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# BIOLOGY AND CONSERVATION OF THE GULF SPINY-TAILED IGUANAS (*CTENOSAURA ACANTHURA*)

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***Abstract.*—Spiny-tailed iguanas are a diverse, taxonomically complex group. There are 11 *Ctenosaura* species in México, nine of which are endemic to the country. This work aims to present information on ecological and biological aspects of the Gulf Spiny-tailed Iguana in the state of Veracruz. *Ctenosaura acanthura* is distributed throughout the coastal plain of the state at altitudes below 500 meters above sea level. Based on 120 captures, males were significantly larger and longer than females, and their heads were wider. We documented that *C. acanthura* consumes a wide variety of food resources (24 species) including both native and ornamental plants, as well as a variety of arthropods. Average clutch size was 27.7 ± 9.1 eggs. There was no relationship between the body length or mass and clutch size. Laboratory incubation took 78.2 ± 6.3 days, at 29–31° C, and the hatching rate was 58.3%. Currently, populations of *C. acanthura* appear stable, due to its ecological plasticity and its presence in all protected areas with tropical forest and wetlands on the plains of Veracruz that we sampled. However, studies of population density, and biological, ecological, physiological, and behavioral research are needed.**

***Resumen*.—Las iguanas de cola espinosa son un grupo diverso y taxonómicamente complejo. Existen 11 especies de *Ctenosaura* en México, nueve de las cuales son endémicas del país. Este trabajo tiene como objetivo presentar información sobre los aspectos ecológicos y biológicos de la iguana de cola espinosa del estado de Veracruz (*Ctenosaura acanthura*). Esta especie se distribuye por toda la llanura costera del estado, en altitudes inferiores a 500 metros sobre el nivel del mar. Basado en 120 capturas, registramos que los machos fueron significativamente más grandes y más pesados que las hembras, y sus cabezas fueron más anchas. Documentamos que *C. acanthura* consume una amplia variedad de recursos alimentarios (24 especies) incluyendo tanto plantas nativas y ornamentales, así como una variedad de artrópodos. El tamaño promedio de la puesta fue 27.7 ± 9.1 huevos. No encontramos relación entre la longitud del cuerpo o masa y el tamaño de la nidada. Realizamos pruebas de incubación en laboratorio y estimamos 78.2 ± 6.3 días, a una temperatura ± 29 a 31° C, y la tasa de eclosión de 58.3%. Actualmente, las poblaciones de *C. acanthura* parecen estables, debido a su plasticidad ecológica y su presencia en todas las áreas protegidas de bosques tropicales y humedales en las llanuras de Veracruz que muestreamos. Sin embargo, se necesitan estudios de densidad de poblaciones, así como de más información biológica, ecológica, fisiológica y conductual.**

*Key Words*.—distribution; endemism; Iguaninae; México; natural history; protected areas

## INTRODUCTION

México has the highest diversity of iguanas (subfamily Iguaninae) of any country, with four out of the eight recognized genera present, and 19 species, representing 43.2% of the world's species. The most diverse genus is *Ctenosaura* (Spiny-tailed Iguanas) which includes 11 of these species (Faria et al. 2010; ITWG this volume). Nine of these are endemic to México (*C. acanthura, C. clarki, C. conspicuosa, C. hemilopha, C. macrolopha, C. nolascensis, C. oaxacana, C. pectinata*, and *C. alfredschmidti*, and one, *C. defensor*, is barely distributed beyond México. Most of these species have small continental ranges or live exclusively on islands; accordingly they have very narrow ecological requirements. However, others are widespread, have more general habits, and occur in many states of the country, like *C. acanthura*, known as the Gulf Spiny-tailed Iguana, Tilcampo, Garrobo, or Chiquipile. It ranges mainly in the state of Veracruz, although it is also found in Llera and Tepehuaje, Tamaulipas, to the southeast to the Isthmus of Tehuantepec, and to the west in San Luis Potosí in the Huasteca region, the Tehuacán Valley in Puebla, and Cuicatlán in Hidalgo (Bailey 1928; Smith and Taylor 1950; Martin 1958; de Queiroz 1995; Köhler et al. 2000; Mendoza-Quijano et al. 2002; Canseco-Márquez and Gutiérrez-Mayén 2010).

