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IGUANA

CONSERVATION, NATURAL HISTORY, AND HUSBANDRY OF REPTILES

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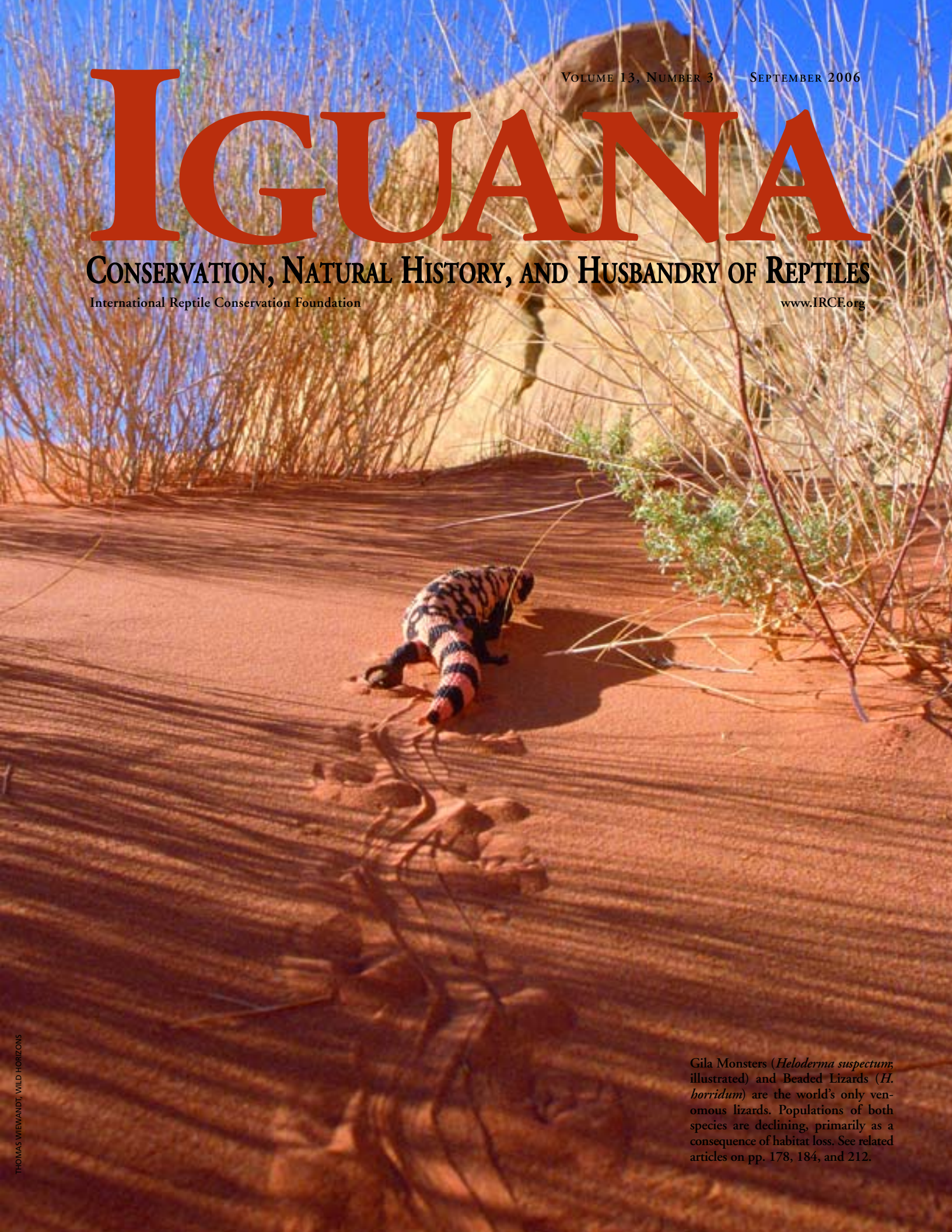

THOMAS WIEWANDT, WILD HORIZONS

Gila Monsters (*Heloderma suspectum*; illustrated) and Beaded Lizards (*H. horridum*) are the world's only venomous lizards. Populations of both species are declining, primarily as a consequence of habitat loss. See related articles on pp. 178, 184, and 212.

ZOOTROPIC

The critically endangered Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*) is restricted to forest remnants in the Motagua Valley (see articles on pp. 178, 184, and 212).

JEFF SCHMATZ, MODIS, NASA/GSFC

Many aspects of the Fijian Crested Iguana's (*Brachylophus vitiensis*) biology remain unknown, mostly because of the remoteness of the uninhabited Iguana Sanctuary Island of Yadua Taba (see article on p. 192).

JOSEPH BURGESS

Green Anoles (*Anolis carolinensis*) were first reported on O'ahu in 1950, and now occur on all of the major Hawaiian Islands. A recent introduction to Coconut Island (off O'ahu) apparently failed (see article on p. 198).

NÉSTOR F. PÉREZ-BUITRAGO

In March 2006, an adult female Cuban Iguana (*Cyclura nubila*) in a population established on Isla Magueyes, Puerto Rico, chased, caught, and ate a conspecific hatchling (see article on p. 206).

JOSEPH M. POLANCO

Ovulation in Emerald Treeboas (*Corallus caninus*) follows some time after the cessation of breeding activity. During ovulation, many females hang grossly distended midbody loops off their perches (see article on p. 209).

GAD PERRY

Brown Treesnakes (*Boiga irregularis*) have caused the elimination of most of Guam's native forest birds, and decimated other birds, lizards, and mammals (see travelogue on p. 216).

WENDY HODGES

Populations of the Texas Horned Lizard (*Phrynosoma cornutum*) have disappeared in eastern and central Texas, and are decreasing in other areas (see "Historical Perspectives" on p. 224 and the "Focus on Conservation" on p. 240).

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JOHN BINNS

A Rhinoceros Iguana (*Cyclura cornuta*) at ZooDom (Parque Zoológico Nacional, the National Zoo of the Dominican Republic). When basking, lizards often sprawl to get as much surface in contact with the warm substrate as possible. The considerable volume and relatively limited surface through which heat can be absorbed result in high thermal inertia for especially the larger species. Consequently, iguanas and other lizards of comparable body sizes do everything they can to acquire heat from all possible sources.

TOMMY OWENS, SAN DIEGO ZOO

Guatemalan Beaded Lizards (*Heloderma horridum charlesbogerti*) are endemic to the semiarid Motagua Valley in Guatemala.

The Guatemalan Beaded Lizard: Endangered Inhabitant of a Unique Ecosystem

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Photographs by the author except where indicated.

The semiarid Motagua Valley in Guatemala is one of the most endangered and unique ecosystems in the world. This region receives the lowest average rainfall in Central America (ca. 500 mm) and is characterized by many endemic species. This region once occupied about 200,000 ha, most of which is now a heterogeneous landscape of crops, grasslands, thornscrub, and very dry deciduous forest remnants. The latter are home to the very rarely encountered endemic Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*).

Natural History

The Guatemalan Beaded Lizard, which (in conjunction with *H. h. alvarezi*) may actually represent a distinct species, is restricted to forest remnants in the Motagua Valley. The Beaded Lizards and Gila Monsters (*H. suspectum*) comprise the Helodermatidae, a unique family of lizards with venom glands. Although the subspecies *H. h. charlesbogerti* was described in 1988, it had not been studied until very recently.

This species reduces its activity drastically during the dry season (December to May), when individuals remain almost constantly concealed in subterranean shelters that provide protection from extreme temperatures and desiccation. Suitable shelters are limited resources in the remaining forests and may limit population size. Recent estimates, based on average home-range sizes of this and other subspecies and on remaining available habitat, suggest that only 200–250 individuals remain in the wild.

Only 24,000 ha of suitable habitat remain, and these are comprised of patches ranging in size from < 1 ha to around 1,500 ha. If only those patches of > 100 ha are considered, the potential distribution of these lizards is reduced to 17,000 ha. This area comprises the localities of Cabañas, Usumatlán, and Gualán in the Zacapa Department, and El Jicaro in the El Progreso Department, in the semiarid region of the Motagua Valley in Guatemala.

Conservation Status

The Guatemalan Beaded Lizard is almost certainly the most endangered species in Guatemala. It is listed in CITES Appendix II and as vulnerable in the IUCN Red List of Threatened species. The greatest threats to its continued existence are agricultural practices not compatible with conserva-

A female Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*) in the wild.

tion, illegal extraction for local and international collectors, and persecution by local people, who consider it to be dangerous. From 1994–2000, an estimated 30 animals were illegally collected, and, from 2000–2001, local people at only one locality killed 11 lizards.

Another factor that may have had a negative impact on wild populations of *H. h. charlesbogerti* was Hurricane Mitch in November 1998. Vast zones of the most arid portions of the Motagua Valley were flooded that year, causing considerable damage to the human population and to the wildlife of the region. Late October-early November is the beginning of the egg-laying season for Beaded Lizards, and the eggs are known to be very sensitive to humidity. A number of clutches may well have been lost or failed to hatch because of floods. Unfortunately, no baseline data existed at that time, so the impact on wild populations cannot be evaluated.

L. MELENDEZ, ZOOTROPIC

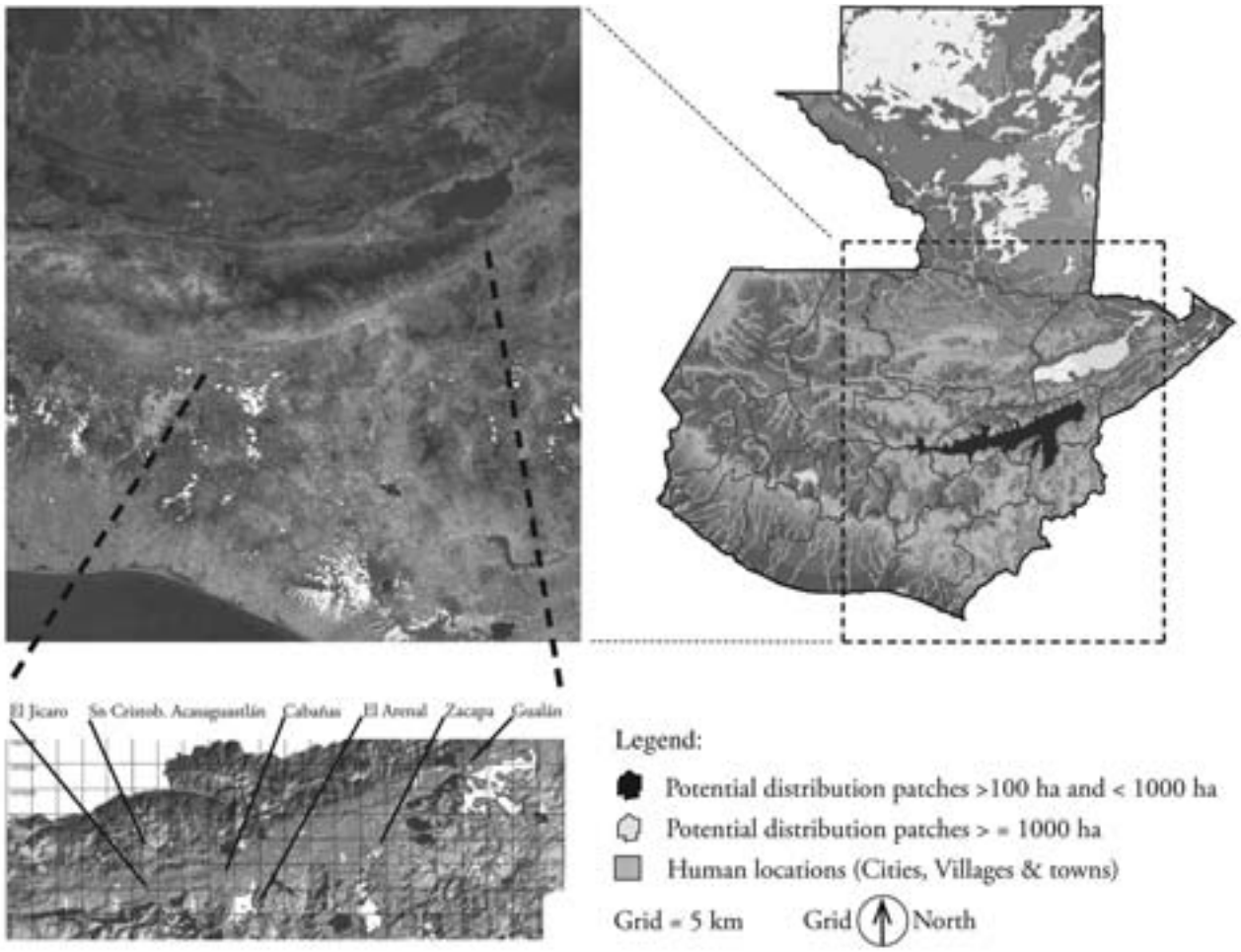
Land-use changes within the distribution of *Heloderma horridum charlesbogerti*: Changes are primarily attributable to production of commercial crops like melon (top) and subsistence crops like corn (bottom).

L. MELENDEZ, ZOOTROPIC

Guatemalan Beaded Lizards (*Heloderma horridum charlesbogerti*) emerging from and resting in subterranean shelters.

Conservation Efforts

Since the initiation of intensive studies in 2002, conservation efforts have increased, in part because of an increased public awareness regarding the threatened status of the species. These efforts have been led by a local NGO, "Zootropic." The program is constituted of four basic elements: (1) education, (2) applied scientific research, (3) habitat conservation, and (4) development of conservation policies for this species. Research has focused on determining distribution, the nature and cause of threats, the basic biology of the species, movement patterns, shelter use and their availability as a limiting resource, and characterization of venom. The education program has been ongoing since mid-2003 in localities where this species occurs and in coordination with local authorities and local partners of Zootropic. The habitat conservation component has two approaches: (1) conservation of private lands by commitment of owners to preserve forest remnants and (2) an official declaration of municipal, communal, and private natural reserves as



Potential distribution of *Heloderma horridum charlesbogerti* in the semiarid Motagua Valley in Guatemala (indicated by the shaded area on the map). Determination of the potential distribution took into account historical and recent collection sites, land use patterns, rainfall and temperature data, forest types, and distances to human settlements.

part of the Guatemalan protected areas system. Finally, Zootropic has promoted and coordinated the planning of a national strategy for Guatemalan Beaded Lizard conservation with the support of The Nature Conservancy. This conservation plan was generated in collaboration with local and international experts representing 16 institutions, including the National Council of Protected Areas (CONAP), which is Guatemala's official institution in charge of biodiversity conservation.

Local People: Poachers and Conservationists

Considering that two of the most serious threats to the species are illegal trade and extermination, environmental education has been strongly emphasized. This program actively engages local people, some of whom were poachers of *Heloderma* in the past. Today, they are proud conservationists. Demonstrating the uniqueness and importance of conserving this species, locals have learned that many of the myths associated with the species were not true. Some individuals have learned to use the radiotelemetry equipment and implement basic research techniques. The principal objective of this involvement is to incorporate members of the community in the research in order to instill an appreciation for this species. Only with a strong relationship between locals and scientific researchers is an understanding of the importance of the project possible. These people now function as promoters of the conservation plan within their own communities.

L. MELENDEZ, ZOOTROPIC

Current research is using radiotelemetry to reveal movement patterns and shelter selection in the wild

A *Heloderma horridum charlesbogerti* with a radiotransmiter is entering a subterranean shelter.

L. MELENDEZ, ZOOTROPIC

A. GONZALES, ZOOTROPIC

The environmental education program addresses local farmers (top) and school children (bottom).

A group of local and international experts (representing 16 institutions) are collectively responsible for the National Strategy for Guatemalan Beaded Lizard Conservation.

Next Steps

In spite of strong conservation efforts already implemented, gaps still exist in the data. Very little is known, for instance, about the species' ecology, characteristics of the nests, and which specific physical factors affect shelter selection. Reproductive behavior has not been observed or documented in the wild. Such data are of great importance for implementing *ex situ* and *in situ* conservation strategies. Also, emphasis continues on strengthening environmental education programs and continuing to promote the conservation of this species to official environmental agencies. A captive-breeding program has been initiated. Within the year, genetic analyses of wild and captive populations are slated to begin.

Land owners have designated forest remnants on their farms for protection; this large remnant near El Arenal is inhabited by Guatemalan Beaded Lizards.

Acknowledgements

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JOHN BINNS. ANIMAL COURTESY OF WEST COAST IGUANA RESEARCH

The distribution of Guatemalan Black Iguanas (*Ctenosaura palearis*), also known as Paleate Spiny-tailed Iguanas, is restricted to the Motagua Valley. Populations are known to be sparse and the species stands to benefit from the preservation of this unique ecoregion.

The Conservation of Thorn Scrub and Dry Forest Habitat in the Motagua Valley, Guatemala: Promoting the Protection of a Unique Ecoregion[1]

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Photographs by author unless otherwise indicated.

