

Lizards (Reptilia: Squamata) of the Corn Islands, Caribbean Nicaragua

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ABSTRACT: The Corn Islands are two small Caribbean islands with the richest collection of endemic herpetofaunal taxa in Nicaragua. Despite increasing human population and associated habitat alteration, both islands lack protected areas. The lizard fauna of Great Corn Island consists of 14 species corresponding to nine families, and includes three endemic taxa. We collected three lizard species (*Corytophanes cristatus*, *Gonatodes albogularis*, and *Hemidactylus frenatus*) that were not previously recorded from that island. On Little Corn Island, where there were no previous records of lizards, we found seven species (*Ctenosaura similis*, *Gonatodes albogularis*, *Hemidactylus frenatus*, *Holcosus undulatus*, *Iguana iguana*, *Lepidodactylus lugubris*, and *Norops unilobatus*), all of which are also present on Great Corn Island.

INTRODUCTION

The Corn Islands (or Islas del Maíz) are two small islands approximately 70 km off the central Caribbean coast of Nicaragua that rise above the eastern Nicaraguan shelf in the Región Autónoma Atlántico Sur (RAAS) or Departamento Atlántico Sur (Figure 1). Great (Big) Corn Island (the larger of the two) is located between latitudes 12°08'40" N and 12°11'83" N and longitudes 83°04'24" W and 83°01'38" W, and has an area of 10.3 km², with Mount Pleasant (113 m elevation) being the highest point on the island (Ryan *et al.* 1998). Lesser (Little) Corn Island is located 15 km to the northeast and comprises 2.9 km², reaching a maximum height of 38 m elevation (Ryan *et al.* 1998). Both islands are made up of Tertiary (Miocene-Pliocene) basalts that protrude through late Tertiary carbonates (Ryan *et al.* 1998), and present a low general topography: Ruden (unpublished data) calculated that approximately one-half of Great Corn Island lies beneath the 2 m contour line, and that a sea level rise of only 0.5 m would inundate about one-third of the island.

The Corn Islands correspond to tropical Lowland Moist Forest formations (Holdridge 1967), with an annual average air temperature between 27–28°C (Ryan *et al.* 1998). The coolest months are between December and March and the warmest between May and September (Ryan *et al.* 1998). Ryan *et al.* (1998) estimated an average relative humidity of 81% and an average rainfall of 3.5 m per year with the rainy season between May to December and a relatively dry season between January and April, which is coincident with the strongest trade winds that blow steadily from the ENE with a steadiness factor of 90% (Roberts and Suhayda 1983). The highest global radiation in nearby Bluefields (about 77.5 km WSW from Great Corn Island; Villa 1972b) occurs in April and the lowest in December (López de la Fuente 1994). The highest evaporation rates in the islands occur during the months of April and May and the lowest during November (Peralta-Williams 1991). Although the

islands lie practically outside the hurricane belt (Peters 1929), tropical storms, depressions, and less occasionally hurricanes often impact the Corn Islands mostly around the second half of the rainy season, with Hurricane Joan (October 1988) being the most severe in recent history devastating 95% of all standing structures on the islands (Ryan *et al.* 1998).

Peters (1929) was the first zoologist to visit the Corn Islands from December 10th, 1927 to January 3rd, 1928. He estimated the human population on Great Corn Island to be 800 inhabitants, mostly inhabiting the coastline. A permanent population on Little Corn Island consisted of a dozen or fewer persons where families from Great Corn Island cultivated small patches of ground, or grazed horses and cattle on the savannah. Already by that time there was no heavy forest on Great Corn Island and “quite probably there never was any” where areas not cultivated with coconuts or staple provisions were composed of overgrown scrubby woodland (Peters 1929). Currently, a small percentage of the total Nicaraguan population lives on the Caribbean coast and population densities are in general very low on the eastern part of the country. However, the Corn Islands constitute Nicaragua’s largest and most populated oceanic islands, with 6131 inhabitants living in 1659 houses on Great Corn Island (595 individuals/km²), and 495 inhabitants in 191 houses on Little Corn Island (171 individuals/km²) in 2005 (INIDE 2008). During our 2010 visit we observed that very few people live inland on Great Corn Island, and that similar scrubby woodland vegetation is present in areas that are not cultivated for traditional agriculture, which currently occupies roughly 50% of the inland areas of Mount Pleasant. Similarly, coconut trees are still abundant around the shore on both islands and the same magnificent “large groove of almond trees on the windward side of the island” (Peters 1929) remains on Little Corn Island. Unlike the islands Peters encountered eight decades ago when he spent Christmas