Gulf Spiny-tailed Iguanas (Fig. 1) are robust lizards reaching a snout-vent length of 450 mm. Their tails are


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thick and longer than their bodies, with a series of spiny scales forming rings. The head is triangular and dorsally flattened. Males typically have a dorsal crest formed by long, spiny scales, which are shorter or nonexistent in the females. The tail exhibits black rings. Five to seven femoral pores are present, and in males are up to 2.5 mm in diameter, while in the females they only reach 1 mm diameter (Bailey 1928; Köhler 1993; Canseco-Márquez and Gutiérrez-Mayén 2010).

The body of the males is dark gray, with light stripes or ocelli that are not always present. Their color can also be pale gray, depending on their microhabitat. The hatchlings are green and the juveniles have a light blue color ventrally, with a dark ocellus on the gular region. The transverse stripes on the dorsum are also more evident, with a green background and extending as black rows toward the abdomen. Dark bars are present below the labial region (Bailey 1928; Smith 1935; de Queiroz 1995).

This iguana inhabits the coastal plains of the Gulf of México across many different habitats, including disturbed environments (Suárez-Domínguez et al. 2011). The Mexican Regulation regards this species as Under Special Protection (NOM-059-SEMARNAT-2010: NORMA Oficial Mexicana, Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo). It has not yet been evaluated internationally on the Red List of Threatened Species (IUCN. 2014. The IUCN Red List of Threatened Species. Available from http://www.iucnredlist.org [Accessed 5 September 2014]). The information published on this species to date mainly concerns its systematics (Köhler et al. 2000, 2003; Köhler 2004), geographical distribution (Martin 1958; Mendoza-Quijano et al. 2002; Canseco-Márquez and Gutiérrez-Mayén 2010), and behavioral and ecological aspects (Suárez-Domínguez et al. 2004, 2011). It is unknown whether this iguana is present in different protected areas within its distribution, or other conserved unprotected areas. This work presents information on the distribution and ecology of the Gulf Spiny-tailed Iguana in the state of Veracruz, and discusses its current state of conservation and interactions with humans, acknowledging its occurrence, abundance, and role as an indicator of the quality of the habitat.

**FIGURE 1.** Male Gulf Spiny-tailed Iguana from Catemaco, Veracruz. (Photographed by Jorge E. Morales-Mávil).

## METHODS

***Study site***.—The study was conducted on the coastal plains of Veracruz. Two large plains form the state of Veracruz, one on the north and the other on the south, separated by the foothills of the Trans-Mexican Volcanic Belt, which constitute an important geographic and climate barrier (Soto Esparza and Geissert Kientz 2011). These plains represent 73% of the area of the state (INEGI 1987).

Veracruz is quite diverse in climate: the northern plain has an average annual temperature from 24 to 25° C, and a minimum temperature (annual average) of 13 to 16° C. In the southern plain, the average temperatures are higher, reaching from 25 to above 26° C, with a minimum annual average from 16 to 17° C. The maximum extreme temperature is similar in both plains, oscillating between 27 and 28° C (Soto Esparza and Giddings Berger 2011). The human population is estimated at nearly eight million with an annual growth rate of 2.0% (INEGI, Instituto Nacional de Estadística Geografía e Informática. 2010. Principales Resultados por Localidad (ITER) del Censo de Población y Vivienda 2010. Available from http://www.inegi.org.mx/sistemas/consulta_resultados/iter2010.aspx [Accessed 23 August 2014]).

The vegetation of the plains consists of: (1) tropical evergreen forest; (2) semi-deciduous tropical forest; (3) tropical deciduous forest; (4) palms; (5) savanna; (6) gallery forest or riparian vegetation; (7) mangrove; (8) coastal dune vegetation; (9) pasture; (10) popal-bulrush; and (11) secondary vegetation (Rzedowski 2006). The secondary vegetation in different successional stages, also called *acahual*, constitutes the most widespread vegetation type, which reflects the disturbance of most vegetation types (Castillo-Campos et al. 2011).