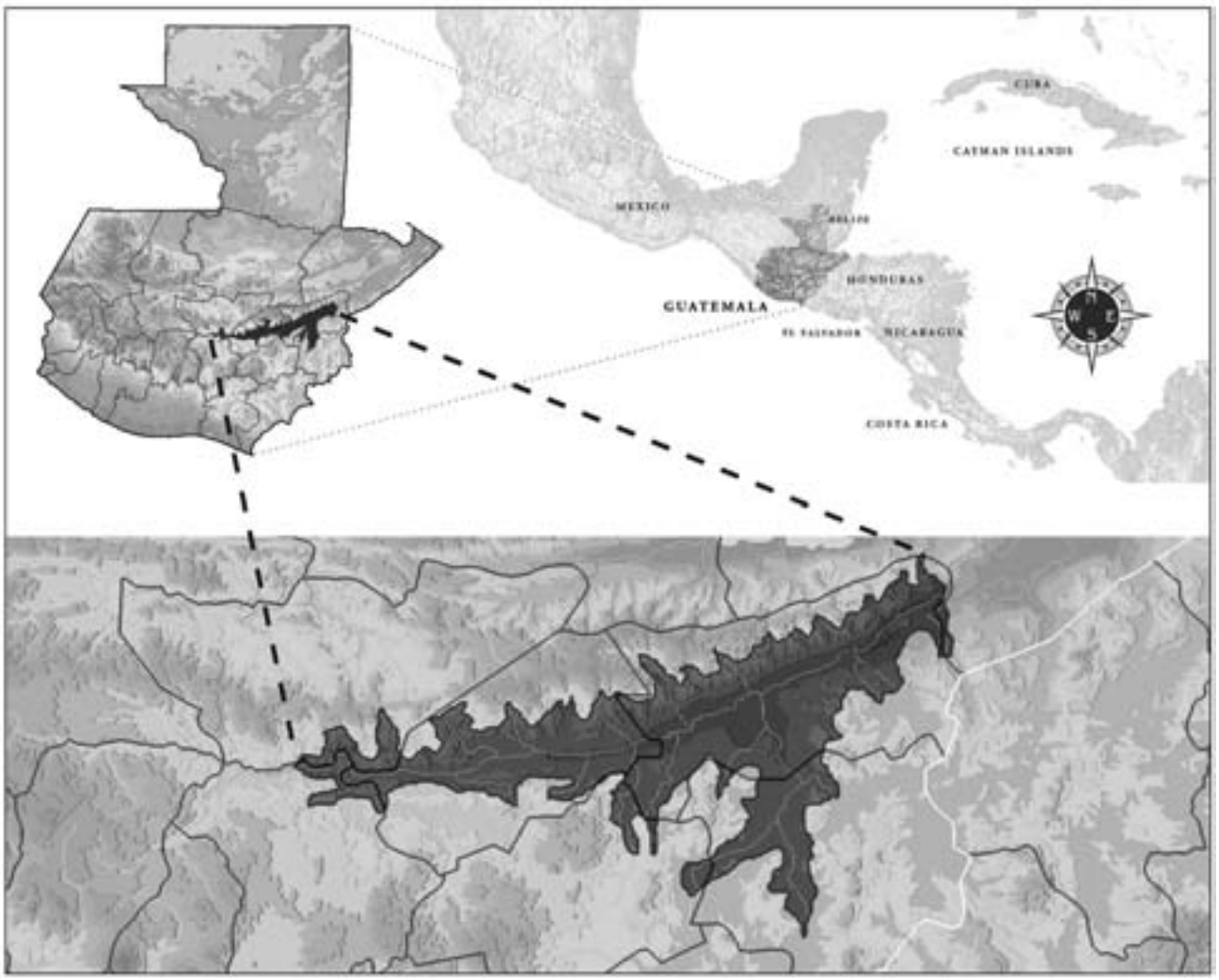
The semi-arid region of the Motagua Valley in northeastern Guatemala has been classified as an ecoregion in the classification developed by the World Wildlife Fund (WWF) (Dinerstein et al. 1995) based on its biodiversity and high degree of endemism, among other unique qualities. Because the region is also highly threatened, the Guatemalan NGO Fundación Defensores de la Naturaleza (FDN), with the support of The Nature Conservancy (TNC) and Dutch cooperation, are leading a participatory and interinstitutional conservation program.

Description of the Area

The small (approx. 200,000 ha), semi-arid region of the Motagua Valley is in the departments of El Progreso, Zacapa, and Chiquimula, and contains two habitat zones: Subtropical thorn scrub and subtropical dry forest (TNC and FDN 2003). The valley is surrounded by the Sierra Las Minas, with peaks reaching to 3000 m above sea level creating a natural barrier to

[1] Translated by AJ Gutman

The semi-arid region of the Motagua Valley is seriously threatened. Despite its importance and singularity, it is barely represented in the Guatemalan Protected Areas System.



Geographic location of the semi-arid region of the Motagua Valley, Guatemala.

the moisture originating from the Atlantic (TNC and FDN 2003). With annual precipitation of approximately 500 mm per year, the area has the lowest annual precipitation recorded for any part of Central America (Powell and Palminteri 2001), whereas the surrounding mountains receive up to 3000 mm of annual precipitation (Powell and Palminteri 2001).

Precipitation data indicate a rainy season extending from May to September. The average relative humidity ranges from 60–72%, and the average temperature varies from 22–28 °C (Castañeda 1997), reaching a maximum of 45 °C during the warmest months of March and April, and a minimum of 7 °C in December (Valle et al. 1999).

Vegetation

The climatic conditions of the region have resulted in the development of caducous vegetative communities, in which leaves fall at the beginning of the dry season and appear at the beginning of the rainy season (TNC and FDN 2003). Thorn-bearing species make up approximately 50% of the plant life, hence the descriptive habitat name of "thorn scrub" (Castañeda and Ayala 1996). With the exception of the gallery forests, in which the constant flow of water permits the development of very different and much greener vegetative communities, which provide a refuge to many animal species, the lower elevations of the region are dominated by thorny species such as the Cactaceae, Acacia, and leguminous shrubs (Powell and Palminteri 2001).

Recent studies of the thorn scrub in the Motagua Valley have documented the presence of 107 families and 598 species of plants, of which 140 are trees, 89 shrubs, 273 grass, 74 lianas,

Several bromeliads and species of cacti, such as this *Melocactus*, are threatened by illicit extraction.

12 epiphytes, 4 parasitic species, and 3 aquatic species (Véliz et al. 2005). The most diverse families are Asteraceae and Euphorbiaceae with 46 species each, Fabaceae with 41, Poaceae with 39, Mimosaceae with 28, Caesalpiniaceae with 20, Convolvulaceae with 18, and Boraginaceae, Cactaceae, and Solanaceae with 15 species each.

Geologic processes affecting the region have created isolation that has favored plant speciation, producing a number of new species with distributions restricted to the Motagua Valley, for example, various Cactaceae, Euphorbiaceae, and Mimosaceae (Castañeda 1997, Valle et al. 1999, Morales 2003). The endemic bromeliad, *Tillandsia xerographica*, is in danger of extinction. It, along with species of cacti in the genera *Mammillaria* and *Melocactus*, are extracted illegally for the ornamental plant trade.

Among the most common and typical species in the thorn scrub of Guatemala are *Guaiacum coulteri, Caesalpinia velutina, Cassia emarginata, Cassia skinneri, Haematoxylon brasileto, Leucaena collinsii, Ximenia americana, Bursera schlenthendali, B. graveolens, Acacia farnesiana, Prosopis juliflora, Juliania adstringens, Stenocereus pruinosus, Pereskia lychnidiflora, Nopalea guatemalensis, Pilosocereus leucocephala, Cordia dentata,* and *Cordia truncatifolia* (Véliz et al. 2005).

Many important tree and shrub species are used by the local inhabitants for firewood, wood for small and medium-sized industry or crafts, and as a source of medicinal plants, food, and ornamentals (Castañeda 2004). The main species that make up the cover in the thorn scrub, recognizing the limitations of the zone, are the Ceibillo (*Ceiba aesculifolia*), Orotoguaje (*Acacia deamii*), Yaje (*Leucaena diversifolia*), Aripín (*Caesalpinia velutina*), Mountain Oak (*Bucida macrostachya*), Jiote (*Bursera simarouba*), Caraño (*Juliana adstringens*), Guayacán (*Guaiacum sanctum*), and the Barreto (*Plocosperma buxifolium*) (Castañeda 2004). The Barreto and the endemic Motapino (*Mimosa zacapana*) also have ornamental uses (Castañeda 2004).

Fauna

The semi-arid region of the Motagua Valley is home to a greater diversity of species in some groups of vertebrates compared with other types of forest, largely due to the interactions between the riverine and semi-arid forests (TNC and FDN 2003). The presence of 48 species of mammals and 101 species of birds has been reported (Valle et al. 2003), some of which make use of the gallery forest that provides them with food and sites for reproduction (TNC and FDN 2003). The bird families Columbidae, Tyrannidae, Icteridade, and Fringilidae are sufficiently abundant

Gallery forest and dry forest in the Motagua Valley, showing the river basin during the dry season and the gallery forest that remains green.

CESAR QUEME

The Russet Crowned Motmot (*Momotus mexicanus*) is a species that is considered to be a reliable indicator of high-quality habitat.

as to be considered characteristic of the region (Land 1970). The valley is the only site in Central America where the Russet Crowned Motmot (*Momotus mexicanus*) is found, a species that is considered to be a reliable indicator of high-quality habitat. Nevertheless, recent studies (Perez 2003, Nájera 2004) indicate that most bird species whose presence was recorded in the valley are habitat generalists and little affected by disturbed habitat.

The threatened mammalian species in the region include the bats *Pteronotus dhabi*, *P. parnelli*, and *Leptonycteris curasoae*, the Armadillo (*Dasypus novemcinctus*), which is endangered due to hunting, the skunks (*Conepatus semistriatus, Mephitis macroura*) due to exploitation for medicinal uses, Cacomistle or Bassarisk (*Bassariscus sumichrasti*), and the Water Possum (*Chironectes minumus*), which is threatened by the advance of the agricultural border (Valle et al. 2003).

Sixteen species of amphibians and 54 reptiles have been reported in the Motagua Valley (Acevedo 2004). The frog, *Craugastor inachus*, that was only recently described (Campbell and Savage 2000) is endemic, and the salamander, *Oedipina taylori*, is a regional endemic (Acevedo 2004). Among the reptiles is the Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*), an endemic subspecies that is in serious danger of extinction. Recent studies of this species (Masaya 2005, Ariano 2003) report that, even in the most optimistic scenario, the surviving population of *H. h. charlesbogerti* is only around 174 individuals (Masaya 2005).

The Conservation Plan

In 2003, the FDN and TNC undertook the task of creating a Conservation Plan for the semi-arid region of the Motagua Valley, in view of the importance of biodiversity in this area and of the urgency to initiate formal actions for its preservation. In 2005, the plan was updated based on new findings and lessons learned during the first years of work in the Motagua Valley (FDN and TNC 2005).

The Conservation Plan is based on the methodology of Planning for the Conservation of Areas (PCA), proposed by TNC (TNC 1999) and which takes into account all available ecological and social data on the area in question. The methodology is based on the identification and selection of conservation elements, and an analysis and prioritization of the threats and advantages affecting those elements. The next step is the definition of strategies to reduce the threats and maximize advantages. The final step is to define indicators that can be used to measure the success of the proposed strategies.

The application of this methodology to the region permits an approach to the initiative from a local perspective, recognizing the region's inhabitants as stakeholders in the conservation process. To date, the FDN has focused on promoting the declaration of both private and municipal protected areas, environmental education, incentives for forest conservation, ecotourism, and the enforcement of existing conservation legislation.

Conservation Elements

The conservation elements identified for the semi-arid region of the Motagua Valley are: (1) Thorn scrub and dry forest, (2) Tillandsias and cacti threatened by extraction, (3) Guatemalan Beaded Lizards (*Heloderma horridum charlesbogerti*), (4) gallery forests, and (5) the fluvial system. These five elements and the key ecological processes by which they are connected are the focus of the conservation efforts undertaken since 2004 at the field level.

Threats and Advantages

The most serious threat identified to date is agricultural practices inconsistent with conservation. Areas of thorn scrub and dry forest converted for agricultural use have led to the destruction of 60,000 ha (ca. 30% of the land in the region; Secaira 2004). Also considered serious threats are incompatible forestry

Cacti in the Valley are threatened by extraction.

Guatemalan Beaded Lizards (*Heloderma horridum charlesbogerti*) are endemic to the Motagua Valley.

practices, the elimination and extraction of *H. h. charlesbogerti*, and non-sustainable selective forest product extraction. The most threatened elements within the thorn scrub and dry forest ecosystem are the Beaded Lizards and the fluvial system, because the factors threatening them are severe and could eliminate them entirely in the near future if no action is undertaken.

Investigations in the area have identified further factors leading to the degradation of the ecosystem, including decreases in the amount of forest, an overall reduction in biodiversity, and contamination of the rivers. Another element to consider is the implementation of monoculture systems and the pressures that the impoverished human populations exert on the local flora and fauna (Valle et al. 1999).

Nevertheless, factors also exist that favor the conservation of biodiversity in the Motagua Valley. Among the most significant of these is the presence of diverse institutions and local governments that are actively increasing awareness of the importance of the region and of conservation projects centered on the thorn scrub and dry forest. Also, since the formal implementation of the PCA in 2004, an increasing interest in scientific research and ecotourism in the Motagua Valley has served to directly and indirectly promote the conservation of biodiversity.

Strategic Objectives and Advances

The strategic objectives for the reduction of threats and an increase in the positive factors affecting the conservation elements are set for a term of five years from the update of the Conservation Plan in 2005. One of the main objectives is to establish formal conservation mechanisms in at least 10% of the present natural cover, which amounts to having at least 10,000 ha of thorn scrub and dry forest under protection by 2010. With the collaboration of local governments, communities, and private landowners, the first protected areas have been established in the region adding up to a total of 934 ha, comprised of municipal regional parks and private natural reserves. Disputes over land ownership have inhibited further progress on this objective. In some instances, well-preserved areas with cooperative and enthusiastic owners could not be declared as protected areas due to the lack of property registries. In many other cases, a lack of realization of the importance of the ecosystem on the part of local property owners, communities, and governments works against the creation of new protected areas, thus the intense focus on environmental education for adults and children in the region.

One factor stimulating efforts to conserve thorn scrub and dry forest has been the recent inclusion by the Guatemalan National Forest Institute of these types of habitat into their Forest Incentives Program (Programa de Incentivos Forestales, PINFOR). This program provides economic incentives to private and municipal owners to maintain the existing natural vegetative cover on their properties or to reforest them with native species. To date, five private owners have been provided with economic assistance for choosing to conserve the forest on their property.

The goal for 2010 with regard to *Heloderma horridum charlesbogerti* is to maintain existing population numbers

(Masaya 2005, Ariano 2003). Beaded Lizards are seriously threatened by destruction of their habitat, elimination due to false suppositions regarding the dangers posed by this venomous animal, and illegal extraction for the exotic pet trade. Various institutions have initiated their own environmental education programs to sensitize the local population to the need for protection. Recently, the national strategy for *Heloderma* conservation was developed (Zootropic and TNC 2005), and work moves forward on the telemetry studies initiated in 2004 (Masaya 2005), as well as environmental education efforts within the distribution of *Heloderma* to ensure the protection of the remnant population of this species.

The strategic objectives for the gallery forests and the fluvial system are largely the purview of the FDN team that works in the adjacent Sierra de las Minas Biosphere Reserve (SMBR). Since the water supply of the Motagua Valley comes almost entirely from the Sierra de las Minas, in which 63 permanently flowing rivers originate, an initiative for the integrated management of the water supply has been created ("Fondo del Agua" = Water Fund). The objective of this project is to ensure the volume and quality of the water originating in the SMBR for the long term by providing technical and financial assistance to improve water management and the river basins (FDN 2004). For the semi-arid region of the Motagua Valley, the strategic objective for 2010 is to maintain the quality and volume of water produced annually by the SMBR, and to ensure the preservation of the gallery forests of three high-priority river basins between the Motagua Valley and the SMBR. Work toward these objectives has been accomplished primarily through the Water Fund project with the formation of river basin committees and through education emphasizing the importance of sustainable usage of hydro resources in the region.

To improve progress towards the fulfillment of the proposed objectives, a plan for the conservation of cultural patrimony has been developed and integrated into the existing PCA in an effort to take advantage of synergies between nature and culture to increase local and institutional support, education, and the promotion of sustainable tourism. This Natural and Cultural Conservation Plan (FDN and TNC 2005) tries to integrate the diverse stakeholders and local institutions through the formation of an "alliance for the conservation of the semi-arid region of the Motagua Valley." The objective of this alliance is to promote and coordinate activities for the conservation of the natural and cultural resources of the region, and to extend management support to national and international organizations for the implementation of the PCA. The alliance also seeks to generate political support and to establish strategic alliances with participating institutions and local governments, to continue working on the application of effective environmental legislation, the conservation and recovery of high-priority areas, social organization, and environmental education, with the purpose of promoting and consolidating mechanisms likely to preserve the natural and cultural resources of the Motagua Valley.

The archaeological sites of the Motagua Valley, such as this one called Guaytán, are among the cultural elements in need of conservation.

Since early 2004, we have made discernible progress on all proposed strategic objectives, and have learned many lessons. One of the latter is the necessity and importance of a combination of interinstitutional alliances and local support to develop a more integrated and sustainable long-term initiative. Promoting conservation in this region of Guatemala has been a challenge, but the participating institutions truly hope that the conservation efforts that are being implemented will ensure the permanence of this important ecosystem, as well as fortify and consolidate diverse areas of conservation in the semi-arid region of the Motagua Valley.

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Our sincere thanks to each of you.

Brad Lock, Zoo Atlanta, and John Binns, IRCF

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JOE BURGESS

Adult Fijian Crested Iguana (*Brachylophus vitiensis*).

Soaking Wet in a Fijian Dry Forest

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Photographs by Peter S. Harlow unless otherwise indicated.

Just 30 minutes earlier, we had left the Fijian village of Denimanu on Yadua Island in totally calm weather, but with heavily overcast skies, and were now skimming over gray waters. First stop on the 8-km boat trip to Yadua Taba Island is always to get fresh water from the only permanent stream on Yadua, in the small bay of Waisevu (Fijian for "welcoming water"). Because the creek near the village only flows during the wet season, the 120 inhabitants have to rely on tank or well water for most of the year and rarely have enough to spare. On the smaller island of Yadua Taba, no permanent fresh water exists, probably the main reason it has remained uninhabited.

As we left Waisevu Bay with our five precious water containers full to the brim, a strong wind suddenly arrived from nowhere and instantly whipped the sea into angry whitecaps. Ten of us were in ranger Pita Biciloa's overloaded 18-foot fiberglass boat, National Trust staff, a few of us visiting researchers, and a scattering of helpers from the village. We squatted precariously around a huge mound of camping gear, boxes of food, and now enough fresh water to last the first week on the uninhabited Iguana Sanctuary Island of Yadua Taba.

Unlike our previous trips to Yadua Taba during the long dry season when rain never falls, this was our first wet-season trip and we could expect heavy tropical downpours at least several times a week. Sure enough, as we motored the last 5 km to Yadua Taba, a huge angry front of heavy black clouds moved rapidly toward us, while the wind increased and the crests of the small, sharp waves exploded over the boat's bow to soak us all.

Luckily the high tide allowed us to motor all the way to the beach on Yadua Taba and we quickly began unloading and moving the huge mound of gear to our campsite just inside the for-

B. THAMAN

The Yadua Taba Crested Iguana sanctuary island is surrounded by coral reefs.

Tima, one of our field assistants, up early and making "babakau" (Fijian fried bread) for breakfast.

est. A wall of rain could be seen a few hundred meters out to sea, moving quickly toward us, and the rush to complete the unloading increased. The gear was thrown into a pile in a central clearing and covered with a large tarpaulin just as the rain struck, a gentle roar in the forest canopy above us at first, but within seconds so heavy that we had to shout to hear each other speak. We stood around laughing, and were all totally soaked in just a few seconds. Even if we had them, umbrellas and raincoats are useless in the hot tropics, so we ignored the rain and began to erect our largest tarpaulin, which would be the center of the camp, our kitchen, and the only dry area for eating and working.