in a fisherman's shack on Little Corn Island, both islands are home to a number of hotels due to a massive increase in the tourist industry. Locals are turning to tourism as an alternative to the fishing industry that produces over 40% of Nicaragua's total seafood exports and has been the primary source of income for the islands (Ryan *et al.* 1998). Despite abundant fishing and increasing tourism, 40.9% of the population of the Corn Islands lives in extreme poverty, with 48% of houses lacking running water and 9.7% lack electrical power (INIDE 2008).

Regardless of its small size and relatively high population, the Corn Islands harbor the greatest percentage of endemic Nicaraguan herpetological taxa. To date, these herpetofauna include three endemic species: *Lithobates miadis* (Barbour and Loveridge 1929) on Little Corn Island, and *Norops villai* (Fitch and Henderson 1976) and *Marisora magnacornae* Hedges and Conn 2012 on Great Corn Island. Additionally, there are four endemic subspecies among the herpetofauna of Great Corn Island: *Holcosus undulatus miadis* (Barbour and Loveridge 1929), *Drymobius margaritiferus maydis* Villa 1968, *Tretanorhinus nigroluteus obscurus* Villa 1969, and *Micrurus nigrocinctus babaspul* Roze 1967. Future systematic work might demonstrate that some or all of these "subspecies" could be recognizable at the species level. Despite the large amount of endemic herpetological taxa, the Corn Islands lack nationally protected areas, constituting one of the most threatened regions in Nicaragua (Sunyer and Köhler 2010) due to habitat destruction, which if left unchecked is likely to change the islands' faunal community dramatically.

The herpetological collection made by Peters and his team in 1927 on the Corn Islands was examined and published by Barbour and Loveridge (1929), which is the only publication addressing all the herpetofauna of the islands. Herpetological fieldwork was then almost nonexistent until the 1960's and 1970's, when the herpetofauna of the islands was sampled, primarily by Jaime D. Villa. To date, most of the taxonomic revisions dealing with species that occur on the Corn Islands [*e.g.*, Dunn (1940); Dowling (1952); Keiser (unpublished data); Roze (1967); Savage and Heyer (1967); Zweifel (1967); Duellman and Fouquette (1968); Villa (1968; 1969; 1970; 1972a, b, c; 1983; 1984); Leon (1969); Duellman (1970); Wilson and Hahn (1973); Fitch and Henderson (1976); Fitch and Seigel (1984); Villa *et al.* (1988); Köhler (1999, 2001); Hillis and Wilcox (2005); Köhler and Veselý (2010); and Hedges and Conn (2012)] involved specimens collected between the 1920's and the 1970's. During the last one-third of a century, herpetological research on the Corn Islands once again has been almost absent. For example, there have not been any new amphibian or snake records since Villa's (1972b, c) revision of these groups on the islands. Villa (1972c) anticipated a third contribution on the Corn Islands this time on the island's reptiles, where he also would include a detailed account on the ecology of the Corn Islands. Unfortunately, this contribution never appeared and the only additions he made to the Corn Islands herpetofaunal checklist involved turtle species (Villa *et al.* 1988; Villa 1993). Therefore, the purpose of the present note is to revive Villa's goal to produce a checklist for the lizards of the Corn Islands, and include a brief account on the ecology and herpetological history of

the islands. We follow Villa's style in his amphibians and snakes of the Corn Island's contributions (Villa 1972b, c), including a key to the lizard species in the islands (see Appendix). We additionally include a map of the islands (Figure 1) and color images of all the lizard species we collected both on Great and Little Corn Island (Figures 2 and 3), with the exception of *Hemidactylus frenatus* from Great Corn Island.

MATERIALS AND METHODS

We surveyed the herpetofauna of the Corn Islands from 15–18 June 2010, focusing survey efforts on forested areas that were least impacted by urban influences. Few natural areas occur on the islands and much of the original habitat is developed, so we attempted to explore urban areas as well for evidence of herpetological species. All five coauthors conducted diurnal and nocturnal surveys by searching for species along trails and as far off trails as possible on both islands. Voucher specimens for each species were collected, preserved, and deposited in the Museo Herpetológico de la UNAN-León (MHUL), Universidad Nacional Autónoma de Nicaragua-León, León, Nicaragua. Acronyms for museum collections follow those of Sabaj-Pérez (2013). Specimens were collected under permit No. 011-102010 issued by MARENA (Ministerio del Ambiente y los Recursos Naturales), Managua, Nicaragua. All animals were handled according to approved IACUC standards and protocols (IACUC #16-13).

