different context (flight).

Because of their lack of limbs and other appendages, one might think that the most unlikely group of vertebrates to evolve flight mechanisms would be snakes. However, in peninsular Malaysia, three, closely related species of snakes have the ability to glide for considerable distances. These are the Tree Snakes (genus *Chrysopelea*). Their flight modification involves a simple little notch on each side of each belly (ventral) scale where the ends turn upwards along the lower sides of the body. This notch works like an expansion joint, allowing Tree Snakes to flatten out and widen their bodies. The flat, wide body works like a parasail, and its undulatory movements during flight, analogous to a spinning frisbee, stabilize the body to prevent it from overturning. Prior to launching themselves from branches, Tree Snakes hang the uncoiled forepart of their body off the

branch in a “J-loop.” Then, by rocking the body upward while simultaneously springing outward by rapidly straightening their coils and releasing their hold on the branch, the snakes take flight. Intermediate conditions to this style of flight are found in related, semi-arboreal snakes such as Bronzebacks (mentioned earlier), which have notched ventral scales that help anchor them to the substrate while climbing vertical surfaces. They also expand their rib cages as a defense mechanism to expose brightly colored markings on their scales. So, the three main ingredients, arboreality, notched ventral scales, and a behavior involving the expansion of the rib cage, already existed in this group of related snakes — perhaps another example of preadaptation.

So, back to the earlier questions of “why flight, and why here in southeastern Asia?” I think I’ve pretty much answered “why flight,” so let’s look at “why in southeastern Asia?” With the exception of birds and bats, when you compare the number of flying vertebrates in Asian and Australasian rainforests to



Crowns of adjacent Kapur Trees (*Dryobalanops aromatica*) chemically repel one another, resulting in a discontinuous crown.



Tree Snakes (*Chrysopelea*) flatten out and widen their bodies and can glide for considerable distances. From top to bottom: *C. ornata*, *C. paradisi*, and *C. pelias*.



Flat-tailed Geckos (*Cosymbotus platyurus*), a species closely related to the Frilly Gecko, use folds of skin along the head, body, limbs, and tail to prevent the curvature of the body from casting a shadow on a tree trunk and giving away its location to a predator.

those in the world’s other major rainforest ecosystems — Central and South America and Africa — a striking pattern emerges. These other rainforests have no flying vertebrates. Also, no really solid or generally agreed upon hypotheses explain why. However, the most common explanation suggests that the presence of flying reptiles has to do with Asian rainforests lacking the extensive vines and understory vegetation that, in the other rainforests, connect adjacent trees to one another. Additionally, the crowns of some trees in Asian rainforests are discontinuous. In fact, in species such as the Kapur (*Dryobalanops aromatica*), the crowns of adjacent trees chemically repel one another. Consequently, getting from one tree to the next is more difficult for arboreal species unless they climb down to the ground and walk across the forest floor, running a substantial risk of becoming prey for some opportunistic predator — so they fly.

Whatever the reasons behind these remarkable evolutionary success stories, I don’t think I will ever become accustomed to standing in the forest and seeing a snake go gliding by overhead or a Giant Gliding Lizard with a wingspan like that of a small pigeon leap from a tree to glide 30–40 meters across a stream and land on another. In no other rainforests in the world can we enjoy these natural eccentricities, which leaves me saying to myself once again, “I sure wish I could fly.”

# Reptiles of the Santa Lucia Cloud Forest, Ecuador

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Photographs by the author.

Santa Lucia is a cloud forest reserve of some 820 hectares in a lushly forested section of Pichincha Province, Ecuador. Draped over the steep slopes of the Andean Cordillera Occidental, the reserve lies between elevations of about 1400–2600 m. Because the region receives about 2,000 mm of rain per year, the precipitous slopes host an astonishing plant and animal diversity despite the rugged terrain and the often chilly climate. The large Maquipucuna Reserve borders Santa Lucia to the south, protecting an additional 6000 hectares. Together, these reserves protect an extensive complex of pristine and regenerating subtropical cloud forest that makes up much of the Rio Umachaca drainage.

Santa Lucia is a local conservation and eco-tourism cooperative established by a number of land-owning campesino fam-

ilies to find a sustainable alternative to the agriculture and ranching for which a small fraction of the less precipitous slopes were formerly used. About 84% of Santa Lucia's land is primary cloud forest. The remaining area is about evenly divided between secondary forest and pastured hillsides.

Santa Lucia hosts an astounding variety of plant and animal species. Particularly speciose groups include birds, arthropods, and orchids. The current bird list exceeds 370 species and over 340 species of orchids (among nearly 2000 vascular plant species) have been documented in the neighboring Maquipucuna Reserve (Webster and Rhode 2001, 2005).

Although the reptilian fauna of Santa Lucia is not nearly so diverse as the groups mentioned above, many of the species are endemic and have relatively small ranges. Additionally, our



Thick clouds of fog settle on the mountains at night and often linger well into the day.





Situated at the end of a ridge, the lodge at Santa Lucia overlooks lush valleys on three sides.

knowledge of most of these species is so scant that their natural history and habitat preferences usually have not been described in the literature. Perez-Santos and Moreno (1991) published a volume that renders the chaos of identification a bit less imposing, at least as far as snakes are concerned, but no comparable treatment covers Andean lizards, although some fairly comprehensive treatments of entire genera (i.e., Harris 1994, Torres-Carvajal 2001) make diagnosis a bit more feasible. However, the following list is the first that documents the reptilian species from an Andean cloud forest site. I have made every effort to present information in a manner that does not require prior knowledge of obscure Andean taxa and to gather and present all available ecological and distributional data, both from the literature and my own observations.

This list represents the squamate species I found at Santa Lucia over a five-month period from November 2004 to April 2005. Most were caught along a ridge at elevations from 1800–2000 m. Several additional species are probably present in the reserve, especially at its upper and lower reaches. I particularly suspect that one or more species of elusive, litter-dwelling Spectacled Lizards (“microteiids” in the family Gymnophthalmidae) escaped detection. One species in the gymnophthalmid genus *Proctoporus* from the lower reaches of the reserve remains unidentified, as does a species of Ground

Snake (*Atractus*, probably *A. major*). Additionally, the reserve’s guides and staff reported several other species of snakes, but none could be captured and identified.

Readers should bear in mind that considerable geographic variation in coloration exists for many of the species described. However, the color variations mentioned herein refer solely to documented differences within the populations at Santa Lucia. Any information not specifically cited is based on my own observations and measurements.

## L I Z A R D S

### *Anolis aequatorialis* Werner 1894

**Description:** This relatively large anole has snout-to-vent (SVL) lengths that can exceed 80 mm. Dorsal color patterns include a series of dark transverse markings with mottled greens, browns, and blacks, with juveniles exhibiting significantly more brown and black coloration. The striking dewlap has greenish-yellow lines where it comes into contact with the body and throat, but these quickly degenerate into a series of brick-red blotches on a black background. Hints of turquoise often appear on the anterior part of the dewlap near the throat. Both males and females of the species possess dewlaps, although those of males are relatively larger in individuals of similar sizes. Juveniles also have an ocellum on each side of the head poste-



Edge habitats, such as this partially forested slope, provide favorable conditions for some lizards such as *Anolis gemmosus* and *Cercosaura vertebralis*.

rior to the tympanum. This appears to dissipate in older males, but is retained in adult females.

**Ecology:** This species is most often found on well-shaded leaf litter, although juveniles are frequently seen in low undergrowth near the ground. These lizards seem to prefer cooler substrates and air temperatures, both of which averaged around 18.5 °C. Average body temperature of 21 *A. aequatorialis* was 20.5 °C. The elevational range for the species is roughly 1000–2000 m (Torres-Carvajal 2001).

*Anolis gemmosus* O'Shaughnessy 1875

**Description:** This anole reaches just over 60 mm SVL. An astounding diversity of color phases can occur within a single population. Perhaps the most common phase at Santa Lucia is the patterned phase, in which males have a series of transverse rows of black spots. In females, this pattern manifests itself as a caudal series of spade-shaped black blotches. Other color phases include a nearly solid green, which occurs in both males and females, and a female morph with a wide, light-brown vertebral stripe bordered by two thinner gray stripes on a green background. In a very rare variation of the male patterned phase, the spaces between the rows of black spots are filled with large white markings.

**Ecology:** These anoles appear to prefer cooler environmental temperatures much like those associated with *A. aequatorialis*. Average substrate and air temperatures were both around 19 °C. Body temperature of 34 *A. gemmosus* averaged 21.1 °C. *Anolis gemmosus* differ from *A. aequatorialis* in that they are completely arboreal. The elevational range is roughly 2000–3000 m (Torres-Carvajal 2001). These lizards are most frequently encountered along forest edges, but never in direct sun. The preference for edge habitat is probably an artifact of increased arthropod prey abundance in those areas.

*Cercosaura vertebralis* (O'Shaughnessy 1879)

**Description:** A gymnophthalmid of medium size, Santa Lucia *Cercosaura vertebralis* had SVLs to 69 mm, although adults were usually below 65 mm SVL. These lizards have a prominent 2–3 scale-wide vertebral stripe that starts as light orange on top of the head and fades through yellow to become white over the sacrum. Dorsal background color is black to dark brown. Golden-yellow subocular stripes run from the tip of the snout under the tympanum and terminate at the front limbs. White-centered ocelli often are present on the flanks around the fore- and hindlimbs. More prominent ocelli are frequently accompanied by red highlights on the flanks and a red venter mottled with black. In other individuals, the venter would be cream



*Anolis aequatorialis*. Top: male (left, 80 mm SVL) and female (right, 76 mm SVL); bottom: male (79 mm SVL).

with extensive black mottling. This coloration was displayed far more frequently in animals collected between November and January than in those collected from February to April. This suggests that red on the venter and flanks, as well as the enhanced ocelli, may be breeding coloration.

**Ecology:** *Cercosaura vertebralis* belongs to a group of three gymnophthalmid genera that have recently been shown to be monophyletic (Doan 2003). The species is highly heliophilic, and individuals are mostly active in dry leaf litter. However, they can be seen both foraging and basking on soil, litter, and deadfall anywhere where sunlight is sufficient. They may be completely absent from the surface for days if weather is not suitable. Substrate and air temperatures for sites at which *C. vertebralis* was found averaged 26.8 and 21.9 °C, respectively. These lizards maintain relatively high body temperatures, which averaged 27.9 °C (n = 20). The species has been recorded at elevations as low as 700 m and as high as 2500 m and ranges from northern Colombia and far southern Panamá through Ecuador and the far north of Perú (Uzzell, 1973).

*Proctoporus oculatus* (O'Shaughnessy 1879)

**Description:** This impressive gymnophthalmid can grow as large as 88 mm SVL (Kizirian 1996) and have a tail more than twice that long. The dorsum is dark brown with two faint dorso-lateral bands extending from the head and dissipating near the pelvis. A series of yellow-centered ocelli extend from the neck to the base of the tail. The black-and-white mottled venter gradually fades into a very striking pattern of red and black along the flanks.



*Anolis gemmosus*. Color phases: transverse bars (top), white blotches (middle), and striped (bottom).



*Cercosaura vertebralis* is heliophilic (sun-loving), and individuals are mostly active in dry leaf litter.



*Proctoporus unicolor* quickly turns lethargic when held in the heat of a human hand. They forage under the thick cover of damp leaf litter and hardly ever emerge on the surface.



*Proctoporus oculatus* is rarely seen on the surface. They seem to prefer the cool temperatures and cover afforded by abundant leaf litter.

**Ecology:** This species occurs in only a few drainages along the western Ecuadorian Andes, and has been previously recorded in sympatry with *P. unicolor* (Kizirian, 1996). They are rarely seen on the surface, and prefer the cool temperature and cover afforded by abundant leaf litter.

*Proctoporus unicolor* (Gray 1858)

**Description:** This medium-sized gymnophthalmid grows to slightly over 60 mm SVL. Dark brown dorsally, it has two light dorsolateral stripes that extend over the shoulders and dissipate quickly. A small amount of white spotting may be present on the throat or flanks. A bright red accents the ventral part of the flanks, and extends most of the way down the tail. The underside of the jaw is white mottled with black. Otherwise, the venter is solid black. Kizirian (1996) indicated that considerably more color variation exists than was observed at Santa Lucia, where all *P. unicolor* generally adhered to the description above.

**Ecology:** Like *P. oculatus*, this species is limited in range to the northwestern Ecuadorian Andes. It has been previously reported at elevations from 2390–3300 m (Kizirian 1996). These lizards appear to prefer cool temperatures, and quickly turn lethargic when held in the heat of a human hand. They forage under the thick cover of damp leaf litter and hardly ever emerge on the surface. They have extremely powerful jaws and a strong tail that can be up to 250% of SVL if unbroken and not regenerated.

*Proctoporus* sp.

**Description:** Only one individual of this unknown species was captured. It measured 49 mm SVL and 146 mm total length (with a complete tail). This lizard had a brown dorsal background color with broken dorsolateral lines of lighter brown blotches outlined with black. Flanks had a number of yellow-centered ocelli that were particularly prominent near the forelimbs and decreased in size posteriorly. Venter was white with regular black spotting forming rows and increasing in intensity posteriorly. White markings remained near the cloaca, but the ventral surface of the tail was solid black with a strong iridescent blue sheen.





*Proctoporus* sp.: Only one individual of this unidentified species was found in the lower reaches of the reserve at an elevation of about 1500 m.

**Ecology:** The one individual was found in the lower reaches of the reserve at an elevation of about 1500 m.

*Ptychoglossus plicatus* (Taylor 1949)

**Description:** A medium-sized gymnophthalmid lizard, *P. plicatus* grows to about 65 mm SVL. Head scales are light lime green, with the exception of supraocular scales, which are black and have a yellow-green stripe on the very edge. These stripes, as well as the other colored head scales, join at the back of the skull to form a dorsal stripe 3–5 scales wide that fades towards the tail. The dorsal ground color is dark brown. Lateral cream-colored lines extend back from behind the eyes. These lines are more prominent in some individuals than in others, but they usually begin to dissipate around the forelimbs. Flanks are a deep mahogany red. The venter is a bright salmon-red, fading



*Ptychoglossus plicatus* is an active forager that can sometimes be seen weaving in and out of the leaf litter. They will tolerate both full shade and mixed sun, and are most often found in mature forest.

to cream around the throat and jaw, with some green tinges near the very front of the mandible. *In situ*, *P. plicatus* can appear quite similar to *Cercosaura vertebralis*, but they are easily distinguished by the distinctive cephalic green coloration and relatively thicker vertebral stripe.

**Ecology:** This species is known to occur from Costa Rica to the Panamá-Colombia border, with another population possibly occurring slightly farther south in northwestern Colombia (Harris 1994). Obviously, a population in northern Ecuador represents a very considerable extension to the range of this species. Because Santa Lucia lies at the upper extremity of their documented elevational range of 30–1890 m (Harris 1994), that more *P. plicatus* were seen several hundred meters below the main collection area, which was located just above 1900 m, is probably indicative of an elevational range mostly below that of the reserve. This lizard is an active forager that can sometimes be seen weaving in and out of the leaf litter. They will tolerate both full shade and mixed sun, and are most often found in mature forest.

*Stenocercus varius* (Boulenger 1885)

**Description:** This stocky lizard in the family Tropiduridae can grow to about 8.5 cm SVL (Torres-Carvajal 2000). Basic coloration consists of regular black markings along the dorsum, with a dark greenish-brown background and occasional yellow spots. The top of the head has the same dark background coloration, with the region around the mouth and eyes generally a much lighter shade of green. The flanks also are a lighter shade of green, with yellow-green spots arranged in regular transverse rows. The venter is green to greenish-white with a light orange color on the ventral surface of the tail. These lizards are capable of rapid color change. They can appear nearly melanistic at times, with the light green of the mouth and eyes and the yellow spotting on the flanks completely obscured.

**Ecology:** *Stenocercus varius* occurs at elevations from 1460–2200 m. They are restricted to montane forests with high rainfall, and are frequently found on tree trunks and fallen logs, particularly in cleared areas. They also occur along forest edges (Torres-Carvajal 2000). They are quite rare at Santa Lucia, although they appear to be quite territorial, with one individual recaptured 3 m from the release site after a period of four months.



*Stenocercus varius* appears to be restricted to montane forests with high rainfall, and is frequently found on tree trunks and fallen logs, particularly in cleared areas.

## S N A K E S

*Atractus occidentalis* Savage, 1955

**Description:** This rather small snake in the family Colubridae reaches lengths a bit under 35 cm total length in mature females. They are thick snakes with small heads and no obvious neck differentiation. Symmetrical pairs of black spots mark the dorsum. Dorsal ground color exhibits some variation, with both brown and burgundy phases documented. Additional variation may exist. The venter is black posteriorly and mottled with a rose-tinged cream anteriorly.

**Ecology:** This species has been documented as occurring at elevations from 1200–3000 m (Perez-Santos and Moreno 1991). They are terrestrial snakes that generally forage in the litter of the forest interior. In mid-February, a heavily gravid female with SVL = 31 cm (34 cm total length) was encountered basking on a trail and responded to capture by playing dead. She was kept



*Atractus occidentalis* is a small inconspicuous snake that forages in leaf litter on the forest floor.



*Bothrocophias campbelli* are small, stout pit-vipers that are perfectly camouflaged and almost invisible in leaf litter.

for observation, and, about 12 hours after capture, laid two eggs, each measuring about 3 x 1 cm. Both eggs were fertile and appeared to be developing when candled. However, they had not hatched by the time I left the reserve about 3 months later. They were kept moist and still appeared healthy at that time.

*Atractus (major?)* Boulenger, 1893

**Description:** This tentative identification is based on a single specimen that was captured, but could not be photographed. Consequently, the species is only tentatively identified as *A. major*. This individual displayed a very distinct pattern of broken, irregular, longitudinal bands running the length of its body. Markings were brown with black bordering on a brick-red ground color. Venter was white with some dark blotches. The single specimen measured about 45 cm total length (38 cm SVL), which is over the maximum length of most species of *Atractus*, but well under the maximum known for the presumed species (72 cm; Perez-Santos and Moreno, 1991).

**Ecology:** *Atractus major* is very widespread throughout the Amazonian slopes and eastern lowlands of Venezuela, Colombia, Ecuador, Perú, Bolivia, and Brazil. This species has been documented at elevations from near sea level to almost 3000 m (Perez-Santos and Moreno, 2001). Given this large elevational range, *A. major* or a closely related species could very easily be present on the Pacific slopes of the Andes. This is particularly likely in light of the Huancabamba Depression, an area in northern Perú where both Andean cordilleras drop well below 3000 m.

*Bothrocophias campbelli* (Freire 1991)

**Description:** These stout pit-vipers can grow to over half a meter in length. A pattern of brown angular blotches on a gray background extends laterally from either side of the middorsum. These coalesce into a more cohesive banded pattern toward the tail. The venter is gray with black speckling, and a series of regular black splotches occur ventrolaterally.

**Ecology:** Four species of snakes, including *B. campbelli*, were recently allocated to a new genus, with this species being restricted to the Ecuadorian Cordillera Occidental (Gutberlet and Campbell 2001). This species has a very restricted range, especially in comparison with two of its congeners, both of which have extensive ranges on the eastern side of the Andes and in parts of the Amazonian lowlands. These snakes are perfectly camouflaged and are almost invisible in leaf-litter. They are inconspicuous, secretive, and nocturnal.

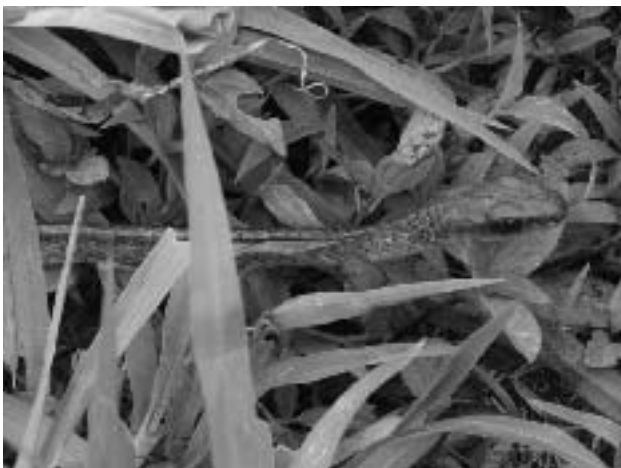
*Chironius monticola* Roze 1952

**Description:** This impressive colubrid snake can grow to over 1.5 m in total length. The dorsum is a solid forest-green with dark outlines of each scale. The venter is a light gray-green, turning yellow anteriorly. Throat, jaw, and upper labials are a bright yellow.

**Ecology:** This terrestrial snake is most often seen basking in the open on warm, sunny days. It is very alert and can disappear rapidly into the leaf litter and undergrowth. They range from



*Dipsas oreas elegans* is arboreal and has a laterally compressed body and a large, blunt head. The former character facilitates climbing and the latter the consumption of relatively large prey.



*Chironius monticola* is very alert and can disappear rapidly into the leaf litter and undergrowth.

Venezuela through Bolivia, and have been documented at elevation from 1200–2000 m (Perez-Santos and Moreno 1991).

*Dipsas oreas elegans* (Boulenger 1896)

**Description:** This small, elegant colubrid has a laterally compressed body and a large, blunt head. The body is covered by alternating bands of brownish-gray and black. The venter is a silvery gray with black blotches. The long, prehensile tail accounts for about a third of the snake's total length.

**Ecology:** *Dipsas oreas* is an arboreal snake with an elevational range of 1200–3000 m (Perez-Santos and Moreno 1991). The diet consists mostly of invertebrates, especially soft-bodied species. They are active nocturnally.

*Liophis epinephelus albiventris* Jan 1863

**Description:** This medium-sized colubrid snake grows to just under 80 cm (Perez-Santos and Moreno 1991). Ground color of the dorsum is deep green. A series of black spots along the



*Liophis epinephelus albiventris* (female, 41 cm SVL): This terrestrial species responds to threats by flattening its head and body in a convincing viper impersonation.

dorsum merge posteriorly to form two lateral stripes and a thicker dorsal stripe. The venter is bright yellow, as are the superior and inferior labials. Bright orange skin can sometimes be seen between dorsal scutes.

**Ecology:** This terrestrial species responds to threats by flattening its head and body in a convincing viper impersonation. This particular subspecies is restricted to Ecuador, whereas two other subspecies occur throughout northern South America as far north as Panamá and as far south as Perú (Perez-Santos and Moreno 1991). Virtually nothing is known about the ecology of this species.

*Mastigodryas boddaerti* (Sentzen 1796)

**Description:** A relatively large colubrid snake, *Mastigodryas boddaerti* can reach 160 cm in total length (Perez-Santos and Moreno 1991). It has a brown dorsum, sometimes with dark longitudinal stripes. A white subocular stripe extends from the rostrum to the nuchal region, where it fades into the brown of the dorsum. The venter is a creamy-yellow with a small amount of black spotting. Some variation in coloring has been documented for this species.



*Mastigodryas boddaerti*. Other than being largely terrestrial, little is known about behavior, habitat use, or life history.

**Ecology:** A fairly widespread species, *M. boddaerti* ranges from Colombia to Bolivia and Brazil. It has been documented at elevations ranging from close to sea level to about 2000 m (Perez-Santos and Moreno 1991). Aside from the fact that it is mostly terrestrial, not much is known about behavior, habitat use, or life history.



*Mastigodryas pulchireps* is an alert, terrestrial snake found mainly in forest interior.



*Mastigodryas pulchiceps* (Cope 1868)

**Description:** This striking snake has a beautiful pattern consisting of a row of blackish-brown rectangles running along the dorsum, with another lateral row of rectangles along either flank. Each rectangle is separated by a whitish-gray stripe. The tail is almost entirely black. The venter is black with a small white spot on either side of each scale. Black ocular stripes help to camouflage the eyes. Maximum size for this species is not known. The only specimen I caught was 24 cm SVL (32 cm TL). Specimens at the zoology museum at the Pontificia Universidad Católica del Ecuador were “somewhat larger” than the one I caught, but I did not measure them.

**Ecology:** This species is known from Colombia and Ecuador, although it has heretofore been documented only as high as 1500 m (Perez-Santos and Moreno 1991). The specimen I caught in the reserve was at an elevation of about 1750 m. It is an alert, terrestrial snake found mainly in forest interior. Little else is known about its life history.

*Tantilla melanocephala* (Linnaeus 1758)

**Description:** This small colubrid reaches over 40 cm in total length. Neonates can be as small as 5 cm SVL. The neck is not distinctly differentiated. The head is black with a light snout, postocular stripes, and two white spots on the back of the head.



*Tantilla melanocephala* eats mostly small arthropods and arthropod eggs, and is often found in association with leaf litter.

Dorsal background color is a light brown, and some individuals may have a varying number of longitudinal stripes. The venter is yellow.

**Ecology:** This is an extremely widespread species, ranging from Central America to northern Argentina and Uruguay. They can occur from sea level to 2500 m (Perez-Santos and Moreno 1991). They eat mostly small arthropods and arthropod eggs, and are often found in association with leaf litter. They were the most abundant snakes I encountered at Santa Lucia, with four of 13 snakes belonging to this species.<sup>1</sup>

**Acknowledgments**

I thank all the staff and community members of Santa Lucia, especially Santa Lucia's administrator, Francisco Molina. I am indebted to Jorge Noé Morales, Julio Ayala, Carlos Calvache, Eduardo Tapia, and Arturo Alba Zuñiga for help in collecting animals. I also thank Dr. Luís Coloma and the Pontificia Universidad Católica del Ecuador for access to their collections. Robert Henderson generously helped with identification, advice, and material support. Robert Powell provided useful advice during my time at Santa Lucia and since.

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<sup>1</sup> Editor's note: Snakes in the mainland Neotropics often are difficult to find, apparently due to a combination of low population densities and secretive habits. The low number of encounters at the reserve also reflects conditions at high elevations, which are rarely ideal for squamate reptiles.



JOHN BINNIS

Fire on the reserve side of the wetlands.

# Fire in the Salina Reserve, Grand Cayman

Frederic J. Burton

Blue Iguana Recovery Program  
National Trust for the Cayman Islands



Mid-May brought an unexpected threat to the Blue Iguana Recovery Program (BIRP) in the form of a large-scale fire that started in a small agricultural plot and swept out of control into the Salina Reserve's sedge wetlands. There, it burned fiercely along the southern margins of the swamp, fueled by green *Cladium* leaves, and then unexpectedly started to spread east into the dry forest where Hurricane Ivan had left large amounts of dead wood on the forest floor in 2004. Local fire services are not equipped to deal with blazes in remote areas, and were initially inclined to let it burn, but when the flames worked around the east end of the Salina wetland and started to threaten the Blue Iguana (*Cyclura lewisi*) release site, action had to be taken. With considerable support from the Department of Environment (DOE), BIRP managed to get permission for a helicopter to airlift staff and volunteers into the fire zone. This brought the fire services on board, and a joint team effectively tackled the blaze with a water bucket chain, shovels, and machetes. The main fire was doused quickly, and residual smolderings were eventually extinguished using "water bombs" dropped from the government's mosquito spray plane. The Cayman Islands' dry forests are not a fire-adapted ecosystem, and it is rare for fires to spread so far beyond the man-made grasslands where this fire began. Ground-nesting birds, terrestrial and epiphytic orchids, and small reptiles are among the forest flora and fauna which are likely to have been impacted. In contrast, the sedge community around the margins of the Salina wetland do burn once every few years, and the critically endangered endemic wildflower *Agalinis kingsii* often thrives in the year after a major burn. The Blue Iguana habitat, fortunately, escaped all harm.



West Indian Whistling Duck (*Dendrocygna arborea*) in the aftermath.

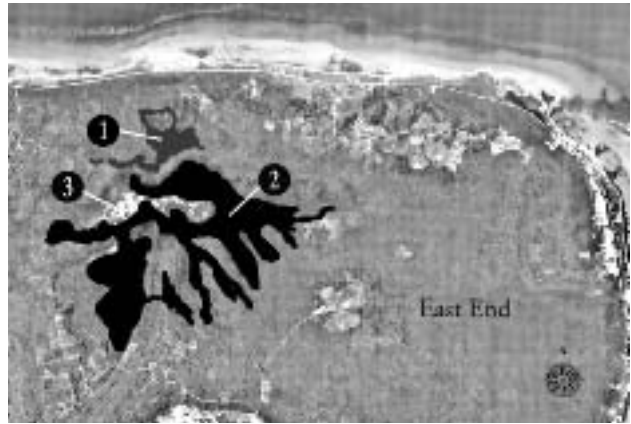


Fred Burton, Blue Iguana Recovery Program, working toward the fire line to assess the situation.



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Small hot spots often reignited in the heat of the day.



Map of the Salina Reserve showing extent of the fire in relation to the Blue Iguana release site. 1 = Salina Blue release site; 2 = area burned; 3 = wetlands.



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Burned out area.



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Recent fire area aftermath.



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Recently released Blue Iguana (*Cyclura lewisi*) in the Salina Reserve.

## HORNED LIZARD WORKING GROUP MEETING

The next meeting of the Horned Lizard Working Group will be held September 15 - 17, 2006, on a private Ranch near Snyder, Texas. The meeting will include presentations about recent research, discussions of management and research priorities, and a field trip. The meeting will be held at the Windmill Ranch (<http://www.windmillranchp-reserve.com/>), which has accommodations for staying overnight, presentations and food service. Additional accommodations are available in Snyder, less than 10 miles away.

We are currently working on the program for the meeting. If you would like to present or just participate, please contact Dr. Wendy Hodges ([hodges\\_w@utpb.edu](mailto:hodges_w@utpb.edu)) or Dr. Gad Perry ([Gad.Perry@ttu.edu](mailto:Gad.Perry@ttu.edu)), as soon as possible. If you would like to speak, please indicate so and provide a tentative title.

Hope you can make it.

Wendy Hodges

University of Texas – Permian Basin

Gad Perry

Texas Tech University



WENDY HODGE





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*Ctenosaura bakeri* basking in Utila's mangroves.

# Population Structure and Reproduction in *Ctenosaura bakeri* on Isla de Utila<sup>1</sup>

Alexander Gutsche

Institute of Biology, Department of Sensory Biology, Humboldt University, Berlin, Germany

Photographs by the author except where indicated.

Field studies occurred mainly in two phases, from 27 June 1999 until 17 July 2000 and 1 January to 31 December 2001, allowing examination of distribution, abundance, and population structures within a complete annual cycle.

## Population Structure: Biometric Data

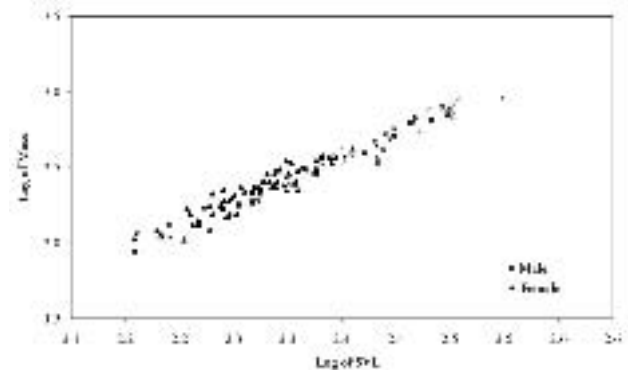
Data for *Ctenosaura bakeri* captured during the study at various sites and for which sex could be clearly determined are included. As in most iguanas, males were longer and heavier than females. The total length (TL) of the largest animal captured, a male with a partial tail, was 781 mm. Adding the snout-vent length (SVL, 315 mm) and the mean tail length/SVL suggest a possible TL of about 828 mm. Males attain a larger size (mean 230.9 mm and 460.6 g) than females (mean 188.0 mm and 237.4 g), with females averaging 81.4% of SVL and 51.5% of body weight of males. Mean tail length for males (337.0 mm) was 11.9% longer than that of females (296.9 mm). Differences in relative tail length (tail length/SVL) of both sexes did not differ significantly.

## Growth and Development

I examined growth of captive juveniles maintained in outdoor enclosures for periods usually lasting one year, at which point the sex of the animals could not yet be clearly determined. Some individuals were raised and measured for up to 2.3 years,

Biometric values for male and female *Ctenosaura bakeri* from Isla de Utila (mean values  $\pm$  1 standard deviation, range, sample size). Lengths are in mm and mass in g.

Character	Males	Females	Total
SVL (mm)	230.9 $\pm$ 42.2 145–315 n = 76	188.0 $\pm$ 18.6 151–229 n = 80	208.9 $\pm$ 38.7 145–315 n = 156
Tail length/SVL	1.60 $\pm$ 0.09 1.40–1.74 n = 38	1.57 $\pm$ 0.09 1.32–1.79 n = 48	1.58 $\pm$ 0.09 1.32–1.79 n = 86
M (g)	460.6 $\pm$ 231.5 100–923 n = 76	237.4 $\pm$ 79.9 105–424 n = 80	339.9 $\pm$ 200.6 105–923 n = 156

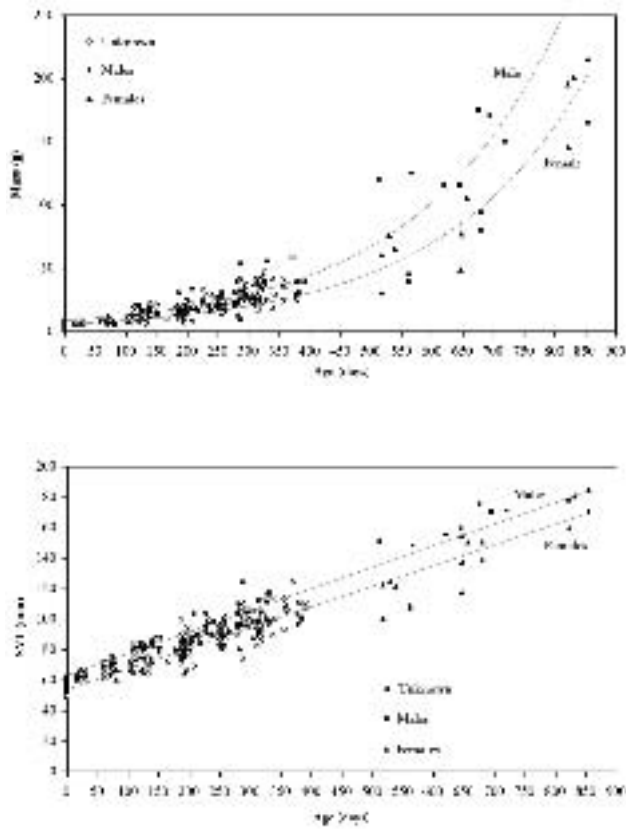


Relationship between mass (g) and snout-vent length (SVL, mm) of adult *Ctenosaura bakeri*. Because of a suspected allometric relationship,  $\log_e$ -transformed variables were used.

enabling collection of sex-specific growth data. Increases in length were predominantly linear, whereas weight increased exponentially. Juveniles (sex unknown) attained 1.7 times initial SVL and 4.9 times initial weight at 300 days. Development was sex-specific. Males were 5.1% larger and 8.6% heavier than females at hatching, 17.9% larger and 48.6% heavier at 300 days, and 9.1% larger and 27.9% heavier at 650 days. No comparisons were made beyond 800 days as only one (small) male remained. When I compared growth rates of captive-held and wild-caught animals, rates of growth were essentially similar for captive and wild caught animals of both sexes.