Erecting a large plastic sheet with only one rope on each corner would seem to be a simple proposition. This task was clearly up to our Fijian hosts, and, even though our suggestions were politely considered, everyone seemed to have a different plan. A lengthy discussion that considered the pros and cons of where, how, and when continued as the first wall of rain diminished to a steady, heavy downpour and the wind suddenly dropped.

Since both the rain and the tarpaulin discussions could continue indefinitely, rather than stand around in the rain looking useless and bedraggled, we headed into the forest. We were both eager to look for signs of nesting iguanas, so we walked toward an area that we knew had the greatest density of Crested Iguanas (*Brachylophus vitiensis*).

The forest on Yadua Taba is classified as "tropical dry forest." The canopy is low, usually 6–10 m. The island receives less than 200 cm of rain per year, nearly all during the 3–4 month

A Fijian Crested Iguana watches from a low branch.

wet season. This dry forest plant community is the most endangered in Fiji. On most islands, it has been burned and cleared for farming, coconut plantations, or cattle and goat grazing, while remnant patches on other islands have been overtaken by exotic invasive plant species. Yadua Taba Island is the single exception, and it is the only small island example of dry forest remaining in Fiji. To add to its lucky isolation, it has no introduced cats, mongooses, or exotic rat species (only the endemic Pacific Rat, *Rattus exulans*), which is probably why it supports at least 6,000 Crested Iguanas. Even the remnant grasslands and patches of invasive plants on the ridges of Yadua Taba are reverting to native forest since burning stopped in 1980 and the last few goats were removed in 2004. The National Trust for Fiji is carefully monitoring, poisoning, and removing the most invasive of the island's exotic plant species in an effort to maximize the native forest available to the critically endangered iguanas.

The first obvious differences from our dry season experiences in the forest were the small purple fruits and white flowers of the Cevua Trees littering the ground, a carpet of tiny green seedlings, and abundant recent soil diggings. These diggings, however, were from land crabs, not gravid iguanas. The main reason for our February visit was to document Crested Iguana nesting biology, as no records document nesting in the wild for either species of Pacific iguana. Previous field trips to Yadua Taba in months from May to December over seven years had not located a single gravid or nesting female. However, we had seen hatchlings appear toward the end of November in several years — but when and where the eggs are laid remained a mystery. Do female Crested Iguanas migrate to communal nesting areas, and do they guard their nest sites like many iguanas? These are just some of the questions that Suzi wants to answer during her Ph.D. project on the species. Because eggs laid in captivity take

The fruiting Cevua tree (*Vavaea amicorum*) is important in the wet season diet of Crested Iguanas on Yadua Taba Island. Only the soft and ripe purple fruit will be selected and eaten during this season of plenty.

Z. PIERCE

The authors processing captured Crested Iguanas in the forest on a dry night.

Suzi and Mata in the village on nearby Yadua Island.

between 6 and 9 months to hatch (depending on incubation temperatures), and hatching starts in late November on Yadua Taba, we assumed that nesting had to occur during the middle of the wet season, from February to April. John Gibbons, who described this species after first finding it on Yadua Taba in 1979, suggested that females nest between April and May, but he never saw a nesting female.

Yadua Taba is a small (70 ha), rocky, volcanic island with steep slopes and many cliffs. As we slipped and slid our way up a muddy slope in the pouring rain, we were pleased to see a ravine, which we had only seen dry, flowing like a river between pools of fresh water. Although we were soaked to the skin, the possibility of a regular wash was not lost on us, as on previous dry season trips, the lack of fresh water had meant that the salty Pacific was our only bath for weeks at a time. Perhaps our normally precious fresh water supply could be relegated to backup for this trip.

Deep in the forest, land crab diggings are less common and, as we walked farther, we began seeing excavations that were more like the agamid lizard nesting burrows with which we are familiar in Australia. Then we saw one — a fat, green, mud-covered Crested Iguana frozen to the ground, watching us, a neat burrow at her snout, and a pile of muddy soil at her side. She was heavily gravid, the eggs could be seen as large lumps inside her. We stood in silence, certainly not the first to observe this, but knowing that we were the first to record it. We marked the site with colored tape and left quietly, hoping not to disturb her nesting. In less than half an hour on the island, we had found what we had come to see.

The next day, as the rain continued and we began to reminisce fondly of the dry season, we returned to that same site.

The first Crested Iguana nest located; excavated to show the three large eggs.

Suzi explaining to the children in the village on Yadua why she is working on Crested Iguanas on Yadua Taba.

The female and the burrow were gone, the site camouflaged to look like it had never been disturbed. We carefully excavated the soil with a spoon, took measurements and photos, added a tiny temperature data-logger to the clutch of three huge eggs, and refilled the nesting burrow. In the weeks that followed, as our never-to-dry-again T-shirts slowly rotted off our backs with the continued rain, we found another 13 nests.

Surprisingly, many other aspects of the Crested Iguana's biology also remain unknown, mostly because of the remoteness of Yadua Taba and the expense and difficulty of working there. Yadua Taba is not open to the public, and only researchers are issued permits to visit. With the exception of a visiting U.S. botanist, the last foreign visitors before us were the IUCN Iguana Specialist Group, who visited for one day in November 2004 after their annual meeting in Suva, Fiji's capital. For most of the year, the island remains solely the realm of the iguanas, interrupted only by short visits of the National Trust ranger, Pita, to monitor invasive plant species and patrol for uninvited guests.

Crested Iguanas probably will be translocated from Yadua Taba to other iguana-free islands in Fiji in the next few years. Before this can happen, however, we need to understand not just their breeding biology, but a host of other important ecological attributes such as diet, population dynamics, and basic biology. The information from this field season, added to the growing knowledge base on the biology and habitat requirements of Crested Iguanas, will be integral to future reintroduction or translocation efforts. In November of this year, we will return to Yadua Taba to witness the emergence of hatchlings from the monitored nests. Knowing a little more this time of what to expect from a wet season in a dry forest, we'll be sure to bring along a few spare T-shirts!

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ROBERT POWELL

World War II-era spotlights testify to the military role of Coconut Island. Today, they remain among decorative plantings utilized extensively by Cuban Brown Anoles (*Anolis sagrei*).

The Anoles of Coconut Island, Kane'ohe Bay, O'ahu, Hawai'i

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Originally, Moku O Lo'e, owned by the Bishop family estate, was used by shepherds and local fishermen. During the 1930s, Christian Holmes, owner of Hawaiian Tuna Packers (now Coral Tuna) and heir to the Fleischmann yeast fortune, purchased the island for his tuna-packing factory. At that time, the island was 12 acres in size and had several coconut trees, which is how it got its popular name, Coconut Island. Holmes, unhappy with the small size of the island, had it expanded to 28 acres and also created many fishponds. Holmes imported hundreds of exotic plants to the island, constructed a large saltwater swimming pool equipped with a slide and a diving board, built outdoor bars at various points around the island, introduced a bowling alley, and reconstructed a shooting gallery that he had bought at an amusement park in San Francisco. Coconut Island even housed a small zoo for a short time. Animal residents included donkeys, a giraffe, monkeys, and a baby elephant. After Holmes's death, these animals became the foundation for the Honolulu Zoo.

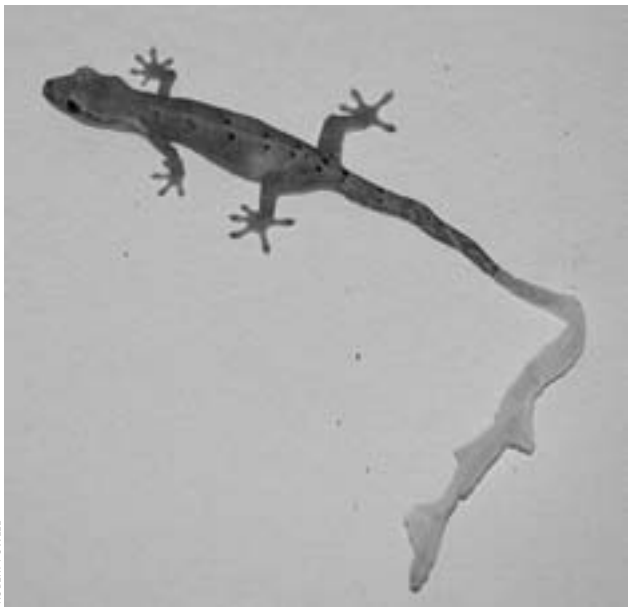
During the war, the military used the island as an R&R post for officers. In 1947, a group of five wealthy oilmen bought

Coconut Island in Kane'ohe Bay. Photograph courtesy of the Hawaii Institute of Marine Biology.

NOLAN ROBERSON

Lagoon on Coconut Island. Plantings in the foreground were occupied by *Anolis sagrei*.

the island. Eventually, one of them, Edwin Pauley, bought out the interests of the other four and became sole owner of the island, where his family spent their summers. Many famous people visited Coconut Island as Pauley's guests. Included among them were Harry Truman, Lyndon B. Johnson, John Wayne, Red Skelton, Richard Nixon, and Ronald Reagan. In 1951, Pauley helped establish the Hawai'i Marine Lab. The name was changed in 1965 to the Hawai'i Institute of Marine Biology, now affiliated with the University of Hawai'i.



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Mourning Geckos (*Lepidodactylus lugubris*), here shedding its skin in one of the suites on Coconut Island, and Stump-toed Geckos (*Gehyra mutilata*) are abundant.

Amphibians and Reptiles of Coconut Island

No terrestrial amphibians or reptiles are native to Hawai'i, but many species have become established, introduced primarily as escaped or released pets. Due to frequent movement of people and materials back-and-forth from O'ahu to Coconut Island, many of the species established in the Kane'ohe area now occur on Coconut Island as well. In 2001, documented species included the Cane Toad (*Bufo marinus*), Stump-toed Gecko (*Gehyra mutilata*), Mourning Gecko (*Lepidodactylus lugubris*), Metallic Skink (*Lampropholis delicata*), and Island Blind Snake (*Ramphotyphlops braminus*). In 2004, two species of *Anolis*, *A. carolinensis* and *A. sagrei*, were found on the island. Both had highly restricted distributions, suggesting that both introductions had occurred shortly before their discovery.

Coconut Island Anoles

Anolis carolinensis, the Green Anole, is moderately sized (SVL of Hawaiian animals = 51–76 mm, total length = 125–230 mm). These lizards are native to the southeastern United States. Populations also have become established in Europe (Spain), Japan (Bonin and Ryukyu islands), the West Indies (Grand Bahama Island, Anguilla), and the Pacific (all of the major Hawaiian islands; Guam; Tinian and Saipan in the Northern Mariana Islands; Yap; Koror and Malakal islands in the Republic of Palau (or Belau). An introduction on Sand Island, Midway Atoll, failed. Green anoles were first reported on O'ahu in 1950, when they were initially misidentified as *A. porcatus* (a closely related Cuban species).

Anolis carolinensis is a "trunk-crown ecomorph" (ecomorphologies anatomically and behaviorally influence microhabitat use as a way of reducing interspecific competition). These lizards are abundant in Hawai'i, especially in gardens and resorts, where introduced plants and insect prey provide suitable conditions. Although they will forage on the ground on occasion, Green

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Cane Toads (*Bufo marinus*) are well-established on Coconut Island.

Anoles spend nearly all of their time on elevated perches in bushes, trees, or artificial substrates like fences and buildings.

Anolis (*Norops*) *sagrei*, the Cuban Brown Anole, is a moderately sized (SVL of Hawaiian animals = 38–64 mm, total length = 130–210 mm) lizard native to Cuba, Bahamas, and Cayman Islands, but which has become established in various mainland (e.g., southeastern United States, Belize, and southern México to northern Honduras) and insular (e.g., St. Vincent, Grenada, Jamaica, Hawai'i [O'ahu and K'auai], and Taiwan) locales. Brown Anoles were first reported on O'ahu in the late 1970s and early 1980s.

Anolis sagrei is a "trunk ground ecomorph," meaning that it spends most of its time within two meters of the ground, and is generally less arboreal than *A. carolinensis*. *Anolis sagrei* is most commonly found in shrubs, on tree trunks, the ground, and rock piles, but readily exploits human dwellings, planters, and fences. It feeds on small invertebrates (mostly insects), but will occasionally take small lizards. Foraging strategies typically exploit an ambush mode, often involving a rapid descent from a vertical, head-down, sit-and-wait posture. This species can also be found in a vertical, heads-up position while basking, especially in the morning.

Both species are habitat generalists, a trait that appears to have served them well as colonists of areas far from their native ranges. Like most anoles, both are diurnal, largely arboreal, primarily insectivorous, and intensely territorial. Several females and juveniles may occupy the territory of a single male. Adult

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Male *Anolis carolinensis* from Coconut Island (2004).

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Female *Anolis carolinensis* from O'ahu (2006). Although apparently extirpated on Coconut Island, Green Anoles remain abundant elsewhere in the Hawaiian Islands.

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Male *Anolis sagrei* from Coconut Island (2006).

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Female *Anolis sagrei* from Coconut Island (2006).

males frequently exploit different microhabitats, such as higher perches, than females or juveniles.

Somewhat more robust than the more gracile Green Anole and apparently more aggressive, introduced *A. sagrei* has largely displaced the native Green Anole, especially in disturbed habitats, where the two species are sympatric in peninsular Florida and elsewhere in the southeastern United States.

Methods

During a visit to Coconut Island in March 2006, we sought to establish the ranges of both species, which we expected to have increased since the discovery of the two populations in 2004. We also examined microhabitat use by anoles in different size classes to test a null hypothesis that perches of lizards of different sizes do not vary.

At various times of day and under varying weather conditions (which were often rainy during our stay), we searched microhabitats where anoles were most likely to be found, concentrating on areas near where they were first observed in 2004. For each anole sighted, we recorded time, size class, height above ground, perch diameter (if applicable), orientation, and various behaviors. Anoles were categorized into three classes: "1" for adult males, "2" for subadult males and adult females (which are sometimes difficult to distinguish from a distance), and "3" for juveniles of indeterminate sex. Orientation on a perch was numerically interpreted as 1 = vertical, facing up; 2 = horizontal; 3 = vertical, facing down. We used StatView 5.0 (SAS Institute, Inc., Cary, North Carolina) for statistical analyses. Means are presented ± 1 standard error.

Results

We were unable to find *Anolis carolinensis*. Shrubs and intermingled vines in the area where they were most abundant in 2004 had been cleared, although considerable, apparently suitable habitat remained, including large Ficus trees where individuals had been observed two years previously.

Anolis sagrei remained abundant in the area where first seen in 2004, and these lizards had expanded their range to nearby areas and to a peninsula characterized by only marginal habitat. Considerably more apparently suitable habitat exists throughout much of the island, including sites adjacent to those where we found lizards. We found no Brown Anoles in the area that had been occupied by *A. carolinensis* in 2004.

For obvious reasons, our investigation of microhabitat use was restricted to *A. sagrei*. We made 82 observations (12 adult males, 50 subadult males/adult females, 18 juveniles, and 2 for which size class was not recorded). Most (n = 65) were under cloudy skies or during rain. Seven observations were of individuals on the ground, 18 on rocks, 17 on artificial perches (e.g., pipe, box, debris, planter), 8 on stumps or logs, and 32 on vegetation. Of the latter, 20 were on leaves. We observed one individual eating (small arthropod), one mating pair, one other incidence of courting behavior, and two territorial displays. Fifteen instances of elicited escape behavior included 10 individuals jumping to the ground or crawling under an object on the ground and five lizards jumping onto vegetation, four of them from rocks or the ground.

Distribution of *Anolis sagrei* in 2004 (narrow dashed line) and in 2006 (solid narrow line) and of *A. carolinensis* in 2004 (broad solid line).

Mean perch height for all size classes was 35.1 ± 2.8 cm (n = 79), mean perch diameter was 8.7 ± 1.9 cm, and mean orientation was 1.9 ± 0.1, or predominantly horizontal.

Perch heights of adult males (53.8 ± 6.6 cm, n = 12) were significantly higher than those of subadult males and adult females (34.1 ± 3.5 cm, n = 48) and those of juveniles (29.1 ± 5.1 cm, n = 17; ANOVA, P = 0.02). Mean perch height differences between classes 1 and 2 (19.7 cm) and between classes 1 and 3 (24.6 cm) were significant (Fisher's PLSD, both P = 0.01). However, mean perch height differences between classes 2 and 3 (5.0 cm) were not significant (P = 0.45).

Perch diameters used by anoles in different size classes did not differ significantly (ANOVA, P = 0.82), nor were any differences between any two classes significant (Fisher's PLSD, between classes 1 and 2 P = 0.65, between classes 1 and 3 P = 0.54, between classes 2 and 3 P = 0.69). Similarly, orientations did not differ significantly among classes (ANOVA, P = 0.97), nor between individual classes (Fisher's PLSD; not valid between classes 1 and 2 due to limited sample sizes; between classes 1 and 3, P = 0.85; between classes 2 and 3, P = 0.80).

Discussion

The apparent absence of *Anolis carolinensis* may represent one of the few documented failed colonization attempts by any invasive reptile. Despite the altered vegetation in the area where these lizards were most commonly encountered in 2004, the presence of apparently suitable habitat, including some used by Green Anoles in 2004, suggests that other factors are involved. Because we found no *A. sagrei* anywhere near where *A. carolinensis* had been found previously, we have ruled out displacement as a consequence of interspecific competition. In a concurrent survey of

ROBERT POWELL

An adult male Cuban Brown Anole (*Anolis sagrei*) seeks shelter in vegetation near the base of a large Banyan Tree (*Ficus benghalensis*) on Coconut Island in 2006. Ecologically versatile, these anoles readily exploit large trees, small bushes and shrubs, as well as walls, buildings, and human debris.

birds, we did find many more introduced Red-Vented Bulbuls (*Pycnonotus cafer*) and a lesser number of Red-whiskered Bulbuls (*P. jocosus*) than had been observed during similar surveys in 2001 and 2004. Both species are known predators of diurnal lizards, both in their native range (Indian Subcontinent through southeastern Asia) and in Hawai'i. The combination of altered vegetation and presumably increased predation pressures may have combined to eliminate Green Anoles from Coconut Island.

Although *Anolis sagrei* remains present and has expanded its range on the island, the extent of the expanded range in light of abundantly available and apparently suitable habitat is much less than we had expected. Because vegetation in the areas occupied by Brown Anoles had not been substantively altered, bulbuls may be implicated in the slower-than-expected exploitation of suitable habitats by *A. sagrei*.