***Data collection***.—Habitats likely to harbor iguanas were systematically sampled by transects, particularly in protected natural areas (state, federal, and Ramsar sites). These protected areas included: Port and City of Veracruz (two transects from June to July 2008), Presa Chicayán (two transects from July to August 2009), Santa Gertrudis Area of Forestal and Faunal Protection (two transects from July to August 2009), Los Tuxtlas Biosphere Reserve (two transects from March to April 2011 and two transects from June to July 2011), Santuario del Loro Huasteco (two transects from July to August 2009), Arroyo Moreno (two transects from June to July 2008), and Ciénega del Fuerte (two transects from July to August 2009 and one transect in March 2010). The Ramsar sites included: mangroves and wetlands of Lake Sontecomapan (two transects from August to September 2011), Alvarado lagoon system (two transects in August 2008), La Mancha and El Llano (one transect in February 2009, one transect from October 2009 to January 2010, and two transects from April to May 2010), the mangroves and wetlands of Tuxpan (two transects from October to November 2011 and three transects from February to March 2012). Transects were also conducted in the wetlands of Coatzacoalcos-Minatitlán (four transects from February to April 2009 and two transects from November to December 2009), Catemaco Lake (two transects from May to June 2010), El Raudal (one transect in June 2010), and areas surrounding Ciudad Cardel (one transect in October 2012). Everywhere, we interviewed local people about human consumption of meat or eggs of iguanas.

For one week each month we inspected each site for eight hours a day, between 0800 and 1600 by foot, boat, or land vehicle. Tree branches and bushes, rock piles, palapa (bungalow) roofs, walls, houses, and abandoned buildings were searched. Iguanas were captured opportunistically and manually with a rod, with a noose, or with the support of *iguaneros* (people dedicated to capturing iguanas for food). UTM coordinates as well as the description of the capture site and microhabitat were noted for each observation. Captured iguanas were measured using a vernier caliper and weighed using field spring scales. Sex was determined by the difference of femoral pore size (present in both sexes but larger in males) and the vertebral row of enlarged spines from base of head to base of tail, being much larger in males (Bailey 1928; Köhler 1993). We measured head width at the widest part of head immediately behind the eyes, and head length from the snout to the angle of the jaw.

***Dietary data*.—**We determined diet using direct observation ($n$ = 26) of feeding in iguanas from Los Tuxtlas, using the animal-focal method with continuous recording (Martin and Bateson 1991) for 30 minutes for each focal or for the time the iguana kept eating. Two people carried out observations separately, each with a focal record. Observations were conducted between October and December 2003 and May to August 2004, at different hours between 0700 and 1900. Other diet records were made from fecal samples ($n$ = 15) obtained from iguanas captured and held captive for two or three days in the La Mancha area. We collected comparative plant materials in the field to use for identification of fecal components. All fecal samples were dried in a desiccation chamber before separation, and identification of the different components (plant and animal) were attempted to order, family, genus, or species.

***Reproductive data*.—**Some gravid females captured in Coatzacoalcos and Sontecomapan between February to April 2009 were held captive within galvanized sheet metal closures (dimensions: 9 x 1.8 x 1.5 m). The enclosures contained a substrate of sand about 50 cm deep where the iguanas were able to nest. The enclosures were conditioned with concrete block shelters and 50 x 70 cm concrete slabs on which to place food, which consisted of fruits and vegetables *ad libitum*, ensuring that all females had access to food. Once the females laid their eggs they were released at their capture site. Eggs were measured, weighed, and transferred to polystyrene boxes (30 x 22 x 25 cm) filled with sand. Eggs were buried in sand with no direct exposure to air. The sand with the eggs was sprinkled regularly to keep it humid during the incubation period. Boxes were covered with a metal mesh cover (fine sieve) and placed on wooden shelves in an incubation room, under ambient temperature between 29 and 31° C and between 60 and 80% humidity. Hatchlings were measured, weighed, and then released in the same capture sites as the females.