The proportional growth of SVL and tail length was examined for 145 wild caught animals with intact tails. Relative tail length decreased with increasing SVL, from longer tails in juveniles to relatively shorter tails in adults. The relative tail length of juveniles was significantly greater than that of adults. Sex-specific differences for relative tail length were not evident, although males had longer tails than females.

<sup>1</sup> This is a continuation of a series that began in Iguana 12(3):142. See that article for an introduction to the series and for maps and detailed descriptions of the study sites. All articles are based on the dissertation research of the author. Translation by AJ Gutman.



Snout-vent length (SVL) and mass of captive *Crenosaura bakeri*.

### Sexual Maturity

In order to clarify the issue of age and size of *C. bakeri* at onset of sexual maturity, I compared body weights of 87 wild-caught gravid females with those of individually marked iguanas that were raised under controlled conditions. The smallest wild-caught gravid female had an SVL of 150 mm, likely the lower limit of sexual maturity for this species. Among captive-raised animals, three of five females had attained an SVL of 150–154 mm at an age of about 650 days, and at an age of about 840 days, all females had attained an SVL > 150 mm.

By the end of 2001, mating activity had not been observed among the captive-raised animals. Only in the following spring (2002), during the regular mating season, was mating activity first noted in this group (S. Knapinski, pers. comm., 2002). At that time, animals were approximately 2.5 years old, likely the earliest age at which mating would be initiated in the wild.

### Population and Age Structure

The following data are based on the capture-recapture study. Based on growth data from captive animals, I roughly evaluated age structure. When comparing the individual study sites, the proportion of subadult iguanas (< 150 mm SVL) in Iron Bound was higher than that at Blue Bayou and Big Bight Pond. At Big Bight Pond and Iron Bound, the proportion of both adult iguanas and large iguanas was higher than at Blue Bayou.

Of the 24 iguanas captured at Blue Bayou, four animals (16.7%) were subadults and 20 animals (83.3%) were adults. Subadults (50–130 mm SVL) ranged in age from about 0.5–1.5



Nesting area at Iron Bound.



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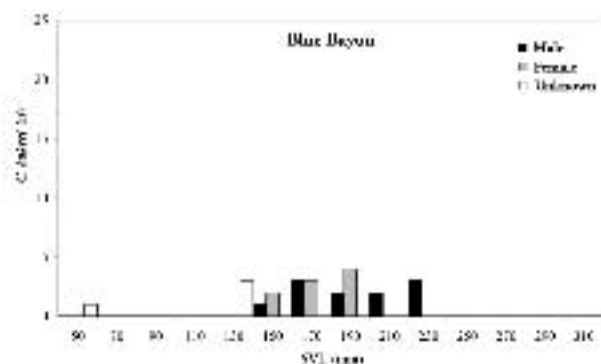
*Ctenosaura bakeri* in copula.

years. Five females (150–170 mm SVL) were about 2.5 years old, and four females (190 mm SVL) were more than 2.5 years old. Four males (150–170 mm SVL) were about 2–2.5 years old, and seven males (190–230 mm SVL) were more than 2.5 years old.

Of 40 iguanas taken at Big Bight Pond, two animals (5%) were subadults and 35 animals (95%) were adults. The subadults (50, 70 mm SVL) were about 0.5 years old. Of the 18 females, one female (150 mm SVL) was about 2.5 years old and 17 (190–210 mm SVL) were older than 2.5 years. Five males (150–170 mm SVL) were about 2–2.5 years old and 15 males (190–310 mm) were more than 2.5 years old.

Of the 107 captured iguanas collected at Iron Bound, 40 (37.3%) were subadults and 67 (62.7%) were adults. Subadults (50–130 mm SVL) were about 0.5–1.5 years old. Thirty females (150–170 mm SVL) were about 2.5 years old, and 11 females (190–210 mm) were older. Of the 26 males, four males were about 2.5 years old, and 22 males (190–270 mm SVL) were more than 2.5 years old.

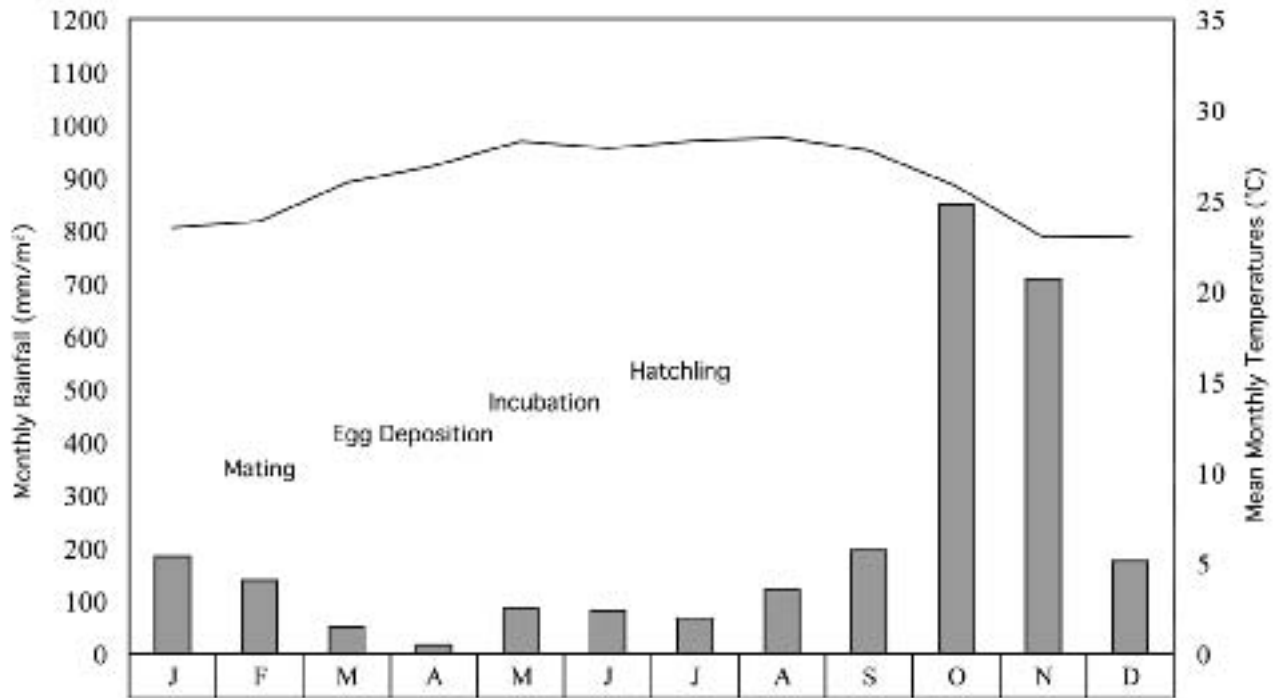
The ratios of males to females at Blue Bayou (11:9) and Big Bight Pond (20:18) were closely balanced, but that at Iron Bound (26:41) was conspicuously female-biased. The latter probably results from the polygynous mating system in the species, rather than a real demographic skew.



Frequency distribution of *Ctenosaura bakeri* by snout-vent length (SVL) for various size classes, differentiated by sex and study site. Data are based on the capture-recapture study.

### Reproduction

The reproductive cycle occurs during the dry season, roughly from mid-January to early August. Mating begins when both the quantity and frequency of precipitation decreases in comparison with the heavy rainfall of previous months. In 2000, the first mating was observed on 17 January. Mating activity reached the highest intensity by about mid-February; the last mating of the year was observed on 24 March. Egg-laying began about mid-March at all study sites and during all three years of the study. The most intense nesting activity was observed from the beginning until the middle of April. Egg-laying ended in early May at all sites. Hatching began during the latter half of June, with the earliest observed hatch occurring on 20 June 2000 at Iron Bound. The latest observed hatching date was 10 August 2001.



Reproductive cycle of *Ctenosaura bakeri* comparing the amount of precipitation (bars) and air temperature (line) throughout the year. Climatic data represent mean monthly values from 1999–2001 (at Big Bight Pond); the reproductive phases are averaged from observational data.



Female digging a nest burrow.



No reproductive activities occurred outside this time period in this or other years.

### Nesting Areas

Female *Ctenosaura bakeri* exclusively use a small number of sandy coastal areas as nesting grounds. All are adjacent to the mangrove areas where iguanas spend the bulk of their time. More distant sandy coastal areas (e.g., at Pumpkin Hill on the northeastern coast or between Big Rock and David Beach on the southern coast) were not used, nor were inland sandy areas bordering mangroves. The total extent of the nesting areas amounted to roughly 109 ha. Vegetation consists largely of plants characteristic of Caribbean coasts (e.g., *Ipomoea pres-caprae*, *Cocos nucifera*, *Coccoloba uvifera*). Nesting burrows were invariably located in the vegetation-free areas. Iguanas avoided even those open areas where the surface of the ground was covered with fallen leaves.

Erstwhile vegetation-free nesting sites used for many years at Iron Bound and Rock Harbor were gradually colonized after 2001 by an invasive creeping vine. In 2002, nest burrows were restricted to the remaining open areas; by 2003, these areas had also become overgrown. Within a few days of the growth being manually removed, the first test excavations were observed.

I noted a clear preference for sunny locations. Of 110 excavations, 55.5% (test and nest burrows) were situated where they received full sunshine throughout the day or were subject to light shade for only a few minutes. Such conditions were present primarily in sandy areas where short periods of shade occurred only in the vicinity of isolated trees. Partly sunny locations subject to shade at particular times of the day were also utilized (49 excavations; 44.6%). These locations were close to or within adjacent beach forest.

Burrows were preferentially selected in areas with sandy substrate and few coarse coral fragments. Larger coral fragments or pieces of driftwood were often (61.8%) incorporated into nesting burrows, with entrances located directly beneath these surface structures.

Depths of nest chambers were occasionally influenced by various environmental factors. Chambers in areas with well-developed root networks were directly beneath the root system. These nests were generally deeper (mean 345.0 mm) than those in sandy areas without root networks (mean 242.9 mm). Surface



Beginning of a nest excavation (test dig).



Opened nesting chamber with temperature logger.

substrates (to 170 mm) were dry. Nesting chambers, however, were discernibly damp.

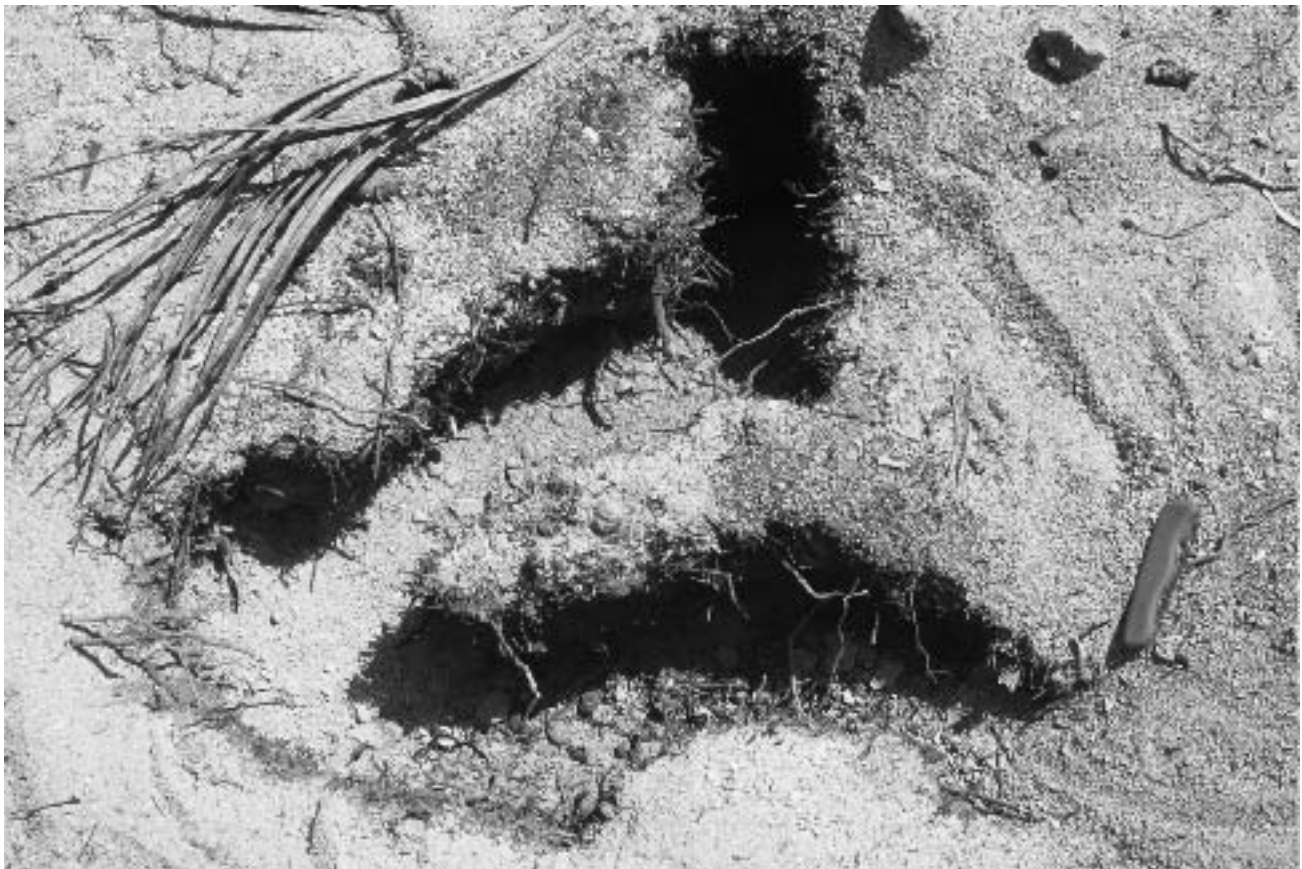
Temperature loggers buried at depths of 200 and 400 mm (representing upper and lower limits where nests were typically found) recorded mean temperatures between 29.7 °C (200 mm) and 30.3 °C (400 mm).

### Migration of Females to Nesting Areas

Five females marked in the mangroves were recaptured in various nesting areas. Two were from Blue Bayou and the other three from Iron Bound. Distances between the original capture site and the nesting areas were 158.1–880.0 m. Four of the females were recaptured in nesting areas bordering their home mangrove areas. The fifth female was marked at Iron Bound and recaptured 880 m away on the beach at Rock Harbor. The return journey was documented for two of the females at Iron Bound, with both recaptured at their home trees.

### Nesting Burrows

Females dig individual nesting burrows in sandy beach substrate in order to deposit eggs. Burrows are dug anew each breeding season. Females will usually dig a number of test burrows in various locations before selecting a final nesting site. Test burrows are abandoned in various stages of completion. The actual nest burrow is backfilled with substrate following successful oviposition.

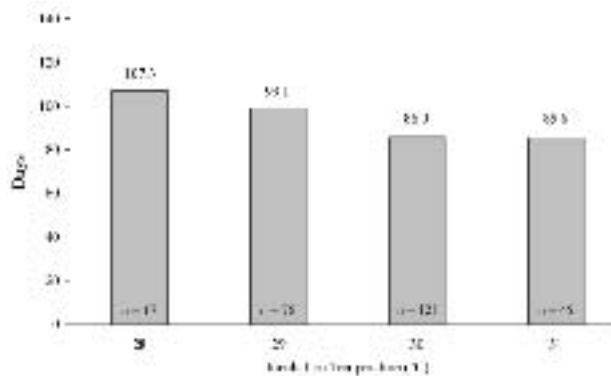


Opened nest burrow; the knife marks the entrance.

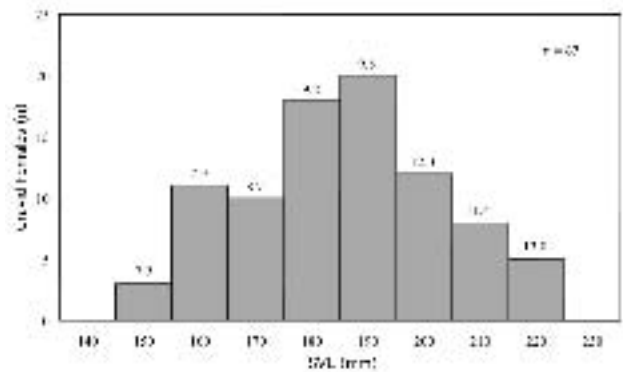
Nest burrows consist of an entrance, a tunnel, and a connecting egg-laying chamber. Openings were uniformly oval. The smallest measured entrance was 60 x 30 mm, the largest 100 x 70 mm. Tunnels were roughly circular in cross-section with diameters of 50–70 mm and lengths of 510–1240 mm from the entrance to the end of the nest chamber. Nest chambers were fist-shapes, measuring on average 112 x 73 mm (width x height). Depths, measured from the surface of the ground to the bottom of the nest, were about 300 mm (160–450 mm). Of 22 nest chambers excavated, five had approximately 1-cm air pockets above the eggs, all others were filled with loose sand.

**Incubation**

Data on natural incubation temperatures were collected for four clutches in 2000 and four clutches in 2001. Data loggers were placed directly next to the eggs either on the day they were deposited or on the day following and removed 95 days (13 weeks) later. Temperature fluctuations were generally small and varied, despite differing locations, times of day, and depths, on average between 29.1–30.8 °C with a total mean of 30.1 ± 0.2 °C. Deeper nests varied less (only by about 1.0 °C around the mean value) than shallower nests. Observations on last oviposition and first hatch indicated incubation periods in the wild that



Incubation periods for *Ctenosaura bakeri* at various temperatures under artificial conditions.



Distribution of gravid *Ctenosaura bakeri* females by size class. Numbers above the bars are mean clutch size for that size class.

ranged from 91–99 days. Also, all eggs in nests ( $n = 22$ ) excavated after 95 days had hatched. Under artificial conditions, incubation period decreased with increasing temperature.

#### Hatching Rates

Seventeen clutches from 2000 consisted of 204 eggs with clutch sizes of 6–16 eggs. Hatching rate was 94.1%. One clutch of 12 eggs all died. One day following oviposition, an inspection of the nest, which had not been sealed by the female, revealed that hard root tips had pierced the shells of two eggs and the yolk had run out. The nest was full of tiny black ants feeding on the damaged as well as undamaged eggs. All eggs had been fertile.

Five clutches from 2001 contained a total of 57 eggs with clutch sizes of 9–14 eggs. Hatching rate was 86.0%. One clutch of 14 eggs produced only six hatchlings; the other eight eggs died. Of these, seven contained dark, hardened yolk remnants, and one egg contained remnants of vertebrae. Fly pupae (family Sarcophagidae) were on and in all of the dead eggs.

#### Clutch Data

Clutch data were obtained from free-living females ( $n = 87$ ) that were caught at various nesting sites and others housed in outdoor enclosures at the “Iguana Station” until oviposition. The SVL of



Female with collapsed flanks following oviposition.



Gravid female on the trunk of a Coconut Palm. Eggs are clearly visible along the flanks.

captured gravid females ranged from 150–229 mm. Mean body weight before egg-laying (body weight including clutch) was 224.5 g (118–435 g). Whereas clutches averaged 27.5% of female body weight before egg-laying, the average loss of body weight due to egg-laying was about 33%. The difference of roughly 5.5% might reflect water released during ovipositioning. Mean clutch weight was 55.3 g (30.6–107.3 g) and varied significantly according to the number of eggs per clutch. Mean egg weight was 6.2 g (4.8–8.4 g). The mean number of eggs laid was 9.8 (5–16). Mean egg dimensions were 30.5 x 18.7 mm (27–35 x 18–19 mm).

Larger females produced significantly more eggs per clutch, but only very slightly larger eggs. The relationship of body weight before and after egg-laying was strongly linear. Egg and hatchling masses were significantly correlated, but clutch size had no apparent effect on hatchling mass.

Using number of adult females captured, mean clutch sizes for each size class, and the natural hatching rate (92.3%), I calculated birth rates for females at each study site for the year 2000. Using census and distribution data for each area, hypothetical birth rates were 79.9 (Blue Bayou), 184.0 (Big Bight Pond), and 346.0 (Iron Bound) hatchlings per hectare.



# Iguana Specialist Group Meeting

6–7 November 2005  
South Andros, Bahamas

The ISG expresses its appreciation to Chuck Knapp (University of Florida/Shedd Aquarium), Sandra Buckner, and the Bahamas National Trust for the extensive planning and organization of a successful ISG Meeting and Species Management Workshop for the Andros Island Iguana (*Cyclura cyclura cyclura*). Special thanks also go to Mike and Petagay Hartman, of Tiamo Resort, for the fabulous accommodation, gourmet food, deeply discounted rate, and warm welcome. It was a truly wonderful meeting that was enjoyed by all.

## Blue Iguana Recovery Program

Fred Burton

*National Trust for the Cayman Islands*

Fourteen months have now passed since Hurricane Ivan, a category 4–5 hurricane, tracked along the southern coast of Grand Cayman causing catastrophic damage to human property and livelihoods, and delivering dramatic impacts to natural environments. Aerial photographs eight months after the storm show the



Resident male *Cyclura cyclura cyclura* at Tiamo Resort, Andros.



Participants in the 2005 ISG Meeting and Species Management Workshop (left to right): Rick Hudson, Peter Tolson, Kirsten Hines, Steve Conners, Tom Wiewandt, Stesha Pasachnik, Joe Burgess, Quentin Bloxam, Ricardo Johnson, Jeff Lemm, Byron Wilson, Karen Graham, John Iverson, Allison Alberts, Catherine Stephen, Bruce Weissgold, Miguel Garcia, Jan Ramer, Fred Burton, Tandora Grant, Samantha Addinall, Tarren Wagener, Joe Wasilewski, Sandra Buckner, and Chuck Knapp.



JOHN BINNS

Grand Cayman Blue Iguana (*Cyclura lewisi*).

island's once extensive Black Mangrove forests shattered and scarcely beginning recovery, while the dry forests are beginning to regenerate a closed canopy despite extensive treefall. The xerophytic shrubland communities that are habitat for the Grand Cayman Blue Iguana (*Cyclura lewisi*) were only lightly impacted and appear fully recovered. The captive-breeding and head-starting facility for the Grand Cayman Blue Iguanas, in the QEII Botanic Park, is now fully restored and has been further expanded and enhanced since the hurricane.

Twenty-three two-year-old *Cyclura lewisi*, originally slated for release at the time the hurricane struck, were finally released in December 2005, and were radiotracked with assistance from a team of international volunteers for two months after release (December 2004–January 2005), and for a further two months in May and June 2004. After a period of weight loss immediately post-release, the iguanas established home ranges and foraging patterns which were characterized in the summer tracking period. Survival over the first seven months was at least 91%.

Summer usage areas of females was 0.6 acres, surprisingly similar to summer usage areas determined by Goodman et al., for larger, mature, free-roaming females in the QEII Botanic Park, and a single wild adult female tracked by the program in summer 2005. The released males in the Salina Reserve occupied an average of 1.4 acres each, with much more extensive overlap in usage areas. Spacing and overlap of the usage areas indicates the iguanas chose to maintain a population density of 4–5 iguanas per hectare in this unnatural setting of a single age class sur-

rounded by unpopulated habitat. A second release, of 70 individuals, is scheduled for December 2005, into the same areas currently occupied. This release will bring the restored population in the Salina Reserve to approximately 91 individuals, with representation from ten different founder lines. Subsequent releases will require access to the Salina's southernmost soil zones.

The studbook continues to be maintained to a high standard by Tandora Grant (San Diego Zoo/CRES), and is now informing the program's release strategy with a goal to reach representation by at least 20 different founder lines in each restored subpopulation by the time each reaches its anticipated carrying capacity. Progress to date is on target towards this goal. Three new founders bred in captivity for the first time in 2005.

A high infertility rate was observed in nests laid in the southern sector of the QEII Botanic Park, where a new dominant male had taken over a territory of five females, four of which were his siblings. As a result of this unusual infertility, only 92 eggs were initially viable from a total of 166 eggs laid in both the captive and free-roaming populations. The dominant Park male was taken back into captivity to allow unrelated males to claim this territory for the 2006 breeding season.

One hundred new hatchling cages were prefabricated and flat-packed in the USA as the result of a three-month IRCF campaign to secure funds and a manufacturer capable of a customized design in time for the August hatch. These cages were subsequently assembled in Grand Cayman by volunteers from the Rotary Club of Grand Cayman Central. These lightweight



cages are holding the 2005 hatch until the next iguana release in December frees cage space at the facility. Again, with IRCF assistance, funds are currently being sought to complete a security fence around the facility, which will also serve to secure tour income to the program.

A custom non-profit company, Tours for Nature Ltd., has been formed and has secured a contract with Royal Caribbean Cruise lines and Celebrity Cruises to operate cruise passenger tours to the Blue Iguana facility with all profits going to the program. Tours are now operational and are expected to generate useful revenue for the first time in the coming winter tourist season. Tours are also being expanded to cater to on-island bookings for guests at major hotels.

The program is collaborating with the Fort Worth Zoo in a project to characterize the physical, climatic, and dietary environment in the successful captive-breeding facility on Grand Cayman, and to compare this to enclosures at Gladys Porter (Brownsville, Texas) and Indianapolis zoos, where captive breeding has been less successful to date. Results are intended to guide *ex-situ* captive managers in efforts to improve breeding success, which is currently one constraint on achieving *ex-situ* population goals for this species.

The first Species Recovery Plan for *C. lewisi* (2001–2005) has now run its course. Achievements were reviewed and a new plan developed in a workshop hosted by the Grand Caymanian Resort on Grand Cayman in September 2005. Local participants represented the BIRP staff, the National Trust for the Cayman Islands, and the Cayman Islands Department of Environment. Visiting participants came from Durrell Wildlife Conservation Trust, San Diego Zoo, ISG/IIF, and IRCF. The workshop was facilitated by Simon Hicks.

Review of the 2001–5 plan showed that the protected area goals were substantially not met, but that all other goals in the plan (population restocking, captive breeding, education and awareness, and resource development) have been met and in some cases surpassed. Over the period 2002–5, while the Blue Iguana Recovery Program has been fully operational, considerable funds have been raised and substantially expended in implementing this plan. These reflect both the ambitious scope of work achieved, and the often unavoidably high cost of doing business in the Cayman Islands. The majority was contributed by corporate donors within the Cayman Islands. Other leading sources of project financing were raised and channeled through the Durrell Wildlife Conservation Trust, the International Reptile Conservation Foundation, and the International Iguana Foundation. Income from commercial activity (retail products and tours) has been relatively insignificant, but is now targeted to expand.

Volunteerism has expanded greatly. Notable volunteer resources have been recruited internationally via IRCF, and locally through service clubs and individual long-term volunteers. The program now has three full time staff: a volunteer director and two salaried wardens. IRCF continues to provide extensive free services equivalent to additional program staff, as well as consistent contributions from other overseas participants who made commitments in the 2001–5 SRP. The cumulative effect has been a massive savings on the cash cost of the work achieved.

The new Species Recovery Plan 2006–2010 calls for 300–500 acres of xerophytic shrubland on Grand Cayman to be protected in order to support a restored population of at least 1,000 Blue Iguanas. Plans have been extended to breed and rear sufficient genetically optimal iguanas for release, to safeguard the species via an *ex-situ* captive population, to continue education and awareness activities, and to further build the financial, human, and technical resources that will be essential to save this species.

### Ricord's Iguana

Jan Ramer

Indianapolis Zoo

Grupo Jaragua, ZooDom, and Indianapolis Zoo have been working together to develop a Ricord's Iguana (*Cyclura ricordii*) curriculum directed toward the 3rd grade classroom. This work is funded by grants from the U.S. Fish and Wildlife Service - Wildlife Without Borders Latin America and Caribbean Program, and AZA's Conservation Endowment Fund. The curriculum includes a booklet with natural history information about the species and its habitat, vocabulary words, maps, etc. Resource kits consist of a plastic bin that students will fill with sand. Plastic eggs, cacti, thermometers, light bulbs, etc. allow students to pretend to incubate eggs and take sand temperatures. A game board with iguana questions and a poster are provided for every classroom. Teacher workshops will be held in Santo Domingo, and in the towns closest to Ricord's Iguana habitat this spring, and the curriculum will be implemented this fall. The



Ricord's Iguana (*Cyclura ricordii*) at ZooDom.

JOHN BINNS

Dominican Department of Education is helping fund these workshops!

ZooDom's four Ricord's Iguana juveniles that hatched during the ISG meeting in 2002 are all doing very well, and the ten hatchlings from 2004 received PIT tags and physical exams in April when Jan Ramer was there with a group of Indianapolis Zoo members. The breeding pair was also examined and found to be in good health.

Ernst Rupp, Grupo Jaragua, has been working hard in the Pedernales habitat, recording hundreds of hatchlings last year. Grupo Jaragua has worked tirelessly on local education and involvement in the conservation program, and also in developing ecotourism opportunities in the area. Ernst received emergency funds last fall from the International Iguana Foundation to conduct survey work on the southern shore of Lago Enriquillo, when he learned that one of the local senators was planning to bulldoze a prime Ricord's Iguana habitat to build houses.

Indianapolis Zoo, Grupo Jaragua, and Durrell Wildlife Conservation Trust recently submitted a proposal to the U.S. Fish and Wildlife Service to continue population and habitat analysis in all three known Ricord's Iguana habitats and to conduct workshops for biology students and Department of Wildlife technicians. If funded, this work will continue through 2007.

#### **Jamaican Iguana Recovery Project**

Byron Wilson and Rick Van Veen

*University of the West Indies, Mona*

A grant for \$20,000 (US) was recently obtained from the Disney Wildlife Conservation Trust (submitted through the IIF).

Additional funds to support work over the past year were obtained from the International Iguana Foundation, the International Iguana Society, Conservation International, and the Miami Metrozoo. Two new GPS units were purchased with funds from a New Initiative grant awarded to Byron Wilson (BSW) from the University of the West Indies, Mona.

*Research and Outreach Activities.*—We continued to encourage protection of the Hellshire Hills ecosystem through the participation of other researchers and interested parties. In the past year, we initiated a new project focusing on the intestinal parasites of wild pigs (with Professor Ralph Robinson and postgraduate student Chinedu Okoro from UWI). Ms. Tamia Harker has just begun a postgraduate program (with BSW) that will involve sea turtle work along the Hellshire coast, and Dr. Dave Miller (Geography and Geology, UWI) has been conducting research on the beach profile dynamics of Manatee Bay. Other notable visitors included Dr. William Cooper and Dr. Karl Rollings. In addition, we coordinated camping field trips for three different UWI courses (two in conservation biology, one in forest ecology). We also recently hosted an overnight excursion for the Jamaican Geographical Society, and assisted with a children's show for local television, "Hello World Jamaica" on CVM-TV. In short, we are trying to get as many people involved and interested in conserving the Hellshire Hills as possible.

*Pitfall Trapping Experiment.*—This field experiment, examining the impact of mongoose control on the terrestrial herpetofauna of the Hellshire Hills, proceeded into its ninth year. The 2005 results were not remarkable in terms of faunal abundance. 2006 should be an interesting year due to anticipated increases in faunal abundance resulting from high levels of productivity



BYRON WILSON

Jamaican Iguana (*Cyclura collei*).

spurred by high levels of rainfall. In addition, removal trapping of mongooses and other mammalian predators from control plots will be conducted during the period of pitfall trapping assessments, to remove the confounding influence of predators tampering with traps or trapped specimens.

*Headstart and Release.*—In conjunction with the Fort Worth Zoo, in February 2005, we released 15 headstarted *C. collei* into the core iguana conservation zone. Three UWI undergraduate students also participated in the release, which brought the total number of repatriated headstarters to 75.

*2005 Nesting Season.*—The first nest was deposited on 24 May, and the last nest was deposited on 20 June. A total of 14 nests were recorded from the two known communal nesting sites (i.e., “Upper” and “Lower”). Dawn Fleuchaus and Stephanie Wicker assisted with nest watches, as they did during the 2004 nesting season. Iguanas attempted to nest at the two new nesting areas identified in 2004, but abandoned the effort after the areas were disturbed by wild pigs. One new nesting area was discovered in a rock hole, with eggshell fragments indicating that seven hatchlings emerged in the 2005 season; additional evidence of nesting from previous year(s) was also noted.

*South Camp Reconstruction.*—Our primary research station (“South Camp”) was severely damaged during Hurricane Ivan in September 2004. Using discounted and salvaged materials, South Camp was re-built in June 2005 with major assistance from Brian and Stephanie Wicker and Larry and Dawn Fleuchaus. In particular, Brian and Larry, both professional tradesmen, put in several days of hard labor and saw the reconstruction effort through to near completion. We are indebted to them all for their hard work, good company, and donations of tools and other camp toys.

*Invasive Predator Control.*—Predator-control efforts continue to make the core iguana area a safer place for young iguanas and other threatened wildlife species. In addition to the 55–60 small mammal traps that are operated continuously, we also expanded our wild pig and dog control efforts through the deployment of additional snares. Catch totals for the period include: 7 cats, ~85 mongooses, 25+ pigs, ~50 rats, and 0 dogs. The main problem with our anti-invasive effort continues to be the difficult nature of cat control. Some individuals are simply not trappable by our current methods. Because leg-hold traps and poisons would pose a risk to native wildlife species, the only solution is to obtain a small caliber rifle outfitted with a spotlight and a silencer. This piece of equipment is at the top of our wish list, but the legal (and illegal) gun situation in Jamaica is not conducive to making this a reality. We would also like to expand our present trapping grid to include a loop trail outside the existing trapping loop. Recent radio-telemetry results indicate that such an expansion would enhance post-natal dispersal in *C. collei* (see below). The current trapping program remains a major effort, owing primarily to the difficulty of accessing the remote interior Hellshire location, not to mention the logistical obstacles posed by the transport of equipment and traps to remote sites. However, continuous removal of mammalian predators is arguably the only conservation activity that is improving conditions for wild iguanas in Hellshire. We thank other members of the trapping team for their efforts, especially Marlon Osborne and Edwin Duffus.