Activity may have been suppressed by inclement weather, but observed perch choices and escape behaviors were compatible with expectations for a trunk-ground anole. Males selecting higher perches and the sexual size dimorphism evident in these lizards may serve to spatially partition resources among different size classes, thereby reducing intraspecific competition. Larger animals (i.e., adult males) perching higher than smaller conspecifics may indicate that the former are able to take advantage of their size to monopolize microhabitats that facilitate optimal foraging. These more elevated positions also may result in more distinct territorial boundaries between conspecific males.

SCOTT STREIT (WWW.BIRD-FRIENDS.COM)

Red-vented Bulbuls (*Pycnonotus cafer*) are aggressive predators on small, diurnal lizards. These introduced birds have become increasingly common on Coconut Island.

Data regarding perch diameters were equivocal due to too few observations of adult males and juveniles (n = 1 in each instance). This does reflect the large number of observations of animals using perches other than those for which diameter data were appropriate (e.g., the ground, rocks, and artifical perches such as boxes, refuse, and even buildings). This conforms to observations for this species in other areas, and to expectations for a trunk-ground ecomorph. The same frequency of occurrence on the ground and common use of rocks and artificial perches were undoubtedly responsible for the fact that most anoles were oriented horizontally, which did not vary among size classes.

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An adult female Cuban Iguana (*Cyclura nubila nubila*) on Isla Magueyes, Puerto Rico, chased, caught, and ate a hatchling.

Cannibalism in an Introduced Population of *Cyclura nubila nubila* on Isla Magueyes, Puerto Rico

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All photographs by the senior author.

In the mid-1960s, Cuban Iguanas (*Cyclura nubila nubila*) were introduced to Isla Magueyes, a 7.2-ha islet in southwestern Puerto Rico (Rivero 1978). Anecdotal information affirms that this population originated from a single pair of individuals (A.R. Lewis, pers. comm.). Christian et al. (1986) estimated the size of the population at 167 animals (157 adults and 10 juveniles) and density at 23.2 iguanas/ha. Since 1986, those numbers have increased considerably. Surveys by Ortiz and Lewis in 2004 estimated a population density of 62.5 iguanas/ha (unpublished data). Recent informal surveys (2005–2006) provided population size estimates of 400–500 individuals, numbers consistent with the 2004 estimates of Ortiz and Lewis. Although these

Other adult lizards gathered around the female while she was holding the hatchling in her mouth.

The incidence of cannibalism in Rock Iguanas (*Cyclura* spp.) may be aggravated by high population densities.

population density estimates are for all of Isla Magueyes, iguana distribution on the island is distinctly heterogeneous. The highest densities are associated with the facilities of the Department of Marine Sciences–University of Puerto Rico.

Herein, we report an episode of cannibalism observed on 17 March 2006 at 1430 h, when an adult female chased, caught, and ate a conspecific hatchling. The event lasted around 12 minutes. Other mid-sized and adult animals appeared to take note of the female while she was holding the hatchling in her mouth. Eventually, she managed to bend the hatchling's head parallel to its body axis in order to swallow it.

Cannibalism had not previously been reported for either this introduced population or for this species. Cannibalism in *Cyclura* has not been commonly documented, although it has been reported for Bahamian *C. carinata* (Iverson 1979; Auffenberg 1982). Adult iguanas have been considered predominantly herbivorous, but observations of scavenging or opportunistic consumption of animal protein are not uncommon. Iverson (1979) suggested that high *Cyclura* population densities could be a factor inducing cannibalism in *C. carinata*. The population of *C. n. nubila* on Isla Magueyes is indeed dense, possibly increasing the likelihood and frequency of cannibalism.

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Eventually, after bending the hatchling's head parallel to its body axis, she swallowed it.

HUSBANDRY

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

Part III: Propagation

Joseph M. Polanco

Photographs by the author.

The first two installments (*Iguana* 13(1): 37–41; 13(2): 133-137) proposed a set of guidelines for the habitat preparation, acquisition, maintenance, and diet of Emerald Tree Boas. Part three presents some of the more technical details associated with propagation.

Breeding and Reproduction

Imported shipments of *Corallus caninus* have been observed to contain gravid specimens most frequently during the months of March and April and again during September and October (the latter is considered the most common for parturition). For this reason, these snakes are thought to breed more or less opportunistically on a year-round basis. Other possibilities for such an extensive birthing season might include sperm retention or the ability for females to delay ovulation until environmental conditions are optimal. September through November in the Amazonian Basin is the hottest and driest time of year. This also is when most herpetoculturists begin entering eligible animals into breeding trials. Beginning in early to mid-October, two weeks prior to initial introduction, temperature cycling should be initiated. Breeders should begin raising the daytime high (DTH) and dropping the nighttime low (NTL) temperatures at a rate of 1 °F every third day, continuing until a 15 °F differential has been established. Once these levels have been reached, but prior to introduction, misting should begin for all prospective breeders. Those who regularly mist as part of their husbandry regime should increase the frequency and duration of each session by 50%. Other keepers should initiate two daily misting periods of 3–5 minutes each at dawn and again at dusk. The sprayer setting should deliver a medium-sized water droplet, resembling rain. Atomized droplets are not appropriate. Misting should be maintained for three days, after which males should be introduced into a female's enclosure, with lights on, on the morning of the fourth day. The pair should receive the first misting immediately.

In cases where individual animals are unfamiliar to each other or are breeding for the first time, interest between prospective mates may take several days to develop. Pairs should be allowed to remain together for a period of three days, separated again for another three, then re-introduced. These periods during which pairs are separated can be used to offer meals. Ideally, animals should feed continuously throughout the season, although this rarely occurs for many males.

The use of multiple males in breeding (polyandry) is believed to be beneficial. The presence of competitors may increase testosterone production levels, thereby augmenting instinctive breeding behavior. Females may instinctively embrace

Corallus caninus copulation.

An Amazon Basin female eating a still-born neonate.

A litter of neonate *Corallus caninus.*

Breeding behavior known as "barber-poling."

polyandry as a form of insurance against genetic incompatibilities. One study of a colubrid snake showed that females that practiced polyandry and subsequently produced multiple-sired litters, retained greater postpartum body weight and delivered larger overall litters. A less scientific personal observation suggests that not all males are created instinctually equal. In essence, it takes two to tango, and, if one of the dancers is unwilling, being able to call in an understudy may well increase the likelihood that the show will go on.

In cases where multiple males are employed, the second male should be introduced immediately upon removal of the first. At the end of this pairs' three day interval, the female should be allowed an equal period of recuperation prior to beginning the cycle anew.

Both temperature cycling and pair-rotation should be continued for as long as breeding activity is observed. However, actual breeding behavior may not be observed or recognized. In such instances, breeding trials should be continued throughout the season. One additional environmental stimulus reported to be effective at virtually any time of year is direct exposure to a drop in barometric pressure, such as those that often precede the onset of a thunderstorm. Such exposure is commonly reported to evoke immediate breeding responses from males that had previously been slow to respond or shown little interested in breeding. I have personally observed virtually every sexually mature male in my colony begin cruising and scent-marking his perches at such times.

May marks the end of the breeding season, and, at this time, pairs should be separated, misting stopped, and reverse temperature cycling initiated. The same cycling protocol is used in reverse until maintenance-level DTH and NTL levels have been re-established.

Ovulation, Parturition, and Postpartum Maintenance

In the case of gravid females, the onset of ovulation (the discharge of mature ova from the ovaries) follows some time after the cessation of breeding activity. Although no recognized timeframe seems to govern its onset, the peak of this activity is usually unmistakable. Most often females appear to grow exceedingly uncomfortable and begin to display notable midbody swelling. Less frequently, a female may go through the process unnoticed, but these instances are exceptional. In such cases, the subsequent behavior patterns associated with gravid females are often sufficient to tip the breeder as to what has occurred. During ovulation, which lasts anywhere from three to seven days, most females will continue to give an impression of extreme discomfort, often hanging grossly distended midbody loops off their perch. Within 30 days of peak ovulation, females will become opaque, indicating the onset of the post-ovulatory shed (POS). From the date of actual sloughing, females average 138 days to parturition. Some breeders prefer to provide females with a constant 90 °F-basking spot, while others, I for one, do not vary from the regular maintenance cycle. To date, experimentation with both methods has produced no apparent differences in resultant litter size, size or sex ratio of the offspring, or time from POS to parturition.

Because *C. caninus* is a livebearer, births tend to be somewhat messy affairs that rarely seem to occur at convenient hours of the day. Therefore, I recommend that on POS day 125, the water bowls be removed from the birthing enclosure and that thrice-daily misting be used instead to supply the female with water for drinking. Directly spraying the animal's body ensures that it will become aware of the moisture being provided and lessen the chance of it becoming dehydrated. Rarely, an animal that is accustomed to using a drinking bowl may begin showing signs of dehy-

Neonate *Corallus caninus* vary in color, but the green adult coloration appears only later.

Breeding behavior in which the pair is tightly intertwined is called "cuddling."

dration. In these instances, a large flat dish containing no more than 1/4" of water can be introduced. Newborn emeralds not fully broken free from their egg sacs at birthing may be inadvertently dropped into water bowls and subsequently drown.

Litter sizes average between eight and eleven (as few as 1 and as many as 22 have been recorded) and newborns should be active and, in the best case scenario, have no sign of an external umbilicus. Neonates should be gently wiped clean of amniotic fluid using a damp paper towel and clear 75 °F-tap water, and subsequently placed in small individual containers, supplied with a water dish and a perch no greater than 5/8" in diameter. Most babies will enter into a shed phase within two weeks of birth. Keepers should resist the urge to feed newly shed babies, as it takes as long as 30 days for a baby to deplete its supply of internal yolk. Two weeks after the initial shed, feeding trials can begin. Most breeders prefer to begin trials employing thawed pink rats that have been repeatedly dipped in hot water until they register a temperature of 115–120 °F, a process I refer to as "superheating." My preference is to use live Siberian Dwarf Hamster crawlers (approx. 8 g). To date, this method has never failed to inspire neonate emeralds to do what nature intended. Their suitability for this task is unsurpassed in my experience and, when practical, I highly recommend their use. This is perhaps one of the most valuable tidbits of information that I can offer prospective *C. caninus* owners. When all else fails, these little guys will get the job done. Current captive-born survival rates are thought to be the inverse of those found in the wild, meaning that over 80% of all babies conceived and born in captivity should survive long enough to be given an opportunity to reproduce.

The reconditioning of postpartum females should begin immediately. Females who have completed the cycle should be offered food the night after parturition. These animals must begin to regain their conditioning as quickly as possible in order to avoid the onset of illness triggered by opportunistic pathogens. Since some females flatly refuse to feed from the onset of ovulation until after parturition, the sooner they are offered a meal and begin the process of recovering, the less susceptible they will be. Females should be bred bi-annually, giving them a full year of recovery before beginning the process anew. In her lifetime, a properly maintained female can remain viable for many years and is capable of delivering over 100 babies.

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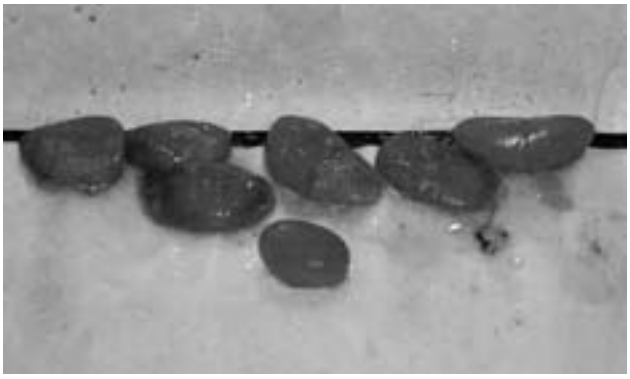
Parturition is frequently a messy affair in this live-bearing species.



Infertile ova are discolored and shrunken.

Until the umbilicus is healed, which usually occurs within a few days, hatchling Guatemalan Beaded Lizards (*Heloderma horridum charlesbogerti*) are kept on damp towels in a Rubbermaid™ shoebox.

HUSBANDRY

Ex-Situ: Notes on Reproduction and Captive Husbandry of the Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*)

Thomas C. Owens

San Diego Zoo

Photographs by the author except where noted.

As conservation strategies are developed for the Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*), understanding all aspects of the life history of this species has become essential. Unfortunately, this elusive and very rare lizard has not yet presented researchers with an opportunity to observe many aspects of its reproduction and characteristics related to hatchlings (e.g., size, weight, and coloration). Beginning in 1986, after observing the moribund situation in the endangered ecosystem of the Motagua Valley, Dr. Jonathon Campbell brought eleven animals into captivity as an assurance colony. This colony was eventually divided between the San Diego Zoo and Zoo Atlanta. These eleven animals have served as a paradigm of the animals in nature, provided us with data on reproduction, and have helped to elucidate elements of the Guatemalan Beaded Lizard's life history.

LEE GOSS

Adult Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*) at Zoo Atlanta, one of eleven founders of an assurance colony that has served as a paradigm of the species in nature.

Enclosure

Since their arrival at the San Diego Zoo (SDZ), the adult Beaded Lizards (2:3) have been housed in a variety of enclosures and conditions in an attempt to determine the optimum environmental conditions needed for reproduction. Upon arrival at SDZ, the group of *H. h. charlesbogerti* was housed together in a 2.3 x 3.6 m room in a quarantine facility. This room had floor heat, basking spots, and large hollow logs that served both as visual barriers and refugia. Following the quarantine period, the lizards were moved to 1.3 x 0.6 x 0.6 m glass terraria. These enclosures utilized pine-bark substrate, 1–1.5 m cork-bark tubes (hollow), and a heavy dish for water. The latter type of enclosure was in use when the first successful breeding occurred. Since not all females (n = 3) had nested, the group was moved to two 2.5 x 0.75 x 0.75 m Neodesha™ cages. These enclosures are plastic with screen mesh for ventilation and mesh-covered openings in the top for basking lamps and 4-ft. fluorescent fixtures. With access through the front, these cages also made it safer and easier to work with venomous lizards. The substrate was pine-bark mulch and the same cork-bark tubes were used. These enclosures, unlike earlier models, were equipped with nest boxes for the female Beaded Lizards. These were large Rubbermaid™ storage containers with lids attached and 2/3-filled with Supersoil™ potting soil. With circular holes cut in the side large enough for adult *H. h. charlesbogerti* to pass in and out of the container, they also served as refugia for individuals of both sexes.

Lighting/Photoperiod and Temperature

In all the vivaria described in this article, Beaded Lizards were subjected to Acrylite™ OP4 skylights that transmit Ultra-violet light. Consequently, the photoperiod varied seasonally, providing an abbreviated winter at 9:15 light-to-dark ratio and extended in the summer to 13:11. In addition, fluorescent fix-

Yolk storage in hatchlings with a large abdomen may be sufficient so that food will not be accepted or needed until the yolk is depleted

tures utilizing a Sylvania™ 350 Blacklight bulb and a Philips™ 40w Colortone bulb in tandem supplied artificial light. Basking lights consisted of 75-watt spotlight bulbs for 9 hours daily. The ambient temperature varied with season and time of day. The daytime temperatures during the summer range from 25–29 °C and at night can drop to 23 °C. The winter daytime temperatures are slightly milder, rarely getting much higher than 26 °C and dropping as low as 20 °C. Basking spots are situated so that animals may choose to bask directly on the substrate or elevated on cage furniture (e.g. log, nest box). The basking temperatures ranged from 33 °C directly on the substrate to 46 °C at the highest basking spot.

Feeding

When the group of adult *H. h. charlesbogerti* arrived at the San Diego Zoo, they did not feed readily on adult mice. If hatchlings have a large abdomen, yolk storage may be sufficient so that food will not be accepted or needed until the yolk is depleted (Burghardt and Layne 1995). Some individual animals were reluctant to feed even after the yolk mass was spent. For the adult Beaded Lizards that would not eat, our initial feeding strategy involved forcing the nose of an adult mouse into the lizard's mouth until the lizard began to swallow the prey on its own. At this time, subsequent mice could be fed by putting the head of another mouse into the mouth of the Beaded Lizard as it finished the prior mouse. This process took place weekly until all animals in the group began to feed on their own. Adult *H. h. charlesbogerti* are fed three 21–35 g adult mice weekly. This diet is offered with the same frequency throughout the year. Juveniles are fed 1–2 adult mice once per week. Hatchlings are started on 2–4 g newborn mice and are quickly moved to 8–15 g mice. Sometimes, as with other *Heloderma*, some individuals are very difficult to feed for the first few meals after hatching. Even reluctant feeders can usually be induced to feed by placing a pre-killed newborn mouse at the end of forceps and touching it to the base of tail of the hatchling Beaded Lizard. The animal will spin around defensively. This procedure is repeated until the lizard bites the newborn mouse defensively and then begins to swallow.

Breeding

Since the 1970s, with helodermatid lizards reproducing infrequently in captivity, the reproductive habits of Beaded Lizards have been slowly revealed, but difficult to assimilate into a successful breeding program. Sexing *H. h. charlesbogerti* using previously described ultrasound sexing techniques (Morris and Alberts 1996, Morris and Henderson 1998) was problematic due to enlarged preanal plates and thick scalation. The population of *H. h. charlesbogerti* housed at SDZ is comprised of two males and three females. Since the time that they were housed together as a group in quarantine, many combinations of total numbers and sexes were utilized in an attempt to stimulate breeding. Attempted combinations included one male and one female, one male and two females, and isolating males from females entirely until the breeding season, when they are reintroduced. Two females have produced eggs and only one male has been observed breeding. The sizes of the two reproductive females are 43.2 cm snout-vent length (SVL), 72.4 cm total length (TL), 1.8 kg and 40.9 cm SVL, 74.3 cm TL, 1.5 kg, respectively. The nonreproductive female is smaller. The size of the reproductive male is 47.9 cm SVL, 81.0 cm TL, and 2.1 kg. The other male is smaller. Breeding has been observed on many occasions during July and August. At SDZ, we have never observed combat behavior between males either in situations where two males are living together or where they are introduced just prior to being paired with a female. Zoo Atlanta has reported seeing very intense male combat behavior on multiple occasions (B. Lock, pers. comm.) At SDZ, males will sometimes refuse prey for 2–3 weeks during the breeding season.

Hatchling Guatemalan Beaded Lizards (*Heloderma horridum charlesbogerti*) have 4–5 broad yellow tail bands separated by black bands. After some experimentation, clutches are incubated on mixtures that are slightly drier than a 1:1 water-to-vermiculite ratio.