***Statistical analyses*.—**We used both parametric and nonparametric tests, depending on the data distribution. Body size using snout-vent length (SVL) and head size of males and females were compared using ANOVA, with an $\alpha$ = 0.05. Means are followed by ± 1 SD and range. Relative clutch mass (RCM) was calculated by the clutch mass/gravid female mass quotient (Vitt and Congdon 1978; Cuellar 1984; Castro-Franco et al. 2011). Regression analysis was applied to relate SVL and body mass with clutch parameters. We hypothesized that sex ratio should be 50:50 and we recorded the proportion of males captured per site. A Mann-Whitney U test was used to compare the diet of males and females. We calculated differences between expected value and observed values with a chi-square test.

## RESULTS

***Morphometrics and distribution*.—**One hundred twenty adult iguanas (28 males and 92 females) and 13 juveniles were captured. Males were significantly longer than the females: SVL = 239.2 ± (SD) 27.8 mm (range, 194–282 mm) versus non-gravid female SVL = 194.6 ± (SD) 25.7 mm (range, 148–245 mm; $F$ = 18.4, $P$ = 0.0002). Males were also significantly larger compared to non-gravid females in mass: 423.2 ± 120.4 g (range, 206.3–610.0 g) versus 250.5 ± 26.9 g (range, 95.9–371.1 g; $F$ = 15.9, $P$ = 0.0005). Male heads were larger in length: 55.9 ± 9.9 mm (range, 43–68 mm) versus 42.1 ± 1.6 mm (range, 33–49 mm; $F$ = 18.39, $P$ = 0.00023); as well as width: 39.8 ± 6.3 mm (range, 30–50 mm) versus 29.4 ± 4.2 mm (range, 24–35 mm; $F$ = 25.8, $P$ < 0.0001; Fig. 1). The sex ratio (M:F) was 1:3.28 ($n$ = 120), significantly different from a sex ratio of 1:1 ($\chi^2$ = 34.1, $P$ < 0.001).

Gulf Spiny-tailed Iguanas were found in all the protected areas and Ramsar sites explored, as well as the wetlands of Minatitlán-Coatzacoalcos, Raudal, Catemaco,

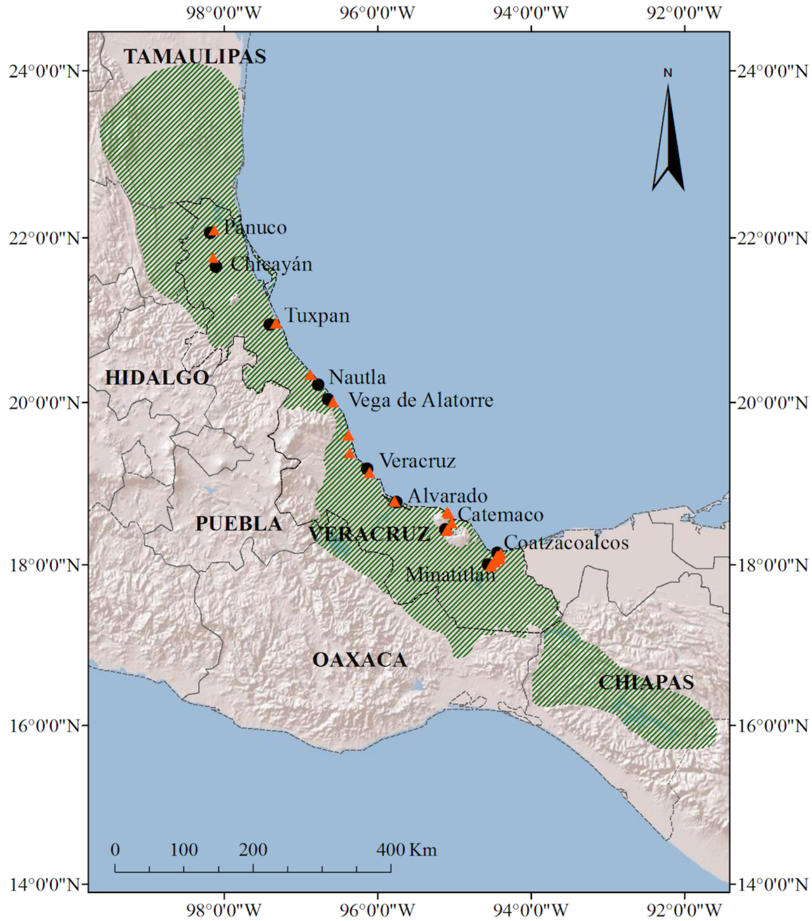


**FIGURE 2.** Distribution of Gulf Spiny-tailed Iguanas (*Ctenosaura acanthura*) in the state of Veracruz, México. Green indicates current distribution; red triangles are collecting sites; black dots indicate major cities within the distribution.