*2005 Hatching Season.*—The 2005 hatching season was extraordinarily successful, with a minimum of 157 hatchlings recorded for the season (2.5 times as many as 2004). Interestingly, and probably attributable to wetter incubation conditions, the average SVL and mass of hatchlings in 2005 was notably greater than in 2004. Twenty hatchlings were taken to the Hope Zoo for headstarting, 41 participated in a radio-telemetry study (see below), and the remainder were marked and released.

*Radio-Telemetry of Hatchlings.*—Forty-one hatchlings were outfitted with radio transmitters, of which six slipped out of their harnesses almost immediately; hence, data were collected for 35 individuals. Activity patterns and hide-site selection were similar to patterns observed in 2004, although dispersal distances were greater. High mortality attributable to mongoose and cat predation was also noted. Preliminary analysis of mortality data indicates that hatchlings that disperse out of the predator-controlled area are doomed. Direct observation of mongoose predation on a transmittered hatchling was also observed, and one hatchling was tracked to the stomach of a young Jamaican Boa (*Epicrates subflavus*). Detailed data on dispersal, post-dispersal settling, and subsequent behavior were also obtained. Still on-going, the study will conclude in early December 2005.

*Goat Islands.*—Two reconnaissance trips were made to the Goat Islands in 2005. The habitat still looks relatively intact, but a rumored organized charcoal operation on Great Goat Island is of great concern. As always, the critical impediment to a Goat Islands rehabilitation program concerns the delegation of management authority. Recently, however, the Urban Development Corporation (UDC) has finally been delegated management authority for both of the Goat Islands, as well as for most of the Hellshire Hills (the organization also owns those areas). We are presently in discussions with UDC that should result in the signing of an MOU with the Durrell Wildlife Conservation Trust (DWCT) and the Department of Life Sciences (UWI), so we can initiate fund-raising activities and begin the restoration project.

*2006 Objectives:* (1) Continue existing initiatives (e.g., predator control, headstart and release, monitoring iguana population); (2) Radio telemetry of post-partum iguanas; (3) Biological surveys of the Goat Islands; (4) Assessment of “western” and “eastern” Hellshire iguana populations; (5) Consolidation of *C. collei* data sets; (6) Advocacy for management capacity (UDC); (7) Formalization of Goat Island restoration agreements (DWCT); (8) Initiation of genetic studies of Jamaican Iguanas; (9) New postgraduate student to undertake GIS-based habitat assessment of Hellshire; (10) Revision of Species Recovery Program (Summer 2006?); (11) Iguana project facility — Port Royal Marine Laboratory; (12) Fund-raising...

### Turks and Caicos Iguana

Glenn Gerber and Allison Alberts

*Zoological Society of San Diego*

*Translocations.*—The recently established populations of *Cyclura carinata* on French, Six Hills East, Bay, and Middle Cays were last visited in April/May 2005. All of these populations have exhibited excellent adult survivorship and growth rates. Average adult sizes on all the translocation cays are now larger than those documented for the source cays, Big Ambergris and Little Water. Successful reproduction has occurred on all translocation cays

each year since establishment (January 2002 for French, Bay, and Middle Cays; January 2003 for Six Hills East Cay). All animals captured in April/May 2005 from the first cohort of juveniles produced on the cays were determined to be reproductively mature, based on published size at maturity data (Iverson 1979). Compared to the source populations, this represents a reduction in age at maturity on the translocation cays from 6–7 years to 1.5–2.5 years. Accelerated growth rates on the translocation cays are occurring despite significantly lower plant diversity than on the source cays, and are attributed to low levels of intraspecific competition on these cays relative to the dense source populations. Growth trajectories are expected to decrease as population densities increase.

*Big Ambergris Cay.*—Development activities on Big Ambergris Cay have increased dramatically in the past year due to new partnerships with outside developers and resulting in establishment of the Turks and Caicos Sporting Club. Irreparable damage to native habitats was already underway in April 2005 during our last visit, and recent reports from Big Ambergris by TCI-based colleagues are extremely grim. Heavy machinery of all kinds is in daily use and no visible effort is being made with regard to iguanas or other wildlife.

*Little Water Cay.*—Cats, which first crossed the sandbar connecting this cay to Water and Pine Cays in 2000, are still the major concern for this otherwise protected population. A small-scale cat-trapping program that was initiated last year resulted in the capture and removal of three cats from the island's southern end, but this program was suspended in the spring of 2005 and has not yet been reinstated due to a shortage of TCNT staff. No sign of cats was seen during my last visit at the southern boardwalk study site in May 2005, and recent reports from Bryan

Manco of the TCNT suggest that this is still the case. Cats were still in evidence at the northern boardwalk study site in May, and their impact on this population (most notably juveniles) is gradually becoming evident. Gerber will accompany a team from Island Conservation to Little Water, Water, and Pine Cays in March 2006 to assess the situation and begin the preparations necessary for full-scale cat and rat eradications. In collaboration with engineers at Johnston's International, efforts are underway to produce and price a fence design that will stretch across the sandbar and isolate Little Water Cay from Water and Pine Cays. Johnston's has offered to install the fence for free.

*Caribbean Wildlife Foundation.*—The Zoological Society of San Diego is helping to establish a non-profit conservation organization in the TCI through the donation of boats and equipment that have been dedicated to the TCI iguana project for the past five years, and by covering legal fees associated with incorporation. The new non-profit (tentatively called the "Caribbean Wildlife Foundation") should be functional by mid-2006. Operation will depend on securing outside funding through grants, donations, and other sources. While much of the initial focus will undoubtedly be on iguanas and the TCI, the organization will not be bound to these taxonomic or geographic restrictions. As a non-profit based in a Caribbean country, the foundation will be eligible for a variety of funding sources closed to US- or UK-based non-profits.

### *Cyclura cyclura figginsi*

Charles R. Knapp

*John G. Shedd Aquarium and University of Florida*

Iguana populations in the Exumas were monitored briefly in May 2005 by the Shedd Aquarium. The translocated *C. c. figginsi* population on Pasture Cay (see past ISG reports for historic details) was visited for 1.5 days, but only six adult iguanas were seen or captured. Pasture Cay is inhabited by rats, and this population is being used to investigate the potential impacts of rats on the growth of iguana populations. Sixteen iguanas were translocated originally in 2002. Three iguanas (two in 2003 and one in 2005) have been confirmed dead and six alive. The others remain missing. The lack of adults is a strong concern but mitigated slightly by the presence of hatchlings and juveniles. We have documented extraordinary growth rates in recaptured juveniles. The unintended translocation of a male-biased propagule is suspected as the reason for the apparent loss of adult iguanas. Intensive monitoring of the population is needed to study the long-term effects of the male-biased translocated colony.

Bitter Guana and Gaulin Cays were monitored for a total of four days resulting in 45 iguana captures (18 recaptures). The goats reported previously on Gaulin Cay were not seen; however, we documented the larvae of *Cactoblastis cactorum* for the first time on an *Opuntia* cactus pad. The iguana education signs posted originally in 1998 have fallen and must be replaced. Bitter Guana Cay was surveyed briefly and two goats were observed. Our concern is the substantial increase in tourist traffic on the two cays, especially Gaulin Cay. Over the past decade, we rarely observed tourists on Gaulin Cay. However, tourists were observed on the cay each day. The visitors come from Staniel Cay located immediately north of the cays. The tourists are being told to visit the island and feed the iguanas. This is a concern because visitor



JOHN BLINKS

Turks and Caicos Rock Iguana (*Cyclura carinata*).



JOHN BINNS

Exuma Island Rock Iguana (*Cyclura cyclura figginsi*).

traffic in the Exuma Cays has been increasing substantially over the past decade. Many of these tourists land on cays inhabited by iguanas. For example, the Allen Cays in the northern Exumas experience up to 600 people each week from one-day Nassau excursions. The islands in the southern Exumas also receive high-impact visitors from Great Exuma aboard one-day excursion tourist trips. Consequently, few iguana populations in the Exumas remain free from visitor impacts. Visitors purposely feed the iguanas, thus altering their natural behavior and potentially their health. A study should be initiated to investigate the potential impacts of visitor traffic on iguana populations in the Exumas.

The Exuma Island Iguana occurs on only seven cays in the archipelago, and the total population does not exceed 1500 individuals. Protection offered in the form of isolation is being eroded as more yachtsmen cruise the Exumas and islands are leased. Humans bring with them their dogs, cats, and unwittingly deleterious behavior of feeding the lizards. I have become increasingly concerned for the Exuma iguanas over the last two years because of elevated human activity on the cays they inhabit. More protection in the form of signs with rules should be offered to the few populations remaining throughout the Exumas.

#### 25-Year Overview for *Cyclura cyclura inornata*

John Iverson  
Earlham College

We continued our study of the Allen Cays Rock Iguana with fieldwork in May 2005. Analysis of the mark-recapture data for subadults and adults (>25 cm snout-vent length) over the first 25

years of field work (1980–2004) using Program MARK (courtesy Gary White at Colorado State University) demonstrated that: (1) the two natural populations of Leaf and U Cays have more than doubled over those 25 years (total populations on Leaf and U Cay now number about 600 and 300, respectively, excluding young of the year); (2) the sex ratio on both islands has shifted from about two males per female in the early 1980s to one-to-one currently; (3) annual adult survivorship has averaged about 90% (although higher in the shy females than the bolder males, and higher on U Cay than Leaf Cay, where tourist visitation and feeding is much higher); and (4) population growth has slowed to near zero over the last few years. Our analysis suggests that the two populations are approaching or have exceeded the



CHARLES R. KNAPP

Allen Cays Rock Iguana (*Cyclura cyclura inornata*).



carrying capacity (K) of their respective islands (with standing crop biomass exceeding 100 kg/ha on Leaf Cay).

The fact that adult survivorship is higher on Leaf than U Cay and yet annual population growth rate on Leaf Cay has exceeded that on U Cay seems antithetical. However, we believe this pattern is a result of higher juvenile mortality on U than Leaf Cay. Preliminary data on nest survivorship for two years (2001–2002) support this hypothesis. Nesting areas on U Cay are less than one meter above sea level, and have wetter, more easily saturated soils. Storms during hatching season in September can cause the suffocation of late-stage eggs or hatchlings in the nest.

During our fieldwork in May 2005, we also visited two other islands onto which iguanas were apparently introduced, and we discovered a third. One of these islands had no iguanas in 1996, but now has at least 40, representing all size classes. Fieldwork in March 2006 will focus on more rigorous surveys of these translocated populations, as well as the exploration of many other small cays in the northern Exumas to which iguanas may also have been introduced.

### *Cyclura pinguis*

Kelly Bradley<sup>1</sup> and Glenn Gerber<sup>2</sup>

<sup>1</sup>Dallas Zoo and <sup>2</sup>Zoological Society of San Diego

The Anegada Iguana headstart and release program is going very well, with a consistently high rate of survival. The first 24 headstarted iguanas to be returned to the wild were released in October 2003 and ranged in size from 2050–750 g. Survival after two years has been 79%, with 19 animals still alive. The 24 ani-

mals released in 2004 ranged from 1540–600 g. After one year, this group has experienced an 88% survival rate with 21 animals still living.

Because the smallest animals from the 2003 and 2004 releases survived, we decided to further reduce animal size for the October 2005 releases. This past fall, an additional 24 iguanas were released, ranging in size from 1055–415 g. The same release strategy was used as in years past. Twelve animals (6.6) of equivalent sizes were released at each of two study sites: rocky woodland on Middle Cay and sandy scrub in Bones Bight.

The eight smallest iguanas ranged in size from 612–415 g and received internal transmitters to insure our ability to monitor them long-term. Dr. Bonnie Raphael and Nina Palmer from the Wildlife Conservation Society conducted the health screenings and transmitter implantation surgeries. The 16 remaining iguanas were fitted with external transmitters attached to the nuchal crest with nylon coated stainless steel wire and crimping tubes.

All of the animals were released into the wild during the first week of October. The iguanas were tracked daily for the first month, after which survival was 100%. The first follow-up monitoring trip took place in December 2005. After 60 days, 22 animals were still alive, representing a 91% survival rate. Additional follow-up trips will take place in February, May, July, and October 2006.

### Conservation Outreach for the Anegada Iguana

Lee Pagni

*Zoological Society of San Diego*

Conservation Education continues to play an important role in the recovery of the Anegada Iguana (*Cyclura pinguis*). With momentum building from previous years' activities, 2005 saw numerous conservation education activities related to the recovery program.

The program received a grant from the IUCN's Sir Peter Scott Fund for creating outreach materials to include an interpretive guide to the headstart facility, a poster, and complementary brochure to raise local awareness about recovery efforts. These materials will be produced and distributed in 2006. Funding was also received from the World Association of Zoos and Aquariums for capacity building of local educators. These funds were used to cover travel expenses for a group of 12 educators from the BVI to attend a one-day workshop on environmental education coordinated by the Virgin Island Network of Environmental educators (VINE), based in St. Thomas, USVI, the BVI National Parks Trust, and the San Diego Zoo. A grant from the Institute of Museum and Library Services helped fund outreach for a genetic analysis of the San Diego Zoo's captive group of Anegada Iguanas. The outreach activities include a secondary-level lesson on microsatellite DNA that is posted on the San Diego Zoo's website.

An annual highlight is the release of headstarted iguanas back to the wild. This year, 11 members of the Anegada community took part in the October releases. Besides bringing more awareness to the headstart program, local involvement in these types of activities is important to improving local support for other recovery efforts that include protecting key habitat and controlling feral predators.



JEFF LEWIS

Anegada Iguana (*Cyclura pinguis*) from Anegada.

Finally, outreach efforts were not restricted to the Caribbean. Middle-school students from the San Diego Zoo's ZooCorps program took part in important outreach activities. First, the group learned about Anegada Iguana conservation, produced a display about what they learned, and educated visitors to the zoo about the recovery program. ZooCorps members also created "genetic jewelry" based on a sequence of an Anegada Iguana gene. These colorful and genetically accurate beaded necklaces were given to students on Anegada during an outreach presentation by Kelly Bradley of the Dallas Zoo.

### Fijian Iguana Update

Peter Harlow

Taronga Zoo

Thanks to the 18 Iguana Specialist Group members and all the other international specialists who made the long and expensive trip to Fiji for the "Conservation and Management Plan Workshop for Fijian Iguanas" in November 2004. The Species Recovery Plan from the workshop should be finalized and printed in early 2006. Several of the recommendations from the workshop have already been completed or are currently being implemented.

Two reports recommended by the workshop have been completed: the first, titled "Survey Techniques and Data Analyses for Estimating Fijian Iguana Abundance" (by Peter Harlow and Pita Biciloa), has been printed and distributed to all potential users in Fiji. This is a user-friendly description of how to conduct

line-transect surveys and analyze the data using distance-survey techniques to obtain abundance estimates for both species of Fijian iguanas.

The second report, "Invasive Plant Assessment and Weed Management Plan for the Fijian Crested Iguana Sanctuary island of Yadua Taba" (by Jennifer Taylor, Peter Harlow, and Jone Niukula) has been printed and distributed. Four species of invasive plants were identified as needing intervention to control and eventually remove from Yadua Taba: Rain Tree, *Wedelia trilobata*, Guava, and *Lantana*. These species are continuing to spread on Yadua Taba and thus decrease the amount of dry forest habitat available for Crested Iguanas (*Brachylophus vitiensis*). Over 300 rain trees have so far been poisoned, which is more than half of the estimated total on the island. The report includes a five-year plan for the removal of these four invasive species by the sanctuary ranger.

This project began in July 2003, and by September 2005, *Wedelia trilobata* or "Trailing Daisy," as it is also called, had been totally eradicated from the island by intensive hand removal. This species is native to the Caribbean, but is highly invasive in the Pacific, covering the forest floor with a foot-thick layer of interconnected plants and choking potential iguana nesting habitat. The successful removal of this species from Yadua Taba is the first record of an invasive plant species being removed from any island in Fiji.

In September 2005, Clare Morrison, Isaac Rounds, Nunia Thomas (University of South Pacific), Pita Biciloa and Jone Niukula (Fiji National Trust), and Peter Harlow (Taronga Zoo)



JOE BURGESS

Fijian Crested Iguana (*Brachylophus vitiensis*).

completed the first of four two-week field trips to Yadua Taba Crested Iguana Sanctuary. We collected tree-use data and buckets of iguana fecal material (for later analyses) to obtain a better picture of Crested Iguana diet across all seasons. Six permanent transects were established and complete vegetation and iguana surveys along each transect were completed. Knowledge of the dietary requirements of this herbivorous species across all seasons is needed to assess potential islands suitable for future translocation of Fijian Crested Iguanas, or for forest restoration on degraded islands. The second trip took place in December 2005, and the fourth and final field trip is scheduled for July 2006.

In September 2005, Craig Morley (University of South Pacific) and Peter Harlow, with local assistance, completed a rapid survey of Crested Iguanas on the 40-ha island of Macuata, where Crested Iguanas were re-discovered in 2004. Based on 22 nighttime sightings along 800 m of transect, an average of 25 iguanas per hectare of forest occur on the island, and almost half this island is currently covered in regenerating forest. This island is one kilometer off the northern coast of Viti Levu, Fiji's largest island, and about two hours by road from the capital of Suva. It is privately owned, and was heavily burned and goat grazed until 1994, when goats were removed. The forest is now recovering, and most of the iguana's favorite food tree species are present but in low abundance. This island is second in importance after Yadua Taba for the long-term conservation of the Crested Iguana, and together with Yadua Taba, these are the only Crested Iguana populations in Fiji where numbers are stable or increasing.

Doctoral student Suzie Morrison from the Australian National University (Canberra) began her field research on Yadua

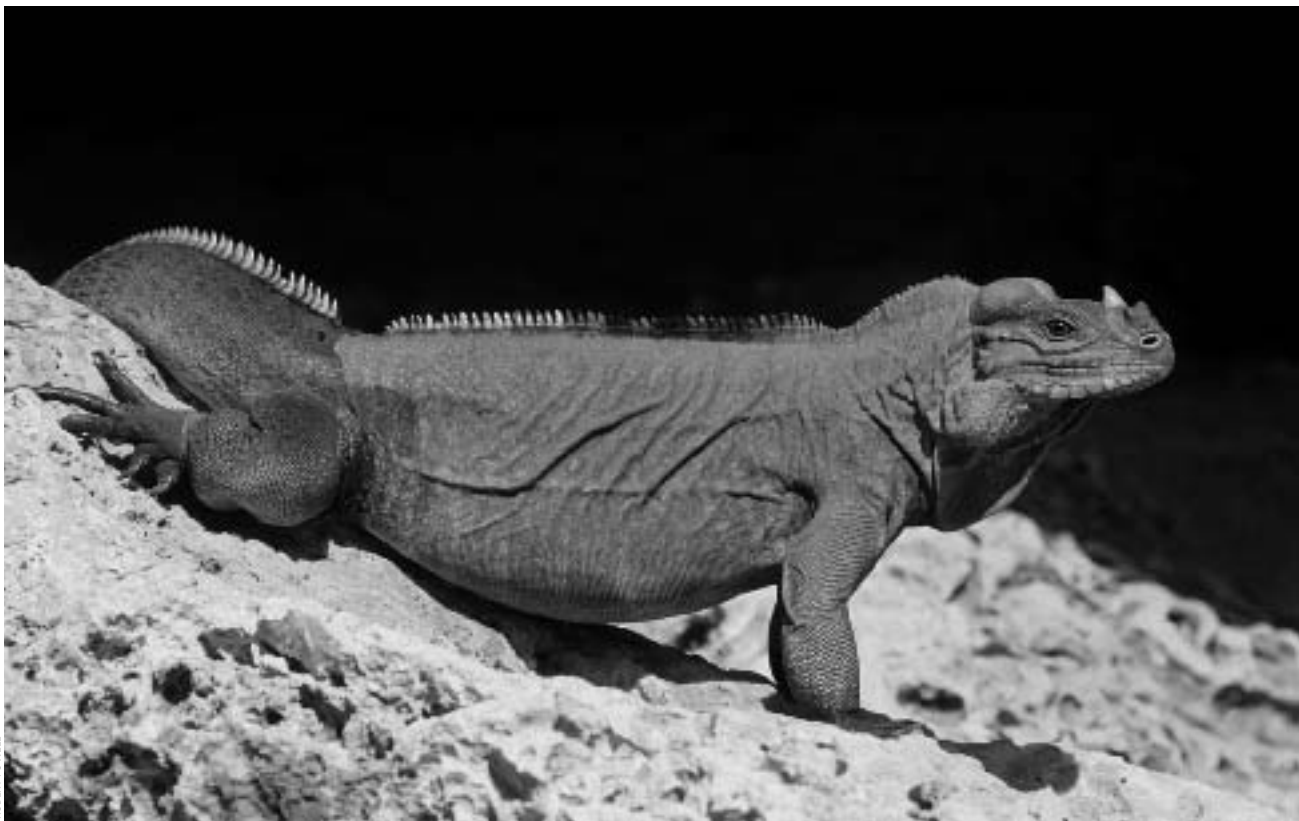
Taba in September 2005. Suzie and her partner, Zach Pierce, will be using mark-recapture and radio-tracking techniques to gather basic biological data on reproduction, juvenile recruitment, and habitat requirements of Crested Iguanas. Other projects include seed dispersal by iguanas and rats, the effects of the introduced invasive "crazy ant" on Crested Iguanas and their habitat, and dry forest restoration projects. See their project website at: <http://www.fijiancrestediguana.com/>

#### Mona Island Iguana, *Cyclura cornuta stejnegeri*

Miguel García

*Puerto Rico Department of Natural  
and Environmental Resources*

The endemic Mona Island Iguana, *Cyclura cornuta stejnegeri*, has been listed as endangered under the Endangered Species Act and the Regulation to Govern the Endangered and Threatened Species of the Commonwealth of Puerto Rico. This is because the species exhibits a limited distribution, relatively low population numbers, and reduced recruitment of juveniles into the breeding stage. Therefore, a head-start program was started in 1999 and is conducted by the Department of Natural and Environmental Resources (PRDNER), the Toledo Zoo, and the University of Puerto Rico. By October 2005, 87 headstarted iguanas had been released and 33 animals had been recaptured. We have recorded dispersal data for nine individuals and found relatively large home ranges, ranging from 2.4–22.2 ha. The average home range (MCP) for all individuals was 19.8 ha. All of the headstarted iguanas observed are active and in good health, indicating the success of this management strategy.



ROBERT POWELL

Mona Island Rock Iguana (*Cyclura cornuta stejnegeri*).

In summary: (1) No released iguanas have been found dead; (2) Relatively large home ranges; (3) Survivorship data are still being recorded by active searching of marked individuals (with or without radios); (4) Population and Habitat Viability Assessment is needed to determine number of released iguanas necessary to obtain a positive and sustained population growth.

#### *Cyclura nubila* on Isla Magueyes, Puerto Rico

Miguel García

*Puerto Rico Department of Natural  
and Environmental Resources*

The introduced population of Cuban Iguanas on Isla Magueyes has become a problem. These lizards are very charismatic, but the Commonwealth of Puerto Rico has a strict public policy against exotic biota. Only researchers, students, and field workers (no tourists) are allowed on the island, but the animals have been fed and are now aggressive and numerous (~500 on 7.2 ha).

A discussion of this issue was held among ISG members and key points are listed below. A sub-group was formed to help the Puerto Rico Department of Natural and Environmental Resources find an acceptable solution to this dilemma.

Issues include: (1) The population is exempt from the U.S. ESA rules because it is an introduced population. Legally, the animals could be moved from the island to the pet trade within the U.S. Placing the animals in the U.S. pet trade poses serious risks that include improper care, undesirable precedent, and potential release and conversion to a new feral population. (2) This is a CITES I-listed species, so trade within the U.S. is not regulated.

Translocating iguanas back to Cuba would involve U.S. export and Cuban import permits. Translocation back to Cuba is zoonotically risky to other herpetofauna. (3) The Cuban government should be contacted by the Puerto Rico Department of Natural and Environmental Resources to assess their interest and involvement in the future of this population. (4) The ISG is concerned about stating a policy in the event of backlash, preferring instead to have the Puerto Rican government decide policy and the ISG then advising on the potential problems of any action. (5) The establishment of colonies on mainland Puerto Rico is unlikely because of many predators even though the over-water distance is short. (6) A control plan is needed with an analysis of harvesting of adults through relocation (outside Puerto Rico), stopping population growth (nest destruction), and euthanasia (last resort).

#### Molecular Analysis of the Ctenosaurs of Nuclear Central America: Insights into Speciation, Conservation, and Management

Stesha Pasachnik

*University of Tennessee*

Mesoamerica has been defined as one of the Earth's biodiversity hotspots. The *Ctenosaura* group exemplifies this pattern because it is an incredibly species-rich clade; however, it has received little attention thus far in scientific research. In order to evaluate plausible explanations for speciation within this clade, I plan to: (1) construct a molecular phylogeny of the iguanas of the *Ctenosaura melanosterna* complex inhabiting the Caribbean borders and islands of Honduras, the heart of Mesoamerica (using



Honduran Black-chested Spiny-tailed Iguana (*Ctenosaura melanosterna*).

the *C. quinquecarinata* complex as an outgroup); (2) investigate the colonization by *C. bakeri*, *C. similis*, *C. melanosterna*, and *C. oedirhina* of the Bay Islands, Cayos Cochinos, and various Caribbean islets bordering Honduras; and (3) document the degree and directions of hybridization, between endemic *C. bakeri* and a wide-ranging congener, *C. similis*, on the island of Utila, Bay Islands, Honduras. This study will provide insight into diversity, species status, and the conservation and management strategies that are necessary to preserve species in the *Ctenosaura melanosterna* complex.

#### Genetic Studies Update

Catherine Stephen

Utah Valley State College

*Iguana Phylogeography.*—*Iguana* consists of two species, *I. iguana* and *I. delicatissima*. Whereas *I. delicatissima* historically has a very limited range restricted to the Lesser Antilles, *I. iguana* is found throughout the Neotropics and the Lesser Antilles (Burghardt and Rand 1982). *Iguana iguana* is unlikely to constitute a single interbreeding population, given the enormous physical distances and barriers to gene flow. We are using nuclear and mitochondrial DNA-sequence data to explore the phylogeographic history of this species. Samples included in the preliminary analysis have been collected from 17 different countries. Results from both data sets show a congruent, deep lineage divergence between the Central American populations and the South American plus Lesser Antillean populations of Green Iguanas. The topology of the phylogeny indicates that *Iguana iguana* arose on the South American continent and radiated much more recently into Central America.

*Subfamily Iguaninae Phylogenetics.*—Iguaninae is an ancient group with eight modern genera distributed throughout the Western Hemisphere and the Fijian Archipelago. Previous morphological and molecular studies of iguanine relationships have relied on incomplete sample sets that yielded conflicting topologies. The subfamily collectively spans thousands of miles across multiple geographical boundaries and exhibits a high degree of regional and island endemism. Because of its age and distribution, the group is uniquely suited to test biogeographic hypotheses, such as suggested occurrences of past refugia or relictual fragments, as well as allow empirical evaluation of molecular clock models. In order to generate a robust phylogeny, we have collected DNA-sequence data at four loci (two nuclear and two mitochondrial) for all eight genera, including 28 of the iguanine species. Phylogenies generated from maximum likelihood analysis of separate data sets result in congruent phylogenies with varying levels of resolution.

Preliminary analyses strongly support *Dipsosaurus* as the most basal lineage in the subfamily, followed by an early dispersal of *Brachylophus* to the Fijian Archipelago and a subsequent divergence of the *Cyclura* lineage. A sister relationship between *Sauromalus* and *Iguana* is supported by the combined analysis, and this clade is sister group to the rest of the subfamily (*Ctenosaura*, *Amblyrhynchus*, and *Conolophus*). Interestingly, *Ctenosaura defensor* falls outside of the *Ctenosaur* clade in the three data sets in which it was included.

*Booby Cay Study.*—*Cyclura carinata*, a Bahamian Rock Iguana, currently has two recognized subspecies. *Cyclura c. carinata* is found on several islands and cays throughout the Turks and Caicos Islands. The second subspecies, *C. c. bartschi*, is now



JOE WASILEWSKI

Bartsch's Rock Iguana (*Cyclura carinata bartschi*) from Booby Cay.



known only to exist on Booby Cay, a small island off Mayaguana Island, Bahamas, which is also within the subspecies' historic range. Support for subspecific status is weak. Geographic isolation appears to be the only strong indicator of genetic isolation. Recent conservation attempts made on the species' behalf have raised questions regarding the taxonomic status of the subspecies. We used mtDNA-sequence data to ask whether any genetic variation distinguishes *C. c. bartschi* from several sampled populations of *C. c. carinata*. Our findings show that the Booby Cay population of *C. c. carinata* is fixed for a common mtDNA haplotype found in Caicos Island populations of *C. c. carinata*. In contrast, four different haplotypes were found among populations designated *C. c. carinata*. We conclude that evidence is insufficient to support *C. c. bartschi* as a subspecies and recommend that the Booby Cay population of *C. c. carinata* be included in ongoing conservation efforts currently focused on the Turks and Caicos Islands.

#### **Bartsch's Rock Iguana, (*Cyclura carinata bartschi*)**

Steve Conners, Joe Wasilewski,  
Joe Burgess, and John Bendon

The population of *Cyclura carinata bartschi* found only on Booby Cay, Mayaguana, Bahamas has been monitored annually since 1998. Repeated observations by a core group of team members indicate that the population has remained healthy and stable over this time period. All size classes and sexes have been seen during each visit despite the continued presence of introduced goats, rats, and a strong hurricane. Human activity (periodic camping by fishermen) on the island has had no negative impact on the

iguanas. Interviews with local residents indicate that harvesting of goats may be increasing, which would reduce their population, and thus their impact on the vegetation. Currently, 50 individual iguanas are marked, but few recaptures have been made. Iguanas were observed foraging on seagrass during extremely low tides. A set of transect surveys has been completed, resulting in a conservative population estimate of 14.5 lizards/ha, or a total population of 558 animals on the Cay. We recommend that annual monitoring of this population continue.

#### **International Iguana Foundation Report**

Rick Hudson  
Fort Worth Zoo

The International Iguana Foundation (IIF) currently has 14 Board members representing zoos, NGOs, corporations, and foundations; the group is largely U.S.-based with one foreign partner (Durrell Wildlife Conservation Trust). To date (December 2005), nearly \$400,000 has been raised through a combination of annual Board pledges, grants, and donations. The IIF has received and administered over \$120,000 in grants from a number of sources including AZA Conservation Endowment Fund, Morris Animal Foundation, SSC Sir Peter Scott Conservation Action Fund, Conservation International, and a host of zoos. One of the IIF's most generous sponsors has been the Disney Wildlife Conservation Fund (DWCF), which has awarded \$68,750 to the IIF for iguana programs in Grand Cayman (2002–2003), Turks and Caicos Islands (2004), and Jamaica (2005).



JOE BURGESS

Resident male *Cyclura cyblura cyblura* at Tiamo Resort, Andros.



JOE BURGESS

Aerial view of Andros Island.

Where have these funds gone? The IIF has awarded just over \$170,000 over four grant cycles (including the recent 2005 awards) to support iguana conservation work in Grand Cayman, Jamaica, Anegada, St Lucia, Dominican Republic, Isla Mona, the Bahamas, and Fiji. Funds also have been raised to support major projects that include emergency relief efforts for Hurricane Ivan damage (\$17,000), Hope Zoo iguana facility renovations (\$9,000), and the development of a feral mammal control plan for Anegada (\$11,000, thanks to San Diego Zoo). Highlights of some of the projects and programs that IIF has supported include:

- Salary support for manager of the Blue Iguana headstart and breeding facility on Grand Cayman
- Support for the release and monitoring of 23 Blue Iguanas in Grand Cayman's Salina Reserve in 2005–6
- Support for biologist Rick Van Veen's salary to conduct fieldwork in Jamaica's Hellshire Hills, where he is solving many mysteries on the life (and death) of the Jamaican Iguana
- Support for the ongoing predator control effort in Hellshire Hills and studying the impact of their removal
- Support for the repatriation of 28 headstarted Jamaican Iguanas (2003 and 2005)
- Provided support to the ongoing iguana headstart program at Jamaica's Hope Zoo
- Support for field surveys and conservation research for the Anegada Iguana recovery effort
- Funding for the pre-release health screening, repatriation, and follow-up monitoring for 72 Anegada Iguanas (2003–2005)
- Assistance with the purchase of a dedicated project vehicle for the Anegada field researchers (split with IRCF funds from Daytona NRBA auction)
- Training and technical support for the Anegada Iguana headstart program
- Funding of signage for the protected nesting area for the St. Lucia Iguana
- Funding for research on the nesting ecology and hatchling survival of the St. Lucia Iguana
- Funding to the NGO Grupo Jaragua to conduct field research that led to the discovery of a major hotspot of

Ricord's Iguana habitat in the Pedernales region of the Dominican Republic

- Funding for the translocation of ten San Salvador Iguanas from Green to Cut Cay in the Bahamas in 2005
- Funding for a new iguana population field assessment technique for the Mona Iguana
- Support for an ongoing natural history study for the Fiji Crested Iguana on Yadua Taba

The IIF faces a number of major challenges in 2006; these include the development of a strategic business plan, identification of corporate partners, ramping up fund-raising efforts, increasing visibility and exposure, and expanding content on the IIF web site.

The IIF Board of Directors met on 9–10 November 2006 following the ISG meeting in South Andros, Bahamas. The Board reviewed five proposals requesting a total of \$53,473. Due to funding constraints, the Board was able to award \$31,864 to the following five programs, four of which provide direct support to iguana species ranked Critically Endangered by the IUCN Red List (*Brachylophus vitiensis*, *Cyclura lewisi*, *C. collei*, and *C. pinguis*). Subsequent to the meeting, emergency funds were awarded for conservation of *C. ricordii*, also Critically Endangered.