Eggs and Incubation

While eggs were yielded in all the enclosure types described above, viable eggs were obtained only in the latter two. Reports indicate that egg-laying for *H. h. charlesbogerti* in the wild begins in late October and early November (Campbell and Vannini 1988, Ariano 2003, Beck 2005). At SDZ, we have had eggs produced from the end of September until the beginning of January. Clutch size for adult females (n = 2) has ranged from 5–10 eggs with a mean clutch size of 8 (n = 8). In all three types of enclosures provided at SDZ, nesting has been problematic. Although females have layed in a nest box, they seem to scatter the eggs on the substrate, and will lay in or behind the hollow logs even when provided with deep soil in a variety of nest boxes. The first four clutches were set up in a 1:1 water-to-vermiculite mixture. The fourth clutch of 10 eggs, was incubated at 30 °C (86 °F), and four eggs hatched after an incubation period of 145–148 days (Owens et al. 2003). At a one-month interval, this clutch of eggs was candled and vascularization was well developed. Embryos approximately 2 cm in length were observed in five of the eggs. About two months into incubation, one egg with an embryo ruptured and failed to hatch. Incubation media were modified to a 1:2 water-to-vermiculite mixture for the next two clutches. Both of these clutches began to dehydrate after only two months of incubation. So, clutches seven and eight were set-up just slightly drier than a 1:1 water-to-vermiculite ratio. Due to infertility, one of these clutches deteriorated immediately. The last clutch of six eggs was incubated at 28 °C (82 °F). Two of the eggs successfully hatched after 163 and 164 day incubation periods. This incubation period is considerably shorter than that reported for other subspecies of Beaded Lizards (Ramirez-Bautista 1994).

Hatching

Hatching success has occurred in two different clutches. The first event occurred in May 2003 and the second in March 2006. Once slitting the egg, each hatchling took anywhere from 1–2 days to fully emerge. Little to no yolk was visible externally at time of emergence. Until the umbilicus is healed, which is usually within a few days, the hatchlings are kept on damp towels in a Rubbermaid™ shoebox. All hatchlings (n = 6), from two different females, ranged in SVL from 119–124.9 mm (197–208 mm TL) and weighed 33.5–37.0 g. Coloration of the young is much like that of other forms of *Heloderma horridum.* Instead of 4–5 pairs of distinct yellow tail rings separated by black bands, the hatchlings have 4–5 broad yellow bands separated by black bands.

Once eggs are slit, hatchlings take anywhere from 1–2 days to fully emerge.

Hatchling Guatemalan Beaded Lizard (*Heloderma horridum charlesbogerti*).

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As part of an effort to reawaken an awareness of pre-European culture, a Guamanian youth troupe recreates an ancient Chamorro dance.

TRAVELOGUE

Guam and the Commonwealth of the Northern Mariana Islands: Pieces of America in the far Pacific

Gad Perry

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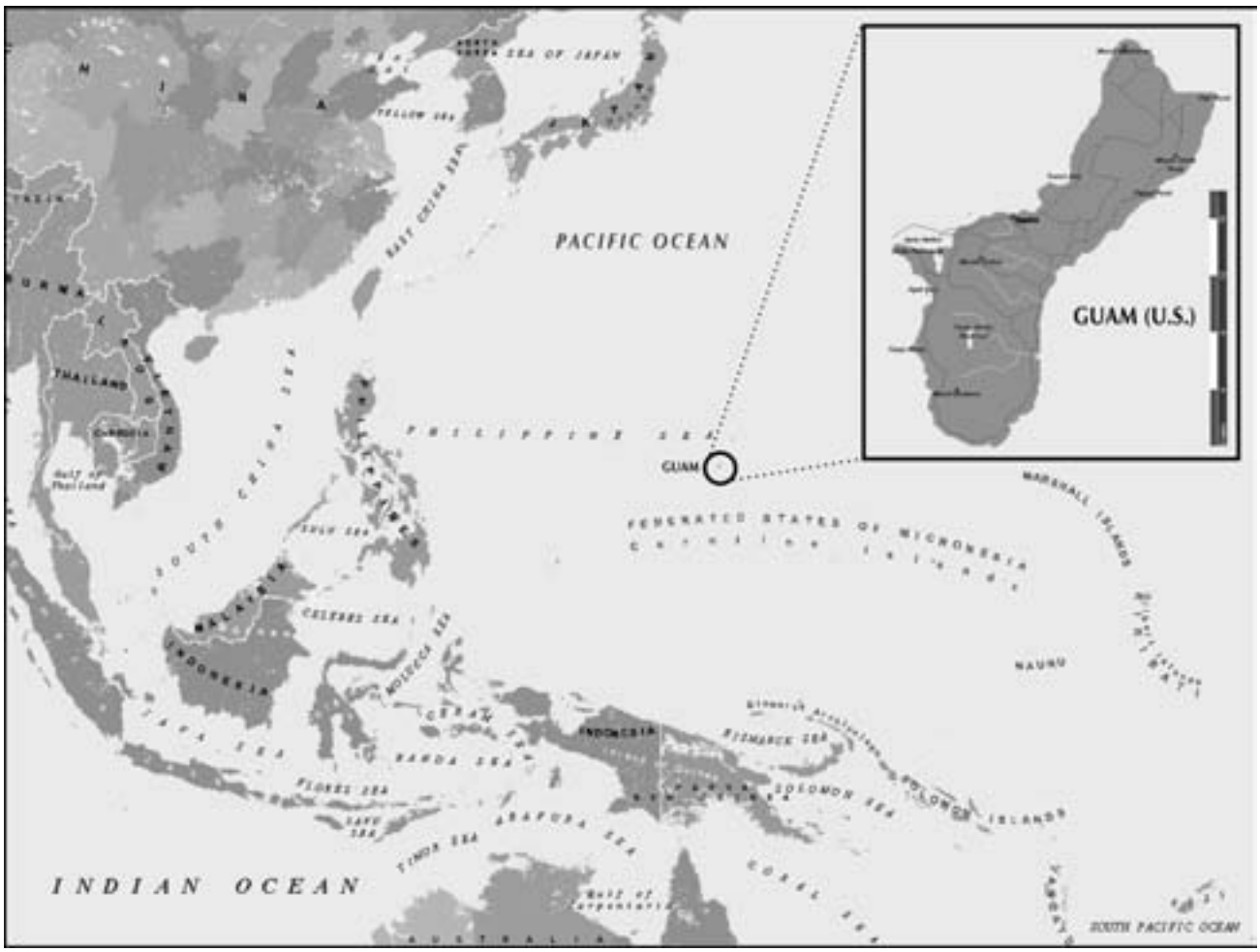
Photographs by the author except where noted.

In the spring of 1521, Ferdinand Magellan and his crew became the first Europeans to see the Pacific islands we now know as the Marianas. Magellan named Guam, Saipan, Tinian, Rota, and a number of uninhabited islands the Islas de las Velas Latinas (= Islands of the Lateen Sails). His crew coined the name still sometimes used today, Islas de los Ladrones (= Islands of the Thieves). At that time, the island's inhabitants, the Chamorros, had been there for several thousand years and had developed a distinct culture and language. Concepts of personal property among the locals apparently differed greatly from those of the Europeans, leading to the unflattering name used by the seamen. When Spain formally claimed the islands in 1667, an estimated 40,000–60,000 Chamorros lived there. Unappreciative of the efforts to make them into good Catholic subjects of Spain, the



JOHN BINNS

A simplified map of the western Pacific showing some important nations for orientation. Guam and the Northern Mariana Islands are in the center, surrounded by lots of water.

locals resisted. Showing the Christian charity typical of the period, the Spaniards proceeded to exterminate nearly all of them. Today's Chamorros are typically Catholic and carry last names such as Cruz and Santos. Guam is now a U.S. Territory, and the other islands form the Commonwealth of the Northern Mariana Islands (CNMI), also a US protectorate.

Arriving in Guam's airport, one is welcomed by a sight not very different from many places in the U.S. or Europe. The island's center is highly urbanized, and contains most of the local population (about 100,000) and the major concentration of tourists (some 1 million each year). However, the heat and humidity of the Tropics (Guam is at latitude 13) immediately tell you this is just an illusion, and, like Toto and Dorothy, you quickly realize that you are no longer in Kansas.

Not all of the island is as dramatically affected by humans as the center. The southern part remains especially beautiful, with many picturesque coves. Although little remains of the pre-European Chamorro culture, a few archeological sites exist. Attempts are ongoing to encourage the use of the Chamorro language among the youth, many of whom are more comfortable in English, and to revive some of the cultural practices that were likely carried out by ancient Chamorros. Much more common today are signs of the Catholicism, a backbone of modern culture on Guam.

I first arrived on Guam in late 1995 as part of a team studying the devastating effects of the Brown Treesnake (*Boiga irregu-*

Latte stones, such as this one located in Inarajan, testify to the presence of the pre-European Chamorro culture. Archeologists believe series of these stones served as the foundations of raised houses that were safe from occasional flooding.

A structure just outside Guam's international airport welcomes visitors and locals. The capital and largest city, Hagatña (formerly known as Agaña), is in the background.

This cove near Inarajan is one of many beautiful spots in the south of Guam.

Bellin's 1752 map of the Mariana Islands (http://www.carto.com/maps/02118761.jpg). Guam is shown in an inset on the bottom left.

laris) on the ecology of the islands. Almost immediately, I went to assist with a project on Saipan and discovered that the disparaging name dating back to Magellan's crew still held some truth. While we were conducting research in the forest at night, someone broke into both of our vehicles, the contents of the trunks were stolen, all eight tires were slashed, and large rocks were used to smash the windshields. Luckily, this did not set the tone for the rest of my time in the region, which was much happier.

Typhoons, the Pacific equivalent of North Atlantic hurricanes, rarely get press exposure in the U.S. Strong typhoons can leave behind extensive damage to human structures, snapping thick concrete poles like matchsticks. The result can be weeks or months of recovery time, during which much of the island may lack power or water. Such powerful winds are a common feature in the Marianas, and an important organizing feature affecting the local ecology. Although I was off-island for Typhoon Paka, I returned soon thereafter. I also got to experience several other typhoons, including Keith earlier in 1997. Storm preparations are a lot like getting ready for an impending war. One collects food and water, makes sure plenty of batteries are available, covers all the windows with heavy metal shutters, and waits. As the storm approaches, power is cut off to preserve the infrastructure. Your house now lacks both air conditioning and air flow. You are in a dark, hot, humid space. Your battery-powered radio gives occasional updates on the progress of the storm: how close, how fierce. You wait. When the storm hits you can hear it through the concrete walls: torrential rains, buffeting winds, and flying debris all hit your "shell" with a passion. You wait some more. Eventually, it recedes and you step outside to see how much damage has been done and to begin the process of picking up the pieces and starting life again.

Super-typhoon Paka swept ashore in December 1997 with measured winds of up to 380 km per hour (240 mph). The damage was extensive. Here, a grove of coconuts that lost their tops in the storm. Few trees hit this badly recovered.

This small sign is all that marks the place where Little Boy was attached to the *Enola Gay* before its fateful flight to Hiroshima, Japan (http://tourtinian.homestead.com/files/bpit.jpg).

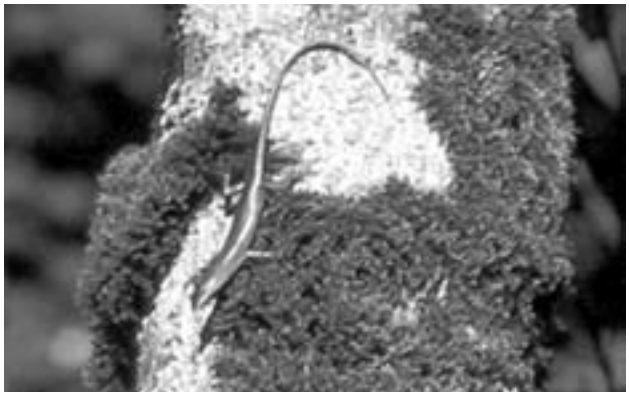
American troops on the beach near Camel Rock. The reoccupation of Guam occurred in 1944 and was very costly. This is a Park Service placard on Guam.

Japanese tourists visit an old gun emplacement their countrymen placed on Rota during WW II.

Pandanus, a native plant common in the Pacific, often serves as a daytime hiding place for Brown Treesnakes.

For many years, the Marianas were a sleepy backwater. The U.S. became the landlord after the Spanish-American War of 1898, but not much changed. Things became a lot less pleasant when the Japanese took the islands at the beginning of World War II. The fighting that followed when the U.S. took the islands back near the end of the war in the Pacific was fierce, as the Japanese were heavily fortified. One can still see some of the gun emplacements. Some 80% of the structures on Guam were destroyed in the shelling that preceded the ground offensive. The Japanese had built large bases, especially airfields, on all the major islands in the chain. All of them were taken back by the U.S. military and served in the war, but the one on Tinian had an especially important role to play. The *Enola Gay*, an American B-29 bomber, left from there on 6 August 1945, carrying "Little Boy," a U-235 bomb, to Hiroshima, Japan. Some 100,000 people died when the bomb exploded at 08:16:02, and a similar num-

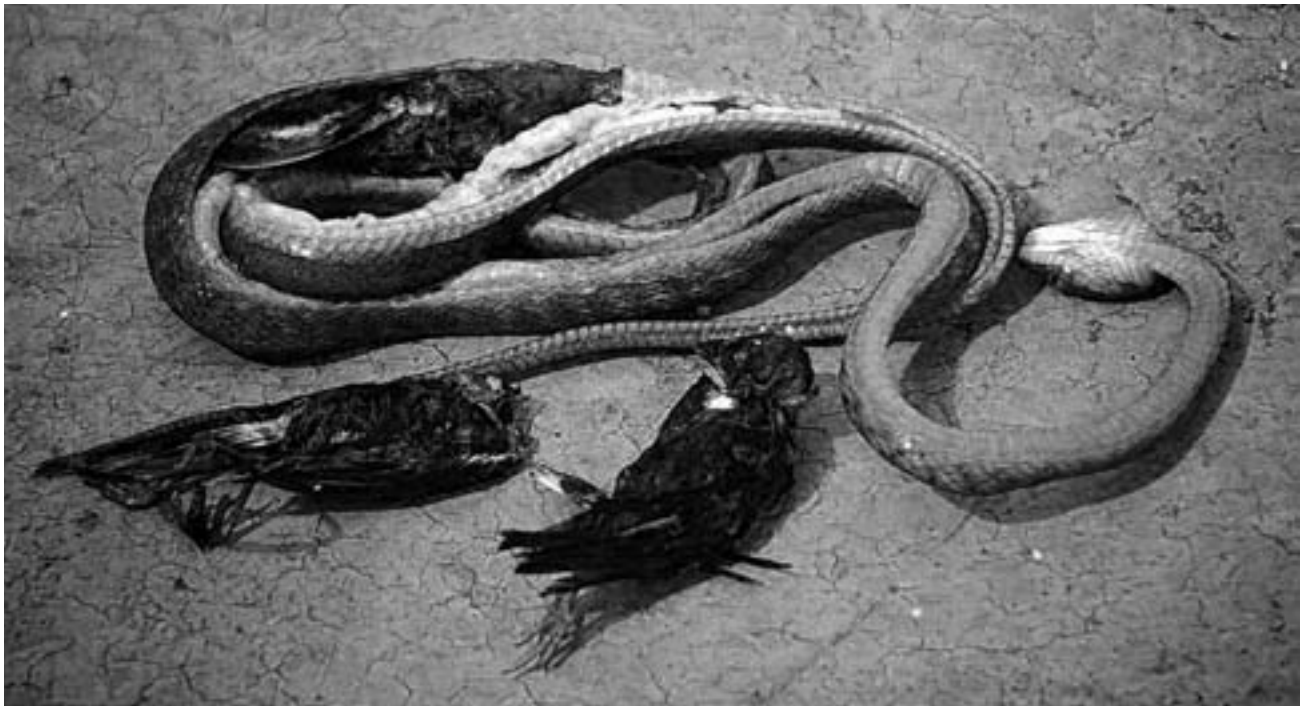
The Brown Treesnake (*Boiga irregularis*) is a nocturnal tree-dweller with a broad diet. These invasive snakes have had a profound ecological and economic impact on Guam.



The Green Tree Skink (*Lamprolepis smaragdina*) rarely visits the ground and can be green, bronze, or gray. It often perches head-down on trunks of trees.

A mating aggregation of introduced Cane Toads (*Bufo marinus*) takes advantage of a puddle created by the explosive rains of the wet season. Tadpoles develop quickly and can take advantage of even small bodies of water. No native amphibians occur on Guam.

Mangrove Monitors (*Varanus indicus*) climb well and are often encountered on trees.



A medium-sized Brown Treesnake and its prey: Three introduced Tree Sparrows (*Passer montanus*) it had eaten before being captured. These snakes are extremely efficient predators.

The endemic Guam Rail (*Gallirallus owstoni*) used to be common on the island. It is now extinct in the wild, but breeds well in captivity.

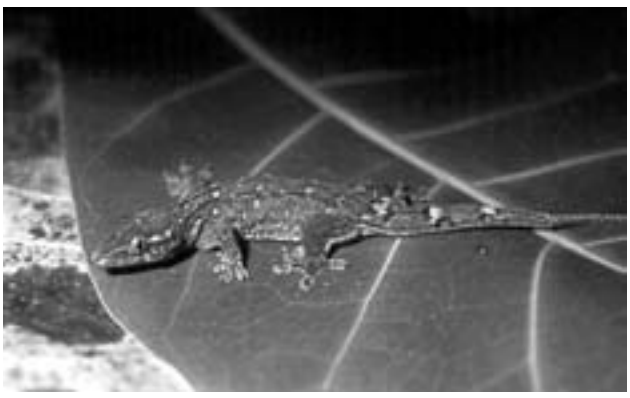
ber were seriously injured. Today, only a small and badly-kept marker stands at this historic location.

The snake that I came to study on Guam was accidentally introduced in the aftermath of WW II, when Guam became a major hub for U.S. military activity in the Pacific. Other invasive reptiles and amphibians occur in the Marianas. Among others, these include the Mangrove Monitor (*Varanus indicus*), the Green Tree Skink (*Lamprolepis smaragdina*), which has been widely introduced but never established on Guam, probably because of snake predation, and the Cane Toad (*Bufo marinus*), which has caused so much trouble in Australia. However, none are as damaging as the Brown Treesnake. By 1980, the snake was found island-wide, had caused the elimination of most of Guam's native forest birds, and had decimated other birds, lizards, and mammals. Today, only three species of forest birds remain on Guam, and nine are gone. Of the remaining species, one, the Aga Crow (*Corvus kubaryi*), is down to five individuals; a single cave houses about two hundred Vanikoro Swiftlets (*Aerodramus vanikorensis*); and only a few hundred Micronesian Starlings (*Aplonis opaca*) remain. We have even found evidence that the ecological damage has trickled down to impact plant communities, many components of which have lost their pollinators and seed-dispersers. The snake is also responsible for frequent and costly power outages and social change, including infant envenomation and loss of culturally important species. Species such as the Guam Rail (*Gallirallus owstoni*, known locally as the "Ko'ko," extinct in the wild) and Marianna Fruitbat (*Pteropus tokudae*, the "Fanihi," down to about 150 individ-

Small-scale test arenas, such as this concrete model built at the Guam NWR, were the final testing stage for all of the snake barriers we developed.