and the surroundings of Cardel, in the central part of the state (Fig. 2). Hence, these iguanas were distributed across many different types of vegetation of the coastal plains, including rural, suburban, and even urban environments as in the City and Port of Veracruz, Boca del Río, and Coatzacoalcos cities, where iguanas occur in vacant lots, traffic islands, large gardens, and rooftops.

**TABLE 1.** Components identified in the diet of *Ctenosaura acanthura* in Veracruz based on an analysis of scat samples ($n = 16$).

| Taxon | Occurrence percentage |
|---|---|
| Vegetal components | |
| *Cordia dentata* (Boraginaceae) | 60 |
| *Malvaviscus arboreus* (Malvaceae) | 40 |
| *Nectandra sanguinea* (Lauraceae) | 20 |
| *Xylosma* sp. (Salicaceae) | 20 |
| *Rhacoma urogoga* (Celatraceae) | 20 |
| Unidentified (Leguminosae) | 100 |
| Animal components | |
| Coleoptera | 100 |
| Hymenoptera | 100 |
| Crustaceae (Oniscidea) | 60 |

***Diet.***—From our analysis of 15 fecal samples from adult iguanas (seven males and eight females), we documented nine different components (six plants and three animals) in the diet of *C. acanthura* (Table 1). Also, all samples contained sand and small rocks. No differences were found in the diet of males and females ($U = 49.5$, $P = 0.47$). Vertebrate items were not recorded (Table 1). On the other hand, from our observations ($n = 26$) we recorded 17 components (11 plants and six animals; Table 2). Vertebrate items were not recorded except for the consumption of their own skin.

***Reproductive aspects.*—**Gravid iguanas ($n = 26$) were captured in February and March; 13 were captured on the margins of the Coatzacoalcos River in mangrove vegetation, secondary vegetation, and pastures, and the other 13 from the community El Real in the Sontecomapan lagoon wetlands consisting of mangrove vegetation, apompal (*Pachira acuatica*), and secondary vegetation.

**TABLE 2.** Components identified in the diet of *Ctenosaura acanthura* in Veracruz based on direct observations of feeding. Percentage frequencies were calculated separately for animals and plants.

| Taxa | Number of items consumed | Percentage of total items consumed | Number of events in which consumption was observed | Frequency of occurrence |
|---|---|---|---|---|
| Animal components | | | | |
| Lepidoptera | 1 | 1.52 | 1 | 1.89 |
| Orthoptera | 1 | 1.52 | 1 | 1.89 |
| Coleoptera | 2 | 3.03 | 2 | 3.77 |
| Hemiptera | 11 | 16.67 | 1 | 1.89 |
| Diptera | 42 | 63.64 | 42 | 79.25 |
| Their own skin | 9 | 13.64 | 6 | 11.32 |
| Vegetal components | | | | |
| *Spondias mombin* | 19 | 0.83 | 7 | 4.58 |
| *Pimenta dioica* | 32 | 1.41 | 1 | 0.65 |
| *Anona* sp. | 43 | 1.89 | 7 | 4.58 |
| *Diospyros digyna* | 52 | 2.28 | 4 | 2.61 |
| *Opuntia* sp. | 90 | 3.95 | 5 | 3.27 |
| *Senecio* sp. | 125 | 5.49 | 11 | 7.19 |
| *Sida* sp. | 128 | 5.62 | 5 | 3.27 |
| *Calophyllum* sp. | 343 | 15.07 | 18 | 11.76 |
| *Capsella* sp. | 427 | 18.76 | 31 | 20.26 |
| *Solandra* sp. | 484 | 21.27 | 32 | 20.92 |
| *Passiflora microstipula* | 533 | 23.42 | 32 | 20.92 |