#### IRCF Report

John Binns

#### *International Reptile Conservation Foundation*

In December, IRCF was granted \$36,400 by the Dart Foundation toward improvements to the Blue Iguana Recovery Program's captive breeding and head-starting facility on Grand Cayman. IRCF's 501c3 status facilitated this grant, which will be transferred to the Blue Iguana Conservation Fund on Grand Cayman, where it will be utilized to refurbish and subdivide an oversized breeding pen, complete a storage shed and food preparation area, install piped water throughout the facility, and supplement funds already being raised by an IRCF web appeal to erect a security and tour management fence for the facility.

# The VIII National Meeting on Iguanas in México, An Overview

Víctor Hugo Reynoso<sup>1</sup>, Laura Briseño<sup>2</sup>, Gerardo Olmos<sup>3</sup>, and Víctor Hernández<sup>4</sup>

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The National Meeting on Iguanas in México has been conducted annually since 1998 as the primary forum for the Technical Consulting Subcommittee for the Conservation, Management, and Sustained Use of Iguanas in México (SCT-Iguanas). SCT-Iguanas is part of a broader national initiative for the recovery of priority species within the country. In addition to iguanas, priorities include crocodiles and sea turtles. Last year, the meeting was held in the city of Lázaro Cardenas in the state of Michoacán, west-central México, and, for the first time, our group was able to attract both authoritative speakers and private companies as sponsors. Pre-event activities included a press con-

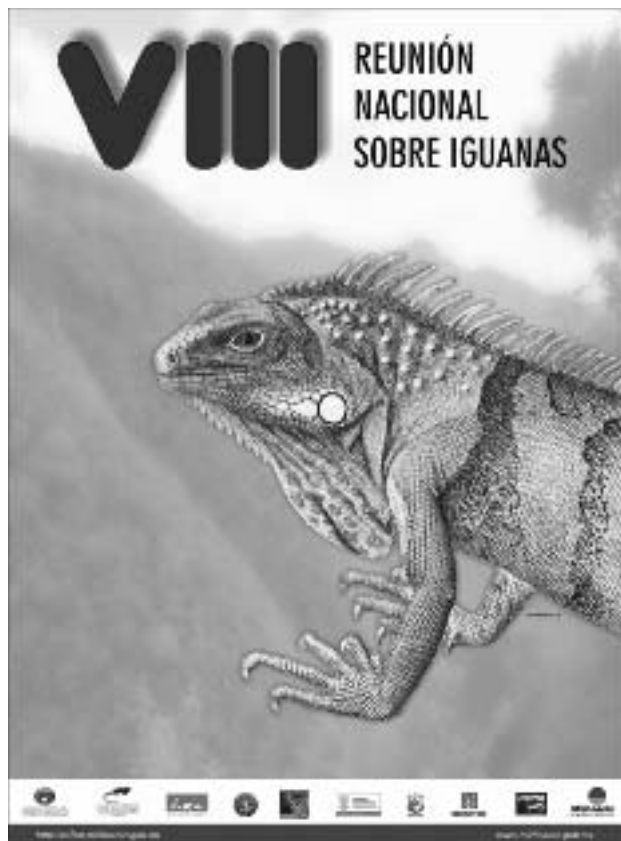
ference with Juan José Reyes, Director of the Forest Commission of the State of Michoacán, Víctor Ricardo Aguilera, Director of the Morelia Zoo in Michoacán, and Víctor Hugo Reynoso, then president of SCT-Iguanas. Reports from the press conference were published in national and local newspapers.

Of major concern is the continued increase in the irrational exploitation of the Pacific Spiny-tailed (Black) Iguana, *Ctenosaura pectinata*, which is used as a traditional food source by Mexicans. This species lacks any formal means of protection, and the need to establish a viable conservation program at the local level is quite urgent. The Balsas depression situated along the border of the Mexican states of Michoacán and Guerrero is one of the larger areas used for illegal hunting and trading of Black Iguanas. This area also is one of the sites with less-developed programs to protect Black Iguanas, in contrast to places like the Isthmus of Tehuantepec in the southern state of Oaxaca, México, where serious conservation efforts were initiated almost 10 years ago. Hunting and trading Black Iguanas is illegal throughout the country. However, without local enforcement, current conservation legislation is largely ignored in many regions.

Local conservation authorities, business people, and academics in Michoacán considered the meeting a good opportunity to raise local interest in iguana conservation. As the event progressed, we found that more people were interested in the captive management of iguanas for profit than in the conservation of the species per se. We also became aware that many more people were interested in farming Green Iguanas for sale as pets than in solving the problem of possible local extirpation of Black Iguanas due to overexploitation. This dichotomy of interests led to some very complicated interactions between presenters and public. In spite of this, the conference was successful. This meeting was also the first time we were able to attract the attention of Central American environmental groups, speaking about similar conservation problems facing their endemic iguanas, as well as people doing iguana research internationally.

## The Meeting

The meeting included four main sections: (a) the plenary meeting; (b) the iguana captive management workshop; (c) the Green Iguana commercialization workshop; and (d) technical talks.



Poster promoting the VIII National Meeting on Iguanas in México.

During the plenary talks, the recent transfer of the Priority Species National Committee from SEMARNAT (the Mexican Natural Resources Management Secretary, analogous to the U.S. Fish and Wildlife Service) to the CONANP (National Commission for Protected Areas) was discussed extensively. The iguana group led by Victor Hugo Reynoso and Georgina González-Monfil (Instituto de Biología, UNAM and SCT-Iguanas) clearly argued that this transfer was inappropriate because priority species are already protected within natural reserves, and special programs urgently need to be implemented in non-protected areas, outside the mandate of CONANP. Most of the distributions of listed species of iguanas (including seven species of *Ctenosaura* as well as Green Iguanas) lie in areas vulnerable to exploitation and away from natural reserves, suggesting that a planned strategy carefully implementing sustained-use programs will preserve the species in a wider range of their distributions than a focus on conservation programs in the very limited areas of Natural Reserves. To our surprise, Manelik Olivera and co-workers (CONANP) emphasized that jaguars, Golden Eagles, prairie dogs, and sea turtles deserve urgent attention; whereas the conservation needs of iguanas and 15 other priority species groups are of lesser priority. Needless to say, this led to considerable discussion.

Plenary talks ended with the presentation of Paul House and Vanessa Rodezano (CREA, Honduras) about the conservation status of the Jamo Negro (*Ctenosaura melanosterna*) in Honduras, a problem new to many of us and not previously covered at any of our meetings. This species of Spiny-tailed Iguana has been intensively hunted, almost to the point of extinction. The species, which is endemic to Honduras, has a restricted distribution and has been practically extirpated from the Aguan Valley, where the last remaining very dry tropical rainforest is found. Although this species is considered critically endangered by the IUCN, local conservation efforts are only beginning. Conservation plans include the implementation of a farm for the captive management and release of hatchlings within the 200-ha area of the Centro Regional de Educación Ambiental in Arenal, Honduras.

The second and third meeting sections took place in tandem. During the management workshop, experts in different areas of iguana management and conservation from locations throughout México gave talks on the introduction of captive



JOHN BINNIS, ANIMAL COURTESY OF WEST COAST IGUANA RESEARCH

The Jamo Negro (*Ctenosaura melanosterna*) has been intensively hunted in Honduras, almost to the point of extinction.

farming. These talks have been improved through seven years of Iguana National Meetings, and we now include a broad range of experiences from different farms, pointing out the benefits and shortcomings of the various techniques currently in use. This workshop has become the heart of the Iguana National Meetings. The workshop included talks on the biology and general issues on iguanas, enclosures and facilities, nests and incubation, feeding and growth, diseases and their treatment, and legal issues.

The iguana commercialization workshop led by Víctor Hernández (UMA Los Amatores) attempted to introduce farmers to the Green Iguana pet market. An important issue was the lack of sales due to the increasingly competitive nature of reptilian imports from Central America. The group intended to provide knowledge, techniques for production, administration, use of optimum harvesting ratios for commercialization, quality of specimens, and packing. The workshop also identified national and international markets, and discussed the standardization of the national market to equally benefit farms throughout the country. Four major problems faced by farmers trying to sell their products were identified: Lack of market strategies, paperwork and legal issues, finances, and lack of production volumes. Another issue discussed at the meeting was the importance of lobbying governmental environmental agencies to forbid the sale and importation of iguanas captured in the wild, even if considered legal in their country of origin. Finally, the necessity of forming a National Association of Iguana Farms was mentioned.

The technical talks section included a broad spectrum of iguana-related themes. Silvia Abdala-Romero (Instituto de Investigaciones Antropológicas, UNAM) talked about the importance of iguanas in Mexican culture, showing how iguanas figured in ancient civilizations ranging from Mayans to Aztecs. From post-colonial México to modern times, iguanas are featured in music, dance, paintings, literature, movies, fashion, handicrafts, cooking, festivals, and humor. Abdala-Romero pointed out how indelibly iguanas are imprinted upon our culture, yet sometimes this is less than readily apparent due the influence of the cultural elite on mainstream culture in México.

Presentations of a more technical nature followed. At this year's meeting, for the first time Spiny-tailed Iguanas were the subject of major concern. Jose Luis Arcos and co-workers (UMAR, Puerto Escondido) correlated changes in the reproductive apparatus with behavior during the reproductive period. Several important reproductive parameters in captive Black Iguanas were compared with values reported in the literature for their wild conspecifics and led him to conclude that normal reproductive behavior is not altered for animals that are managed in captivity. Jose Luis Contreras (UAM-Iztapalapa) and Cesar Casiano (UMA Iguanas, Acapulco) discussed the importance of spontaneous seminal emissions in Green Iguanas to implement artificial insemination techniques for the enhancement of reproductive management in farms. Ruben Castro and Guadalupe Bustos (UAEM, Morelos) presented research showing a lack of clear evidence of rainfall (which influences food availability) affecting reproductive characters such as numbers of eggs, mean volumes of eggs, nest weight, nest total weight, and relative nest mass. Martha Pastrana and co-workers (UMA Los Amatores) presented a new, low-cost rustic facility as a model

for incubating Green Iguana eggs. The four-level wooden incubator is covered with transparent polyethylene and houses foam receptacles with a sand and vermiculite mixture. With no power source, incubation temperatures can reach 35–40 °C and the hatching success rate is 78%. Pilar Rueda and co-workers (Instituto de Biología, UNAM and Colegio de Posgraduados, Texcoco) presented digestibility and growth rates in Black Iguana hatchlings fed commercial chicken and rabbit food. Her research shows that higher food consumption rates, better food conversion, better growth and weight gain were achieved in iguanas raised on rabbit food. Victor Aguirre and co-workers (Plymouth University, UK and Instituto de Biología, UNAM) presented a method to evaluate mortality rates caused by predation in hatchling Black Iguanas using wax models. Wendoli Medina and Víctor Reynoso (Instituto de Biología, UNAM) presented models evaluating population growth in a severely hunted population that could be applied to sustainable harvesting of Black Iguanas in tropical deciduous forest. Eugenia Zarza and co-workers (East Anglia University, UK and Instituto de Biología, UNAM) showed the presence of genetically distinct clades within the distribution of *Ctenosaura pectinata*, indicating that harvesting and releasing iguanas from site to site is not recommended. Gabriela García Besné and co-workers (Instituto de Biología, UNAM and Durrell Wildlife Conservation Trust, UK) discussed the nesting behavior of the threatened Santa Lucia Green Iguana at the only two beaches where this species



JOHN BINNS. ANIMAL COURTESY OF WEST COAST IGUANA RESEARCH

is known to nest. Jorge Morales-Mávil and co-workers (Universidad Veracruzana) presented the role of Green Iguanas in the regeneration of rainforest by comparing the germination success of seeds passing through iguana, toucan, and Spider Monkey guts. Green Iguanas were shown to be the best promoters of seedling growth.

In another set of talks, Juan Antonio Hernández (Mundo Iguana iguana, Tabasco) indicated that illegal trade of juvenile Green Iguanas has decreased significantly in southeastern México; however, most iguanas sold in local pet stores are introduced by traders from México City, Honduras, El Salvador, or Guatemala. He concluded that importation of Green Iguanas into Tabasco is shameful, considering that this species naturally inhabits the area. The last two talks emphasized the importance of the use of new technologies to support conservation efforts. Ubaldo Guzmán (Facultad de Ciencias, UNAM) presented a data base designed to record all known iguana diseases caused by viruses, parasites, or bad management, and their treatments. Silvia Abdalá (Instituto de Investigaciones Antropológicas, UNAM), on the other hand, showed the importance of internet technologies to communicate new findings, share data, provide support, and communicate among iguana groups. She emphasized the need to have a more active web page for SCT-Iguanas.

Technical talks were published in a 108-page volume (plus program and index). The abstracts, available only in Spanish, can be downloaded from [www.subcomitedeiguana.org/publicaciones.htm](http://www.subcomitedeiguana.org/publicaciones.htm), where abstracts of previous meetings can also be found. The meeting concluded with a field trip to CICARSA, an iron-manufacturing company that dedicates part of its land for species conservation. This company has been very interested in promoting safe areas for the conservation of Green Iguanas. The field trip was led by experts who attempted to estimate the sizes of iguana populations at some sites.

In 2006, the IX National Meeting on Iguanas will be held in the city of Zihuatanejo in the state of Guerrero from 18–20 May. More information is available on our web page ([www.subcomitedeiguana.org](http://www.subcomitedeiguana.org)) or you may contact José Luis Arcos-García ([jarcos@colpos.colpos.mx](mailto:jarcos@colpos.colpos.mx)).

A workshop on Green Iguana (*Iguana iguana*) farming included talks on the biology of iguanas, but also addressed enclosures and facilities, nests and incubation, feeding and growth, diseases and their treatment, and legal issues related to farming.



THOMAS WIEWANDT, WILD HORIZONS

A workshop on Green Iguana (*Iguana iguana*) farming included talks on the biology of iguanas, but also addressed enclosures and facilities, nests and incubation, feeding and growth, diseases and their treatment, and legal issues related to farming.



## HUSBANDRY

# Emerald Gems (*Corallus caninus*): Captive Husbandry and Propagation

## Part II: Acquisition, Maintenance, and Diet

Joseph M. Polanco

Photographs by the author.

With the largest known range of any currently recognized species of boid and a fascinating and beautiful variety of morphologies, one might logically assume that the Emerald Tree Boa (*Corallus caninus*) would be among the most recognizable and widely kept species in herpetoculture. However, it is only recently that a broader understanding of the species has enabled prospective keepers to adapt and develop the environmental regimes necessary for this highly specialized snake to thrive in captivity.

The first installment (*Iguana* 13(1): 37–41) proposed a set of guidelines for the acquisition and preparation of enclosures appropriate for housing the species. Part II presents one sound strategy for the acquisition of healthy, viable specimens as well as some of the more technical details associated with husbandry.



Prospective purchase of an Emerald Treeboa (*Corallus caninus*) should only be considered when the snake's outward physical appearance conforms to criteria established for robust, healthy animals.

### INTRODUCTION

Preparation and forethought equal to that employed during the conceptualization, procurement, and setup of the enclosure should now be addressed to acquiring a snake. One of the best resources for today's herpetoculturists is the internet. This interactive knowledge base provides access to reams of information, anecdotal experiences, and live response forums linking new keepers with those who have already had success with Emerald Tree Boas. Judicious use of the internet can help prospective keepers form realistic expectations, minimize the likelihood of unpleasant surprises, and provide a generous sounding board for those actively seeking answers to specific questions. Researchers involved primarily with species classification and the study of natural history have long benefited from the publication and dissemination of scientific information. The information-sharing capabilities of the internet have resulted in an exponential increase in interest and success for herpetoculturists involved with the captive husbandry of this and other species.

### SPECIMEN ACQUISITION

As with habitat selection, personal taste and practical affordability are important factors during the selection of an animal. The uninitiated often tend to overlook the subtleties that differentiate individuals within any given species. For *C. caninus*, this can



A healthy Emerald Treeboa (*Corallus caninus*) is robust, unblemished, brightly colored, and active, coiling tightly on elevated perches and responding quickly to stimuli.

lead to an “all emeralds are more or less equal” mindset, which may place too much weight on the physical beauty of an individual specimen. This is one of the most common mistakes first-time keepers are likely to make. As with icebergs, within the *Corallus* complex, what lurks beneath the surface is what needs to be evaluated in order to make a wise decision. The temperament and physical condition of animals available on the open market varies widely and individuals inexperienced with the species do not have the odds in their favor. Wild-caught animals, especially those that have not been in a stable, controlled environment for a minimum of one year, should never be considered by any but the most seasoned of veterans.

Acclimating wild-caught treeboas is no simple undertaking. Any reputable dealer, even those with years of experience, will tell you that the mortality rate of imported specimens of this species is appallingly high. Statistics indicate that more than 50% of captives of all ages die during the first year. For those specimens that do survive the initial acclimation period, chances of survival in the long term (> three years) are equally grim. Although I have not been able to collect empirical data, my own numbers reflect a survival rate of just over 65% for adult treeboas and just over 70% for animals acquired prior to their ontogenetic change.

Therefore, as a rule, only captive-born and bred specimens (subsequently referred to as CBB), purchased from well-established, reputable sources should be considered. Where *C. caninus* is concerned, “impulse buying” more often than not leads to an unfortunate experience. Morphological conformation notwithstanding, prospective acquisitions should only be considered if and when their outward physical appearance conforms to the criteria describing a robust, healthy animal. Animals that appear skinny, dehydrated, blemished, dull, sluggish, or gaping, or those that are loosely coiled or not perched at all should be dismissed out of hand. For the purposes of this article I will restrict all future references and recommendations to those applicable to CBB specimens.



Wild-caught animals, especially those that have not been in a stable, controlled environment for a minimum period of one full year, should never be considered by any but the most seasoned of veterans. This individual, although superficially healthy, was dead on arrival at the facilities of a dealer in tropical reptiles.



Blister disease can be debilitating; acquiring an animal with the intent of nursing it back to health is a bad idea, even for an experienced keeper.

The above-mentioned physical conditions are often symptomatic of a variety of potentially serious pathologies. One of the few true challenges associated with this species is that even the most common ailments are often difficult to detect. Devoid of compassion or sympathy for the infirm, nature provides many species, including *C. caninus*, with the instinct to mask illness. Emeralds are so adept at this practice that by the time a problem becomes obvious the individual is often beyond salvage. For this reason, animals with a history of illness, however minor, should be dismissed from consideration.

The previously mentioned statistics largely reflect the more commonly available “Northern” variety of the species. Although susceptible to the same maladies, stress-related illnesses, and parasitic infestations, the Amazon Basin variety appears to benefit from two factors that may be largely responsible for the differences seen between the two populations. First, the Basin form is widely believed by those intimately familiar with both varieties to be hardier and more resilient. Although this disparity itself is undocumented and remains largely unexplained, one popular belief is that this form’s larger geographic distribution has provided for an inherently wider set of environmental tolerances. The other more prosaic factor has been the lack of ready availability of Basins to the export trade. Local restrictions and the logistical challenges associated with their collection have kept the exported numbers of Basins very low for over three decades and the prices charged for these rarely seen but highly prized exports have tended to be very high. With the laws of supply and demand keeping prices high, improved care at every stage of the importation process provides better returns for importers.

Currently, a relatively strong U.S. community of well known, reputable breeders is involved with the propagation and sale of both Northern and Basin varieties. On the whole, these



The “Northern” variety of *Corallus caninus* (left; this animal is from Suriname) is more commonly available, although the Amazon Basin variety (right) appears to be hardier and more resilient.

individuals happily offer support and guidance before, during, and sometimes after the sale. This type of networking acts as an invaluable safety net for those interested in keeping this species. By availing themselves of the knowledge and experiences of others, prospective keepers are able to tip the scales steeply in their favor, drastically reducing the duration of the *C. caninus* learning curve.

#### Husbandry Basics

The essentials of effectively keeping *C. caninus* in captivity can be broken down into three categories: environment, diet, and record keeping. The first installment discussed the importance of stabilizing environmental factors prior to the introduction of a live animal. Although *C. caninus* is not an overly delicate species, keepers can be quickly overwhelmed with health issues when tolerances are violated.

Until such time as accurate DNA-profiles of the species allow for a classification by which herpetologists can identify and differentiate individual populations, accurately fine-tuning individual environmental variables to specific animals remains impossible. Locality data on imported specimens are non-existent, and morphological differentiation is far too imprecise to provide even the most remote hope of accuracy. Therefore, today’s Emerald specialists have chosen to employ a range of temperature and humidity standards derived from averages gathered from across the entire range of the species. Tables 1 & 2 list average temperature and relative humidity levels from across the species’ natural range for periods ranging from 4–23 years.

I have derived the following environmental maintenance schedule from these data. Averaging the recorded temperature data and buffering them by 4 °F toward the median, provides a temperature range within which any individual, regardless of geographic origin, can thrive. Recommended daytime high and nighttime low temperatures for captive *C. caninus* should be 84 °F (DTHT) and 74 °F (NLT), respectively.

Although some keepers use the same data to regulate relative humidity (RH) levels, years of experimentation have led me to depart from levels found in the wild. Table 2 reflects daytime relative humidity highs (DTRH) and nighttime relative humidity lows (NTRH) averaged from eleven locations across the species’ range. The data from which these averages were derived were collected over periods from 2–21 years. The reason I choose to deviate from these natural averages is the negative effect of sustaining such high RH levels within enclosures. Without the natural cleansing processes found in nature, black molds tend to grow in very high concentrations. These molds produce spores that become air-borne and eventually settle on and adhere to every porous surface in an enclosed habitat. Even over relatively short periods, such concentrations present an unnaturally high risk of infection or allergic reactions for both snakes and human handlers.

Therefore, over the years, I have adopted modified RH levels that have proven completely adequate, enabling me to main-

**Table 1.** Temperature (°F) and precipitation (inches) averages across the range of *Corallus caninus*. Portions of the species’ range are indicated by N (= north), S (= south), E (= east), and W (= west). RF = rainfall.

Area	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
N-Hi	86	86	87	88	87	88	89	90	92	92	90	87
N-Lo	72	72	72	73	74	73	73	74	74	74	74	73
RF	8.2	5.6	6.1	8.4	11.7	11.7	9.1	7.0	3.6	3.6	4.8	7.4
S-Hi	91	91	90	90	88	88	90	92	93	93	91	90
S-Lo	72	73	72	70	66	63	61	64	69	72	72	73
RF	10.0	8.6	8.1	4.0	2.2	0.5	0.3	1.1	1.8	5.2	6.0	8.1
E-Hi	87	86	86	87	88	89	88	89	90	90	90	90
E-Lo	76	76	75	75	75	75	75	75	76	76	77	77
RF	10.5	10.0	11.8	12.0	10.5	8.2	6.4	6.5	7.5	9.1	9.8	10.2
W-Hi	88	87	87	87	86	85	85	87	88	88	88	88
W-Lo	73	73	73	73	73	72	71	72	72	72	73	73
RF	10.5	10.0	11.8	11.9	10.5	8.2	6.4	6.5	7.5	9.1	9.8	10.2

**Table 2.** Relative humidity table (%) averaged from across the entire range of *Corallus caninus*. DTRH = daytime relative humidity highs; NTRH = nighttime relative humidity lows.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
DTRH	94	94	94	95	95	93	92	91	91	91	91	93
NTRH	76	78	77	78	77	72	68	66	66	67	70	76

tain a healthy population of tropical species while minimizing the excessive formation of fungal pathogens. While actual RH numbers for each individual facility will vary according to the fundamental variables of area versus air circulation, DTRH levels from 65–75% and NTRH levels from 45–55% have proven ideal.

### Diet

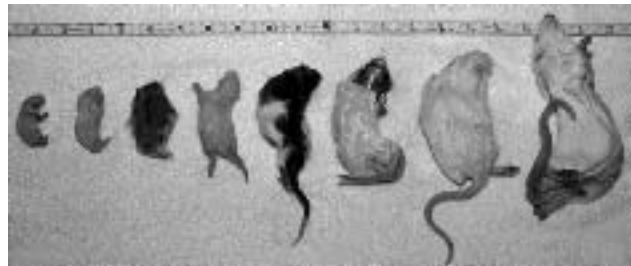
Like that of most opportunistic ambush predators, the natural prey of *C. caninus* in the wild is known to vary widely. For the purposes of captive maintenance, we deal with three major sources of nutrition, all rodents. Rats, mice, and Siberian Dwarf Hamsters are most commonly used. Each species may be fed at various stages of a snake's development. I use the following guidelines in my facility (species may vary, but approximate sizes should be watched closely):

- Siberian Dwarf Hamsters (live crawlers,  $\pm$  8 g): Initiating the natural feeding response in neonate snakes.
- Pink rats (live or frozen/thawed,  $\pm$  8 g): Neonate maintenance once a solid feeding response has been established.
- Fuzzy rats (frozen/thawed,  $\pm$  16 g): Neonates  $>$  60 g.
- Rat pups (frozen/thawed,  $\pm$  25 g): Yearling snakes  $>$  200 g.
- Weanling rats (frozen/thawed,  $\pm$  35 g): Two-year old snakes  $>$  350g.
- Small rats (frozen/thawed,  $\pm$  75 g): Sub-adults  $>$  500 g.
- Medium rats (frozen/thawed,  $\pm$  150 g): Adult animals  $>$  900 g.
- Large rats (frozen/thawed,  $\pm$  250 g): Adult females  $>$  1500 g.

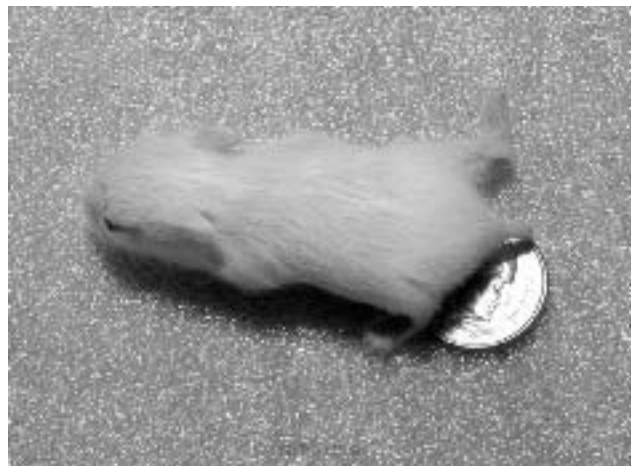
In an effort to promote optimum fitness while avoiding obesity, which may shorten lifespan and reduce reproductive productivity, feeding schedules and maintenance records on every individual should be meticulously maintained. Such records are a crucial tool in managing these snakes, given their naturally low activity levels, which, exacerbated by captivity, are susceptible to a number of GI-related maladies. Avoiding these illnesses is relatively easy, given the proper tools and understanding their use.

Feeding frequency at my facility varies according to age and sex. Younger specimens are fed most frequently, on a 10–14-day schedule from 30 days until approximately eight months of age. The latter frequently coincides with ontogenesis, which is signified in *C. caninus* by a change in ground color from neonatal red, green, or yellow to the familiar adult shade of green. However, this change, which is itself an energy-related process, is not inherently tied to age.

Neonates whose GI tracts are fully engaged at an early age, process meals and eliminate wastes on a fairly regular, predictable schedule. Such individuals will benefit from being kept on a 10-



Frozen food size references.



Live Siberian Dwarf Hamster (crawler) with dime for size reference.



An 18-month-old *Corallus caninus* on a scale for size reference.

day feeding interval. Animals with tendencies to process meals less quickly should be held to a longer 14-day period. Under no



Adult animals should receive food commensurate with their size; in this instance, an adult female boa consumes a large rat.



Highly arboreal treeboas rarely descend from elevated perches, even to consume large prey.

circumstances should a neonate be fed more than two meals without a bowel movement. A majority of neonates will eliminate the waste products from its previous meal within a few days. This waste is literally being moved out in order to make room for the wastes generated by the digestion of newly ingested prey. Should an animal take two meals and fail to produce a bowel movement, one should induce elimination. This can be most easily accomplished by encouraging simple exercise on approximately day eight following the second meal. Allowing the animal to crawl freely over one's open fingers from hand to hand for a period of ten minutes is usually enough to produce the desired result within hours of the session.

For animals from 8 months to three years of age, a 14-day interval between meals is appropriate. From this stage forward, no individual should be given more than three meals between bowel movements. Once an animal has begun eating small rats weighing > 75 g, feeding frequency can be reduced from 14 to 18 or even 21 days. Females can remain on this schedule, but males, having reached sexual maturity (at approximately four years of age) should be shifted to a monthly feeding routine. The one exception to these adult feeding schedules is made in preparation for breeding. Because cessation of feeding is common for both males and females during different stages of the breeding process, "padding" the energy reserves of both during the weeks prior to the onset of the breeding season is prudent. For animals slated for breeding in a given calendar year, I reduce the number of days between feedings to the shortest periods mentioned previously for their respective sexes. Males will be fed (offered food) every 21 days and females every 18 days beginning 60 days prior to introductions and lasting throughout the entire breeding season. Many males will lose interest in feeding shortly after an initial introduction and may not feed again for the rest of the season. By contrast, females will usually feed ravenously throughout the season and stop only after ovulation.

Occasionally, males that are not actively breeding will also stop feeding during this period. For this reason, sexually mature, non-actively breeding males should be removed from the immediate area in which breeding pairs are being housed.

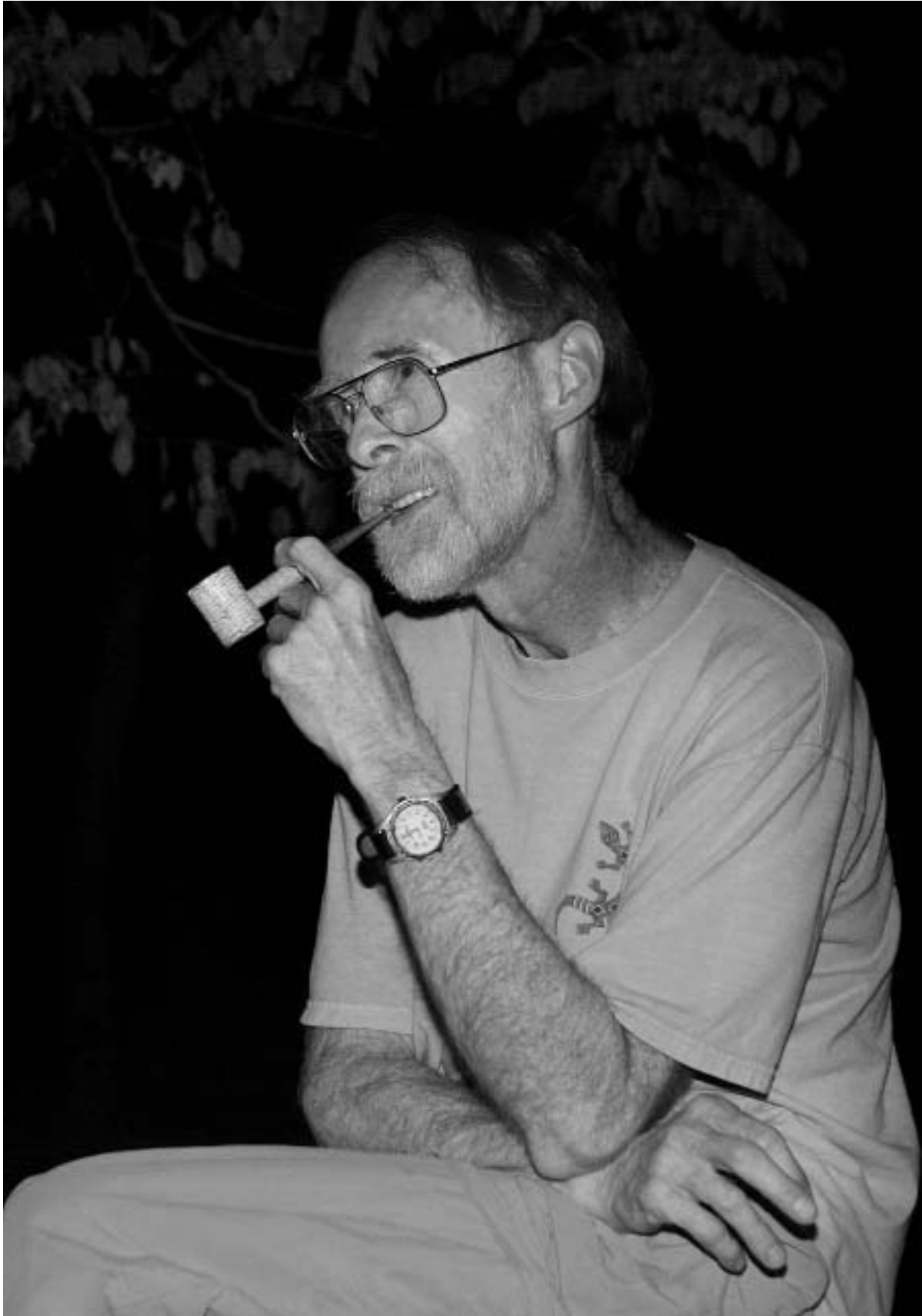
#### Acknowledgments

For general help and sharing of information over the years, and for this particular project as well, I thank John Benz, Rolando Burgos, Stan Chiras, Craig and Karen Clark, Frank Fusaro, Robert Henderson, John Martin, Al Montejo, Tony Nicoli, and the entire online *Corallus* community of readers and participants at <http://www.thetreeboaforum.com>. Your passion inspires and pushes the work forward.

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JOHN BINNS

A contemplative Sandy Echnacht.

## P R O F I L E

# Sandy Echternacht: A Lifetime of Herpetology

Stesha A. Pasachnik<sup>1</sup>

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Even as a toddler, Sandy Echternacht wasted no time in demonstrating an apparently innate affinity for reptiles. “I have no idea what originally attracted me to reptiles, but I’ve always known exactly what I wanted to do.” Sandy tells of how, as a child, despite his mother’s distaste of lizards and snakes, he took to them readily, distinguishing himself as the family herpetologist as early as the age of two while on family trips to various parks in the southwestern United States. On the earliest of these trips to the Grand Canyon, still in his mother’s arms, Sandy was already exhibiting the symptoms of what would become a lifetime habit, happily touching and investigating any snake offered by the park’s rangers.