The Guam National Wildlife Refuge at Rititidian Point protects many habitats in the hope that native species can someday be restored to help create a functional ecosystem.

The Rock Gecko (*Nactus pelagicus*), an all-female ground-dwelling species, is now rarely encountered on Guam. Their decline is almost assuredly attributable to the Brown Treesnake.



The largest gecko in the Marianas, this Island Gecko (*Gehyra oceanica*) is rarely seen on Guam, but remains locally abundant elsewhere in the Marianas. This animal was encountered on Saipan.

A 1.5 m (4 ft) Brown Treesnake hiding in the wheelwell of an airplane about to depart Guam. The snake was located by the pilot during a pre-flight check and was removed by the author.

uals) had high social importance in the life-style of the Chamorros. Unfortunately, the Brown Treesnake is also an accomplished disperser. Stowing away on ships and airplanes, snakes have already reached other Micronesian islands, Hawaii, Texas, and even Spain. Recognizing the potential impact and danger to other locations, Congress in 1990 made the Brown Treesnake the only terrestrial organism controlled under the Non-indigenous Aquatic Nuisance Prevention and Control Act.

I was based at the Guam National Wildlife Refuge, located at Ritidian Point in the northern end of Guam. This is the only area on the island designated and consistently managed for conservation. Part of my job was to develop barriers that could be used to block the dispersal of snakes from Guam. This is the kind of work that is not very exciting to a herpetologist: more technology development than chasing animals. Worse, the technology/biology part is by far the easier element in this equation. We developed three types of barriers that showed great efficacy in various kinds of testing. Several of these are currently in use on Guam and elsewhere, helping protect some of the native species such as the Rock Gecko (*Nactus pelagicus*) and the Island Gecko (*Gehyra oceanica*). Perhaps most gratifying, use of barriers made possible the release of captive Guam Rails into a protected native forest area, where they bred for the first time in two decades. Still, policy adoption has lagged behind the availability of the tools, and many places remain less protected than they could be because the funds to build barriers have yet to be allocated.

The future of the Marianas is uncertain. Much of the CNMI economy has rested on the ability of sweatshops to cheaply produce garments with a "Made in USA" label. Traveling around the CNMI, one can see high walls crowned with barbed wire where workers from other countries labor, often in abject conditions. The garment industry has effectively convinced members of Congress, using the usual free trips, to continue supporting the practice, but this will surely not continue forever. Tourism is a strong basis of the economy, and one that is again lucrative now that Asian economies have recovered from their slump of a few years ago. However, the biggest unknown is the U.S. military, which controls much of Guam's area and is a major source of income for both it and the CNMI. The "Voice of America" reported in August 2006 that the military plans to enhance its presence on Guam. The *Pacific Daily News*, Guam's newspaper, reported that thousands of soldiers currently based on Okinawa soon will be moving to Guam. Some talk has stationed the U.S.S. *Carl Vinson*, a nuclear-powered aircraft carrier, on Guam. Such actions are expected to pump billions of dollars into the local economy, but must come at the cost of native habitats. Moreover, North Korea is repeatedly mentioned in such stories, and I cannot help but wonder what such talk does for the tourist industry. Finally, will the increased traffic associated with this economic expansion result in greater opportunities for Brown Treesnakes to leave Guam, or bring additional species to the region? Only time will tell.

HISTORICAL PERSPECTIVES

Life Habits of *Phrynosoma*[1]

In a recent number of the 'Zoölogischen Anzeiger' Prof. Charles L. Edwards, of the University of Cincinnati, gives the following interesting notes upon the habits of the horned lizards of Texas:

While living in Austin, Texas, from May, 1892, to July, 1894, I had abundant opportunity of verifying previous observations upon the life of *Phrynosoma*, and of adding some notes that, so far as I can find, have not been given before this paper.

Phrynosoma cornutum Harlan, in Texan parlance the 'horny frog,' is easily approached under the natural conditions of its habitat, and with a plentiful supply of live flies I have had no difficulty in keeping from fifty to one hundred of them confined in vivaria for many weeks at a time. Six months of the hot, dry, Texas summer, with long days under the glaring sun, and the ground covered with a layer of fine, limestone dust, gives this species of *Phrynosoma* an ideal environment.

A review of the principal points concerning the biology of this familiar genus as brought out in the literature appended, and confirmed by myself, may be first presented. Not to go back to the original systematic descriptions of Wiegmann, Girard, Harlan, Hallowell, Bell, Gray and Blainville, or to mention the synonymy from the various catalogues of reptiles, the taxonomic needs of this paper may be served by reference to Gentry's review of the genus *Phrynosoma*.

This cunning little Iguanid is harmless, never biting its captor, and soon becoming so tame that it may be trained to work in harness pulling a toy wagon, or to eat insects from one's hand. When gently rubbed it puffs itself out, but when in fear it becomes flattened to the ground. *Phrynosoma* chiefly enjoys a dust heap, where with tail and feet flirting the warm calcareous powder over its body, or with alternate sawing motions of its sides, it quickly buries all of itself save the head, and sometimes even this part, in the dirt. While built after an awkward pattern for a lizard, and generally moving slowly, yet it can, when alarmed, run rapidly. It is very clever at 'playing possum' and, aided by its protective coloring, often escapes from an enemy.

The food of *Phrynosoma* always consists of live animals — spiders, flies and especially ants. In Texas the agricultural ant

[1] Reprinted from *Science*, New Series, Vol. 3, No. 73 (22 May 1896, pp. 763–765).

WENDY L. HODGES

A dorsolaterally flattened body and fringes of scales along their sides allow Texas Horned Lizards (*Phrynosoma cornutum*) to blend effectively with a gravel/sand substrate. This is especially noticeable when they flatten themselves against the ground when frightened. This reduces the animal's shadow (very evident in this photo) and causes its outline to merge with the background, rendering them amazingly cryptic.

Editor's Remarks

Everybody likes Horned Lizards (genus *Phrynosoma*). They are strange-looking but calm, rarely bite or even try to scurry away, and most are attractively colored. Unfortunately, most species are also declining despite local or federal protection over at least some of their ranges. The causes are complex, but primarily appear to involve habitat loss, invasive species such as the imported Fire Ant, chemical use in agricultural fields, and — at least historically — collection for pets (a problem even in the early part of the 20th Century as explicitly stated in one of the following notes). Considerable research is ongoing, and we hope to highlight several projects in the next few issues. Readers can find additional information and ways to become involved at the website of the Horned Lizard Conservation Society (http://www.hornedlizards.org/). The HLCS will be having its annual meeting in Texas later this year, and we will report on the topics covered in a future issue of *Iguana*. In the meantime, we have collected a series of short classics reporting on these fascinating creatures. One of the issues they cover is blood-squirting from the eyes, a defense mechanism primarily employed by the lizards against canid predators. Long enshrined in myth, this behavior came into question when early herpetologists were unable to elicit it. Only later did it become fully established that this does, indeed, occur.

Gad Perry
Texas Tech University, Lubbock

(*Pogonomyrmex barbatus*) furnishes almost exclusively the diet of the horned frog. If, however, a quantity of ants are placed with the latter in a vivarium, they soon find thin places on the apparently tough, horny armor of their enemies, and by stinging they drive the horned frogs crazy and frequently to death. While having an abundant supply of water in the vivarium, I have never seen these lizards drink, although they are said to lap up drops of dew when in natural environment. The molting and the curious habit of ejecting blood from the eyes are phenomena often observed. The statement of Böttger that a voice is absent in *Phrynosoma* must be modified, for under certain conditions of excitement it utters a sharp squeak.

This lizard has always been given as viviparous. On the contrary, it builds a nest and lays eggs therein. The only time I observed the nest-building was on June 25, 1894. The location was on a stony clay bank at the side of an Austin street. When first seen, 6 p. m., the female was excavating a tunnel at an angle of about 75° to the surface of the ground, and wide and high enough to comfortably work in. She dug with her front feet, pushing back the loose earth and bits of stone with her hind feet until this debris was quite clear of the entrance. So absorbed was she in her work that my presence did not cause any alarm. The next morning I found the tunnel neatly filled again and the lizard gone.

After carefully removing the replaced debris, the tunnel was found to be seven inches deep. At the bottom, forming an L with this tunnel, was a narrow entrance leading into a chamber three and one-half inches in diameter and two inches high, which was quite round, except for two projecting stones. Here perfectly packed in with loose earth were twenty-five eggs, while again in a hole one and one-half inches deep, at the bottom of the tunnel, were fifteen more. Since the embryos of one of these sets were at a considerably more advanced stage, this female must have taken advantage of the excavation of another. At the time of ovulation the embryo, while at an advanced stage, is still not ready to hatch by probably some days or even weeks. This stage will be considered in detail in a later paper on the embryology of *Phrynosoma*.

Authors give the period of gestation as high as one hundred days in females kept in confinement, but while I have not complete data from coition to ovulation I believe that under natural conditions the time of carrying the eggs is much shorter. A female which had laid eggs in captivity in August, 1864, became very restless after the eggs were taken away. She tried constantly for two or three days to get out of the vivarium at the place where the wire screen had been raised to remove the eggs. Lockwood gives an instance of this maternal anxiety where a female attempts to distract the attention of an observer from her young.

A Horned Lizard at a High Altitude[2]

T.D.A. Cockerell

On June 30, at the head of John's Cañon, Las Vegas Range, N. M., I was somewhat surprised to find a horned lizard in the uppermost part of the Canadian Zone, above 10,000 feet (the aneroid indicated 10,500, but is not quite reliable at that altitude). The species is *Phrynosoma hernandes*[3] (Girard), and the specimen is dark gray, beneath white mottled with gray. The top of the range is Hudsonian, and no lizards are found there.

[2] Reprinted from *Science*, New Series, Vol. 14, No. 342 (19 July 1901, p. 111).

[3] Mountain Short-horned Lizard, *Phrynosoma hernandesi.*

WENDY L. HODGES

Mountain Short-horned Lizards (*Phrynosoma hernandesi*) can be found at elevations over 3000 m.

A Note on Distinction of the Sexes in *Phrynosoma*[4]

W.M. Winton

A surprisingly small amount of knowledge concerning the embryology and development of the Iguanidæ has been collected. One reason for this is the fact that, for most forms, there is no reliable method of distinguishing the sexes by external characters. This is particularly true in the case of the familiar, but little studied, "horned toad," *Phrynosoma cornutum*, and undoubtedly many "pairs" which have been shipped north by well meaning collectors have been of the same sex.

In making a study of the stomach contents of Phrynosomas, I have had occasion to open some two hundred specimens, trying always to find some connection between external characters and sex. The problem very quickly was solved; and I can affirm, that for this region at least, and during the spring months, the crescent markings on the back of the female are much brighter yellow than those of the male. The difference is very marked, and little or no practise is required to enable one to distinguish the sexes, even without comparison of specimens.

[4] Reprinted from *Science*, New Series, Vol. 40, No. 1026 (28 August 1914, pp. 311–312).

An Examination of Blood-ejecting Horned Lizards[5]

W.M. Winton

The horned lizard's (or horned "toad's") remarkable habit of ejecting blood from its eye when attacked, although well authenticated, is so rarely observed that it is thought by many to have its origin and its creditability in the little animal's dragon-like appearance. Even Ditmars confesses that it took an actual demonstration, witnessed only after handling several hundred specimens, to upset his skepticism. His description of the performance is well known.

[5] Reprinted from *Science*, New Series, Vol. 40, No. 1039 (27 November 1914, pp. 784–785).

WENDY L. HODGES

Texas Horned Lizards (*Phrynosoma cornutum*) share with all other Horned Lizards the capacity to eject blood from sinuses near the eyes. This appears to deter at least some potential predators.

Hay (1892), Stejneger (1893), Van Denburg (1897), Bunner (1907), Bryant (1911) and others have observed and mentioned this peculiar habit. It is not limited to any single species.

Various explanations have been suggested; among others that the phenomenon is connected with the breeding season, that it may be due to some parasite, and that it may be "a secondary use acquired by a relatively few forms."

Bryant sectioned the eyelids of a blood-ejecting specimen, and found them highly vascular and full of blood sinuses.

On July 4, while collecting specimens of *Phrynosoma cornutum* for examination of stomach contents, I was fortunate enough to witness this phenomenon. One of my students, walking by my side, stooped and thrust out his hand to pick up a large specimen, when he was met by a sudden spurt of blood coming unmistakably from the lizard's eye. The blood spread over the young man's hand in a fan shaped and even smear, extending from the second joint of the index finger to the wrist, and being about thirty mm. wide at the base. On July 7, another specimen, while being chloroformed, shot a quick jet of blood from one eye. The blood was given an almost explosive impulse, and formed a single thick drop on the inner wall of the bell jar. On July 20, another specimen ejected blood while being anesthetized. In this case, the blood on the wall of the bell jar was mixed with tiny fragments of skin and a few scales.

WENDY L. HODGES

Texas Horned Lizards (*Phrynosoma cornutum*) have a broad distribution, but have been extirpated from some core areas by urban expansion and alterations of habitat for agricultural purposes.

All three animals were subjected to a very careful examination. All were males. Their lengths were 108 mm., 110 mm. and 108 mm. The lizards were in good condition, even being free from tapeworms and other intestinal parasites with which local *Phrynosomas* are much infected. The stomach contents were characteristic, consisting of agricultural ants, small beetles, isopods, etc. In each case, the eye from which the blood was ejected showed a small quantity of clotted blood in the posterior corner. The vessels were slightly swollen. The cornea seemed to be intact. In the first two cases there was a small spot in the sclerotic coat, which can be best described as a blood blister. The contents on removal to a slide, and staining with Wright's stain, showed nothing except a few red corpuscles and lymphocytes. The third specimen slowed nothing but a mass of clotted blood in the posterior corner of the eye. In each case, careful dissections were made, using needles and working under a 48 mm. objective. No parasites of any kind were found.

In my opinion, the most significant fact of all is that all three animals were moulting, the third being in quite an advanced stage.

A Preliminary Note on the Food Habits and Distribution of the Texas Horned Lizards[6]

W.M. Winton

Random examinations of stomach contents, made by various workers during the past forty years, have indicated that *Phrynosoma cornutum*, the Texas horned lizard, is of great economic importance. To determine its status as a valuable animal, an examination of four hundred and eighty-five stomachs has been made. As only a small per cent. of the animals found in the field were captured and killed, several facts — besides the principal one — concerning this animal have been disclosed.

The Texas horned lizard, unlike the other species of the genus, is distinctly not a desert form. Its area of distribution is quite extensive, going northward into Kansas, southward far into the Mexican table land, and westward into Arizona; but, clearly, the area of its greatest abundance is the north and south strip of Texas known as the Black and Grand prairies. This strip of country includes the cities of Fort Worth, Dallas, Waco, Austin and San Antonio — in fact all of the large cities of the state except Houston and Galveston; and is preeminently the best part from an agricultural standpoint. Within this area, where conditions are all favorable, the *Phrynosoma* population averages at least thirty to the acre. This is despite the fact that for a number of years these lizards have been captured and sold to visitors from the east.

The life history has not been well worked out, but the newly hatched young begin to appear by the first of August; so that it is safe to say that the ordinary agricultural operations such as spring and fall plowing, do not interfere with the life cycle. The natural enemies are few and unimportant, being mainly road runners and opossums.

The stomachs examined included the following forms: four species of ants; four species of bees (mainly miner bees); eight species of beetles; three species of stink bugs; nymphs of grasshoppers and allied Orthoptera; five species of flies; and a few caterpillars, some of which have not yet been identified. The noxious forms found overwhelmingly outnumbered the useful forms.

[6] Reprinted from *Science*, New Series, Vol. 41, No. 1065 (28 May 1915, pp. 797–798).

WENDY L. HODGES

Texas Horned Lizards (*Phrynosoma cornutum*) often have been described as "ant specialists," because of their habit of sitting near ant trails and picking off individuals that stray too close. Although consumption of small prey, if sufficiently abundant and easy to capture, can be energetically efficient, Horned Lizards opportunistically eat essentially any small arthropod that will fit in their mouths.

Agricultural ants were found in 80 per cent. and stink bugs in 60 per cent. of the stomachs. Neither of these is much subject to the attacks of birds. Obviously this enhances the value of *Phrynosoma*. Incidentally, there was a remarkable consistency or homogeneity in the contents of the individual stomachs. For example, in one case, nearly all of the forms present would be Hymenoptera; in another, nearly all would be Heteroptera, etc. This could mean that individuals acquire a taste for sour food, or fatty food, etc.; or, what is more likely, that the same individual requires from time to time certain special elements in its food.

From the data thus far assembled, it can be safely affirmed that the horned lizards of Texas are of tremendous importance to agriculture in that region; and may, perhaps, play as important a part as does the common toad in the better watered regions of the United States.

The Urine of the Horned Lizard[7]

A.O. Weese

Vauquelin,[8] in reporting the first analysis of reptilian urine, in 1822, stated that is was composed almost entirely of uric acid, and since that time this fact has been interpreted by various observers as an adaptation to the conditions of life in arid regions, where animals obtain their only external water supply in very limited quantities in the food substances, and this type of nitrogenous excretion involves practically no water loss. The reptiles of arid regions have been known for some time to excrete practically all of their waste nitrogen in the form of uric acid and its salts, while, on the other hand, birds and aquatic and semi-aquatic reptiles may secrete considerable amounts of urea.

The urine of the horned lizard is excreted in the dry form at the same time as the feces, from which it is separated by a constriction of the common mass, the material voided at any one time having roughly the shape of a dumbbell, one of the enlargements being composed of urine and the other of fecal matter. The following figures for the composition of the urine of *Phrynosoma cornutum* (specimens obtained at Alamogordo, N.M.) have been obtained recently in the laboratory of physiological chemistry of the University of Illinois, the work having been undertaken at the suggestion and under the direction of Dr. H.B. Lewis.