The gravid females ($n$ = 26) had an average SVL of 256.1 ± 30.3 mm (range, 215–310 mm) and body mass of 493.1 ± 144.4 g (range, 275–750 g). Clutch size ($n$ = 21) averaged 27.7 ± 9.1 eggs (range, 18–48 eggs), clutch mass ($n$ = 21 clutches, $n$ = 210 eggs) averaged 172.4 ± 61.2 g (range, 90–341 g), and relative clutch mass (RCM; $n$ = 21) averaged 0.358 ± 0.127 (range, 0.156–0.720; CV = 35.5%). Four significant relationships were detected between female morphometrics and clutch measurements: (1) SVL and clutch size ($R^2$ = 0.421, $F$ = 17.45, $P$ < 0.01); (2) body mass and clutch size ($R^2$ = 0.25, $F$ = 8.02, $P$ = 0.009); (3) SVL and clutch mass ($R^2$ = 0.342, $F$ = 12.49, $P$ < 0.001); and (4) body mass and clutch mass ($R^2$ = 0.211, $F$ = 6.42, $P$ = 0.017). Eggs ($n$ = 210) averaged 29.0 ± 2.5 mm (range, 25–33 mm) in length, 20.5 ± 2.1 mm (range, 17–24 mm) in width, 6.0 ± 0.7 g (range, 5.0–7.2 g) in mass. Incubation time averaged 78.2 ± 6.3 days (range, 70–87 days) and 58.3% of the eggs hatched. A positive relationship between female body mass and RCM was found ($R^2$ = 0.215, $F$ = 6.58, $P$ < 0.017), but there was no relationship between SVL and RCM ($R^2$ = 0.0002, $F$ = 0.005, $P$ = 0.944; Table 3). Newly emerged hatchlings ($n$ = 120) had an average SVL = 52.8 ± 3.0 mm (range, 41–58 mm) and mass = 5.1 ± 0.6 g (range, 3.9–6.4 g).

## DISCUSSION

The Gulf Spiny-tailed Iguana is distributed all across the coastal plains of the State of Veracruz. *Ctenosaura acanthura* occupies a wide variety of environments, although its primary habitats included: medium evergreen tropical forest, evergreen lowland forest, deciduous forest, and wetlands. However, it has also been found in environments with secondary successional vegetation, including grasslands, croplands, and human settlements (Etheridge 1982; Canseco-Márquez and Gutiérrez-Mayén 2010; Morales-Mávil and Suárez-Domínguez 2010; Suárez-Domínguez et al. 2011).

Among ctenosaurs, *C. acanthura* is medium in size, smaller than the closely related *C. pectinata* (Suazo and Alvarado 1994; Castro-Franco et al. 2011), *C. bakeri* (Köhler 2004), and *C. similis* (Henderson 1973; Mora and Barrantes 1985; Lee 2000). Like other spiny-tailed iguanas, males are larger than females and bear a more prominent mid-dorsal crest: *C. palearis* (Elfström et al. 1994), *C. similis* (Lee 2000), *C. clarki* (Pérez-Ramos and Saldaña de la Riva 2002), *C. macrolopha* (Goldberg 2009), *C. melanosterna* (Pasachnik et al. 2012), *C. bakeri* (Köhler 2004), *C. oedirhina* (Pasachnik 2013), *C. pectinata* (Bailey 1928; Evans 1951), *C. praeocularis* (Hasbún and Köhler 2009), and *C. quinquecarinata* (Bailey 1928).

**TABLE 3.** Regression analyses ($R^2$) between reproductive traits and female mass and length of the Gulf Spiny-tailed Iguanas, *Ctenosaura acanthura*. * = Significant.

| | Clutch size | Average egg size | Average egg weight | Relative clutch mass (RCM) |
|---|---|---|---|---|
| Body mass females ($n$ = 26) | $R^2$ = 0.250<br>$P$ = 0.009* | $R^2$ = 0.102<br>$P$ = 0.112 | $R^2$ = 0.142<br>$P$ = 0.562 | $R^2$ = 0.215*<br>$P$ = 0.016 |
| Snout-vent length females ($n$ = 26) | $R^2$ = 0.421*<br>$P$ < 0.001 | $R^2$ = 0.079<br>$P$ = 0.165 | $R^2$ = 0.013<br>$P$ = 0.554 | $R^2$ = 0.0002<br>$P$ = 0.944 |