A one-year-old Sandy and his mother near the Grand Canyon in 1940. Near here, he snatched a snake out of the hands of a park ranger and thereby, according to his mother, became hooked on reptiles. He appears to have weighed about the same then as he does now. Photograph courtesy of Arthur P. Echternacht.

While growing up in Iowa, Sandy delivered newspapers in order to keep himself supplied with lizards, snakes, and even bats. As his collection grew, he was forced to move into the attic of the family home for fear that his collection would invade the rest of the house. His mother had a habit of destroying snakes by chopping them into pieces whenever she came across them, so this move could be considered Sandy’s first contribution to conservation.

Sandy’s interest in collecting and keeping animals soon became more academic. In an effort to learn more about the natural history and taxonomy of the species in his collection, he wrote a letter to a biologist at Arizona State University. To Sandy’s amazement, the professor sent a letter back and, within no time at all, the two had become herpetological pen pals. They corresponded through Sandy’s junior and senior high school years. While still in high school, Sandy was offered a job in the professor’s lab upon his graduation. In 1957, he moved from his hometown in Iowa to Tempe, Arizona to begin his formal studies. Unfortunately, the relationship he once had on paper with the professor dwindled, and Sandy returned to Iowa to attend University and complete his bachelor’s degree in general sciences.

In 1961, Sandy was again drawn to Arizona State University, this time to work on a master’s degree in zoology. In the following year, Sandy was finally able to go on his first formal collecting trip for the Arizona State Museum with his advisor, the ichthyologist Dr. W. L. Minckley. They traveled to New Mexico, México, and back through Texas on what, as Sandy describes it, was one of the most memorable trips of his career — no small claim for someone who has regularly spent time in the Caribbean, South and Central America, Africa, and the Pacific. Sandy’s master’s thesis was a comparative study of unisexual and sexually-reproducing species of *Cnemidophorus* (Whiptail Lizards) in the Santa Rita Mountains of southern Arizona.

Upon completion of his master’s research in 1963, Sandy moved back to the Midwest, but to Kansas this time, to begin his doctoral research with the eminent herpetologist, Dr. William Duellman, at the University of Kansas. Duellman’s interests at that point were in Central America and México, and he was in the midst of collecting data for his monograph on the hylid frogs of Middle America. This provided Sandy with the perfect opportunity to begin his own research in Central America — and he jumped at the chance. Interested in studying geographic variation throughout the region and using the lizard genus *Ameiva* as

<sup>1</sup> Written with input from Todd Campbell, William Duellman, Glenn Gerber, Rachel Goodman, and Justin Walgumary.



SUSAN E. RECHERT

Sandy and shy new friend in Makokou, Gabon, equatorial West Africa, March 1982.



Sandy dwarfed by logs at a “green” logging operation near Itacoatiara, Amazonas, Brazil (ca. 160 km east of Manaus on the northern bank of the Rio Amazonas).



SUSAN E. RIECHERT

Near Makokou, Sandy tried to become familiar with the objects of his interest, communing closely with an unidentified chameleon.

a study group, Sandy devoted more than a year reviewing all available museum specimens.

While at Kansas, Sandy held a teaching assistantship in the Department of Zoology and took an array of courses in the department. He also became closely associated with other graduate students in the Division of Herpetology in the Museum of Natural History where he had an office. Among those students were several who were working on some aspect of Neotropical herpetology, namely John D. Lynch, Charles W. Myers, and Linda Trueb. Sandy and John Lynch were the “bad boys” in the division, and usually were responsible for various pranks, such as littering the professor’s office with innumerable Coke cans and “filing” cut-outs of *Playboy* nudes throughout Duellman’s 3 x 5 card catalog of his reprints.

In the summer of 1965, Sandy piled equipment and survival necessities into a VW bus and headed out of Lawrence, Kansas, with the goal of reaching Panamá while collecting and seeing as much as possible along the way. As Sandy tells it, the two most important pieces of equipment on this trip were a five-gallon bucket for pickling and a bag full of rubber bands (Sandy has a well-deserved reputation, among all who know him, as a crack shot with a rubber band). During the following summer, Sandy collected at remote sites along the Caribbean coast of Honduras and Nicaragua, and on several off-shore islands. His last fieldwork on *Ameiva* was with Duellman and Richard Montanucci in Ecuador in 1971.

After completing his dissertation research, Dr. Arthur C. Echternacht (“Only my mother and telemarketers call me ‘Arthur’,” claims Sandy) joined the faculty of Boston University and soon thereafter became a Research Associate at Harvard. Then, on Columbus Day in 1973, a friend from the University of Tennessee



Sandy processing the fruits of his labors in Loja, Ecuador in 1971.



GLENN P. GERBER

Adult male Little Cayman Rock Iguanas (*Cyclura nubila caymanensis*) are often quite approachable, especially if baited, during the breeding season. In dense thorn scrub forest, the most efficient way to catch them is just to (carefully) pile on.

called to inform him of a job opening there. He applied and was offered the position on a Friday, but on Monday was notified that the funding for the position had disappeared. Two years later, he was offered another job with the University of Tennessee without even applying. Sandy accepted the position in the Department of Zoology, ascended the ranks to full Professor, and served as department head for 13 years. Today, 31 years and countless graduate students later, Sandy continues to be an active member of the department, now called Ecology and Evolutionary Biology.

Sandy had his first experience with Rock Iguanas (genus *Cyclura*) on Grand Cayman in the late 1980s, while vacationing on Little Cayman Island. "I was really entranced by *Cyclura nubila caymanensis* because they were very abundant and out in the open." Sandy took several "vacations" to Little Cayman after that, including one on which he suffered a compound fracture of his ankle while exploring the jagged karst interior on his own. As the story goes, Sandy found two empty Coca Cola bottles (no Pepsi for this man!) to protect his hands from the jagged rocks, and using these dragged himself through the karst and thick underbrush to the edge of Booby Pond. From there he hollered for help, eventually attracting the attention of a local, and was carried out of the bush on a board and taken by boat to Cayman Brac, where he received medical attention. Despite this experi-



JOHN BINNS

Sandy with AJ Gutman and *Ctenosaura bakeri* at the International Iguana Society (IIS) meeting on Isla de Utila, Honduras in 1999.

ence — or perhaps because of it, Sandy's enthusiasm for *Cyclura* continued to grow.

While he and Glenn Gerber were working on Glenn's dissertation research on the interactions between Grand Cayman's endemic anole (*Anolis conspersus*) and the introduced Cuban Brown Anole (*A. sagrei*), Sandy took Glenn to Little Cayman to take a look at the *Cyclura*. Glenn was equally entranced and, with Sandy's encouragement, initiated a year-long autecological study of the iguanas on Little Cayman. He has since gone on to investigate other Caribbean iguanas.

During the course of research trips to Grand Cayman, Sandy met Fred Burton (at that time working for the Mosquito Research and Control Unit and helping to establish the Cayman Islands National Trust). Fred was initiating a captive-breeding program for the critically endangered Grand Cayman Blue Iguana, *Cyclura nubila lewisi* (now *C. lewisi*). Sandy, of course, found these lizards fascinating. He and Fred arranged for Bridget Donaldson, who had just completed her Master's degree working with Sandy on box turtle ecology, to initiate a radio-telemetry study of *C. lewisi*. By then, Fred had quit his job at the National Trust and had founded the Blue Iguana Recovery Program. Sandy's student Rachel Goodman expanded this work with a Master's project that examined the home ranges, behavior, activity patterns, and diet of these iguanas in a protected botanic park on Grand Cayman. Sandy also is active in iguana conservation efforts through his involvement with the International Reptile Conservation Foundation, where he serves on the editorial board, the International Iguana Society, where he served as Treasurer for two years, and by being a member of the IUCN Iguana Specialist Group.

In the past few years, Sandy's interests in iguanids have again been sparked after a trip to the small island of Utila, which is located just off the Caribbean coast of Honduras. This island has been of interest to herpetologists for some time, in large part because it is home to the threatened iguana, *Ctenosaura bakeri*. This island endemic with a very narrow distribution is faced with the all-too common threats of habitat destruction and over-harvesting. However, it is also faced with the threat of extinction by hybridization with its more widely ranging congener, *C. similis*. The most recent addition to the Echternacht lab, Stesha





JOHN BINNS

Sandy and Rachel Goodman on Grand Cayman in 2001.

Pasachnik, has begun to investigate the degree and direction of this hybridization using a slew of molecular markers. A small-scale phylogeny of the *C. melanosterna* clade, the Honduran type series of which was collected by Sandy during one of his early trips through Central America, will also be constructed in hopes of elucidating the colonization events that led to the speciation we see in the Bay Islands today.

In addition to his work with iguanas, Sandy and his students (Mark Wilson, Dan MacDonald, Ed Michaud, Jim Minesky, David Bishop, and Rachel Goodman) have for almost 20 years

been studying the natural history of the Green Anole, *Anolis carolinensis*, in the southeastern United States, including latitudinal aspects of body size, reproduction, and genetics and long-term studies of thermoregulation in several populations living on south-facing cliffs in Tennessee, near the northern range limit of this species. As a logical extension of his expertise with this species, he is also studying the “natural” history of Green Anoles where they have been introduced on islands in the South Pacific. Since the late 1980s, he and his students have been investigating the introduced Cuban Brown Anole, *A. sagrei*, in the southeastern U.S.



TODD CAMPBELL

Sandy plying the tools of his trade, noosing a lizard on a spoils island in the Florida Intracoastal Waterway.



TODD CAMPBELL

Accustomed to the rigors of fieldwork, Sandy seeks a shaded retreat from which to record data on anoles on a spoils island in the Florida Intracoastal Waterway.



TODD CAMPBELL

Accompanied by an inevitable Coca Cola, Sandy marks an anole on a spoils island in the Florida Intracoastal Waterway.

This line of inquiry has attracted the interest and efforts of nearly a dozen graduate students, the work of whom has spanned levels of investigation from physiology and morphology through behavior and reproduction to population dynamics. Early efforts to substantiate anecdotal reports of Green Anole declines following Brown Anole invasion and to implicate direct interspecific male-male aggression in these territorial animals produced surprising results that suggested simple answers would be inadequate in explaining the interaction. Subsequent research included outdoor enclosure experiments with students Glenn Gerber, Todd Vincent, and Justin Walguarnary. An experimental manipulation with student Todd Campbell of whole populations of Green and Brown anoles on dredge spoil islands in the Florida Intracoastal Waterway to simulate invasions has clarified a pattern in which niche partitioning, reproductive interference, and even intraguild predation have a combined negative effect on Green Anoles. Most recently, Sandy and his student Nathan Turnbough have been investigating effects of Brown Anoles on food webs in an effort to explain how these lizards might influence whole communities.

In the end, although Sandy has (for good reason) focused his attention mainly on lizards, his work has made significant contributions to many fields of biology. Powered mainly by Coca-Cola, fine pipe tobacco, and nearly inedible lunchtime snacks, Sandy's energy in the field is infectious, and his effect on students, colleagues, and the general public has been lasting and profound. We can only hope that his enthusiasm for the study of basic natural history of all kinds of organisms has rubbed off on the next generation of scientists.

## HISTORICAL PERSPECTIVE

# Adaptations for Gliding in the Lizard *Draco*<sup>1</sup>

Edwin H. Colbert

## INTRODUCTION

In connection with the detailed description of a Triassic reptile, obviously adapted for gliding because of the presence of enormously elongated and curved ribs, it became apparent that a comparative study of the modern gliding lizard *Draco* was in order. Various pertinent publications were examined, with the surprising discovery that, until recently, very little attention has been given to the gliding activities of this lizard. In fact, some authors have expressed doubts as to the ability of *Draco* to glide at all. Other authors have, however, given definite proof of gliding ability in this reptile. Two good descriptions are those of Hairston (1957) and Herre (1958), quoted in part below. Dr. John R. Hendrickson of Honolulu, Hawaii, has made excellent observations of the gliding behavior of *Draco*, of which one account, taken from a letter to the present writer, is also quoted

below. Finally, Hans Klingel (1965) set forth the results of some interesting experiments on the method of gliding in *Draco*; parts of his paper are summarized below.

From these reports it is obvious that *Draco* is able to glide and is, indeed, an accomplished glider. In spite of the observations by the several authorities who have described the gliding aptitudes of the oriental “flying dragon,” there have been no analyses of its anatomical adaptations for gliding. There are no

<sup>1</sup> Permission to reprint this article is courtesy of the American Museum of Natural History Library, New York, New York. The article was originally published as *American Museum Novitates* No. 2283, 10 March 1967. This and other Museum herpetological publications can be downloaded in full, free of charge, at <http://research.amnh.org/herpetology/pubindex/>.



MARCLUS ING

Lizards in the genus *Draco* are accomplished gliders. The “wings” of this nesting *D. sumatranus* are clearly visible.

## Editor's Remarks

Elsewhere in this issue, an article by Lee Grismer focuses on the “flying” reptiles found in southeastern Asia. To accompany that piece, we chose to include a classic paper on a similar topic by Edwin H. Colbert, whose rich biography is summarized after the article.

This piece was published in 1967, the year that saw the world's first successful human heart transplant. The DNA molecule, today fodder for endless TV whodunits and real-life courtroom dramas, was fully decoded just the year before. Biological exploration of some parts of the world was in full swing, but the main involvement of the United States in Asia stemmed from the ongoing war in Vietnam. By the time that war ended in the early 1970s, over 2.5 million Americans had served and almost 50,000 had died there, but few of them had had the time to engage in scientific research. Our understanding of the biology of the region was extremely poor. Thus, it is not surprising that Edwin Colbert begins his paper by discussing what even amateur herpetologists now take for granted: That lizards of the genus *Draco* have “wings” and can effectively glide between trees. A paleontologist first, Colbert became interested in the issue because of his focus on flight in dinosaurs. This paper provided some of the earliest descriptions of reptilian “flight” and the mechanisms that support it. It is, in many ways, far ahead of its times, bringing a mechanistic, engineering approach that would not become common in herpetology until many years later. This paper is still frequently cited in studies of reptilian gliding in general and the biology of the genus *Draco* in particular.

Parts of Asia remain remote and poorly studied even today. Just a few weeks ago, in early 2006, reports emerged in all the major media of the results of an expedition to a previously unexplored part of Indonesia. Despite the brevity of the visit, the work yielded many new species and biological insights. Just imagine how much less accessible the world was only a few decades ago, before travel became so commonplace.

Gad Perry  
Texas Tech University, Lubbock



In these lizards, elongated ribs on each side support the wing membranes. Historical drawing from *Dover's Animals*.

descriptions of the muscles involved in the control of the wings (the word “wing,” as used herein, designates the gliding membrane of *Draco*), no measurements based on wing shapes and areas and body weights, and no correlative interpretations of relationships between wing areas and body weights. The purpose of the present paper is to correct, in some small way, this deficiency in our knowledge of gliding by *Draco*.

This paper has been inspired not only by curiosity about gliding in *Draco* but also by the evidence gained from the study of the fossil reptile, mentioned above, as well as from closely related fossils found within recent years in the Triassic fissure fillings of the Bristol Channel area of England, that the *Draco* mode of gliding, whereby a wing is formed of a membrane stretched between greatly elongated, free ribs, is geologically probably the oldest attempt at aerial locomotion among the backboneed animals. Reptiles that were able to glide on a rib-supported wing, with the four legs completely free for landing and for running about on the trunks and limbs of trees or on cliffs and rocks, were living in the Northern Hemisphere during late Triassic times some 200 million years ago perhaps 20 million years or more before the first true flying reptiles, the pterosaurs, and 60 million years or more before the first birds. Here we see the first experiment among the vertebrates in aerial locomotion, and as such it is important in the long perspective of aerial locomotion among animals and by man.

### GLIDING FLIGHT OF *DRACO*

Four eyewitness accounts of flight in this lizard are presented [editor's note: two of these have been omitted here]. These descriptions, all by herpetologists, show that its gliding abilities are more extensive and subtle than is generally realized.

"*Draco volans* is an accomplished glider. Ten flights ranged from 4.5 to 12 meters, and averaged 8 meters in length. The distances were doubtless conditioned by the fact that coconut trees are ordinarily planted 8–10 meters apart. Mertens (1930) recorded flights of 15 to 20 meters, and no doubt longer ones are possible, although a habitat in which such flights were necessary would probably be unattractive to the species. In two observations the angle of the glide was estimated. For the first, the estimate was between 200 and 300 degrees from horizontal; for the second, the starting and ending heights were estimated as 6 meters and 3 meters, respectively, and the horizontal distance measured 7.6 meters. Thus, the angle is close to 220 degrees, and is in agreement with the more subjective first estimate. *Draco* would therefore qualify for a gliding animal by the definition of Oliver (1951), who distinguishes 'gliding' from 'parachuting' when the angle is greater than 450 degrees from vertical. The flight appeared rather slow, as though being maintained at close to the stalling point, an observation that agrees with the slight amount of upturn at the end of the glide (see also Schmidt, 1935, on *D. spilopterus*)" (Hairston, 1957, p. 262).

Finally, the recent experiments and observations by Klingel are described. These, seemingly the first carefully controlled experiments, are particularly interesting in that they corroborate the field observations of Hairston, Herre, and Hendrickson.

To measure the distance of flights and their elapsed times, Klingel erected vertical poles, 3.25 and 10 meters high, in an open area, and placed targets, consisting of artificial trees, 20 centimeters wide and 3 meters high, at varying distances from the central poles. According to Klingel: "Usually the animals would immediately run to the top of the pole and within a few minutes would jump off spontaneously." The length of each flight and the height of the landing point on the target were measured. Some of the flights were timed. In some cases the lizards did not fly to the targets, and these targetless flights were also recorded.

In another set of experiments, to determine the control of flight directions, Klingel used a room 4.25 meters square, painted white, and lit by a centrally placed electric bulb. In the middle of one wall was placed a black paper strip, 30 centimeters wide, to serve as a target. The lizards were then thrown upward toward the ceiling, beneath the light, and their flight directions and methods of controlling these directions were observed.

Klingel found that the flight pattern in *Draco* is clearly divisible into three phases. The first phase is the dive flight, in which the lizard launches itself from a tree. In this phase there is a steep downward glide. The kinetic energy developed during the dive flight is then utilized for the second phase of the flight pattern, the glide flight, which can be quite extended. Finally, the third phase of the flight pattern is the ascent flight, or landing phase, in which the trajectory of the lizard rises from the glide flight so that the animal swoops upward as it lands on the target. Klingel recorded flights of as long as 60 meters for animals taking off from a 10-meter pole and flying toward a target. In such flights there was a loss of altitude during the long glide flight of as much as 2 meters, but some of this was recovered during the upward landing. The recovery of altitude at landing was not great, however, because of the slow speed of the glide flight as it reached its end.

### ANATOMY OF THE WING IN DRACO

*Draco* is an oriental lizard of the family Agamidae, ranging from the Philippines, through the East Indies, to Indo-China and portions of India. There are perhaps as many as 14 or 15 species of *Draco*, varying in size from rather small or moderate-sized lizards, with body weights in an adult of 5 or 6 grams, to the relative giant, *Draco maximus*, in which the body weight may be as much as 30 grams.

In these lizards there are five, six, or seven free and elongated ribs on each side, for the support of the wing membranes. Apparently the first of the elongated ribs belong to the eleventh presacral vertebra and thus are situated well behind the pectoral girdle, a position that gives the forelimbs complete freedom of movement. The most posterior of the elongated ribs, whether there be five, six, or seven on a side to support the wing membrane, are likewise at some distance in front of the pelvic girdle, again allowing for freedom of movement of the hind limbs. Each membrane, however, has a free edge, extending from the tip of the last supporting rib to a position just lateral to the cloaca. Thus the posteromedial segments of the membranes are in part beneath the upper segments of the hind legs, but this posterior attachment of the membranes apparently does not limit the movements of the hind limbs when the animal is walking or running.

In a normal resting or walking pose the wings are folded back against the body. But when the animal launches itself into

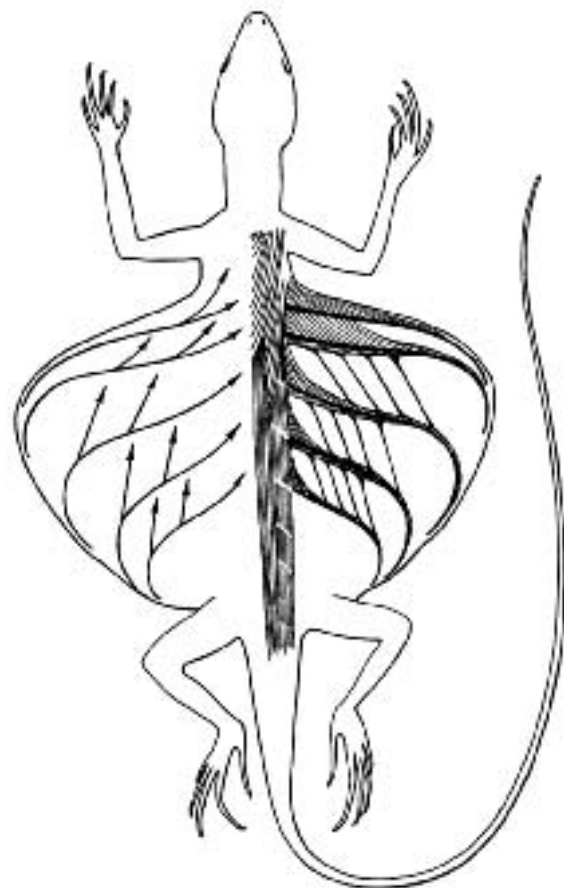


Diagram to show the general arrangement of muscles and ligaments, and their direction of force, in the wing of *Draco*.

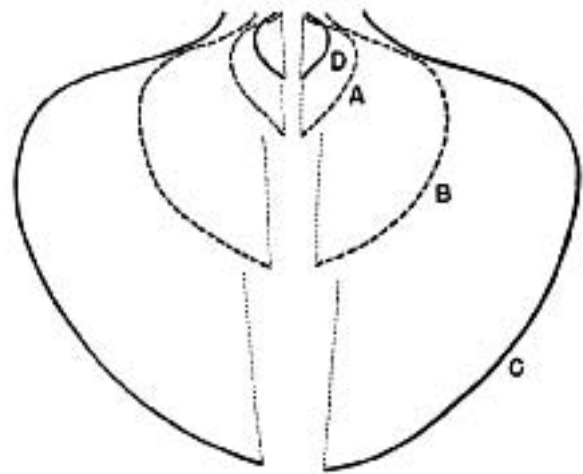


a glide, the wings are expanded to their full extent, making a large gliding surface relative to the size and weight of the body.

### WING AREA AND BODY WEIGHT

If wings for gliding are to be truly functional, they must be of such size, as well as of such form, as to permit the animal to glide through the air at a relatively low horizontal angle. As mentioned above, Oliver defined gliding, as distinct from parachuting, as descent at an angle greater than 45 degrees from the vertical (or, conversely, less than 45 degrees from the horizontal). It is obvious from the descriptions of flight in this lizard that the conditions for true gliding are fulfilled. Indeed, it appears that, if there are any air currents, *Draco* is able to take advantage of them and rise through the air during its forward flight. What are the relations of wing areas to body weight that make the rather astonishing flights of *Draco* possible? How are the ratios of wing areas as related to body weight to be compared with the same ratios in birds of similar size? Careful measurements were made of the wing areas in *Draco*, and for each specimen so measured the weight was recorded. Several species of *Draco* were used, but the present discussion is based largely on *Draco whiteheadi*, of which a considerable series, consisting of 54 specimens ranging from small individuals to full adults, was available. A single specimen of *Draco maximus*, kindly lent to the author by Hendrickson, is also included, because it is the giant among these lizards.

From a comparison of the weight of certain preserved lizards with their live weight, as determined in the field, it was established that the weight of the pickled animal should be, on the average, about nine tenths of its live weight. Consequently, the weights of the specimens as preserved were increased by a factor of one-tenth. Each specimen was then placed on a board covered with paper, with the wing on one side stretched to its maximum extent. As can be seen from the figure, in the series of *Draco whiteheadi* the wing area increases more or less directly as body weight increases, but there is a great deal of individual variation in wing area as related to body weight. It thus appears that there is no very crucial weight-wing-area relationship among these animals, which is to say that a lizard may have a wing area of almost a half less than another individual of approximately the same weight, yet presumably is nonetheless able to glide perfectly well. Perhaps many of these animals have wing surface "to spare," i.e., that they have more wing than is absolutely required for their flights.



Outlines of the wings. A. *Draco whiteheadi*, A.M.N.H. No. 30905 (smallest individual). B. *Draco whiteheadi*, A.M.N.H. No. 30917 (largest individual). C. *Draco maximus*, John R. Hendrickson No. 5338. D. *Draco* sp., newly hatched, John R. Hendrickson No. 2228. A and B show the comparative wing areas in the smallest and largest individuals available of one species. C shows the wing area of an individual of the largest known species, and D shows that of an individual recently hatched.

A comparison of *Draco* with birds shows that wing loadings in the lizard are similar to those of the large soaring birds (the hawks and vultures) rather than to those of the small birds that approach *Draco* in size. The very low wing loading of *Draco* is probably necessary to offset the relatively inefficient shape of the wing. It is semicircular, as seen from above, not a conventional transversely elongated wing like that in birds or airplanes. Thus in effect it has no well-defined leading or trailing edges. Both of these regions merge into what might be considered as the tip or lateral edge of the wing, this constituting by far the largest part of the border of the flying surface. It seems that the problem of weight and wing area is rather different from that in birds; one might expect solutions to this problem also to be different.

### CONCLUSIONS

This study of *Draco* demonstrates that gliding, so efficiently performed by the several species belonging to the genus, is simply



Weights, in grams, and corresponding wing areas, in square centimeters, of 54 individuals of *Draco whiteheadi*.

effected. The spreading of the flight membrane, which is supported by five, six, or seven elongated ribs, is accomplished by the use of a few muscles, particularly the iliocostalis and the intercostals, while the arching and the stiffening of the ribs are performed by the very long, slender muscle slips that run along the length of each rib. The wings in *Draco*, when expanded, provide a flight surface that is very similar in relative extent, and thus of wing loading, to that in the large soaring birds. Perhaps this similarity is due to the fact that the lizards and the birds in question, though quite dissimilar in size, have similar problems of aerodynamics. The significance of the adaptation for gliding in *Draco* is twofold. First, it represents the one example among modern reptiles for aerial locomotion through considerable distances.

Second, although in itself perhaps comparatively recent in reptilian evolution, it seems to represent the earliest type of aerial locomotion to be adopted by the vertebrates. Recent studies of fossil lacertilians of Triassic age show adaptations for gliding that are remarkably similar to those in *Draco*. Hence it is probable that the first aerial vertebrates were reptiles equipped to glide from tree to tree on expanded membranes supported by elongated ribs, leaving all four limbs free for arboreal and terrestrial locomotion. Apparently such adaptations for flight preceded by several million years the first attempts at true flight, attained by the pterosaurs. Thus, looking at *Draco*, we are, in effect, looking back through some 200 million years, to view the manner in which backboneed animals first took to the air.

## B I O G R A P H I C A L   S K E T C H

### Remembrances of Edwin H. Colbert, Paleontologist

Matthew Colbert

University of Texas, Austin  
([www.digimorph.org](http://www.digimorph.org) and [www.ctlab.geo.utexas.edu](http://www.ctlab.geo.utexas.edu))

Photographs courtesy of the author except where indicated.

My grandfather, Edwin Harris (Ned) Colbert, had a long and distinguished career in vertebrate paleontology. Much of this was at the American Museum of Natural History (AMNH) in New York, where he started as a graduate research assistant, and wound up as Chairman of the Department of Fossil Vertebrates. He made good use of the museum's world-class fossil collections and was involved in a number of great fossil discoveries around the world. One of the most significant was the late Triassic Ghost Ranch Quarry of New Mexico, where he recovered multiple skeletons of the early dinosaur *Coelophysis*, a



Ned Colbert in his office at the American Museum of Natural History, ca. 1940s.

discovery that profoundly influenced our understanding of early dinosaur evolution. These global travels also took him on a pioneering trip to Antarctica, where his fossil finds supported emerging plate-tectonic theories. His outstanding publication record includes more than 300 published papers and two textbooks. He also wrote a number of popular books on dinosaurs (including a few targeted at young readers), on plate tectonics, a biography, and two autobiographies. In many ways, his legacy to the field of paleontology was as much a consequence of his efforts at reaching out to the general public, as was his scientific output. Rather than summarize this remarkable career, I here attempt a more intimate portrait using the excavation of *Coelophysis* at Ghost Ranch as a vignette to better understand his life.

When I knew him, my grandfather's research focused on Triassic terrestrial vertebrate faunas from around the world. This research program incorporated newly emerging plate-tectonic theories to explain the distribution of ancient faunas. You can imagine my surprise to find that he wrote a couple of papers on fossil tapirs, a group I now study and one that didn't originate until the Cenozoic! To compound the somewhat inbred feeling that gave me, one of these papers actually reinterprets an earlier tapir-paper by my namesake, great-grandfather William D. Matthew, whose daughter my grandfather had married. Only then did I come to realize the extent of grandfather's work in the middle to late Cenozoic, the study of which was the focus of his Ph.D. dissertation and early career.

My earliest memories of my grandparents predate grandfather's retirement from the AMNH in 1969. My family lived in



My grandfather, brother, and I striking an American Gothic pose. I am on the right.

New York City, and we would often visit on weekends. My mother would take my brother and me to see Grandpa at the AMNH. Like most children, we loved the Jurassic and Cretaceous dinosaur halls that he had designed (now redesigned in a phylogenetic arrangement). I vaguely recollect his Fifth Floor tower office, which commanded a beautiful view of Central Park, and have dim memories of a large mounted theropod skull near his desk. However, I most vividly remember the little plastic dinosaurs he would give us.

I have more concrete recollections of my grandparents after their 1969 move to Flagstaff, Arizona, when I was six. From that year until my graduation from high school, my brother and I would spend part or all of our summer vacations with them. I continued to visit until grandfather passed away in November 2001, at the age of 96. He remained active, having an emeritus position at the Museum of Northern Arizona (MNA). Although he stopped doing active fieldwork near the end of his life, he continued writing, and was working on a book about his Antarctic trip when he died.

Partly as a consequence of my grandfather's presence, the MNA Geology program had attracted a number of bright young paleontologists. As a volunteer in the 1970s, I had the opportunity to see my grandfather interact and work with both staff and visiting scientists. My grandfather had a down-to-earth and generally humble demeanor. Only as I got older did I begin to understand the respect and honor accorded 'Ned' by his peers.

Flagstaff was a nice place to retire for many reasons, but I am sure that part of the call was its proximity to the great Triassic-aged rocks in the southwestern desert. In these rocks, he had made his first great Triassic discovery. Before he worked on dinosaurs (and other Mesozoic and Paleozoic vertebrates), Edwin Colbert worked on fossil mammals.

He was a Midwesterner, born in Clarinda, Iowa in 1905, and raised in Maryville, Missouri. He received his undergraduate degree from the University of Nebraska in 1929. There he worked as a research assistant at the paleontology museum. This training spurred him to pursue paleontology as a graduate student at Columbia University under the tutelage of William K. Gregory. His Ph.D. dissertation examined the extensive collection of Cenozoic mammals from the Siwalik Hills of India.

The strength of his dissertation led him to a job at the AMNH, where he continued to publish on Cenozoic mammals. He thoroughly enjoyed these studies, and would have been happy to make a career out of researching fossil mammals, but opportunities for career advancement were slim at the time, especially because of the crowded field working on fossil mammals. So, when recommended for a position as Curator of Fossil Reptiles and Amphibians, he changed his research direction. He had always had an interest in ancient reptiles, and the switch of focus also made available the extensive dinosaur collections housed at the AMNH.

The collections included fragments of a little dinosaur called *Coelophysis* that had been collected in the late 19th century from northwestern New Mexico. Although only preserved as a few postcranial fragments, these fossils provided a glimpse of what the earliest dinosaurs were like, a key to understanding their subsequent modifications. His realization of the significance of these fossils was further solidified when he had the opportunity to do a little fieldwork in the late Permian of north Texas with paleontologist Al Romer. These earlier Permian faunas were characterized by a markedly different assemblage of animals, the dominant components of which were large amphibians and synapsids (the lineage that ultimately gave rise to mammals). By contrast, these animals were represented only as relicts in the Triassic faunas, which were instead dominated by archosaurs (which included many crocodile-like forms and early dinosaurs). A major faunal transition separated



Ned Colbert relaxing at his Flagstaff, Arizona home.



A photomosaic of Ghost Ranch, northern New Mexico. The reddish sediments exposed below the lowest cliff represents the Triassic Chinle Formation.

ERA	PERIOD	MA
CENOZOIC	QUATERNARY	1.8
	TERTIARY	65
MESOZOIC	CRETACEOUS	248
	JURASSIC	
	TRIASSIC	
PALEOZOIC	PERMIAN	543
	CARBONIFEROUS	
	DEVONIAN	
	SILURIAN	
	ORDOVICIAN	
	CAMBRIAN	
PRECAMBRIAN		

A summary of the geologic timescale



Skeleton of *Coelophysis*. Image courtesy of the University of California Museum of Paleontology.

the two time periods, and Colbert was confident that the ancestry of the Dinosauria was to be found in the Triassic.

With this idea in mind, in the summer of 1947, he petitioned for and obtained permits to collect fossils in the extensive exposures of the Triassic Chinle Formation in the Petrified Forest National Park of northeastern Arizona. Colbert and George Simpson, a paleontologist who was Colbert's superior at the museum set out by train for Albuquerque, where they met their field crews and vehicles. The plan was for Simpson, who studied fossil mammals, to collect from the Tertiary sediments in the San Juan Basin of New Mexico. Meanwhile, Colbert, after spending a few days in Simpson's camp, was to drive with his crew to find ancient reptiles and amphibians. Just east of Simpson's camp, however, were some nice exposures of Triassic rocks in an on-and-off dude ranch called Ghost Ranch. This area had been worked years before by Charles Camp, a paleontologist from the University of California. Colbert had spent a summer at Berkeley a few years earlier and had had the opportunity to see Camp's collections from both Ghost Ranch and Petrified Forest. Thus, on a whim, he decided to take his crew there for a week or two of prospecting for fossils before heading west to the Petrified Forest.