Constituents	Mg. per Gm. of Dry Urine
Total nitrogen	260
Urea + ammonia nitrogen	1.4
Ammonia nitrogen	1.4
Uric acid	765
Creatinine	Trace
Ash	87.5
Phosphorus as P_2O_5	3.5

It will be noticed from the above figures that uric acid accounts for practically the total amount of nitrogen present, and that there is no urea. The small amount of ammonia is probably present as ammonium urate. The ash present is mostly composed of foreign materials (sand grains, etc.) inseparable from the urinary mass and therefore weighed and analyzed with it.

[7] Reprinted from *Science*, New Series, Vol. 46, No. 1195 (23 November 1917, pp. 517–518).

[8] Vauquelin, Louis Nicolas, "Examen des excrémens des serpens que l'on fait voir en ce moment à Paris, Rue Saint-Nicaise," *Annales de Chimie et de Phisique*, 2me Serie, Tome 21, p. 440, 1822. Two boas, species not stated, were the source of the urine examined in this case. Uric acid had also been associated with reptiles as early as 1793, when a "pasty deposit" found in the bladder of a tortoise by Vicq-d'Azyr was found to contain this substance [footnote from original].

SUZANNE L. COLLINS, CNAH

Like most congeners, Desert Horned Lizards (*Phrynosoma platyrhinos*) are found in arid regions that have at least some loose soil available for burrowing.

COMMENTARY

Crocodiles And Alligators Are Very Different[1]

J. Whitfield Gibbons

Savannah River Ecology Lab, Aiken, South Carolina

Florida recently reported another alligator attack. As more people invade alligator habitat in southern states, we have (or at least should have) come to expect such news. Contact between us and them is steadily increasing. Ironically, humans, the invasive species, are the ones who become offended when another species takes objection to our presence.

I do not want to belittle or trivialize the traumatic experience suffered by anyone who has been injured by an alligator or had a family member, friend, or pet actually killed by one. However, a comparison between American Alligators (*Alligator mississippiensis*) and some crocodiles is worth considering, if for no other reason than to show how a truly aggressive species copes with interlopers. The Saltwater Crocodiles (*Crocodylus porosus*) of Australia are very different from American Alligators in their response to humans — they will attack and eat people. These are the reptile world's equivalent of Great White Sharks or Bengal Tigers. They frequent ocean habitats as well as rivers and freshwater marshes near where people live. Their maximum size is enormous, more than 20 feet. A crocodile only 15 feet long could easily kill and swallow a full-grown man.

Despite prevailing views about the sanctity of human life, some predators view people as simply another source of protein — and people living in areas where such attacks are common often develop different attitudes from those to which we are accustomed. For example, one journalist noted that people inhabiting the Northern Territory in Australia "seemed almost jubilant whenever someone was taken by a crocodile." When a "mineworker met a grisly death in the jaws of a giant crocodile" in a national park, many of the residents in the Northern Territory displayed "widespread and bizarre delight" that the crocodile had been victorious.

Once when I visited the region near Darwin, Australia, someone was killed and eaten by a Saltwater Crocodile in the Adelaide River. The local folks with whom I talked the next day were seemingly unmoved by the incident. Why the lack of compassion by the residents? Because, as someone said, they view themselves as "rugged frontiersmen carving out an existence in an untamed wilderness." They reject even the hint of a suggestion that the crocodile population be reduced in any way.

The preservationist attitude about the Saltwater Crocodile by old-time residents is based on the principle that the rivers of northern Australia belong to the crocodile. If humans want to share the waters and adjoining land, they must assess the risks of these giant predators and be prepared to live (or die) with them. This is my image of the pioneering spirit of early America, which differs dramatically from the attitude of most Americans today.

What is the difference between an alligator and a crocodile, aside from the fact that some crocodiles will eat people? The answer is not simple. Almost two dozen species of crocodilians exist today, which vary greatly in shape and size. However, American Alligators have broad snouts, and American Crocodiles (*C. acutus*), which are native to southern Florida, have narrower snouts. Fortunately, American Crocodiles do not indulge in the antisocial behavior of eating people. American Crocodiles, in fact, behave somewhat like alligators, which are usually shy and inoffensive.

Some people consider American Alligators a menace because they occasionally attack people, but this seldom happens without some provocation. Almost all alligator attacks can be traced back to human irresponsibility of some sort, including people feeding alligators. Yet, if an animal causes harm to people, we hold the animal responsible, without considering that we may have entered its natural environment, threatened its young, and destroyed its habitat. Maybe Americans need to be more accepting of the nature of wild animals and more willing to share the environment with them. This doesn't mean we must acquiesce to the idea that humans are acceptable prey items, but none of our native species are typically out to make a meal of us.

To avoid alligator attacks or other unfortunate encounters with nature we must consider the rules of safety and probabilities of risk when dealing with any animal that could bite, trample, scratch, sting, or otherwise injure us. Developing an attitude that we must be responsible will be a good first step.

JOE WASILEWSKI

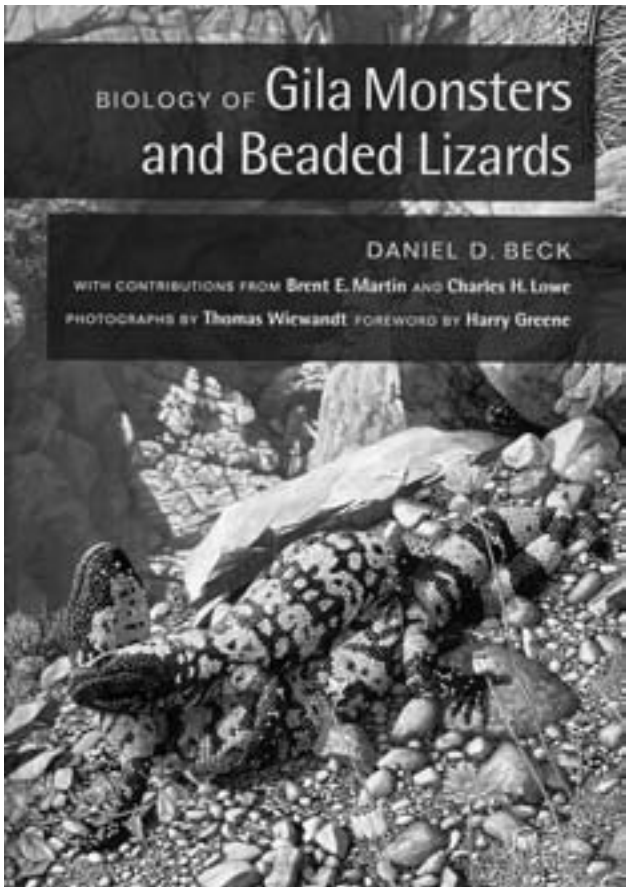
Saltwater Crocodiles (*Crocodylus porosus*) are much more aggressive than American Alligators (*Alligator mississippiensis*) and American Crocodiles (*C. acutus*).

[1] Adapted with permission by the author and Partners in Amphibian & Reptile Cconservation (http://www.parcplace.org/).

BOOK REVIEW

Gila Monsters and Beaded Lizards

Biology of Gila Monsters and Beaded Lizards. 2005. By Daniel D. Beck; photographs by Thomas Wiewandt. University of California Press, USA, 211 pages. Hardback - ISBN: 0-520-24357-9 - $49.95.



Upon learning that the IRCF was partnering with Project Heloderma for the preservation of Guatemalan Beaded Lizards, I realized that I needed a quick and thorough education in all things helodermatid. I knew little about Gila Monsters and Beaded Lizards beyond the fact that they were fascinating in appearance and just a little bit scary. Daniel Beck's *Biology of Gila Monsters and Beaded Lizards* proved to be authoritative, well-organized, and as comprehensive as possible given the current state of research on the world's only venomous lizards.

The book's 10 chapters begin with history and evolution, progress through the venom system and various aspects of ecology, and end with conservation and a look to the future. The first chapter, "Monsters in our Midst: History, Humans and Heloderma," places Gila Monsters and Beaded Lizards into a sociological context. Beck chronicles the history of investigations and presents some of the more colorful folklore and mythology. Despite their fame (or infamy), *Heloderma* has been one of the least-studied lizard genera — until recently.

Chapter 2, "Evolution, Distribution and Systematics," traces the complex evolutionary history of the Monstersauria, the ancient group into which taxonomists place *Heloderma* and six extinct genera. Based on skull morphology, the six currently recognized species in the genus have changed very little over 23 million years, and qualify as living fossils. Their closest living relatives include varanids (Monitor Lizards) and snakes.

If humans require any rationale to preserve Gila Monsters and Beaded Lizards beyond the need to maintain biodiversity, the stimulus lies in chapter 3, "The Venom System and Envenomation." While scientists continue to investigate whether *Heloderma* venom is used to acquire prey or for defense, Beck describes some of the many components of the venom, their physiological effects, and potential uses in treating human ailments as varied as diabetes, cancer, and Alzheimer's disease.

Chapters 4 through 7 discuss aspects of ecology, including physiology, habitat use, and population and foraging ecology. The chapter on population ecology is co-authored with Brent E. Martin and Charles H. Lowe. Virtually every aspect of their ecology served to heighten my fascination with *Heloderma*, from their astonishing energy efficiency to their complex refuge-dependent activity patterns and greater than 20-year-long life histories. Even their diet is unique; these lizards prey largely on nests and nestlings of mammals, birds, and even other reptiles, a feeding niche exploited by few squamates.

Chapter 8 on "Reproduction, Behavior and *Heloderma* in Captivity" emphasizes the challenges involved with conducting research on these animals. The difficulties of enticing *Heloderma* to reproduce in captivity lead into chapter 9 on "Conservation." Gila Monsters and Beaded Lizards are faced with habitat fragmentation and degradation, invasive plants and fire, illegal collection for the pet trade, and destruction by road traffic, domestic pets, and wanton killing due to fear and ignorance. The Guatemalan Beaded Lizard, the conservation of which the IRCF champions, is faced with precisely these threats, and habitat protection may provide its best opportunity to avoid extinction.

In his final chapter, "Future Directions," Beck outlines some of the gaps in our current knowledge and suggests avenues for future research that involve technological advances in radiotelemetry, molecular biology, and pharmacological investigation.

On the whole, *The Biology of Gila Monsters and Beaded Lizards* satisfied my appetite for information about *Heloderma*. Information might have been organized by species, which would have facilitated the acquisition of insights into each taxon. This deficit, however, is not entirely the author's fault; instead, the dearth of information about some taxa, including the Guatemalan Beaded Lizard, leaves little to reveal. Beck's book will surely serve the animals well as it outlines current knowledge, suggests future research, and promotes an appreciation of a remarkable group of reptiles.

AJ Gutman
IRCF

CONSERVATION RESEARCH REPORTS

Reproductive Investment of a Lacertid Lizard in Fragmented Habitat

DÍAZ ET AL. (2005. *Conservation Biology* 19:1571–1577) studied the effect of habitat fragmentation on female reproductive investment in a widely distributed lacertid lizard (*Psammodromus algirus*) in a mixed-forest archipelago of deciduous and evergreen oak woods in northern Spain. They captured gravid females in fragments (≤ 10 ha) and forests (≥ 200 ha) and brought them to the laboratory, where they laid eggs. Eggs were incubated and the first cohort of juveniles released into the wild in order to monitor survival. Females from fragments produced a smaller clutch mass and laid fewer eggs (relative to mean egg mass) than females of similar body size from forests. Lizards did not trade larger clutches for larger offspring, however, because females from fragments did not lay larger eggs (relative to their number) than females from forests. Among the first cohort of juveniles, larger egg mass and body size increased the probability of recapture the next year. Thus, fragmentation decreased the relative fecundity of lizards without increasing the quality of their offspring. Reduced energy availability, increased predation risk, and demographic stochasticity could decrease the fitness of lizards in fragmented habitats, which could contribute to the regional scarcity of this species in agricultural areas sprinkled with small patches of otherwise suitable forest. Results demonstrated that predictable reduction of reproductive output with decreasing size of habitat patches can be added to the already known processes that cause inverse density dependence at low population numbers.

PASCAL DUBOIS

The reproductive output of lizards (*Psammodromus algirus*) from fragmented habitat patches was reduced when compared to lizards from forests.

The Conservation of Brazilian Reptiles: Challenges for a Megadiverse Country

About 650 species — 330 snakes, 230 lizards, 50 amphisbaenids, 6 caimans, and 35 turtles — comprise the known reptilian fauna of Brazil. Only 20 species are considered threatened. Except for the marine and freshwater turtles, which suffer from overexploitation and habitat destruction, species are threatened because of rarity and extremely restricted ranges. Despite its richness and diversity, research on Brazil's reptilian fauna remains largely restricted to alpha taxonomy. TREFAUT RODRIGUES (2005. *Conservation Biology* 19:659–664) suggested that surveys, an electronic database of all herpetological collections, and phylogeographic studies based on molecular genetic techniques are needed to improve our understanding of the biogeography of Brazilian reptiles and to delineate effective conservation strategies to preserve the evolutionary potential of existing lineages. Autecological, population, and community studies that monitor effects of habitat degradation, fragmentation and loss, pollution, and exploitation are needed for a better understanding of the effects of the widespread and ever-worsening degradation of Brazil's natural ecosystems.

ROBERT POWELL

The Black Caiman (*Melanosuchus niger*) is a threatened species, but the conservation status of many of Brazil's other reptilian species is uncertain, a condition largely attributable to a paucity of information.

Effect of Vegetation Matrix on Animal Dispersal: Genetic Evidence from a Study of Endangered Skinks

Maintaining connectivity in fragmented landscapes is a key principle of biological conservation. Although corridors are a widely accepted approach to connecting populations, their merits are still debated, and they may be impractical in many situations. A focus on management of the vegetation matrix between populations has been advocated as an alternative way to deal with habitat fragmentation and has theoretical support. BERRY ET AL. (2005. *Conservation Biology* 19:855–864) combined microsatellite DNA and demographic data to provide an empirical account of how two forms of agricultural land use affect the connectivity of insular populations of an endangered skink in southern New Zealand. The Grand Skink (*Oligosoma grande*) lives in small populations (approximately 20 individuals) on rock outcrops separated from one another by 50–150 m of inhospitable matrix vegetation (either native tussock grassland or exotic pasture). Skinks typically dispersed short distances, and the nature of the matrix both quantitatively and qualitatively affected dispersal dynamics. Skink populations in pasture were significantly more genetically structured and had less genetic variation than similar populations in tussock,

TRENT BELL

The Grand Skink (*Oligosoma grande*) of New Zealand lives in small populations of approximately 20 individuals on rock outcrops separated from one another by 50–150 m of inhospitable vegetation.

WIKIPEDIA: ORCHI

The lack of seed dispersal by a lizard (*Podarcis lilfordi*) extinct on Menorca (a Balearic island in the western Mediterranean) may be responsible for the decline in populations of a perennial shrub considered at risk of extinction.

implying less dispersal between populations in pasture than tussock. Furthermore, although female-biased dispersal was a feature of populations in tussock, no sex bias was evident in pasture. In addition, Bayesian individual-based genetic assignment tests that incorporated prior mark-recapture information revealed that some populations produced many emigrants but received few immigrants, whereas other populations were relatively insular. Patterns of dispersal and response to matrix vegetation were complex, and the causes of these patterns deserve attention in future studies of habitat fragmentation. Managing the vegetation matrix may be a practical way to connect animal populations in some situations.

Disruption of a Plant-Lizard Seed Dispersal System and Its Effects on a Threatened Endemic Plant

The introduction of exotic species to an island can have significant effects on the population density and distribution of native species and on the ecological and evolutionary interactions among them (e.g., plant-animal mutualisms). The disruption of these interactions can be dramatic, significantly reducing the reproductive success of the species and even leading to their extinction. On Menorca Island (Balearic Islands, western Mediterranean), TRAVESET AND RIERA (2005. *Conservation Biology* 19:421–431) examined the consequences of the disruption of the mutualism between two endemic species: a perennial shrub (*Daphne rodriguezii*) and a frugivorous lizard (*Podarcis lilfordi*). The lizard became extinct from this island (as well as from Mallorca) as a result of the introduction of carnivorous mammals, which has continued since Roman times. The relict mutualism between *D. rodriguezii* and the lizard currently persists only in an islet (60 ha) where *P. lilfordi* remains abundant. The authors hypothesized that the absence of this lizard from most Menorcan populations is the factor causing the regression of this plant, currently considered at risk of extinction. Through observation and experimentation in the field and laboratory, they found strong evidence that a lack of seed dispersal in Menorca is the main cause of the low seedling recruitment. First, the population with greatest seedling recruitment was that in the islet where lizards were abundant. Second, lizards appeared to be the only dispersers of *D. rodriguezii*. Lizards consumed large amounts of fruits, without affecting either germination or seedling growth, and moved seeds to sites suitable for plant establishment. Seedlings in Menorca, in contrast, recruited almost exclusively under the parent plants. Third, the effect of other factors that may influence plant population growth (a low fruit set and a high postdispersal seed predation) was similar between the islet and the Menorcan populations. These appear to be the first results to quantitatively show that a biological invasion can cause a disruption of a specialized plant-vertebrate mutualism that sets the plant partner on the road to extinction.

Predicting the Impact of Sea-Level Rise on Caribbean Sea Turtle Nesting Habitat

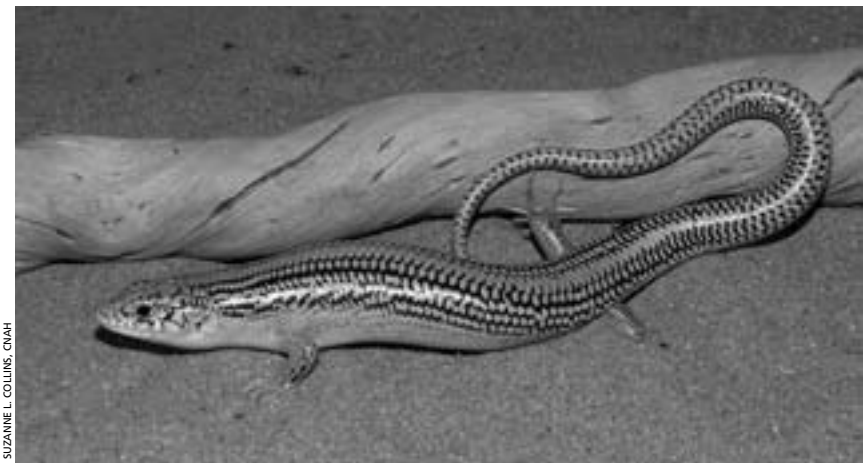
The projected rise in sea level is likely to increase the vulnerability of coastal zones in the Caribbean, which are already under pressure from a combination of anthropogenic activities and natural processes. One of the major effects will be a loss of beach habitat, which provides nesting sites for endangered sea turtles. To assess the potential impacts of sea-level rise on sea turtle nesting habitat, FISH ET AL. (2005. *Conservation Biology* 19:482–491) used beach profile measurements of turtle nesting beaches on Bonaire, Netherlands Antilles, to develop elevation models of individual beaches in a geographic information system. These mod-

Hawksbill Turtles (*Eretmochelys imbricata*) often nest in dense beach vegetation. Their nesting beaches as well as those of other Caribbean sea turtles could be threatened by rising sea levels. Photograph courtesy of the Nature Foundation of St. Maarten (NAF-SXM).

els were then used to quantify areas of beach vulnerable to three different scenarios of a rise in sea level. Physical characteristics of the beaches were also recorded and related to beach vulnerability, flooding, and nesting frequency. Beaches varied in physical characteristics and therefore in their vulnerability to flooding. Up to 32% of the total current beach area could be lost with a 0.5-m rise in sea level, with lower, narrower beaches being the most vulnerable. Vulnerability varied with land use adjacent to the beach. These predictions about loss of nesting habitat have important implications for turtle populations in the region.