The diet was based primarily on the consumption of plant parts. Most frequently, iguanas used active foraging, but without traveling long distances. We documented that *C. acanthura* consumed a wide variety of food resources (24 species), including both native plants and ornamental crops and plants from gardens and backyards, as well as a variety of arthropods (Lepidoptera, Orthoptera, Coleoptera, Hemiptera, Diptera). Thus, *C. acanthura* has an omnivorous diet tending toward herbivory (Iverson 1982), a common dietary strategy within the ctenosaur group like *C. pectinata* (Durtsche 2000), *C. hemilopha* (Blázquez and Rodriguez-Estrella 2007), *C. palearis* (Cotí and Ariano-Sánchez 2008), and *C. similis* (Mora 2010). However, vertebrate items were not recorded, which differs from what has been documented for other spiny-tailed iguanas such as *C. similis* (Fitch and Hackforth-Jones 1982; Mora 1991; Krysko et al. 2000), *C. pectinata* (Alvarez del Toro 1982; Suazo and Alvarado 1994), *C. hemilopha* (Blázquez and Rodríguez-Estrella 2007), and *C. oedirhina* (Pasachnik 2013) whose diets included vertebrates such as lizards (including hatchling iguanas), turtle hatchlings, birds, rodents, and even the consumption of carrion in *C. hemilopha* (Blázquez and Rodríguez-Estrella 2007) and *C. similis* (Mora 2010). The consumption of their own skin is a frequent event in iguanines (Blázquez and Rodríguez-Estrella 2007).

The diversity of the diet probably allows *C. acanthura* to occupy a diversity of ecosystems, including disturbed environments (Villanueva-Noriega 2004; Suárez-Domínguez et al. 2011, 2013). Several species of *Ctenosaura* have habits that have allowed them to adjust to environments modified by humans. These lizards regularly share habitats with humans in rural and urban environments, using roofs, galleries, rock walls, and pipes (Burger and Gochfeld 1990; Stephen et al. 2012). We found *C. acanthura* in many different microhabitats: on trees and bushes, in hollow trees, rock piles, pipes, and on roofs and walls of buildings. Indeed, *C. acanthura* living in these disturbed environments exhibit little behavioral or physiological stress (Suárez-Domínguez et al. 2011).

Gravid female *Ctenosaura acanthura* were similar in SVL to those of *C. pectinata* (256.1 ± 30.3 mm vs. 241 ± 2 mm, respectively), but weighed less (493.1 ± 144.4 g vs. 531.1 ± 12.9 g) (López-Ruvalcaba et al. 2012). Relative clutch mass (0.358) was slightly lower than for *C. pectinata* (0.364; Castro-Franco et al. 2011), but with more variation. The significant relationship between RCM values and body mass for females differed from that recorded for *C. pectinata* by Castro-Franco et al. (2011). The average RCM for *C. acanthura* was high among lizards, and was closer to that in snakes (Fitch 1970; Seigel and Fitch 1984; Shine 1992). Clutch size in *C. acanthura* was positively related to female SVL and mass, as has been recorded for many species of reptiles (Fitch 1985; Shine and Greer 1991; Thomson and Pianka 2001). This same relationship was also found in *C. pectinata* (Castro-Franco et al. 2011). Clutch size can be related more to the age of the females than size in some *Ctenosaura* species (Castro-Franco et al. 2011; López-Ruvalcaba et al. 2012), but we do not have age data for our females.