Ghost Ranch was — and is — a beautiful place. Nestled in a canyon, it boasts spectacular cliffs with rock formations covering the different Mesozoic periods. Triassic-aged rocks are represented by the Chinle Formation, a rock body whose sediments document the passage of a large river system that flowed west from Texas to the coast, which at that time was somewhere in present-day Nevada. Colbert and crew were welcomed there by

the owner, Arthur Pack, who kindly gave them permission to poke around and collect what they found.

Years before, Charles Camp had found numerous skeletons of large crocodile-like animals called phytosaurs from the low badlands of Ghost Ranch. Not surprisingly, then, Colbert and his crew found a nice fossil phytosaur skull on their first day of fossil hunting. They spent about three days collecting it, and then opted to do a little more prospecting before heading west. On a hunch, Colbert decided that they would work some small side-canyons instead of prospecting the flats, as had previously been done. There, George Whitaker, one of Colbert's crew, found some delicate bones, including a small claw, weathering down a talus slope. Excitedly, Whitaker brought the fragments to Colbert, who immediately recognized that they pertained to *Coelophysis*.

Whitaker showed Colbert the spot, and they worked their way up the slope until they discovered the layer from which the bones were weathering. After some cleaning with brushes and awls, they soon realized that they were looking at articulated skeletal remains. At this point, Colbert had to make a decision: Stay in Ghost Ranch and sacrifice the hard-won permits for Petrified Forest, or abandon the site and head west — but the question was really moot, you stick with the fossils in hand.

With these thoughts, Colbert contacted George Simpson and told him of the find. Simpson arrived the next day, and realizing that this was probably the finest Triassic vertebrate site in



Ned Colbert near some ancient channel sandstones and conglomerates.

the world, agreed that they should abandon their Petrified Forest plans. But how much more was to be found? Perhaps the site only extended another couple of inches into the hill, and the steep slope meant that the farther they dug in, the more sediment they would have to remove from above the fossils. This sort of digging was frustrating, as loose dirt and rocks would keep tumbling down from above. More than an annoyance, these rock-falls could easily damage the extremely fragile bones that were emerging (not to mention those working on them!). Accordingly, they spent several days, and considerable effort with picks and shovels, clearing a platform several feet into the slope, a foot or two above the bone-layer.

For every two feet they dug into the slope, the hill rose about a foot. So, when they had finished their platform, they had a small cliff six or seven feet tall at the back of the quarry. They then carefully sunk a couple of small test pits at the base of this little man-made cliff. The moment of truth was approaching, and it was with great joy that they were rewarded by the sight of more bones.

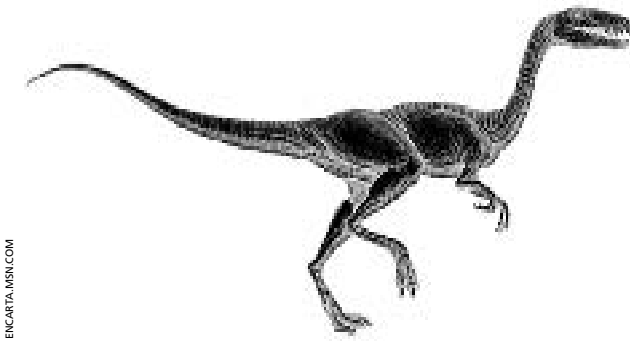
The work was long and tedious. The bones were too fragile and too densely packed to remove one-by-one, instead requiring excavation as a series of large blocks that eventually revealed a mass-grave containing the skeletons of hundreds or perhaps thousands of individual *Coelophysis*. Indeed, the bones were so tightly packed that digging channels between the blocks to separate them was impossible without destroying some bones. The field season lasted into September, and the crew also worked all the next summer. They removed a total of thirteen large blocks, which they shipped back to the AMNH for controlled preparation in the lab. Although the bed was still yielding bone, they decided to stop quarrying after the second season, to allow preparation and description of the material, before going back to collect more.

The exceedingly delicate bones demanded great care in preparation. In fact, preparation of the blocks collected in the summers of 1947 and 1948 was so time consuming that it is incomplete to this day. Enough was revealed, however, to allow Colbert to begin the research process. First of all, the skeleton of *Coelophysis* could now be described thoroughly, revealing itself to be a long-necked, lightly-built biped about 6 to 11 feet in length and standing about 3 feet tall at the hip. It had strong hind legs that were well suited for fast running. Its long bones are hollow, a characteristic for which it was named (*coelo* = hollow, *physis* =



Ned and Margaret Colbert at Ghost Ranch, New Mexico. Margaret is the daughter of a prominent paleontologist, William Diller Matthew.





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Reconstruction of *Coelophysis*.

form). The skull is gracefully constructed with sharp, recurved, and serrated teeth well adapted for a diet of meat. Although details of the anatomy are specialized, in its overall aspect the skeleton of *Coelophysis* provided a nice model of the earliest theropod dinosaurs.

A brief digression on dinosaur classification is necessary here. The Dinosauria comprises two great groups, the Ornithischia and Saurischia. Ornithischians are herbivorous, and include such animals as the horned and frilled triceratops, duck-billed dinosaurs, armored ankylosaurs, and plated stegosaurs. Saurischians, on the other hand, split into two main lineages, one leading to the giant herbivorous sauropods (e.g., the brachiosaurs) and the other to the theropods, which includes all carnivorous dinosaurs (such as *Tyrannosaurus* and *Velociraptor*) and birds. *Coelophysis* is one of the earliest theropod dinosaurs.

A great size-range was represented in the dinosaurs from the quarry, including fully adult forms and presumed juveniles. A size disparity among adult specimens suggests that *Coelophysis* exhibited sexual dimorphism. One specimen has the remains of a juvenile *Coelophysis* contained within its ribcage. The position of the specimen within the ribcage and its preserved condition suggested to Colbert that it was a victim of cannibalism. The accumulation of skeletons and partial skeletons found at Ghost Ranch begs the question of how they all wound up there. Although other species are represented in the quarry, the prevalence of *Coelophysis* suggested to Colbert that these animals might have lived in a group or herd that met its demise as the result of a flood or some other catastrophic event. In any case, this find gave Colbert the unparalleled opportunity to study variation and growth in a 225-million-year-old animal.

Colbert's formal description of the *Coelophysis* specimens recovered from Ghost Ranch was published as a Bulletin of the Museum of Northern Arizona in 1989 — 42 years after the initial discovery. Although he felt that this description did not do justice to the site, he also realized that it needed to be published. He always seemed a little embarrassed about the amount of time it took from discovery to publication. Of course, he had lots of excuses. Not only were the blocks extremely time-consuming to prepare, but he also had other projects that demanded his time. He continued his descriptions of Triassic life, including the gliding reptile *Icarosaurus*, which led to the study of *Draco*, reprinted here. He also was involved in the creation of the great dinosaur halls in the AMNH and had many other obligations as a museum curator.

Perhaps one of his biggest distractions from the *Coelophysis* project was his trip to Antarctica in 1969, where he recovered Triassic vertebrates. The worldwide distribution of these animals helped solidify the newly emerging theories of plate tectonics, and his description of these fossils and their implications to the past connections of continents occupied most of his research during the 1970s.

The last of his published works dealing with *Coelophysis* was a popular book called “The Little Dinosaurs of Ghost Ranch,” which recounted his experiences, and presented the story as a paleontological case study, and on which (in addition to his autobiographies) I have largely based this account.

As mentioned previously, grandfather had a prodigious publication record. Part of his success was a well-defined work ethic. He was able to compartmentalize his life quite effectively, and established personal routines that enhanced his productivity. For example, when I knew him as a ‘retiree’ in Flagstaff, he would walk to his office for a morning of work, and then walk home for lunch at noon. This was followed by an afternoon nap, and then another hour or two of work in the late afternoon before dinner and relaxation. However, these rather strict routines did not mean that he was inflexible.

He remained open-minded and fair throughout his life. As much as he loved paleontology, I think he loved nature even more. I remember his enjoyment watching the squirrels and birds that would come to the feeder in Flagstaff. Ahead of his time, he did not believe in growing lawns in a desert, and left the Arizona meadow and forest intact on their couple of acres. He learned to identify all of the wildflowers that could be found in their little meadow, and delighted in monitoring their appearance after the Arizona summer monsoons. He always exhorted me to observe living animals in order to better understand long-extinct fossil forms. I remember attending a lecture that he gave to the general public, which ended with a slide of the planet Earth from space. Although this was a talk about dinosaurs, he felt it his duty to remind the audience that this is a small world on which we live, and we should treat it with love and respect.



Ned Colbert preparing for fieldwork in Antarctica. His discoveries of Triassic vertebrates there helped solidify emerging plate-tectonic theories.

## COMMENTARIES

# Killing Animals for Profit<sup>1</sup>

Carl Hiaasen, Miami Herald

If your kids asked to bury a small animal alive, you'd be horrified. You'd tell them that's an awful thing and that they ought to be ashamed. Most children wouldn't dream of doing it, of course, because they know what's wrong and what's right. Unfortunately, they don't make the rules.

Consider Florida's poor, pokey Gopher Tortoise. Since 1991, the state has allowed grown-ups to bury 74,000 of them because their burrows stood in the path of future subdivisions, highways, golf courses, and supermarkets. Officials prefer the word *entomb* instead of *bury*, but it's the same dirty deed. Even on his most fleet-footed day, the average tortoise cannot outrace earth-moving machinery. Some are able to tunnel to freedom, but most suffocate slowly over a period of weeks.

Gopher tortoises have been around for 60 million years, but the last few decades have been murder. The Florida Fish and Wildlife Conservation Commission classifies these ancient land turtles as a "species of special concern," although obviously not special enough to be left in peace. A child can't legally keep one as a pet, yet a big company or even a school district can obtain permits to snuff them by the hundreds.

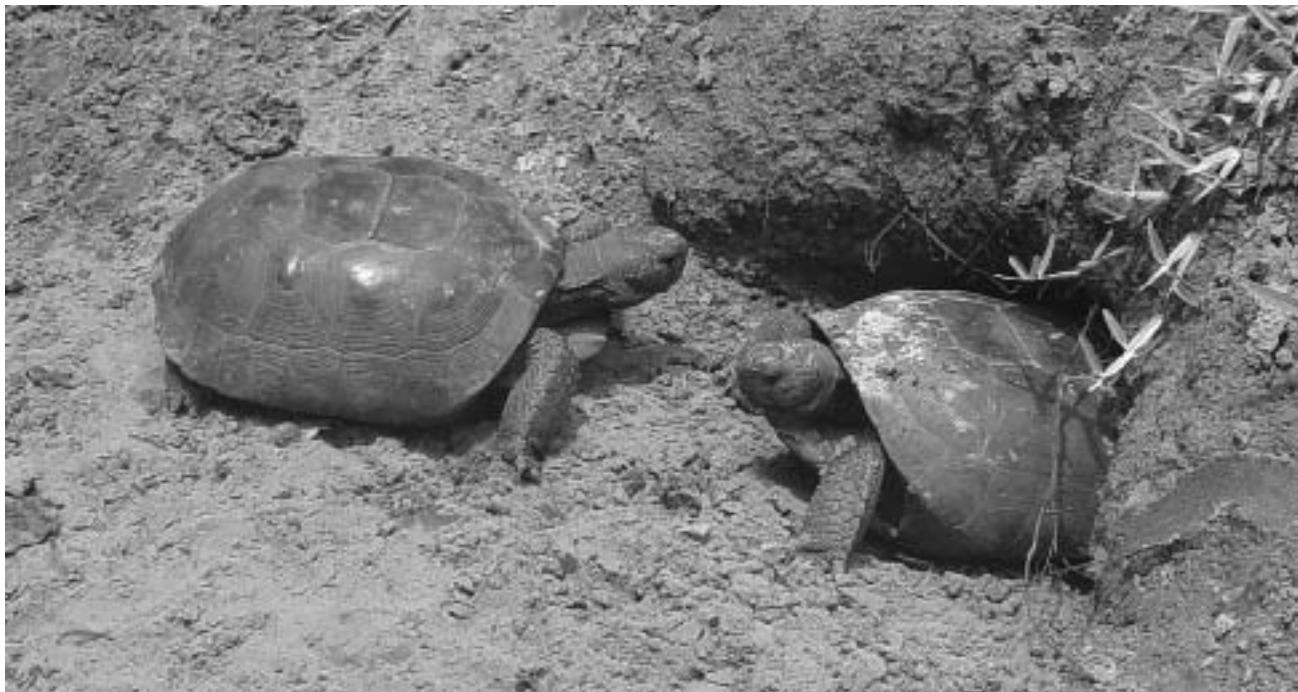
Dwindling in numbers, the animals live in dry hammocks, coastal dunes, and pine scrub. There they dig elaborate dens that provide shelter to more than 300 other species, including rabbits, burrowing owls, and the endangered Indigo Snake. As

luck would have it, prime tortoise habitat is often prime real estate, which means the tortoises get the boot or, more typically, the bulldozer. The state calls this "incidental taking," which is a bureaucratically sanitized way of saying "smothering to death."

The permit process is straightforward. Developers seeking to build on land colonized by tortoises typically agree to contribute to a habitat fund, or set aside a relatively small parcel. It's called mitigation, a lame charade intended to make the state appear vigilant and to make developers appear caring. In the past 10 months, Florida has granted 345 permits to bury tortoises. The [South Florida] *Sun-Sentinel* recently published a sampling:

- The Tuscano golf course development near Sarasota got permission to kill 260 of the reptiles in exchange for preserving 138 acres.
- In Duval County, the Young Land Group was told it could destroy 190 tortoises if it paid \$169,442 for 29 acres of habitat.
- The Orange County Public Schools got permission to kill 110 tortoises on the future site of a high school, in exchange for preserving 12 acres at a cost of \$92,037.

<sup>1</sup> Reprinted by permission of the author and the *Miami Herald*. © *Miami Herald* 7 May 2006.



GLUCK, SCHAEFER

Since 1991, the state has allowed the burial of 74,000 Gopher Tortoises (*Gopherus polyphemus*) because their burrows stood in the path of future subdivisions, highways, golf courses, and supermarkets.

- Vikings LLC in Marion County was approved to wipe out 470 tortoises for a 542-home golf course development, in exchange for preserving 136 acres.
- In Palm Beach County, Wal-Mart got permission to bury five tortoises in exchange for a whopping 1.49 acres of habitat. Mitigation is always meager. A pending project in the Tampa Bay area would obliterate 2,573 acres of tortoise habitat, yet under current rules the developer is required to set aside only 168 acres. That's a net loss to the tortoises of 93 percent of their home territory.

News accounts about the tortoise-burying permits have angered many Floridians and discomfited wildlife officials, who admit that not enough is being done to save the reptiles. The state now wants to expand tortoise preserves in the Panhandle, which sounds like a plan, except that moving the critters hasn't worked. Studies have shown that most of the relocated newcomers have died from respiratory disease or other ailments.

#### Process as Slow as the Tortoise

Four years ago, the FWCC staff proposed elevating the status of

the Gopher Tortoise to a "threatened species," which theoretically would offer more protection from habitat loss. No action was taken, and the sanctioned killings continued.

Several local governments decided there was no time to lose. Lee, Collier, Martin, and Hillsborough counties adopted ordinances that made it more difficult to destroy the species, even with a permit.

On 7 June, the state wildlife commission convenes in West Palm Beach, a public meeting at which the plight of the Gopher Tortoise finally will be addressed. A key factor will be the "risk of extinction," which grows worse with every mass burial. If commissioners agree that the species should be reclassified as threatened, biologists and administrators will begin drafting a management plan. It's a process as slow and lumbering as the tortoise itself.

In the meantime, officials say they're working with developers and landowners to deal with the "entombment issue," which has turned into a serious public-relations headache. There's nothing "incidental" about burying an animal alive. Just ask your kids. They'll know better.

## Are Alligator Snappers Out Of The Soup?<sup>1</sup>

J. Whitfield Gibbons

Savannah River Ecology Lab, Aiken, South Carolina

South Carolina and Louisiana have major problems with some of their senior citizens. As summer begins, Louisiana will have begun to address the problem for one group. South Carolina will still be seeking a solution for their denizens. The problem relates not to AARP members but to turtles: How to control their removal from the wild by commercial turtle trappers. Neither state can afford to lose many more of their native turtles and keep their natural heritage intact. Recent positive action by the Louisiana senate regarding one species bears mentioning.

One of the most magnificent reptiles in America is the Alligator Snapping Turtle (*Macrolemys temminckii*), a species that is fast disappearing from southern rivers and swamps. The giant turtle, one of the largest freshwater turtles in the world, gets bigger than the adults of some sea turtles. Typical adults can weigh more than 100 pounds and the record is more than 200. Alligator Snappers have a come-hither scam that operates quite effectively with hungry fish. The turtle sits on the bottom with its mouth open. Its bright red tongue wiggles like a worm. As unsuspecting fish move in for a meal, they become a meal themselves when the unseen con artist slams its jaws shut.

Alligator Snappers inhabit the Mississippi River drainage and are found as far east as southern Georgia, west to Texas, and north to Indiana, although not in the Carolinas. Once they were in virtually all large rivers throughout their geographic range. Recently, their numbers were estimated to be less than five percent of what they once were, and still declining. All but one state (Louisiana) had passed laws to protect these mighty creatures from the assaults of commercial trapping. I think it safe to say that they are part of the natural world that most Americans would like to preserve.

Louisiana may actually make that a reality. Louisiana Senate Resolution No. 49 introduced by Sen. Robert J. Barham is "to urge and request the Louisiana Department of Wildlife and



SUZANNE L. COLLINS, OMAH

Alligator Snapping Turtles (*Macrolemys temminckii*) are fast disappearing from southern rivers and swamps.

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

Fisheries to place a moratorium on the taking of Alligator Snapping Turtles.” The resolution notes that these turtles have “historically been a vital and integral part of the Louisiana wildlife ecosystem [and are] presently suffering excessive exploitation for meat in local commercial markets, as well as an increasing international market.”

The impact of such a resolution will go far in setting the system right for Alligator Snappers in Louisiana. Other states should consider taking similar steps to protect their turtle species. Although resolutions are only suggestions, and the state’s wildlife department does not have to honor them, such a suggestion by a state senate is a positive start. The Louisiana Wildlife and Fisheries Commission has now taken action and voted to “stop the taking and possession of Alligator Snapping Turtles by anybody with a commercial license.” Recreational trapping of Alligator Snappers was not affected.

I asked Dr. Joseph Pechmann, a biologist at the University of New Orleans, how he thought the Louisiana senate had ever

been able to pass a resolution that would protect the turtles. “They accepted the idea that part of Louisiana’s natural heritage was going to disappear if commercial harvest was allowed to continue. Recreational harvesting of Alligator Snappers is a pastime important to many in the state, but the current levels of commercial removal were clearly unsustainable.”

The southeastern turtle saga is not over, and I’m not sure how it will end before meaningful regulations are in place in all states. I do know the loss of Alligator Snappers from the commercial scene will have little effect on the turtle soup au sherry at Commander’s Palace restaurant in New Orleans. But I do not know whether the South Carolina legislature will realize that it must now step forward and take some action to protect its own turtles. When I asked Dr. Pechmann how he personally felt about the resolution to protect the giant turtles in Louisiana, he said, “It’s about time.” Let’s hope tight restrictions on overharvesting will not be too late coming for Alligator Snappers in Louisiana, or for other turtles elsewhere.

## Global Climate Change: Should You Care?

Gad Perry

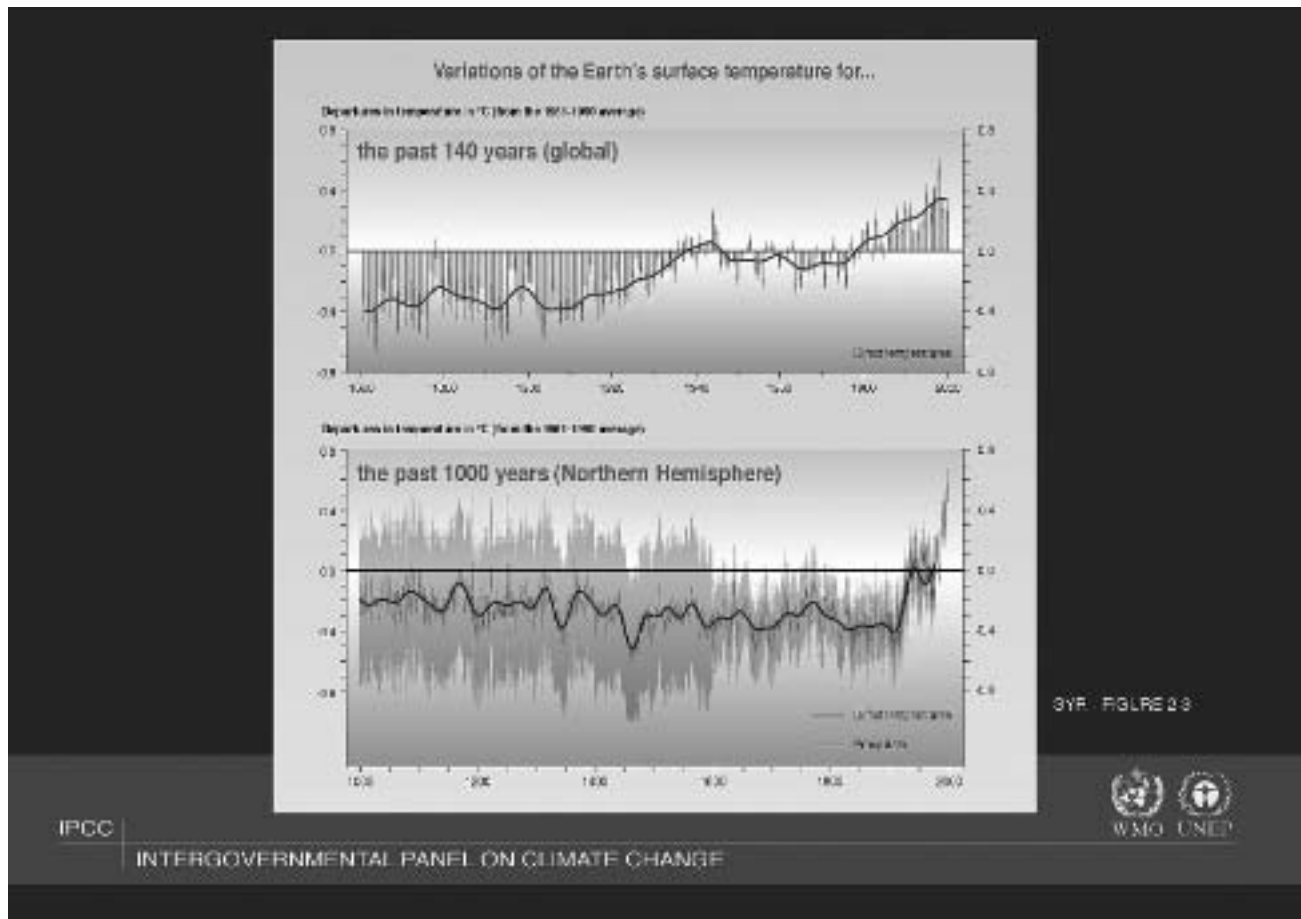
Department of Range, Wildlife, and Fisheries Management  
Texas Tech University, Lubbock, Texas

About ten years ago, I was seated at a large lecture hall at Ohio State University, waiting for an economist to talk about environmental issues. It’s good to get a different perspective every once in a while, after all. The speaker was clear: “I don’t believe for a moment that global climate change is happening,” he stated emphatically, then paused for dramatic effect. “But if it is,” he continued, “all that means is that we need bigger and better air conditioners!” Reactions in the room were mixed. About one third of the listeners cheered, another third seemed unclear about what he had said, and the final third were close to apoplectic. A decade later, things have not changed much. Some people are still warning that the future does not look good. The remainder appears to be divided between those happy not to think about environmental issues and an influential sector that pretends nothing is going on or that bigger AC units will solve our problems.

So, does a problem really exist? Much of the U.S. political and business leadership has spent the last decade or more claiming either that climate change is not occurring or that it is occurring as a consequence of natural processes over which we have no control. Recently, this argument received surprising support from author Michael Crichton. His 2004 book, *State of Fear*, used a hunt for environmental terrorists as a device for bashing environmentalists, and especially anything to do with climate change. Sounding a lot like my economist, one of the characters stated (p. 407): “The threat of global warming is essentially nonexistent. Even if it were a real phenomenon, it would probably result

in a net benefit to most of the world.” Although climate scientists have repeatedly shown the book to be scientifically lacking, an adventure yarn is certainly entitled to have a preposterous premise (consider some of Crichton’s other novels, such as *Jurassic Park*, for which one must suspend any critical analysis to enjoy the story). However, for the U.S. Senate to invite Mr. Crichton to testify on environmental issues is just wrong — and my students using his fiction as an authority by which to reject the evidence compiled by many hundreds of scientists is even worse. Science is built on observing a phenomenon and making predictions that are supported by previous knowledge. A climate expert would know that CO<sub>2</sub> acts as a greenhouse gas and would consequently predict that global climate will change in certain ways if CO<sub>2</sub> levels continue to rise.

Could climate change scientists be wrong? Of course they could. Our data remain limited, and the pattern that has emerged might not be representative of long-term trends. Nonetheless, we have to work with the data at hand, revealed by multiple scientific papers and reports by individual scientists and national and international bodies. The hallmark of science is to test those predictions, which have so far proven depressingly realistic, varying only in assessments of the extent to which the damage will accrue. The scientific community overwhelmingly agrees: Global climate change is occurring, appears to be tied to human activities, and is likely to have devastating effects on both people and other organisms. Because of the magnitude of the impacts and



These graphs, released by the IPCC (<http://www.ipcc.ch/present/graphics/2001syrlarge/05.16.jpg>) show the increase in temperature in the recent past (top) and last 1000 years (bottom).

the long time required to reverse global climate changes, many feel that the risk of not doing anything if climate change is indeed occurring far exceeds the cost of reacting to a threat that we cannot yet fully predict.

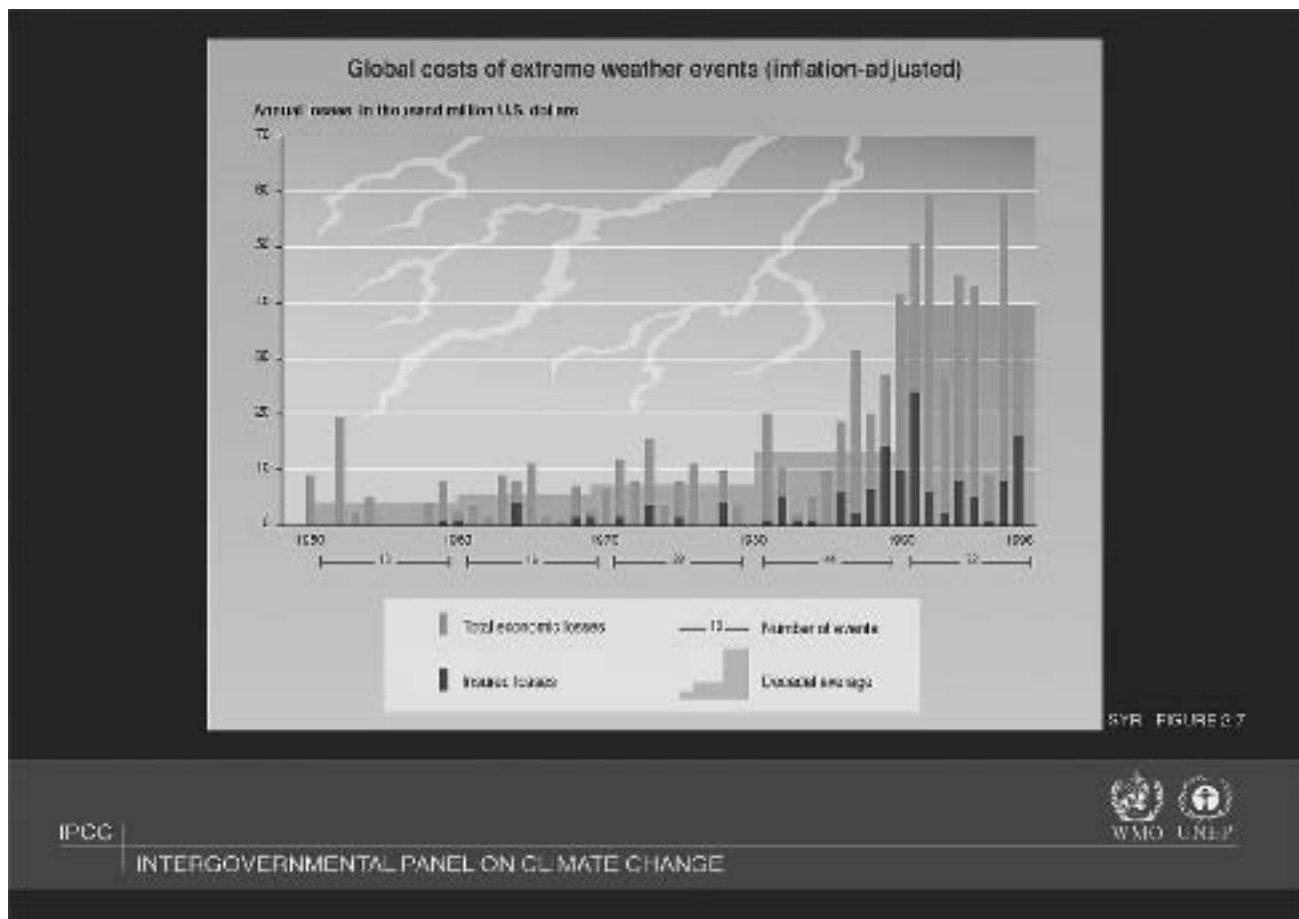
This is a good time to distinguish the commonly-used but naïve “global warming” from the more appropriate “global climate change.” The first term implies two things: First, that we are going to see higher temperatures everywhere, and second, that no other impacts are to be expected. In fact, neither of these is correct. The best predictions current science allows us to make indicate that different locations are likely to be affected in different ways, with impacts to some, such as the Arctic, far exceeding those to others. In 2001, the Intergovernmental Panel on Climate Change (IPCC) released its third report. It was based on the work of about 1,200 scientists from all over the world, went through three review cycles, and is thousands of pages long. The authors concluded that an increase in extreme temperature events is to be expected, with higher maximum temperatures, more hot days and heat waves, and fewer cold days. However, these impacts were not going to affect the entire globe uniformly, so some areas might see a cooling trend even as most become warmer. The IPCC also predicted an increase in extreme precipitation events in many places. With more intense storms dropping more rain in less time, increased flooding, more intense drying during the

summer, and more frequent droughts are likely in many regions.

Data collected in the past few years have certainly supported these predictions and raised additional concerns. Doubting the validity or the magnitude of the problem has become increasingly difficult for the unbiased observer. After all, the ten hottest years ever recorded have all occurred since 1990. Moreover, this past year’s climate brought the issue closer to home for many of us. In December, NASA scientists estimated that 2005 would be the hottest year since reliable records have been kept for about the past 125 years. More viscerally, people notice when a hurricane the magnitude of Katrina slams into the U.S. gulf coast. When storm after storm gets wide media coverage — 26 named storms developed in 2005, an all-time record, and an unprecedented 16 became hurricanes — climate becomes a topic of discussion. “ConocoPhillips recognizes that human activity, including the burning of fossil fuels, is contributing to increased concentrations of greenhouse gases in the atmosphere that can lead to adverse changes in global climate,” now states the energy giant ([www.conocophillips.com/about/Sustainable+Development](http://www.conocophillips.com/about/Sustainable+Development)). Impacts on humans have begun to be quantified. Here are a few numbers from recent reports:

- Worldwide, natural disasters caused by climate change cost over \$60 billion in 2003, according to the UN (<http://news.bbc.co.uk/2/hi/americas/3308959.stm>).





The economic damage of extreme weather events is on the rise (source: IPCC, <http://www.ipcc.ch/present/graphics/2001syr/large/08.17.jpg>).

- A June 2005 report by the Association of British Insurers ([www.abi.org.uk/climatechange](http://www.abi.org.uk/climatechange)) predicted that the cost of cleaning up after climate change will have risen by as much as two-thirds by 2080. Reducing carbon emissions now could reduce insurance costs by 80%.
- According to the members of the G8 economic group of nations (<http://www.g8.gov.uk/servlet/Front?pagename=OpenMarket/Xcelerate/ShowPage&c=Page&cid=1098795669277>), the number of people affected by floods worldwide has already risen in the last four decades from 7 to 150 million today — much faster than population growth. The 2002 flooding in Europe caused 37 deaths and \$16 billion in damages. The 2003 European heatwave caused 26,000 premature deaths and \$13.5 billion in damages.
- In the U.S., in 2005 alone, over 1,300 people lost their lives to Hurricane Katrina and costs are estimated at up to \$200 billion. Damage from Hurricane Rita topped \$9 billion.

So far I have discussed broad patterns that should concern every citizen, but this journal is aimed at people who are interested in biological diversity and its conservation. Should we as biologists be especially concerned? Yes! The data to support that now include dozens of studies on hundreds of species and encompass up to 50 years. Plants are flowering, frogs are emerging, and bird spring migrations are starting earlier than they have in recorded history. The distributions of species are changing, with many

extending their ranges towards the poles or higher elevations and contracting in lower elevations or latitudes. In addition, coral bleaching, associated with warmer water, is becoming more prevalent — being recorded for the first time at two of the Caribbean sites where I work. Even more disconcertingly, the effects of climate change are meshing with those of habitat degradation and invasive species. For example, the *Observer* has reported ([http://observer.guardian.co.uk/uk\\_news/story/0,6903,1670017,00.html](http://observer.guardian.co.uk/uk_news/story/0,6903,1670017,00.html)) that Atlantic Puffins (*Fraterecula arctica*), colorful seabirds that nest in Scotland, are in trouble. Over-fishing has depleted their food source, and now global climate change is allowing the invasive Tree Mallow (*Lavatera arborea*) to expand its range, covering the ground where birds used to nest. Such effects are not going to limit themselves to puffins. Unfortunately, the impacts to non-humans are rarely monitored. How many iguanas died when storms lashed the Caribbean this year? How many sea turtles will lose their nesting beaches as sea levels rise in the decades ahead? How much money would each of these lives be worth, if we could replace it?

