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

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

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Photographs by the authors.

The Semiarid Region of the Motagua Valley (SRMV) is one of the few regions of Mesoamerica in which the unique tropical dry forest and thorn scrub ecosystem still remains. One of the principal characteristics of this region is the presence of many endemic species (Nájera 2006), such as the Guatemalan Black Iguana (*Ctenosaura palearis*). The genus *Ctenosaura* is represented by five species in Guatemala: *C. alfredschmidti* (northern Guatemala), *C. flavidorsalis* (eastern Guatemala), *C. similis* (general distribution), *C. acanthura* (Nentón Valley), and *C. palearis* (Köhler 2003, Acevedo 2006).

Hatchling *Ctenosaura palearis* observed in June 2007.

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

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

Material and Methods

The SRMV is located in northeastern Guatemala. This region has the lowest average rainfall in Central America (500 mm) and comprises an area of about 200,000 ha, covering portions of the departments of El Progreso, Zacapa, and Chiquimula. Fieldwork was conducted in the mountains of El Arenal Village, Cabañas, and Zacapa. Cabañas is located 150 km from Guatemala City at the geographic coordinates 14º56'32" N and 89º48'24.9" W. The vegetation in this area is composed mainly of Mimosaceae, Cactaceae, Fabaceae, Euphorbiaceae, and Burseraceae. Representative species include Zacapan Oak (*Bucida macrostachya*), Quebracho (*Licania hypoleuca*), Palo de Jiote (*Bursera simaruba*), Yaje (*Leucaena* sp.), Zarza Blanca (*Mimosa platycarpa*), Manzanote (*Pereskia autumnalis*), Cactus Cabeza de Viejo (*Pilosocereus albocephalus*), *Stenocereus* spp., Subín (*Acacia spadicigera*), *Opuntia* sp., Naranjillo (*Jacquinia* spp.), and Piña de Coche (*Hechtia guatemalensis*) (Ariano-Sánchez 2003).

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

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

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

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

Results

Traditional Use

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

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

Guatemalan Black Iguanas, especially soup made from their meat, are believed to have medicinal properties. People say it is used to heal eye problems and cancer (especially if the meat is consumed), and the fat is used to relieve swellings and for healing earaches.

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

Habitat Characterization

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

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

Population Size and Habitat Use

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

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

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

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

Feeding Habits

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

We frequently have seen *C. palearis* feeding on fruits of *S. pruinosus*. Faces and forelimbs colored by the red pigment of this cactus fruit are a common site. We captured three individuals with evidence of residual pulp and seeds stuck to their faces. These fruits are available from March through early May.

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

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

JOHN BINNS

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

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

Reproduction

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

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

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

Discussion

Traditional Use

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

Although iguanas have been eaten by humans for many generations, the impact is exacerbated today by habitat loss, illegal trade, and non-sustainable hunting practices. Habitat loss is due primarily to the increasing amount of land used for watermelon cultivation and the construction of new residential zones within the valley. Local people say they have seen a dramatic diminution in wild iguana populations compared to 20 years ago.

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

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

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

Habitat Characterization

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

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

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

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

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

Feeding Habits

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

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

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

Ecological Role of *Ctenosaura palearis*

Iguanas are important pollinators and seed dispersers (Godínez 2004, Olsen and Valido 2003, Traveset and Riera 2005). *Ctenosaura similis* is one of the main seed dispersers for some plants in the deciduous forests of Costa Rica (Traveset 1990). *Ctenosaura palearis* is one of the most important species that feeds on fruits of the cactus *S. pruinosus*, suggesting that it could serve as a seed disperser of this endangered cactus, and consequently contribute to forest cover regeneration. Seeds of *S. pruinosus* have been found in the feces and also attached to the gular region of iguanas.

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

Conservation Status

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

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

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

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