Burn Regimes and Tallgrass Prairie Reptiles

The Flint Hills region of Kansas is the largest contiguous area of tallgrass prairie remaining today. Historically, the tallgrass prairie burned every 2–3 yr on average, but current land managers have altered burn regimes, resulting in a range of habitats from annually burned to long-term unburned. WILGERS AND HORNE (2006. *Journal of Herpetology* 40:73–84) used drift fence/funnel trap arrays and coverboards to estimate species richness, evenness, and diversity of herpetofauna within three different burn regimes: annual, 4-yr, and long-term unburned at Konza Prairie Biological Station, Riley County, Kansas. During the spring and fall of 2003–2004, 315 individuals from 20 species were captured across all burn regimes. Herpetofaunal species richness, evenness, and diversity estimates were not different between the three burn treatments. However, because of species-specific responses to individual burn regimes, community composition was significantly different between the habitats. Four species exhibited preferences among burn regimes, which differed significantly from independent assortment, with Great Plains Skinks (*Eumeces obsoletus*) and Texas Horned Lizards (*Phrynosoma cornutum*) preferring annual burn treatments, Ground Skinks (*Scincella lateralis*) preferring 4-yr burn treatments, and Ringneck Snakes (*Diadophis punctatus*) preferring longterm unburned treatments. Species-specific responses were likely because of changes in vegetation structure and microhabitat (temperature and moisture content) created through different frequencies of fire disturbances. Maximizing large-scale herpetofaunal diversity across the Flint Hills' rangelands could be accomplished by creating a large number of small-scale habitat types through a mosaic style burning plan.



SUZANNE L. COLLINS, CNAH

Great Plains Skinks (*Eumeces obsoletus*) were among four species of tallgrass prairie-dwelling reptiles that demonstrated a clear preference for a particular burn regime, favoring annual burn treatments.

Alligator Snapping Turtles in Southeastern Louisiana,

BOUNDY AND KENNEDY (2006. *Chelonian Conservation and Biology* 5:3–9) trapped 200 Alligator Snapping Turtles (*Macrochelys temminckii*) at an average rate of 0.057 turtles per trap-night in all but 1 of 33 sites in southeastern Louisiana. Trap rate varied between sites, by harvest pressure levels at sites, and by season, but not by hydrology. Perceived trap rate differences under different harvest regimes appeared to be a function of seasonal differences in trap rate. No differences in sex ratio or percentage of immature turtles were detected between sites, harvest regimes, seasons, or waterbody types. Turtle weight varied between harvest regimes and hydrology. Weight–length relations for turtles was highly correlated and similar between sexes, except that males continued to grow to larger sizes than females (males averaged 150% female weight and 118% female carapace length). Sex ratio was 1:1, and immature turtles made up 48% of the total. Average sizes of turtles were very similar between Louisiana and turtles from surveys in several other states. Population structure differed between surveys, with Louisiana having a higher percentage of immature turtles and lower trap rate than elsewhere. Population differences could not entirely be explained by differences in harvest regimes between states. Large-scale turtle butchering operations in southern Louisiana have closed, as has commercial harvest. Anecdotal reports that Alligator Snappers were nearly extirpated from a heavily harvested site proved erroneous. The authors recommended resurvey of sites to determine current population trends.

SUZANNE L. COLLINS, CNAH

Louisiana populations of Alligator Snapping Turtles (*Macrochelys temminckii*) included more immature turtles and exhibited a lower trap rate than populations surveyed in other southern states.

NEWSBRIEFS

Mexican Herpetological Society Meeting

The Mexican Herpetological Society and the Universidad Autónoma de Nuevo León (UANL) School of Biological Sciences are pleased to announce the Ninth Reunión Nacional de Herpetología México on 6–9 November 2006. The meeting will be held in the Raúl Rangel Frías Library, located on the campus of UANL, Monterrey, Nuevo León, México. Participation and attendance is open to all parties interested in the study of Mexican herpetofauna. Papers and posters on Mexican herpetofaunal systematics, biogeographic analysis, faunistics, ecology, conservation, reproduction, and development are welcome.

S. H. M. A. C.

For further information contact: www.sociedadherpetologicamexicana.com or www.fcb.uanl.mx

SUZANNE L. COLLINS, CNAH

ROBERT POWELL

Corn Snakes (*Elaphe guttata*, top) and Red-eared Slider Turtles (*Trachemys scripta*) are invasive species in Australia that might pose serious threats to native ecosystems.

Exotic Snakes in Australia

Keith Larner, senior investigator at the Department of Sustainability and Environment in Victoria, Australia reports that, in the past four years, the DSE has found 340 "exotic" reptiles in Victoria, including 55 Boa Constrictors (*Boa constrictor*) and 63 Corn Snakes (*Elaphe guttata*). He believes that these invaders pose a serious threat to the ecosystem.

Many of the interlopers are discovered by DSE officers executing search warrants, and often are found in the homes of suspected drug dealers. In a recent search, "We gathered enough information for a search warrant, and, as a result, we found a massive amount of stolen machinery, computers, telephones, there were signs of intravenous drug use, a quantity of drugs was seized and a quantity of ammunition," Mr. Larner said.

A profile compiled by the DSE suggests that a person most likely to be keeping exotic reptiles illegally is: 18 to 35 years old, living in the western suburbs or Geelong, a blue-collar worker or unemployed, licensed to keep native wildlife, and a *Cannabis* grower. The DSE says drugs and exotic reptiles go together because *Cannabis* is sold to pay for electricity to keep the snakes warm. Some also believe that a large Boa Constrictor is more of a deterrent to thieves than a dog.

Since 11 September, the postal service has been closely monitored, so reptile smugglers are turning to couriers. "A person from Sydney was recently apprehended at the airport with cobras strapped to his legs," Mr. Larner said. "Some of these snakes might only be eight inches [20 cm] long, but they can still deliver venom. There's a whole network of people out there who have these deadly snakes and they're quite proud of it."

Of more concern is the fact that people are breeding venomous snakes rather than just importing them. As well as the threat to the ecosystem from voracious Corn Snakes and Red-eared Slider Turtles (*Trachemys scripta*), people could be bitten, and little or no antivenom is available for these species in Australia. "These are an environmental pest. We can't do anything about it unless people tell us what's happening out there." The DSE is happy to negotiate with anybody wanting to surrender these animals.

theage.com.au
26 May 2006

SWIG Program is Being Harmed

Please take action by contacting your United States Senators and letting them know that you oppose cuts to the State Wildlife Grants Program, which recently passed in the House of Representatives. Partner-driven and results-oriented, the State Wildlife Grants Program is an

innovative program that is already producing on-the-ground conservation benefits for amphibian and reptilian habitat across the country. Please let your lawmakers know how much more could be done if they support full funding for the State Wildlife Grants Program.

State Wildlife Grants support cost-effective and proactive approaches to wildlife conservation, conserving wildlife and their habitat before they become endangered and hence more difficult and costly to conserve. Robust State Wildlife Grants funding is needed to implement each state's Wildlife Action Plan, each of which was a collaborative effort aimed at outlining the conservation priorities for each state, and without appropriate levels of State Wildlife Grant funding, the plans will remain just that, plans.

To write your lawmakers and urge them to support full funding for the State Wildlife Grants Program, see: http://www.congressweb.com/cweb4/index.cfm?orgcode=iwla&hotissue=11

ALBERTO LOPEZ

Green Iguanas (*Iguana iguana*) have become phenomenally abundant in the San Juan area of Puerto Rico, to the extent of causing problems at the Luis Muñoz International Airport. This individual was photographed near the airport in a stand of Red Mangroves (*Rhizophora mangle*), which are heavily exploited by this introduced population.

Geckophiles Gather in Texas

With an accomplished lineup of speakers and a weekend of exciting gecko-related events, the first annual Geckophile Gathering took place from 9–11 June in Austin, Texas. The festivities began on Friday night, with an informal icebreaker sponsored by Rep-Cal.

The lectures began on Saturday, with a beautiful slideshow and DVD presentation by Joe Furman. He shared his experiences studying Namibian geckos and other herps in the field. Ron Tremper, who talked about his decades of work with leopard geckos, impressed attendees with all of the interesting morphs he has created over the years. Paul Freed then gave a humor-filled talk about geckos and other herpetofauna of Australia, leaving participants hungry for more photos and information about such unique species. After lunch, Tony Gamble discussed his research efforts in Brazil, including his activities to collect geckos and other herps in the field. Daniel Scantlebury, a local University of Texas student and lifelong gecko lover, shared his extensive knowledge about the form, function, and diversity of gecko feet. Dr. Paddy Ryan had the audience in stitches with his lecture about herpetological conservation in New Zealand, which was peppered with hilarious anecdotes and fun facts about the region, and illustrated with some incredible photos of New Zealand geckos and the Tuatara. Finally, one of the most anticipated speakers of the day, Aaron Bauer, shared his exhaustive research of New Caledonian geckos and tried to make sense of forty new species by examining and explaining recent taxonomic and systematic changes within the diverse group of geckos from that region.

After a full day of intense and exciting talks, attendees met for a Tex-Mex style dinner followed by a charity auction to benefit the International Reptile Conservation Foundation. The IRCF graciously donated funds and dry goods for the symposium and auction, and everyone made sure to dig deep to give something back to an organization and a cause they care about passionately. Attendees and many well-known companies in the herp industry offered some fantastic dry goods for the auction. The auction raised hundreds of dollars for the IRCF, and everyone had a great time at the dinner.

Nathan Hall

Puerto Rico To Rid Airport Runways Of Basking Iguanas

Green Iguanas (*Iguana iguana*) basking on runways at Puerto Rico's largest international airport have become such a hazard that this U.S. Caribbean territory plans to rid the area of the invasive reptile species, an official said Friday. Javier Velez Arocho, secretary of the island's Department of Natural and Environmental Resources, said he hopes that teams can soon begin killing or capturing the iguanas, which he described as "a plague," at the Luis Munoz Marin International Airport near the capital of San Juan.

An effort to capture the iguanas alive was under consideration, Velez said at a news conference, but authorities also were discussing other options: flooding burrows where the iguanas lay their eggs or sending teams armed with .22-caliber rifles to shoot the adult reptiles, which can grow to be more than a meter long.

Flight landings and takeoffs have been delayed because of the reptiles, which are sold in Puerto Rico as exotic pets. The lizards also create traffic hazards as they soak up the sun on roads near the airport. Carla Capalli, of the Humane Society of Puerto Rico, said she recognized that the iguanas posed safety problems, but questioned some of the methods Velez suggested to eradicate them. "I understand that they have become a plague, a danger, and a threat, and that they must be removed from the area, but . 22-caliber rifles are also a public security danger," Capalli said.

Endangered Jamaican Iguanas Hatched at the Indianapolis Zoo

First Time Hatching Outside of Jamaica

Exciting News for Conservation

The Indianapolis Zoo is extremely excited to announce that for the first time ever endangered Jamaican Iguanas (*Cyclura collei*) have been hatched outside of their native island nation. Two baby iguanas hatched at the Zoo on 29 August, and a third emerged on 30 August. "Chester," age 15, and "Myrtle," 14, are the parents of the first three hatchlings, which are not only the first Jamaican Iguanas to hatch outside of Jamaica, but the first to hatch via artificial incubation.

This first clutch contained a total of 14 eggs of which six were fertile. Three fertile eggs died at various stages of development.

The zoo has a second clutch of 20 viable eggs (total clutch size of 21 included one infertile egg) that began hatching on 2 September. As of 4 September, seven have hatched from this second clutch. The female that laid this clutch is "Gertrude," age 15.

Hatchling total length ranged from 20.2–22.2 cm. Body masses ranged from 22.4–33.0 g. The first clutch began hatching after an 81-day incubation period, whereas the second clutch started hatching after 77 days.

In 1994, the Indianapolis Zoo was one of only three zoos in North America to receive juvenile Jamaican Iguanas as part of the overall conservation program, which included establishing a breeding population in the U.S. Each year, the Zoo staff has made strides in developing an in-house captive breeding program. This successful hatching is a terrific development that offers hope for the continued survival of these lizards.

In addition to the captive breeding aspect, Indianapolis Zoo has provided support to the "Jamaican Iguana Head Start" Program since the early 1990s.

If all the expected eggs hatch, these hatchlings will double the population of Jamaican Iguanas in North America zoos.

Lynne Villers and Richard Reams
Indianapolis Zoo

RICHARD REAMS

First hatchling Jamaican Iguana born outside of Jamaica; the second egg is "pipping."

RICHARD REAMS

Neonate Jamaican Iguana "pipping" from the egg.

RICHARD REAMS

Sire and Dam of the first Jamaican Iguanas to hatch via artificial incubation.

IRCF ON THE MOVE

IRCF to Sponsor Team Blue 2006 Winter Session

The IRCF has been awarded a $10,000 grant from the Maine Community Foundation. These funds will be used to sponsor the Blue Iguana Recovery Program's Team Blue 2006 winter activities, which represents a critical milestone in the program. Specific projects undertaken by this year's volunteers include assisting with the health screening of animals that are to be released, trail development in the Salina Reserve, mapping, construction and assembly of artificial retreats, placement of those retreats, and release of the next group of head-started Blue Iguanas (*Cyclura lewisi*) in the Salina Reserve. The IRCF expresses its gratitude and sincere appreciation to the donor and the Maine Community Foundation for their continued support of the Blue Iguana Recovery Program.

"Tattoo" Pete Gardiner, auctioneer (left) and Chuck Schaffer, auction facilitator, open the auction with a rare illustration of a Beaded Lizard (*Heloderma horridum*).

IRCF Nets $18,000 for Guatemalan Beaded Lizard Conservation[1]

The IRCF and Zoo Atlanta raised $18,000 for Project Heloderma at this year's National Reptile Breeders Expo benefit auction. The money will be used to help preserve the endangered Guatemalan Beaded Lizard, *Heloderma horridum charlesbogerti*, by funding conservation research, environmental education, and land acquisition to secure critical habitat in the Motagua Valley, Guatemala.

The IRCF extends its gratitude to all those individuals, organizations, and companies that donated goods and services for the auction. Our heartfelt thanks go also to all of the wonderful people who volunteered in Daytona to help solicit items from Expo vendors and run the auction itself. A special thank you to our incomparable auctioneer, Tattoo Pete and to NRBE promoter Wayne Hill for his continuing support for reptile conservation.

In addition to the main auction, items on one of the many silent auction tables elicited the interest of attendees.

Attendees begin to fill the room to capacity during the opening moments of the auction.

[1] See the complete list of donors and volunteers on p. 191.

IRCF
International Reptile Conservation Foundation

Editor's Remarks

Our efforts to expand and diversify the content of *Iguana* create an ever-increasing demand to obtain new and often rare photographs to enhance content and adorn covers. Locating sources for this material is a daunting task that often takes months of searching just to obtain a single photograph. Several generous photographers have consistently donated photographs in support of our efforts. Their contributions have played a major part in shaping the new look of *Iguana*. The IRCF gratefully thanks: **Suzanne L. Collins**, CNAH (www.cnah.org), a major contributor of many photographs over the past few years; **Thomas Wiewandt**, Wild Horizons (www.WildHorizons.com), for spectacular photographs that include this issue's cover; **L. Lee Grismer**, La Sierra University, for breathtaking photographs; **Joseph Burgess**, for photographs and other countless contributions; **Joseph Wasilewski**, Natural Selections (www.natselections.com), for crocodilian and iguana photographs; and **Glenn P. Gerber**, CRES (http://cres.sandiegozoo.org) for photographs of West Indian Rock Iguanas.

John Binns, CEO

Statement of Purpose

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

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

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*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.

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Email: 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). 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.

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Horned Lizard Conservation

SUZANNE L. COLLINS, CNAH

Thirteen species of Horned Lizards (Genus *Phrynosoma*) occur in North America. Ranges extend from southern Canada to Guatemala. Horned lizards live in a variety of arid and semi-arid environments from oak-pine woodlands to thorn-scrub deserts. Populations of several species throughout the range of the genus are in trouble.

For example, populations of the Texas Horned Lizard (*Phrynosoma cornutum*) have disappeared in eastern and central Texas, and are decreasing in northern Texas. Declines and disappearances also have been recorded in Oklahoma and New Mexico. The primary cause for population decline is the loss of habitat to agriculture and urban development. However, overharvesting for the pet and curio trades and invasions of exotic species are also implicated. Some states protect Horned Lizards. In Texas, both the Texas and Mountain Short-horned (*P. hernandesi*) lizards are state-listed as Protected, meaning that it is illegal for anyone to take, possess, transport, or sell them without a special permit. Not only is it illegal to keep Horned Lizards in Texas, but they are difficult to care for in captivity, and most captured animals eventually die from improper care.

The Horned Lizard Conservation Society is dedicated to protecting Horned Lizards. The Mission of the organization is to document and publicize the values and conservation needs of Horned Lizards, to promote Horned Lizard conservation projects, and to assist with Horned Lizard management initiatives. The Society includes three existing chapters in Texas, Southern California, and Oklahoma and emerging chapters in New Mexico, Utah, and Nevada.

If you would like to contribute to the Society, you can help in many ways. We always welcome new faces, new ideas, and new inspiration. For further information contact:

Horned Lizard Conservation Society
P.O. Box 122
Austin, TX 78767
http://www.hornedlizards.org/
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THOMAS WIEWANDT, WILD HORIZONS

Mexican Beaded Lizard (*Heloderma horridum*).

Hawaiian Green Anoles (*Anolis carolinensis*) are descendants of escaped pets. They occupy what was once a vacant ecological niche and thrive in association with introduced plants in the lowlands on all major islands(see related article on p. 198).

ROBERT POWELL