What to do? This is where things get tricky. Different people see the threat of climate change in different ways and have widely varying views on the acceptable price for addressing it. Many in the business and political sectors have taken the stance that doing anything about climate change would cost too much. In a September 2002 speech in New Jersey, President Bush took an unusually clear position: “We need an energy bill that encour-

ages consumption” rather than reducing greenhouse gas emissions. In his much-hyped book, *The Skeptical Environmentalist* (on which Crichton based much of his novel), Bjorn Lomborg estimated the cost of controlling climate change to be between \$3 and \$33 trillion, compared to a benefit of \$5 trillion, and recommended against doing anything. Lomborg’s work has been widely attacked as inaccurate and biased but, not being an economist, I do not feel qualified to judge the details. However, this kind of argument has been made many times. For example, a similar attitude was used to delay the banning of leaded gas and lead-based paints in the U.S. The overwhelming experience with environmental legislation has been a huge payoff in improving public health, developing new technology, and environmental benefits. For example, the CDC estimates that banning the use of lead has reduced the number of U.S. children suffering from lead poisoning from nearly 15 million in 1978 to fewer than 900,000 by the early 1990s. In analyzing the costs and benefits of additional regulations related to the use of lead, the EPA estimated an economic benefit of over \$2.5 billion per year (just as with climate change, however, that is rarely the real issue — in 2004, the EPA decided to scrap the new lead rules). Similarly, the banning of CFCs after a hole was discovered in the ozone layer was initially predicted to create a huge economic impact, yet quickly led to development of alternative chemicals that also allowed more energy-efficient cooling.

Unlike the national U.S. leadership, others inside and outside the country have shown considerable concern. “In my view, climate change is the most severe problem that we are facing today, more serious even than the threat of terrorism,” said Sir David King, chief scientific adviser to Britain’s Prime Minister, in a January 2004 article in the journal *Science*. “We must protect our environment even if it results in great sacrifices,” said Mayor Richard Ward of Hurst, Texas, regarding the climate agreement (<http://www.ci.seattle.wa.us/mayor/climate/default.htm>) unanimously approved by the U.S. Conference of Mayors in June 2005. In December 2005, New York Governor George Pataki, a Republican, led the governors of seven northeastern U.S. states in signing the Regional Greenhouse Gas Initiative, which hopes to use market-based initiatives to first freeze gas emissions at current levels, and then reduce them. The expectation is that household expenses will initially rise slightly (up to \$24/family/year), but that the development of cleaner technologies will ultimately offset the extra cost. The Kyoto Protocol, an international treaty intended to address greenhouse gas emissions, was negotiated in



Michelangelo’s view of the biblical flood illustrates the catastrophic impacts of sea level rise.



Glaciers are melting all over the world. In this example, released by Greenpeace (<http://www.svalbard-images.com/spitzbergen/climate-change-a.php>), the top picture was taken in 1918 and the bottom picture was taken in 2002.

1997, ratified by 156 countries so far (not including the U.S., which was also one of the last to ban lead), and has come into force in early 2005. The Protocol has helped raise awareness and hope. Over 90% of companies responding to information requests from the Carbon Disclosure Project (<http://www.cdproject.net/report.asp>) identified risks and opportunities associated with global climate change. Just over one half have put in place programs to reduce emission levels. Yet plans and pacts are not enough. While 13% of companies in the Fortune 500 reported reductions in emission levels over the past few years, 17% reported increases.

As individuals, we hope to be here for many more years. As a species, we would like to stick around for a few million more years before going extinct. As people interested in conservation, we hope that as many other species as possible will see that future with us. The impacts from global climate change add up quickly, and the excuses for delaying action grow more and more feeble. Unfortunately, both the citizens of the U.S. and their elected leadership are characterized by an abysmal lack of scientific proficiency, which makes many people unable to assess issues as complex as global climate change. We need to remedy this, and we need to act on global climate change before too much more damage is caused. Scientists already estimate that many decades will pass before the effects of our past actions on global climate can be countered.

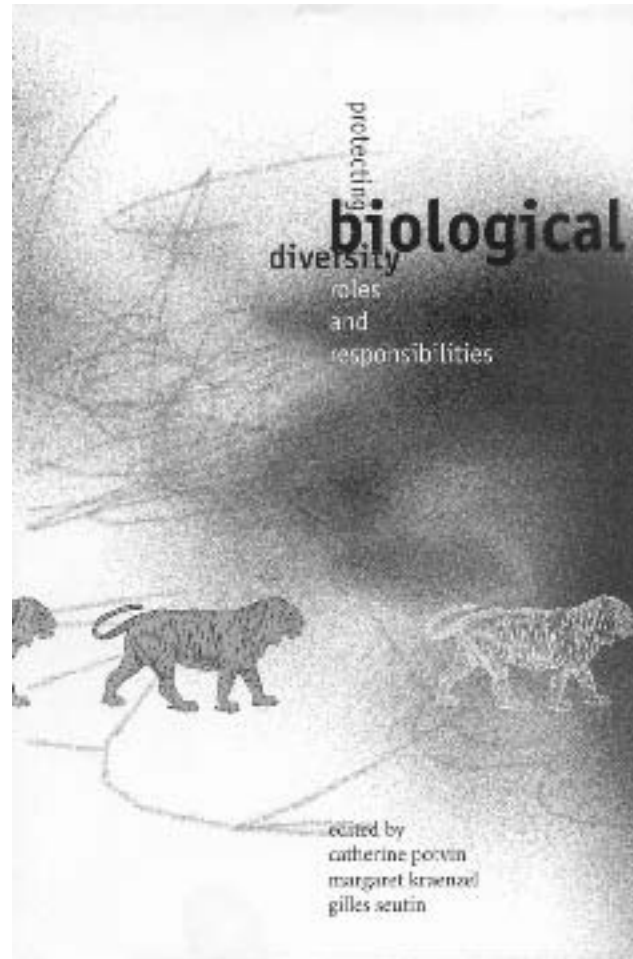
## BOOK REVIEWS

# Three on Consilience: The Difficult Art of Combining Biological and Social Sciences to Protect Biodiversity

1. *Protecting Biological Diversity: Roles and Responsibilities*. 2001. Edited by Catherine Porvin, Margaret Kraenzel, and Gilles Seutin. McGill – Queen's University Press, Canada, 160 pages. Hardback - ISBN: 0773521585 - \$75.00. Paperback - ISBN: 0773521593 - \$24.95.
2. *Experiments in Consilience: Integrating Social and Scientific Responses to Save Endangered Species*. 2003. Edited by Frances R Westley and Philip S Miller. Island Press, USA, 328 pages. Hardback - ISBN: 1559639938 - \$70.00. Paperback - ISBN: 1559639946 - \$35.00.
3. *The Future of the Wild: Radical Conservation for a Crowded World*. 2006. By Jonathan S. Adams. Beacon Press, USA, 296 pages. Hardback - ISBN: 0807085103 - \$27.95.

Life is full of ironies, and this is not the least of them: Many of us “got into wildlife” because we like nature, yet spend most of our professional lives dealing with “people” issues. The rapid extinction of species and the ongoing homogenization of what is left bring a sense of urgency to anyone who would like to see biodiversity protected. Not surprisingly, conservation biology has often been called a crisis discipline. Because the problem is human-caused, the answers must also involve humanity. Conservationists have long realized that biologists and social scientists will have to collaborate, and E. O. Wilson coined the word “consilience” to more-or-less describe this idea in a 1998 book of the same name. The matter of application has remained somewhat fuzzy, however. The three recent books reviewed here attack this question from different perspectives and with varying degrees of success.

One of the ironies of conservation is that the ideology, know-how, and finances typically come from technologically and economically developed but biodiversity-poor countries, whereas the biodiversity to be conserved is usually found elsewhere. *Protecting Biological Diversity* focuses on the need for scientists and practitioners from both spheres to collaborate effectively and equitably. Concerned about the perceived lack of clear ethical guidelines for conservation practitioners, the editors “strive to determine what ‘good practice’ may be.” An edited volume resulting from an IUCN symposium held in 1996, this is a truly international effort. Of the 26 authors, only nine call North America home; nine are from India, and the rest originate from across the tropics. Perhaps because of this unusual makeup of authorship, the book focuses on an important but often-ignored issue: The tension between local and expatriate outlooks on joint conservation projects. Eight chapters offer case studies and make some references to the importance of collaboration between locals



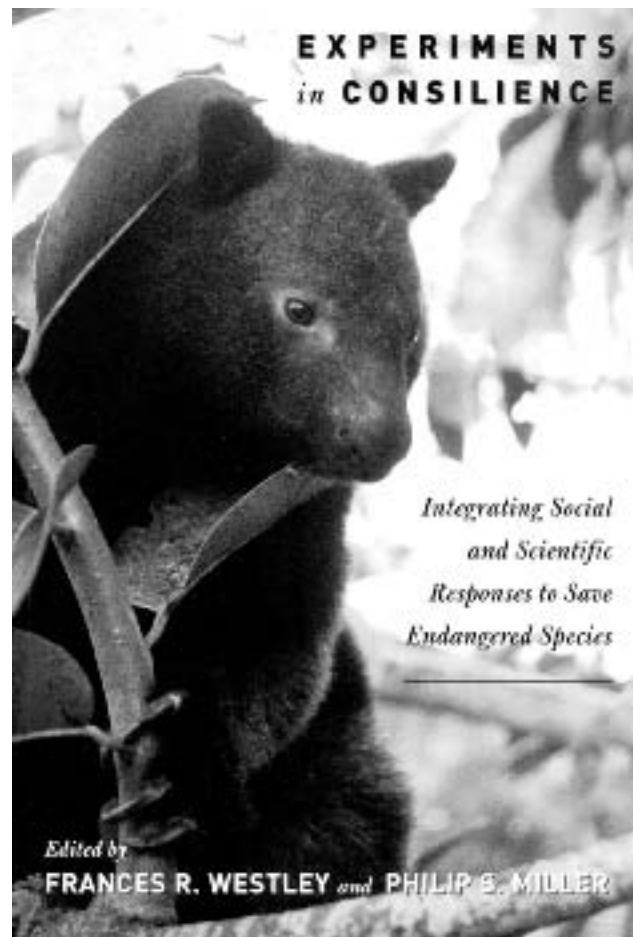
and foreign conservation biologists. For example, chapter one states that “overall, these co-operative and collaborative projects have been remarkably successful...” In general, the authors tend to highly value local knowledge, ignore local deficiencies, and focus on the mismatches. For example, “the philosophy behind the integral reserve is that of pure conservation [but] in a poor country, such as Madagascar, where citizens depend on wood for fuel, it has proved impossible to prevent use of these resources” (chapter 5). The language is often rather strong. For example, chapter 1 denounces “The arrogant and shocking attitudes and behaviour of some European experts.” It goes on to recount “A well-known incident [that] involved an African researcher who

was refused the right to take his seriously-ill spouse to the health centre ... while the Belgian expert allowed himself the luxury of using the vehicle to spend the weekend in the regional headquarters." Potentially most helpful is the ninth chapter, which includes a list of recommendations. Many of these, such as respecting local people, laws, and customs, are commonsensical. Finding ways to remunerate local populations when profit is to be made from their knowledge or biodiversity and making results available to local authorities should also prove non-controversial. However, the authors of this and other chapters take it a big step further: Researchers should not only provide results, but also include field notes. They should not only communicate in the official language of the host country, but "using local dialect in all communications."

As this book amply illustrates, western scientists have not always acquitted themselves well. Scientific imperialism, often in the form of ignoring the contributions of local team members when authorship is decided, is a pernicious problem, and I commend the editors and authors of *Protecting Biological Diversity* for discussing it openly. Nonetheless, statements such as "conservation biologists and ethnobiologists have not yet proved their willingness to conform to either local or universal values" (editors' introduction to the final chapter) seem excessively strong. Working in a foreign country, under time and budget constraints and within a different culture and language, can be overwhelming. Regardless, many western scientists have taken these challenges on because of a deep commitment to helping solve complex problems in far-away places. The book offers some thoughts on how to be culturally sensitive, behaving ethically, and giving credit where it is due, and thus providing insights on how incoming collaborators can enhance the chances of forming successful partnerships. However, the responsibility of host nations to also invest in the collaboration seems to have been forgotten by the authors and editors of this volume, which I generally found repetitive and one-sided.

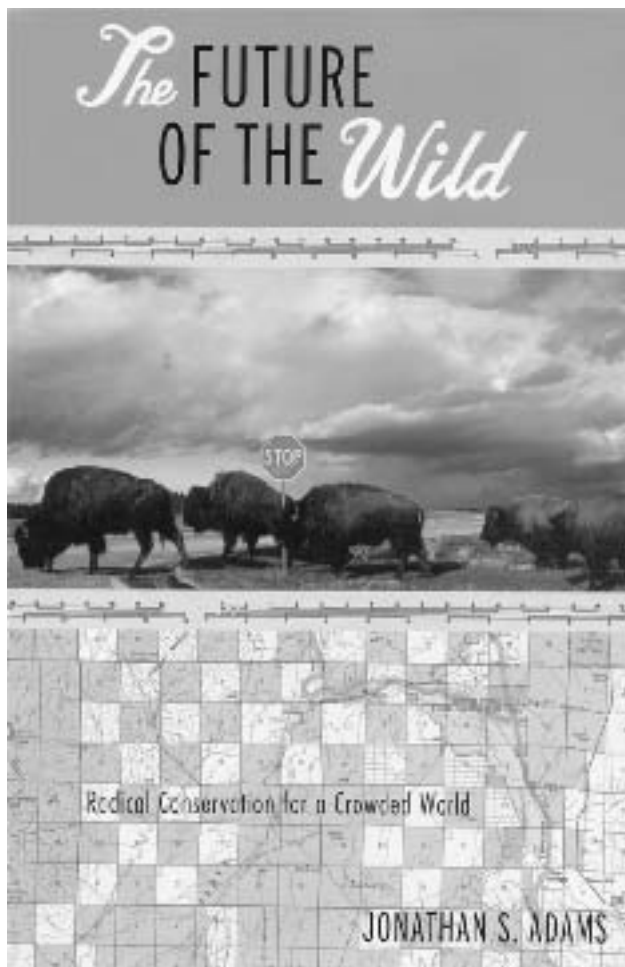
The second book, *Experiments in Consilience*, emerged from a 1997 Canadian initiative "to build interdisciplinary connections and stimulate the exchange of expertise among specialists concerned with the conservation of biodiversity." Social and biological scientists working in teams analyze a series of workshops conducted by the Conservation Breeding Specialist Group of the IUCN. Overall, the authors agree that "bridge building between specializations" is both feasible and advantageous, but also costly and only "useful if it contributes to species conservation." The tone throughout is fairly optimistic. For example, chapter 5 evaluates in detail the overall performance of the IUCN workshops and concludes that the process "is indeed both generic and robust and worthy of further study and development." Ironically, given the recommendations of the previous book, the authors of chapter 2 identify "globalization of scientific norms and culture," rather than conformation to local language and customs, as one of the most important characteristics contributing to their success. Another encouraging conclusion is that "progressive resource-based companies are motivated to become involved in ... conservation of species and habitat" (chapter 16).

This book would be primarily of value to those planning similar workshops. Where similarities exist between the two



books, this one is clearly superior. For example, chapters 9 and 15 focus on how to incorporate local knowledge into conservation projects, and this issue is also addressed in other chapters. Nonetheless, weaknesses exist, most having more to do with the subject matter than with the book itself. "Just as there is no free lunch, there is no (or little) free interdisciplinary collaboration." Most of the species and habitats in need of attention are far less glamorous than the gorillas and wolves (typical of the obsession with birds and mammals so common in conservation) featured in this book, and the IUCN workshop approach would be hard to replicate. The closing paragraph of this book states that "we must continue to refine this and other conservation processes to make use of the conservation world's greatest resource: the judgment and wisdom of all those who care about saving our endangered spaces and the species therein." I finished the book, perhaps as the editors did, with a better understanding of the experiment and a glimmer of hope, but with no abiding enthusiasm or sense of closure.

The final and most recent volume, *The Future of the Wild*, is a single-authored effort by one of the leaders of The Nature Conservancy. His approach carries a different flavor, more an extended op-ed piece aimed at an educated lay audience than detached scientific discourse. In his introduction, Adams explains the impetus for his work: "Across North America and indeed



around the world, conservation scientists, activists, and communities have begun crafting visions for conserving and restoring wild creatures and wildlands. Such visions smack of particularly naïve optimism,” Adams argues, because our idea of the wild is overly simplistic in today’s world. The scale at which we are used to framing conservation questions is too small: “Parks and reserves need to be large enough to absorb the blows from a once-in-a-century” event, whereas “tiny refuges tucked into a landscape otherwise completely converted to intensive human use will not long survive.” Part 1 of the book, entitled “thinking big,” is devoted to making this point by using examples such as the Spotted Owl. Adams argues that science, rather than “politics, aesthetics, and economics,” must be allowed to determine the shape of conservation efforts. To do that, “conservation must come to grips with the human communities that surround parks as well as the more distant communities that value parks and

wilderness ... that they never see.” Adams provides a positive conceptual framework: “Conservation cannot just be the art of saying no ... [it] must offer a sense of the possible, and a reason for hope.” Part 2, “science and community,” focuses on how landscapes in California and Florida have mainly become urban or near-urban over the last few hundred years and how some communities are trying to address conservation problems in such modified landscapes. Adams expects both conservation and society to change. “Some of the changes in conservation will be revolutionary, others evolutionary. All will require new appreciation for where science, community, and values intersect.”

Arguably, the element most missing from modern conservation biology is hope. The number of new reserves being established worldwide, even tiny ones, has declined precipitously since the 1980s, and the administrations of several western countries are trying to dismantle protections for many of those that currently exist. Adams offers some hope in Part 3, where he presents Yellowstone as an example of how things might work. He emphasizes ideas that have been important in the conservation literature for some years, such as looking at landscape-level effects and creating connections among smaller reserves by judicious use of wildlife corridors, but he does so in the context of actual community-wide efforts to achieve integration in fragmented, multiple-use landscapes. The challenge is how to achieve this grand vision on the required scale.

Recent decades have brought the unpleasant realization that, while the human sphere is growing, the rest of the biosphere is in decline. As the human population continues to expand and the average resource consumption per individual maintains an upward trajectory, the need for the priority-juggling exercise that is conservation grows as well. Thus, the better we understand the human element of this equation, the more effective we can become in reaching our goals for the biological side. Adams’s thought-provoking and accessible book, which could be the basis of discussions in undergraduate classes, might offer a small step in this direction.

The three books address a variety of mostly non-overlapping topics involving the interaction between the human and natural sciences in conservation. Ultimately, however, the underlying issue remains the ever-growing size and impact of the human population. As global climate change shows, even the largest and best-protected preserve established today may offer little conservation value tomorrow. Literature in this field could thus benefit from further integrating this topic into its analyses — something that has become rather rare in current mainstream conservation literature.

*Gad Perry*

Department of Range, Wildlife, and Fisheries Management  
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## CONSERVATION RESEARCH REPORTS

### Dietary Shifts of Turtles in Pristine and Oil-polluted Habitats of the Niger Delta in Southern Nigeria

LUISELLI ET AL. (2004. *Herpetological Journal* 14: 57–64) examined the diets of sympatric freshwater turtles at two study areas in the Niger Delta (southern Nigeria). One site was unpolluted and the other was polluted by an oil spill, but both areas were otherwise similar. Four species of turtle (*Trionyx triunguis*, *Pelusios castaneus*, *Pelusios niger*, and *Pelomedusa subrufa*) were captured in the unpolluted area, whereas only two species (*Pelusios castaneus* and *Pelusios niger*) were captured in the polluted area. In the unpolluted area, the taxonomic composition of the diets of *Pelusios castaneus* and *Pelusios niger* was similar, whereas the diets of *Pelomedusa subrufa* and *Trionyx triunguis* were very different from the other two species and one another. In the polluted area, the taxonomic composition of the diet of *Pelusios castaneus* was significantly different from that of conspecifics in the unpolluted area, and consisted mainly of plant matter, annelids (earthworms and leeches), and gastropods. The taxonomic composition of the diet of *Pelusios niger* was also significantly different from that of conspecifics at the unpolluted area, and consisted mainly of annelids and gastropods, and secondarily of plant matter. Amphibian prey (eggs, tadpoles, and adults), which were one of the main food types for all turtles in the unpolluted area,

practically disappeared from the diet of turtles at the polluted area. The two species that survived the oil spill obviously shifted their dietary preferences. In both species, an obvious reduction in the breadth of the trophic niche was apparent. Such a reduction in trophic niche breadth may reflect the reduced availability of most food sources (particularly amphibians, fish, and environmentally-sensitive invertebrates) in the polluted area, despite over 10 years of restoration operations at the site. The reduction in trophic niche breadth also may reflect shifts in habitat use by the surviving turtles, which tended to concentrate into single habitat types in the polluted area, compared to the unpolluted area where they were more habitat generalists.

### Biology of Endangered Ploughshare Tortoises

Successful conservation requires a good understanding of both the direct and indirect causes of any decline in population size. Harvests of wild populations often target the largest, oldest individuals that have the greatest economic value. If these individuals contribute disproportionately more to recruitment than conspecifics, the harvest will cause a greater reduction in population viability than initially anticipated. The Ploughshare Tortoise (*Geochelone yniphora*), endemic to Madagascar, has been reduced to <600



The Ploughshare Tortoise (*Geochelone yniphora*), endemic to Madagascar, has been reduced to fewer than 600 individuals due to exploitation and habitat loss.

individuals due to exploitation and habitat loss. A trial release of captive-bred juveniles has been carried out but the relative suitability of individuals for release, in terms of body size, was not considered. Using data from a long-term mark-recapture study of an unharvested wild population of ploughshare tortoises, O'BRIEN ET AL. (2005. *Biological Conservation* 126: 141–145) found that larger juveniles were significantly more likely to survive their first year of life than smaller tortoises. Juveniles that survived beyond their first year of life generally grew at the same rate, but had a significantly larger hatch size (mean = 41.7 mm), compared with juveniles that did not survive (mean = 39.3 mm). The conservation implications of these results are that release of captive-bred Ploughshare Tortoises is likely to be more successful if larger individuals are released. Previous studies have reported larger female Ploughshare Tortoises laying larger eggs which hatch larger juveniles. This study shows individuals with a larger hatch size retain their size advantage over smaller conspecifics and are more likely to survive their first year of life. This suggests a harvest that targets the largest females in the Ploughshare Tortoises population could be highly detrimental to population viability.

### Herpetofaunal Diversity in Southeastern National Parks

The southeastern United States supports about half of the nations species of amphibians and reptiles, of which about 20% are endemic to the region. Because few areas have been formally inventoried,



CHUCK SCHAEFER

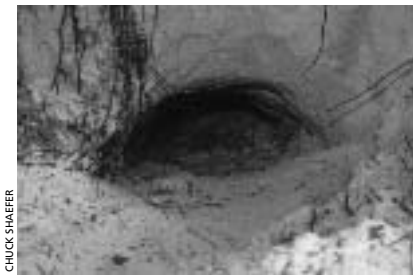
*Pelomedusa subrufa* was restricted to unpolluted areas in the Niger Delta (Nigeria).

TURBERVILLE ET AL. (2005. *Southeastern Naturalist* 4:537–569) conducted biological inventories at 16 parks in the National Park Service's Southeast Coast Network. Using a variety of standard field techniques and surveys of museum collections, the authors documented the presence of 123 native species of amphibians and reptiles in the 16 parks, with numbers of species ranging from 6–64 per park.



SUZANNE L. COLLINS, OMAH

Alligator Snapping Turtles (*Macrolemys temminckii*) and American Alligators (*Alligator mississippiensis*) are but two of 123 native species of amphibians and reptiles found in 16 national parks in the southeastern United States.



CHUCK SHAEFER

Where Gopher Tortoises (*Gopherus polyphemus*) are present, their burrows are used for shelter by many other animals.

### Increasing Leatherback Numbers Linked to Long-term Nest Protection

The Leatherback Turtle (*Dermochelys coriacea*) is considered to be at serious risk of global extinction, despite ongoing conservation efforts. Intensive long-term monitoring of a Leatherback nesting population on Sandy Point (St. Croix, US Virgin Islands) offers a unique opportunity to quantify basic population parameters and evaluate effectiveness of nesting beach conservation practices. DUTTON ET AL. (2005. *Biological Conservation* 126: 186–194) reported a significant increase in the number of females nesting annu-



ROZENNILE SCO

Leatherbacks (*Dermochelys coriacea*) are critically endangered. Beach protection and egg relocation provide a simple and effective conservation strategy for nesting populations as long as adult survival at sea remains relatively high.

ally from ca. 18–30 in the 1980s to 186 in 2001, with a corresponding increase in annual hatchling production from ca. 2000 to over 49,000. They then analyzed resighting data from 1991 to 2001 with an open robust-design capture-mark-recapture model to estimate annual nester survival and adult abundance for this population. The expected annual survival probability was estimated at ca. 0.893 (95% CI: 0.87–0.92) and the population was estimated to be increasing ca. 1.3% pa since the early 1990s. Taken together with DNA fingerprinting that identify mother-daughter relations, their findings suggest that the increase in the size of the nesting population since 1991 was probably due to an aggressive program of

beach protection and egg relocation initiated more than 20 years ago. Beach protection and egg relocation provide a simple and effective conservation strategy for this Northern Caribbean nesting population as long as adult survival at sea remains relatively high.

### Impact of Deforestation on Lizards, Small Mammals, and Birds in Southern Madagascar

Madagascar is a global biodiversity hotspot threatened by forest loss, degradation, and fragmentation, all of which are detrimental to the future survival of forest-dwelling organisms. For conservation purposes, determining how species respond to habitat disturbance, specifically deforestation, is essential. SCOTT ET AL. (2006. *Biological Conservation* 127: 72–87) investigated the impacts of deforestation on three vertebrate communities, lizards, small mammals, and birds, in an area of spiny forest subjected to anthropogenic forest clearance. Spiny forest has high levels of endemism, but conservation in this unique ecosystem is hindered by the lack of research. The authors assessed species richness, species abundance, and community composition of lizards, small mammals, and birds in six areas of 'forest' and six 'cleared' areas. From surveys and opportunistic sightings, they recorded a total of 70 species of birds, 14 species of



MICHEL DE BOER

Oustalet's Chameleon (*Furcifer oustaleti*) is one of the world's largest chameleons and is one of the many unique species of lizards that inhabit the spiny forests of Madagascar.

mammals, and 38 species of reptiles and amphibians. They found forest clearing to have a negative effect on species richness and community structure of all groups and identified loss of canopy cover as a driving factor. However, the response and sensitivity to clearing varied between groups and species. Lizards (50%) and small mammals (40%) had the greatest decline in species richness in response to clearing as compared to birds (26%), although birds showed the greatest shift in community structure. The community in cleared areas contained more generalist and introduced species than species unique to the spiny forest. The first species to suffer from forest clearance were those of high conservation priority due to their restricted geographic range.



RICHARD DANIEL

Larger individuals of Timber Rattlesnakes (*Crotalus horridus*) were more likely than smaller snakes to avoid roads. However, 50% of snakes on the road froze for up to a minute even before vehicles passed, prolonging crossing times and magnifying susceptibility to road mortality.

**Roads and Snake Movements**

Roads affect survivorship and behavior and can act as barriers to movement, which exacerbates habitat fragmentation and disrupts landscape permeability. ANDREWS AND GIBBONS (2005. *Copeia* 2005: 772–782) conducted field experiments that demonstrated interspecific differences in snakes of the southeastern United States that encountered roads. Smaller species exhibited higher levels of road avoidance, venomous species crossed more slowly than nonvenomous forms, and three species responded to traffic by becoming immobile, which prolonged crossing times and magnified susceptibility to road mortality. All species crossed roads at perpendicular angles. Models using crossing speeds indicated that some species couldn't successfully cross roads with high traffic densities.

**Conservation and Reptilian Diversity on the Guiana Shield**

The Guiana Shield region is a biologically rich area that includes much of northeastern South America. It is strictly defined by the underlying geological formation of the same name. Total area is approximately 1,520,000 km<sup>2</sup> and portions or all of five nations are included. In their introduction to the “Checklist of the terrestrial vertebrates of the Guiana Shield,” editors HOLLOWELL AND REYNOLDS (2005. *Bulletin of the Biological Society of Washington* (13): x + 98 pp.) addressed conservation:

With the exception of a few populated localities, the environment of the Guiana Shield has benefited from limited access and low population densities, although this same isolation has hindered biodiversity research. Estimates vary, but much of the vegetation is still relatively undisturbed by human activities. Recently,

however, the pace of disturbance has greatly increased. Current threats include large-scale logging, large- and small-scale gold and diamond mining, oil prospecting, bauxite mining, hydroelectric dams, wildlife trade, and population-related pressures such as burning, grazing, agriculture, and the expansion of Amerindian villages. Taken together, these impacts have begun to take their toll, with vast areas vulnerable to increasing disturbance.

The status of conservation efforts varies by country. Throughout the Guiana Shield, many areas that are designated as protected are often only “paper” parks, because a lack of infrastructure and funds fails to protect the areas. Over the last four decades, Venezuela has established seven national parks, 29 natural monuments, and two biosphere reserves covering about 142,280 km<sup>2</sup>, more than 30% of its share of the Guiana Shield. In Guyana, the progress of conservation efforts has been slower, with only one

Number of reptilian species known to occur on the Guiana Shield: Total numbers of species listed by family, species with broadly endemic distributions within the area, and species with site-specific endemic distributions.

Family	Species	Shield-wide Endemics	Site-specific Endemics
Colubridae	104	6	15
Gymnophthalmidae	45	7	18
Iguanidae ( <i>sensu lato</i> )	32	2	9
Gekkonidae	16	4	1
Elapidae	13	4	1
Teiidae	12	1	1
Amphisbaenidae	10	3	5
Leptotyphlopidae	8	2	1
Boidae	8	1	-
Viperidae	8	-	1
Chelidae	8	1	-
Podocnemididae	6	1	-
Crocodylidae	5	1	-
Anomalepididae	4	-	1
Cheloniidae	4	-	-
Scincidae	3	1	-
Typhlopidae	3	-	-
Testudinidae	2	-	-
Dermochelyidae	1	-	-
Kinosternidae	1	-	-
Bataguridae	1	-	-
Aniliidae	1	-	-

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Three species from the Guiana Shield: *Phimophis guianensis* (left) and *Siphlophis compressus* (center) are colubrid snakes, and *Anolis (Norops) nitens* (right) is an iguanian lizard.

national park of 627 km<sup>2</sup>, about 3% of the country's area, although additional reserves are under consideration. Guyana's 3,710 km<sup>2</sup> Iwokrama Forest is dedicated to sustainable use. Surinam's protected areas system includes one national park and a network of 11 reserves, totaling almost 20,000 km<sup>2</sup>, over 12% of its total area. This includes the recently created 16,000 km<sup>2</sup> Central Surinam Nature Reserve, a UNESCO World Heritage Site that joined and expanded three existing reserves. French Guiana has no officially designated protected areas, but 18 proposed sites total 6,710 km<sup>2</sup>, about 7.5% of its area. The natural areas of Venezuela and Guyana are currently under the most anthropogenic pressure, while those of French Guiana are probably less threatened.

Cooperation among the nations with areas on the Guiana Shield is sometimes hampered by border disputes and illegal cross-border transportation of gold and wildlife. The implementation of conservation practices is further complicated by many issues concerning the indigenous peoples of the region. All of these challenges will have to be overcome on the way to designing and maintaining a viable reserve system.

ÁVILA PIRES (2005. Reptiles, pp. 24–40. In: *Bulletin of the Biological Society of Washington* (13): x + 98 pp.) listed 295 species of reptiles currently known from the Guiana Shield (see Table). When only species endemic to the region are considered, the proportion of lizards and amphisbaenians increases, whereas the proportion of snakes decreases. These differences may be real or sampling artifacts. Amphisbaenians are difficult to sample

and ranges of several species could be wider than presently known, decreasing the number of species considered to be Guiana Shield endemics. In contrast, ranges of widely distributed species of snakes are well-known and probably real, unless most currently recognized species turn out to be species complexes. Many new species remain to be discovered, especially in the highlands.

#### Variability in *Brachylophus*

Most iguanas are found in the Americas, but the genus *Brachylophus* occurs in Fiji and Tonga in the South Pacific. Effective conservation relies on understanding the relationships among the populations on

various islands, which have previously been poorly understood. BURNS ET AL. (2006. *Pacific Conservation Biology* 12:64–77) analyzed DNA samples from 35 individuals from 10 islands. They identified three forms, of which the Tonga animals were the most genetically distinct. Fijian and Tongan populations have each evolved following their separation at least 7 million years ago. The authors suggest a need to reassess conservation strategies to better reflect the greater degree of differentiation identified by this study. Most populations are small and vulnerable to introduced predators, especially cats and mongooses. Both on-site and zoo-based measures are urgently recommended.



JOE BURGESS

Fijian iguanas in the genus *Brachylophus*, like this *B. vitiensis*, may include more genetically distinct entities than previously thought.

## NEWSBRIEFS

### **Turtle Survival Alliance — 4th Annual Conference**

The Turtle Survival Alliance (TSA) is pleased to announce their 4th Annual Conference, hosted by the St. Louis Zoo on 10–13 August 2006 in St. Louis, Missouri. Expanding to a full three-day format, this will be a joint conference with the IUCN Tortoise and Freshwater Turtle Specialist Group (TFTSG). In addition to oral presentations, a special poster session/social will allow greater involvement of participants. To encourage participation by students, the Chelonian Research Foundation will award \$250 prizes for best student presentations. Attendance and presentations at the Conference are open to all interested individuals.

The keynote speaker will be Ed Moll, co-author of the book *Ecology, Exploitation, and Conservation of River Turtles*, co-author and brother Don Moll also will speak. Ed is recognized as one of the foremost leaders in turtle conservation, and “sounded the alarm” years before the Asian turtle crisis was widely publicized. He was also the first Chairman of the TFTSG. Peter Pritchard will be the banquet speaker. Additional speakers will be posted on the TSA web

site as the program develops. Registration information is available on the TSA website (<http://www.turtlesurvival.org/>).

### **Public Outraged at Assault on Sea Turtle Protection**

Public comments received by the Pacific Fisheries Management Council about its 9 March final vote to allow drift gillnets, also known as “curtains of death,” and longlines back into vast protected areas along the Pacific Coast expresses overwhelming public opposition to industry efforts to gut successful conservation measures that protected critically endangered Leatherback Sea Turtles. By the close of the 15 February public comment period, the Council received comments at a ratio of about 2,200 to 1 not to proceed with the expansion of these two destructive fishing practices that injure and kill large numbers of sea turtles, marine mammals, seabirds, and valuable non-target fish. In addition, a unique coalition of ten recreational fishing, animal welfare, and marine conservation groups with about 9 million members are working to oppose the measure.