Incubation times of the eggs of *C. acanthura* (mean = 78.2 days) were slightly longer than those reported for *C. pectinata* from Oaxaca (71.2 days, López-Ruvalcaba et al. 2012) or for *C. palearis* (70 days, Elfström et al. 1994). Hatching success for *C. acanthura* was low (58.3%) in comparison to species like *C. pectinata* (80%) with a similar clutch size and incubated under similar conditions (López-Ruvalcaba et al. 2012). However, under different incubation conditions, incubation times for *C. pectinata* were much shorter (Aguirre-Hidalgo 2007) in Chamela, Jalisco (31 days) and Nizanda, Oaxaca (45.6 days). Clutch size in our study of *C. acanthura* (mean = 27.7) was similar to that reported by Corona-López (2010) in two populations of *C. acanthura* from southwestern Veracruz (24.9 ± 6.2 eggs and 32.9 ± 11.7 eggs) and lower than in *C. similis* (sample means = 43–88 eggs, Fitch and Henderson 1978; mean = 62 eggs, Avery et al. 2014) and higher than in *C. oedirhina* (4–7 eggs, Pasachnik 2013), *C. bakeri* (9.3 ± 2.9, range = 9–16, Gutsche and Köhler 2004), or *C. palearis* (11 eggs, Elfström et al. 1994; 6–12 eggs, Cotí and Ariano-Sánchez 2008).

The fact that the Gulf Spiny-tailed Iguana is found in a wide variety of environments, including disturbed sites and human settlements, is probably the reason why females migrate to open, sandy areas in order to nest, as reported by Suárez-Domínguez et al. (2005). However, even though it has not yet been reported for *C. acanthura*, it is possible that some females nest near their home ranges and sacrifice better incubation sites because of a reduction in their predation risk during migrations, as has been suggested for other iguanines (Morales-Mávil et al. 2007).

Age and nutrition of females are known to affect clutch size, hatching success, and hatchling size in lizards (Fitch 1970; Tinkle et al. 1970; Warner et al. 2008; Ford and Seigel 2010; Uller and Olsson 2010). Females of *C. pectinata* older than 4.5 years produce nests with more eggs and larger hatchlings than younger females (Lopez-Ruvalcaba et al. 2012). The newly emerged hatchlings in our study averaged 52.8 mm SVL and 5.1 g body mass, slightly smaller than for *C. macrolopha* (SVL = 55 mm, Goldberg 2009) and *C. pectinata* (55 mm and 5.4 g, Lopez-Ruvalcaba et al. 2012).

Veracruz has a large oil industry as well as agriculture and livestock. Environmental pollution by heavy metals and hydrocarbons is a permanent risk. Environmental contamination by heavy metals is known to affect reproductive success adversely in reptiles (Hopkins et al. 1999; Khan and Law 2005; Hsu et al. 2006). However, Corona-López (2010) demonstrated that females of *C. acanthura* living at a major oil industrial site were not affected in their size and body mass, nor in clutch size or hatch rate, although they did report an effect on the condition of the hatchlings, as nearly 10% of them had deformed tails. However, that could have been the result of extreme temperature during incubation (Shine 2004). In any case, carnivorous species tend to be the most affected reproductively by heavy metals because of bioaccumulation up the food chain. Because *C. acanthura* is omnivorous with a tendency toward herbivory, the pollution effect may be smaller. However, this once again points to the broad ecological plasticity of *C. acanthura* in surviving in highly disturbed environments.

The local people use iguanas for meat or eggs, as they do for related species (Fitch et al. 1982; Stephen et al. 2012). In order to reduce pressure on wild populations of iguanas, the Mexican environmental authorities (The Ministry of Environment and Natural Resources, SEMARNAT) have promoted the establishment of farms by rural people as an alternative to wild capture. However, this approach has only been successful for the Common Green Iguana (*Iguana iguana*). Farms for Gulf Spiny-tailed Iguanas have not been successful because the iguanas are smaller and exhibit more aggressive behavior.

Although Mexican laws currently regard the Gulf Spiny-tailed Iguana as Under Special Protection (Pr; NOM-059-SEMARNAT-2010), it is still harvested by local people. The Pr category includes those species or populations that could potentially be threatened by factors that adversely affect their viability, recommending support for recovery and preservation, or restoration and conservation, of populations and their habitats. This category may include lower risk categories than the classification of the IUCN Red List of Threatened Species. However, for now the population status of *C. acanthura* appears to be stable, presumably due to its ecological plasticity. Furthermore, it is present in all of the protected areas that were sampled with tropical forest in the plains of Veracruz. Nevertheless, additional research is needed to confirm its status at the periphery of the range in Tamaulipas, San Luis Potosí, and Oaxaca.

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