“It’s time for the Council and NOAA Fisheries to listen to the public and enforce their mandate to protect the

public interest,” said Robert Ovetz, Ph.D., Save the Leatherback Campaign Coordinator with the Sea Turtle Restoration Project, “And the public interest is keeping Leatherback Sea Turtles and other marine species from going extinct and prevent overfishing.”

The United Nations banned drift-nets on the high seas in 1991 and the U.S. has followed with recent closures to large areas in U.S. waters, including the time and area closures along the Pacific Coast. Since 2001, areas north of Point Conception to an intersect with the Oregon coast have been closed to drift gillnet fishing from 15 August through 15 November in order to protect endangered Leatherback and Loggerhead sea turtles. During the past three years of closure, this fishery, which targets swordfish with drift gillnet gear, has had no recorded takes of Leatherback Sea Turtles. Longline fishing, which is also one of the main threats to Leatherback Sea Turtles, was banned along the U.S. West Coast in 2004.

Since 2002, 64 dolphins, whales, seals, and sea lions have been killed by the drift gillnet fishery in the West Coast areas still open to gillnetting. Additionally, seabirds including Northern Fulmars and Cassin’s Auklet have been injured or killed.

The proposed exemption would allow as many as two-thirds of the remaining 36 drift-gillnet vessels and between 71 and 131 longline vessels into the closed areas. “Drift-gillnet and longlines are subsidized unprofitable industries looking for a hand-out at the expense of endangered species like Leatherback Sea Turtles, Humpback Whales, and sharks. The public has spoken. It’s time for the government to listen,” added Ovetz.

Resources include the scientist letter ([http://www.seaturtles.org/pdf/\\_\\_\\_Scient.ltr.PFMC.final.pdf](http://www.seaturtles.org/pdf/___Scient.ltr.PFMC.final.pdf)), the NGO coalition letter ([http://www.seaturtles.org/pdf/\\_NGO.letter.2.final.pdf](http://www.seaturtles.org/pdf/_NGO.letter.2.final.pdf)), and information about the Pacific Fisheries Management Council meeting (<http://www.pcouncil.org/bb/2005/bb1105.html>).

Robert Ovetz ([robert@seaturtles.org](mailto:robert@seaturtles.org))  
Sea Turtle Restoration Project  
2 March 2006



BRIAN HOWME

The Indian Red-crowned Roofed Turtle (*Kachuga kachuga*) is one of many Asian Turtle species that will be discussed at the August TSA Conference.

## Roti Island Snake-necked Turtles All but Extinct

The Roti Island Snake-necked Turtle (*Chelodina mccordi*) is a small, long-necked turtle found only in the wetlands of Roti Island in eastern Indonesia. Since this endemic turtle was described as a new species in 1994, international demand for it has intensified to the point where the species has become all but extinct in the wild. No legal trade of this species from Indonesia has been allowed since 2001. Prior to its description, it was exported illegally as another species, the New Guinea Snake-necked Turtle (*C. novaeguineae*), which has been protected in Indonesia since 1980.

A new TRAFFIC report determined that the capture and trade of these animals has not been carried out in accordance with relevant Indonesian laws.



BONGGI IBARRONDO



BONGGI IBARRONDO



CHRIS R. SHEPHERD

Roti Island Snake-necked Turtles (*Chelodina mccordi*) are found only in the wetlands of Roti Island in eastern Indonesia.



BONGGI IBARRONDO

A trap used to capture *Chelonia mccordi* in a freshwater swamp on Roti Island.

Despite national quotas set for harvest and export of *C. mccordi* between 1997 and 2001, no licenses for collection or transport permits have been issued to date. All specimens of *C. mccordi* that have been exported since 1994 have been illegally acquired.

In 2000, the IUCN Red List categorized the species as “Critically Endangered,” and the Roti Island Snake-necked Turtle was assessed as commercially extinct that same year. The species is listed in Appendix II of CITES, which requires any international trade to be carried out under a permitting system.

However, the continuing international demand from hobbyists and collectors in Europe, North America, and eastern Asia is pushing this endemic species toward extinction. Even if *C. mccordi* is added to the Indonesian list of protected species, monitoring and enforcement of existing laws are lacking and, in some places, non-existent. If these laws, such as those governing capture and transport of wildlife, are not enforced, this species will surely become extinct in the wild in the very near future.

Chris R. Shepherd  
www.traffic.org  
Jakarta, Indonesia  
2 February 2006

### Fear for the Turtle

Worried that a growing market for the meat of Diamondback Terrapins may

wipe out a symbol of Maryland, some state legislators are proposing to outlaw harvesting the turtle in the Chesapeake Bay.

But watermen and the state Department of Natural Resources are fighting an outright ban, arguing that terrapins are not endangered and that more modest state regulations restricting the catch would make more sense.

“I think this subject is important because the terrapin is in decline once again,” said Del. Virginia P. Claggett, an Anne Arundel Democrat who is one of 18 sponsors of House Bill 980, which would prohibit the catching of terrapins. “Any species lost is a real loss, but this also happens to be the state icon.”

Claggett said she finds it frustrating that neighboring Virginia — which does not feature the “Terp” as the proud mascot of its state university — outlaws the commercial harvest of terrapins, but Maryland does not. “If they can do it, we can do it,” she said.

At the center of the debate, which flared before the House Environmental Matters Committee recently, is the unanswered question of how many terrapins still swim in the bay, and whether their numbers are really falling or rising.

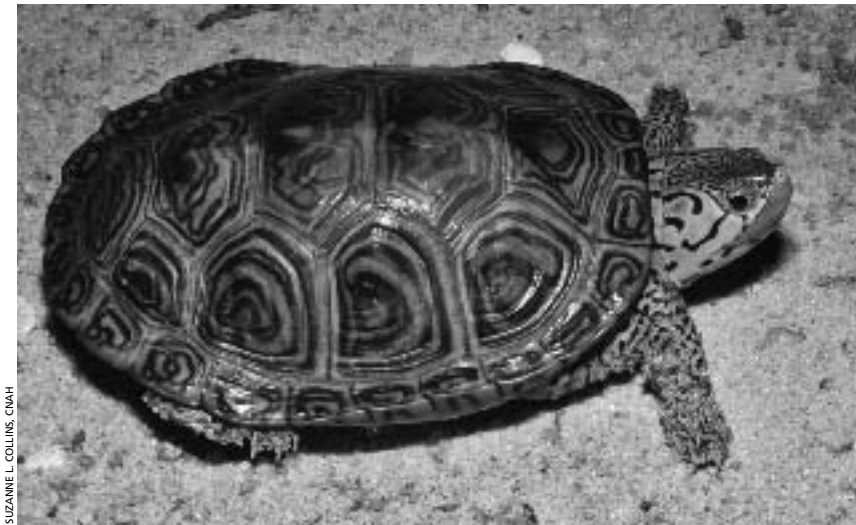
The shy reptiles — up to 9 inches long, with distinctive diamond-shaped growth rings on their shells — live in coastal waters from Massachusetts to Texas, but historically have been found in greatest numbers in the Chesapeake Bay. Considered a delicacy in soup, they were harvested nearly to extinction at the end of the 19th century.

Howard King, director of fisheries at the DNR, said that perhaps hundreds of thousands of terrapins remain in the Maryland portion of the bay. Local watermen, who often catch them in their fishing nets by accident, sell between 5,000 and 12,000 pounds of the turtles every year, King said. The turtles weigh between 1 and 4 pounds each.

More than 2,000 watermen have licenses from the state that allow the catching of the turtles, as well as other marine life. But only five to nine watermen specialize in catching terrapins, mostly around Smith Island and Tangier Sound, King said.

The state imposes no limit on the number of terrapins that a person with a license can catch, and the season lasts





SUZANNE L. COLLINS, CH2AH

Marguerite Whilden, a former DNR fisheries manager who now directs a nonprofit conservation organization called the Terrapin Institute, estimates that as many as 20,000 Diamondback Terrapins (*Malaclemys terrapin*) have been netted in the Chesapeake Bay in the last two years, and that perhaps only 35,000 remain.

three-quarters of the year, from 1 August through 30 April.

As an alternative to a moratorium imposed by legislation, the Department of Natural Resources may propose limiting the season, capping the catch or reducing the number of watermen with terrapin licenses, King said.

"It's hard to tell if they are declining or not," King said. "The terrapin issue is certainly not critical. They deserve conservation, but the population is not at a critically low level."

Marguerite Whilden, a former DNR fisheries manager who now directs a nonprofit conservation organization called the Terrapin Institute, says a growing market for terrapin meat among Chinese restaurants and consumers in Asia is a threat to the turtles.

She estimates that as many as 20,000 terrapins have been netted in the Chesapeake Bay in the last two years, and that perhaps only 35,000 remain.

"We used to be called the Terrapin State. It's an embarrassment that we've been so complacent, and that they are much more concerned about the terrapin in Virginia," Whilden said. "It's a very persistent creature, but once it's gone, it's gone. It can't be raised from the dead."

Her organization is offering to buy terrapins from watermen at market rate — which is about \$4–6 per turtle — so she can return them to the bay. If the state bans terrapin harvesting altogether,

Whilden said, her organization would pay to compensate the watermen.

Larry Simns, president of the Maryland Watermen's Association, said he would support capping terrapin harvests at current levels, but not outlawing catching them. "I think terrapins have been doing better the last five or six years. They're not threatened at all," Simns said. "Every time you lose part of your paycheck, it hurts."

Tom Pelton  
*Baltimore Sun*  
21 March 2006

### Dogs Kill Blue Iguanas

Two Cayman Blue Iguanas (*Cyclura lewisi*) were killed at the Queen Elizabeth II Botanic Park this week, a pregnant female has been mauled, and a fourth iguana is missing. Wild dogs caused the casualties.

Fred Burton, director of the Blue Iguana Recovery Program, identified the dead iguanas as Slugger and Sapphire, both pioneers in the Program to help bring the Blues back from near-extinction. "These two were the most photographed iguanas on the planet," Mr. Burton said. He explained that they were both born in captivity in 1997 and released into the 65-acre park in 1999. "They were not tame, but they were not afraid of people. They were like ambassa-

dors. Thousands of visitors admired them and took their pictures, which are now all over the world," Mr. Burton said.

Another 26 Blue Iguanas roam freely in the park, he indicated. The deaths highlight what could be a long-term problem for the park and a situation with irresponsible pet owners.

Slugger was buried Tuesday morning while park staff and iguana volunteers continued to look for his mate, Yellow-Blue, who was not in her nesting area. She came back late Tuesday, badly injured but determined to finish nesting, Mr. Burton said. She is missing half of her tail and her back right foot. She is expected to lay her eggs in the next few days. Until then, Mr. Burton is reluctant to interfere. Iguanas have an amazing immune system and the risk of infection is not great, he said. After she finishes preparing her nest, she will go underground for a few days. When the eggs are laid, she will come out and go on a feeding spree and Mr. Burton will look at her more closely then. Right now, it's better to let nature take its course.

But a fourth iguana, Santa, has been missing for several weeks and Mr. Burton wonders if he was an earlier victim to the dogs.

The problem was realized in earnest Monday morning, when a staff member was checking the grounds before the park opened to the public. He noticed two dogs down by the lake and went to chase them away. They ran into the bush in the east and it was then he found Sapphire. She was badly bitten and died a couple of hours later.



Fred Burton examines Slugger on the Botanic Park facility's porch where Slugger was observed regularly.

“This was a red alert,” Mr. Burton said. The Department of Agriculture was contacted and officers took another dog trap to the park to go with the one already on the premises. On Monday night the traps were set and Mr. Burton waited until the iguanas went into their retreats. Slugger liked to spend the night under a plywood ramp leading to public toilets near the iguana facility and Mr. Burton saw him go there around sundown.

It rained Tuesday night and the bait probably washed out of the dog traps, he said. On Tuesday morning, Chris Carr came early to check the traps. Instead, he saw digging marks by the ramp. He checked more closely and saw two dogs under the toilet building with an iguana. Mr. Carr was able to retrieve the iguana. It was Slugger, and he was dead.

Mr. Burton said Slugger would not have been afraid of the dogs, probably

never having seen one before. “He was the dominant male in the area. He would have stayed and fought,” he said. Although he was the largest iguana in the park at over 17 pounds, he was no match for the dogs. “If we succeed in catching the dogs, we’ll have to put them down,” Mr. Burton said. It was not clear whether they belonged to anyone. They did not have collars and did not act as if they had any training, he indicated.

But along with the dogs, irresponsible pet owners are causing another monstrous problem for the wildlife in the park. “Well-meaning people are bringing animals to the park and abandoning them, thinking park staff will be kind to animals. We have found kittens, full-grown cats, puppies, and Green Iguanas (*Iguana iguana*), and we have absolutely no option but to trap them and remove them. “They have no place here and

they’re damaging the native wildlife we’re trying so hard to protect,” Mr. Burton said.

Especially worrisome are the Green Iguanas. People think they’re cute when they’re little. But then they grow into big lizards and the owner doesn’t want them any more. The Green Iguanas – with definite black stripes on the tail – are not native to Cayman, he emphasized. They don’t belong here and they are a threat to the vulnerable Blues.

If anything good can come out of this experience, maybe it could be people’s increased awareness of what happens when they allow their pets to roam or when they drop off unwanted animals. “Please don’t bring animals to the park. It’s not a home for them,” he urged.

Carol Winker

Cayman Webnet, 7 June 2006

## O B I T U A R Y

### Ronald Goellner (1945–2006)

With great sadness I report the death of Ron Goellner, Director of Animal Collections at the Saint Louis Zoo. Ron passed away early in the morning of 26 February 2006, in the comfort of his home and with his loving wife Karen at his side. The entire Saint Louis Zoo community is profoundly saddened by the loss of a man who touched the lives of so many, yet we know that Ron would be the first to tell us to “keep smilin’.” You cannot conjure memories of Ron and not follow his advice, because he sowed smiles wherever he went.



Ron Goellner, here holding a Hellbender (*Cryptobranchus alleganiensis*), founded the Center for Hellbender Conservation. Photograph courtesy of the St. Louis Zoo.

Born 4 November 1945, Ron’s career at the Saint Louis Zoo spanned 35 years. He started in the Reptile House in 1970 as a keeper and, within a few years, was promoted to Curator of Reptiles, a position he held until 1995. For the past ten years, Ron served as the Director of Animal Collections for the zoo. Although Ron was intensely interested in all reptiles and amphibians, his true passions were Tuataras and Hellbenders. In 1980, Ron traveled to Stephen’s Island in New Zealand to collect environmental data that could be utilized in the construction of a new off-exhibit enclosure for the Zoo’s Tuatara group, which has been in the collection since 1973. In recent years, Ron founded the Center for Hellbender Conservation, which included the construction of a dedicated off-exhibit facility for captive propagation efforts. In addition, he established valuable links with the Missouri Department of Conservation and researchers at universities in order to implement cooperative *in situ* initiatives for the Hellbender in Missouri.

Ron was an avid gardener and had built several ponds around his house to attract local amphibians. He enjoyed a wide array of outdoor activities and particularly loved camping in the Big Bend region of Texas and the mountains of southeastern Arizona.

Ron was my mentor and colleague, but most of all he was a dear friend whom I will miss very much.

Jeff Ertling

Curator of Herpetology  
Saint Louis Zoo

## IRCF ON THE MOVE

### Governor's Reception

In honor of the Blue Iguana Recovery Program, His Excellency the Governor of the Cayman Islands, Mr. Stuart Jack, CVO, and Mrs. Mariko Jack held a reception at the Government House on Grand Cayman on 9 May 2006. In attendance were the Blue Iguana Recovery Program's staff and volunteers, the National Trust for the Cayman Islands, the Cayman Islands Government's Departments of Environment, Tourism, Education, and Agriculture, local sponsors, and supporters. From the UK, Quentin Bloxam represented the Durrell Wildlife Conservation Trust, accompanied by DWCT Board members and supporters. Representing the International Reptile Conservation Foundation were John and Sandy Binns, and Joel Friesch.

Speeches by His Excellency, Governor Jack, Fred Burton, and Quentin Bloxam expressed gratitude to all the people and organizations that have supported the Program over the years. Looking forward, Bloxam indicated that protected status for the specialized habitat and the Blue Iguanas now residing in Cayman's East End is an important next step in the recovery Plan and urged all those able to influence such a decision to provide support.

The IRCF acknowledges and is grateful for the accommodations supplied by Teresa Foster of the Grand Caymanian Resort ([www.grandcaymanian.ky](http://www.grandcaymanian.ky)). All speeches in their entirety will be available for download on the new IRCF website in the weeks to come.



JOEL FRIESCH

John and Sandy Binns meet the governor.



JOHN BINNS

Chris Carr of the BIRP staff dressed elegantly for the Governor's reception.

### Project Heloderma

The IRCF is proud to partner with Zootropic, Fundación Defensores de la Naturaleza, Guatemala, CONAP, Zoo Atlanta, and The Nature Conservancy in supporting Project Heloderma (see Conservation Focus, p.176), which is focused primarily on the preservation of the Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*). With fewer than 200 individuals remaining in a tiny amount of specialized habitat, this unique subspecies has become one of the most endangered reptiles in the world. The project is part of a conservation effort to



© 2006 PHOTO COURTESY OF STEPHANIE SCANLIN / ZOO ATLANTA

Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*).

preserve the remaining dry forest habitat of the Motagua Valley in Guatemala.

To support Project Heloderma, the IRCF is developing a content-rich website to promote the project. This will include a donation-support program that will be a major tax-deductible donation port for U.S. donors. The site also features information on both species of *Heloderma* plus a section dedicated to support of the upcoming 2006 National Reptile Breeder's Expo auction to benefit the Guatemalan Beaded Lizard.

**Rob Dorson Memorial Trust**

The IRCF has received a \$6,500 donation from the Rob Dorson Memorial Trust to be applied toward the Blue Iguana Recovery Program. We are grateful to the friends and family of Rob Dorson, especially Marilyn, Lee, and Jill Dorson, for their ongoing support in honor of their son and brother who passionately loved Blue Iguanas.

**Andros Iguanas Football Club**

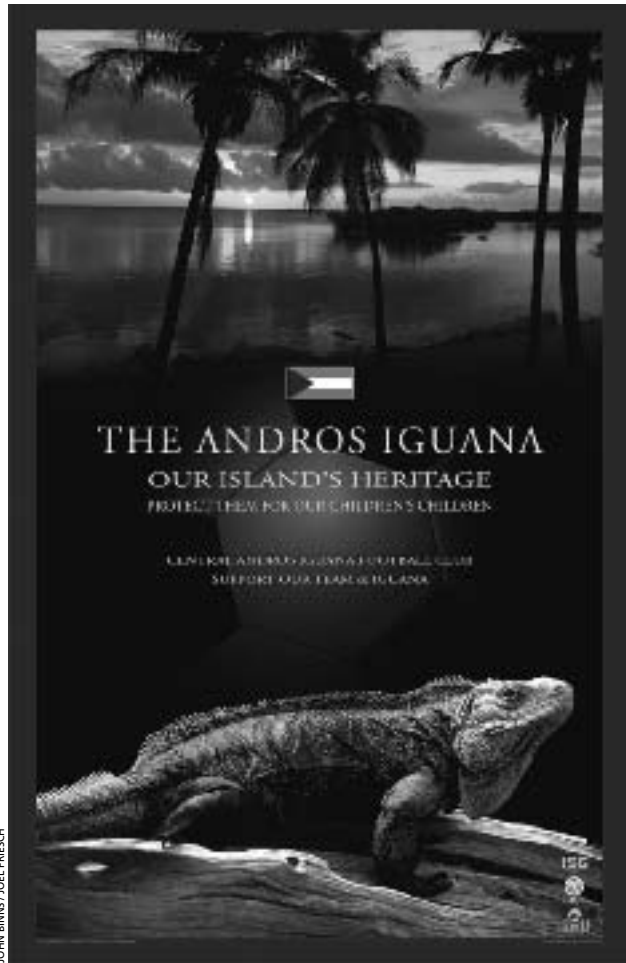
Ricardo Johnson, team coach, reports the Andros Iguana Football teams did well in the Nassau Games, returning with many medals. "All of us came back with an experience that makes us proud to be Iguanas," he commented.

Ricardo reports that the team has expanded to 40 members and now has eight coaches on staff. The next phase is to start a

13-year-old and under team to launch into another dimension. To meet this expansion, the IRCF and Shedd Aquarium, through the efforts of Chuck Knapp, are in the process of creating another shipment of team jerseys. Those interested in contributing to this winning team, all of whom are iguana conservation-minded spokespeople on Andros, please contact John Binns at JFB@IRCF.org

**IRCF Helps Out**

This past March, the Mid-Michigan Reptile Rescue took in 27 assorted varanids (*Varanus*), tegus (*Tupinambis*), and Rock Iguanas (*Cyclura*), many of them extremely thin and dehydrated. All had been in the possession of a Detroit resident, who passed away without leaving any instructions or provisions for their placement. To help buffer the expense of caring for these rescued animals, the IRCF donated \$500 and rallied other IRCF members for donations. Answering the call for assistance, IRCF members Mark Malfati (West Coast Iguana Research), Desiree Wong (IRCF Public Relations), Kathryn Tosney, Ella Marie Poyner, and Jerod Rice amassed \$1,065 in aid. Thank you contributors!



JOHN BINNS / JOEL FRIESCH

Prior to the Nassau Games, the IRCF created this special poster for the event and printed a limited quantity for distribution.



KIRBY METCALF

Rhinoceros Iguanas (*Cyclura cornuta*) at the Dallas Zoo.



KIRBY METCALF

Interpretive sign at the Dallas Zoo, with remaining-numbers poster on right.

**IRCF Poster Used in Dallas Zoo Interpretive Display**

The Dallas Zoo incorporated the IRCF remaining-numbers poster in a new interpretive display near their *Cyclura cornuta* exhibit. Joel Friesch's Rhinoceros Iguana sculpture is also a part of the display, but had not yet been erected when the photo was taken.

**New Addition to the Blue Iguana Website**

The IRCF has been developing an online sponsorship program for the Blue Iguana Recovery Program and it is now in the final testing stages and scheduled for launch very soon. The sponsorship program allows visitors to the Blue Iguana website (www.BlueIguana.ky) to review catalogs of animals available for sponsorship on a yearly basis. Once a selection (and optional items, such as naming the animal for life) has been made, the program generates an official personalized sponsorship certificate embedded with a photo of the sponsored Blue Iguana, a custom photograph, and other optional items, and sends the sponsor a download link for retrieval. The program tracks the sponsorship duration and automatically notifies the sponsor when renewals are due.

**New IRCF Website**

IRCF software developers are creating an updated, dynamic, and informative website. Development is progressing rapidly; we are now incorporating content and plan to launch soon.

**Educational Poster for the Indianapolis Zoo**

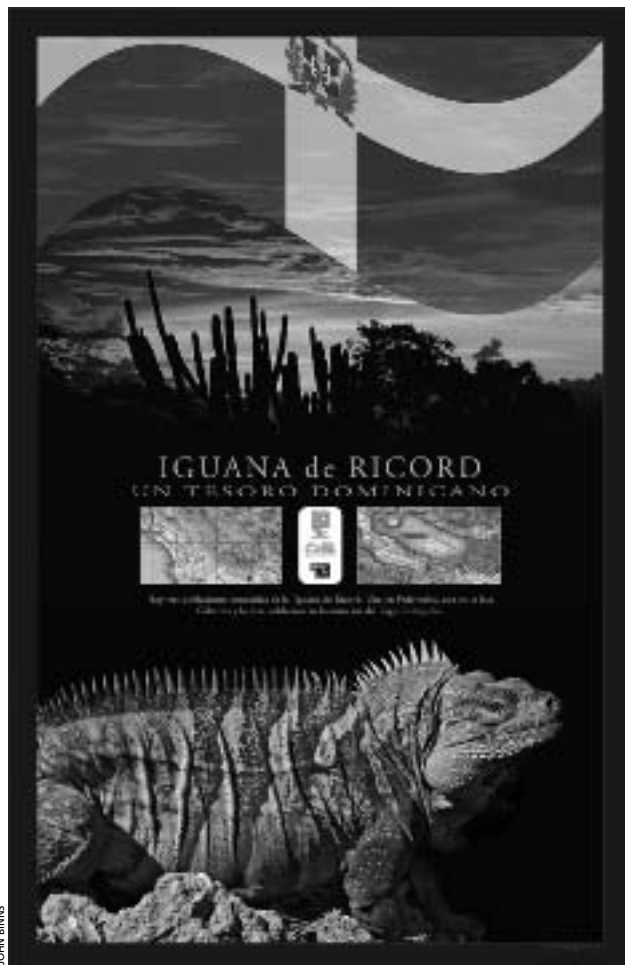
As part of our commitment to support iguana conservation awareness, the IRCF donated creative resources to assist Indianapolis Zoo's Ricord's Iguana conservation efforts in the Dominican Republic. In addition, the IRCF sent 50 copies of Volume 12, Number 4, Special Emphasis on the Dominican Republic, to the Dominican Republic for distribution.



Blue Iguana Recovery Program sponsorship page.



Blue Iguana Sponsorship Certificate.

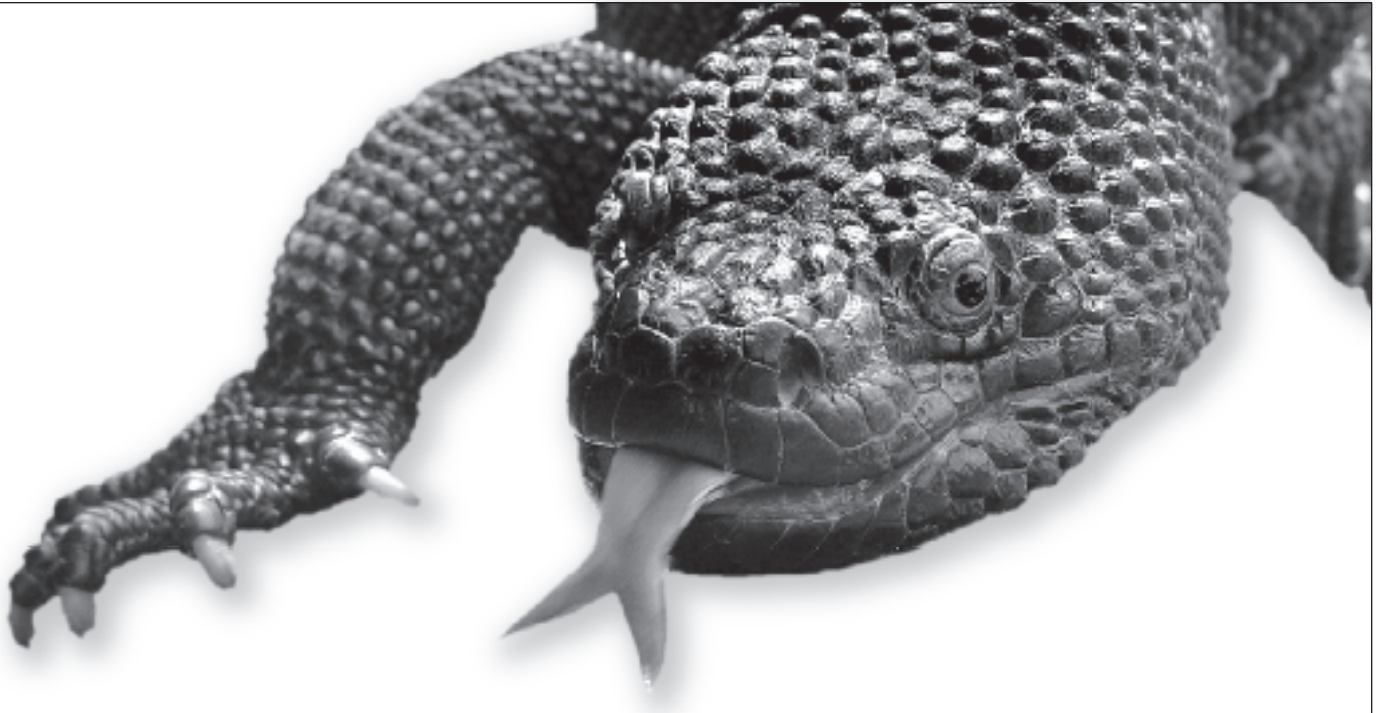


Poster about Ricord's Iguana (*Cyclura ricordii*) conservation efforts at the Indianapolis Zoo.



New IRCF Main Page.





*Zoo Atlanta and The International Reptile Conservation Foundation Proudly Sponsor*

## **2006 NATIONAL REPTILE BREEDERS EXPO AUCTION**

*TO BENEFIT THE*

### **Guatemalan Beaded Lizard of the Motagua Valley**

Both Zoo Atlanta and The International Reptile Conservation Foundation (IRCF) are 501 (c)(3) not for profit corporations whose mission is to conserve reptiles and the natural habitats and ecosystems that support them. The 2006 National Reptile Breeders Expo Auction proceeds will be awarded directly to conservation projects for the Guatemalan Beaded Lizard. Specifically, funding will go towards a natural history study that will help define critical habitat needs of the Guatemalan Beaded Lizard; expansion of a successful education program to include the residents of villages surrounding the Motagua Valley, and towards construction of an in-country breeding facility.

Volunteers from the IRCF and the zoo community will be available to pick up contributions from vendors on Saturday, August 19 for the auction to be held that evening at the Daytona Hilton with Dave Barker hosting. Receipts for your tax-deductible contributions will be issued at that time. To make a tax-deductible donation or view available items prior to the Expo, please visit [www.IRCF.org/projectheloderma](http://www.IRCF.org/projectheloderma)

The Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*) is endemic to the Motagua Valley of Guatemala and is one of the most endangered species of lizard on earth. Its population numbers have been drastically reduced by human encroachment on their habitat. Negative myths about the dangers posed by this venomous lizard have led to killing by local residents and a number of specimens have been collected illegally for the black market animal trade. Estimates place the remaining wild population number at fewer than 200 individuals. The government of Guatemala has just petitioned to have the status of this critically endangered species elevated to the protection afforded by CITES Appendix I.

For direct volunteer and donation information please contact Sandy Binns at [SB@IRCF.org](mailto:SB@IRCF.org)



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## Editor's Remarks

As readers have hopefully noticed, *Iguana* is constantly changing. Over the past few issues, we have expanded our attention to all reptilian species while retaining a focus on conservation. We are committed to maintaining a strong interest in iguanas and will continue to present features such as *IRCF on the Move* in this and future issues. Our expanded goal, however, is more ambitious: We hope to provide a bridge between reptile enthusiasts and herpetological professionals. After all, much of conservation is about people, who create the problems but also hold the solutions. Without a broad base of committed public support and involvement, conservation will not happen. Without access to information, the public cannot become interested or informed. We hope we can continue to address this need, but we need your input. If you have issues you would like to see covered, let us know. If you are working on a conservation project that affects reptiles, write an article for us — and, if you enjoy reading this magazine and share our mission, please see if you can get a friend to join the IRCF.

Gad Perry

## Statement of Purpose

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

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

## Membership Information

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Additional copies are available upon request at \$6.00 each plus postage.

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

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

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## Membership Questions?

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

## Solicitations

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

## Donations

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

## Advertising Policy

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

# FOCUS ON CONSERVATION

## Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*)

### Project Heloderma

**Extinction Imminent.** The Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*), endemic to the arid, desert region of southeastern Guatemala's Motagua Valley, is one of the most endangered reptiles in the world. First seen by scientists in 1984 and formally described in 1988, only a decade later the species was thought to be extinct in the wild. In 2002, a few individuals were found and limited studies obtained the first, sparse data on their lives in the wild, but most of this creature's life history remains a mystery.

The Motagua Valley is a small sliver of desert habitat, isolated on all sides by massive cloud-forested mountains and rainforested valleys. These Guatemalan lizards have evidently existed in total isolation for many thousands of years. Deforestation for cantaloupe, tobacco, and milpa (feed corn) farming has reduced the already tiny amount of suitable habitat for this species to about 16,200 ha and estimates suggest that this is sufficient to sustain at most 150–200 individuals. Negative myths and attitudes have long led local people to kill these venomous lizards on sight. Also, the rarity of this subspecies in particular and the rising popularity of Beaded Lizards and Gila Monsters (*H. suspectum*) as captives have led to exploitation for the pet trade. Estimates suggest that approximately 35 individuals were captured and sold abroad during the 1990s.

With the recent rediscovery of the species and two natural history studies performed with support of Zootropic, an interested NGO, the government of Guatemala has shown interest in protecting these animals and their habitat. In addition, Zootropic has launched an educational campaign targeting villagers in areas surrounding Beaded Lizard habitat. Since 2004, no reports exist of lizards being killed or sold. Studies are needed and planned to answer basic questions concerning critical habitat needs. Resultant data will be used to guide land preservation decisions. A proposed breeding facility in the Motagua Valley is needed, and any young animals produced would be slated for attempted reintroduction into protected habitat.

**How You Can Help:** With fewer than 200 individual Guatemalan Beaded Lizards remaining, your help is desperately needed to save these unique creatures. Wayne Hill and the National Reptile Breeder's Expo will be donating all proceeds from this year's annual auction to "Project Heloderma." To make this auction the greatest success possible, we need auction items. Monies collected for this fund will go only to efforts to save the Guatemalan Beaded Lizard, specifically to fund conservation research projects, raise awareness within its home range about its plight, and build an in-country breeding facility. For more information, to volunteer, or to donate auction items, please log on to:



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This illustration of a *Flugdrache* (= Flying Dragon) is a Gliding Lizard (genus *Draco*). The plate is from Alfred Brehm's *Tierleben* (= Animal Life), volume 2, *Kriechtiere* (= Reptiles), by Franz Werner, published by the Bibliographisches Institut, Leipzig and Vienna, 1913. The artist is Josef Fleishmann of Vienna. The lizards in the figure were identified as *D. volans*, but may actually represent a population formerly assigned to that species but now recognized as a distinct form. Book plate courtesy of Thomas Wiewandt. Bibliographic information courtesy of Kraig Adler, Cornell University.





The Jamo Negro (*Ctenosaura melanosterna*) has been hunted almost to extinction in Honduras (see article on p. 130).