RESULTS

The sampled lizard fauna of the Corn Islands consists of 14 species belonging to nine families (Table 1), one of which, Gekkonidae, includes two introduced species in the islands. We recorded three species (one third of the lizard species we collected) that were previously undocumented



FIGURE 1. Map to the Corn Islands. Source: Lonely Planet (Copyright ©, Pittsburgh Post-Gazette, 2013, all rights reserved. Reprinted with permission).

on Great Corn Island (*i.e.*, *Corytophanes cristatus*, *Gonatodes albogularis*, and *Hemidactylus frenatus*). We also recorded all seven species known to occur on Little Corn Island (*i.e.*, *Ctenosaura similis*, *Gonatodes albogularis*, *Hemidactylus frenatus*, *Holcosus undulatus*, *Iguana iguana*, *Lepidodactylus lugubris*, and *Norops unilobatus*; see Table 1) because no previous published records for these lizards exist.

TABLE 1. List of the species of lizards known to occur in the Corn Islands. Species are listed alphabetically by family followed by the number of genus-number of species. Asterisks (*) indicate the first record for the species on each island.

TAXON	GREAT CORN ISLAND	LITTLE CORN ISLAND
CORYTOPHANIDAE 1-1		
<i>Corytophanes cristatus</i>	X*	-
DACTYLOIDAE 1-2		
<i>Norops unilobatus</i>	X	X*
<i>Norops villai</i>	X	-
GEKKONIDAE 2-2		
<i>Hemidactylus frenatus</i>	X*	X*
<i>Lepidodactylus lugubris</i>	X	X*
IGUANIDAE 2-2		
<i>Ctenosaura similis</i>	X	X*
<i>Iguana iguana</i>	X	X*
MABUYIDAE 1-1		
<i>Marisora magnacornae</i>	X	-
PHYLLODACTYLIDAE 1-1		
<i>Thecadactylus rapicauda</i>	X	-
SCINCIDAE 1-1		
<i>Scincella cherriei</i>	X	-
SPHAERODACTYLIDAE 2-3		
<i>Gonatodes albogularis</i>	X*	X*
<i>Sphaerodactylus argus</i>	X	-
<i>Sphaerodactylus millepunctatus</i>	X	-
TEIIDAE 1-1		
<i>Holcosus undulatus</i>	X	X*

Species accounts

Corytophanes cristatus (Merrem, 1820)

This is the first record of this helmeted lizard in the Corn Islands. We collected a single female (MHUL 100; Figure 3A) on Great Corn Island at night while it was sleeping on low vegetation in a secondary forest patch on the slopes (100 m elevation) of Mount Pleasant.

Norops unilobatus (Köhler and Veselý, 2010)

This anole was first recorded from Great Corn Island by Barbour and Loveridge (1929) as *Anolis sallaei* on the basis of three specimens (MCZ 26964–66). Fitch and Henderson (1976) and Fitch and Seigel (1984) referred to these three specimens from Great Corn Island as *A. sericeus*. Köhler and Veselý (2010) allocated the Great Corn Island population to the cryptic and recently described *A. unilobatus* on the basis of five specimens (AMNH 97034, KU 159642–43, 159645, 159680), all of which lack everted hemipenes.

We collected three males (MHUL 101–103; Figure 3B) and two females (MHUL 104–105) of this species on Great Corn Island, and one male (MHUL 106; Figure 3C) and two females (MHUL 107–108) on Little Corn Island. One male specimen was captured during the day; the remainder were encountered at night sleeping on low vegetation.

In order to establish a species identification on the Corn Island populations of this cryptic species, we everted the hemipenis of the adult males collected on Great Corn Island, which were small, unilobed, and morphologically identical to the description provided in Köhler and Veselý (2010) of the everted hemipenis of *Norops unilobatus* (the generic name usage *sensu* Nicholson *et al.* 2012).

Norops villai (Fitch and Henderson, 1976)

This anole was first recorded from Great Corn Island by Barbour and Loveridge (1929) as *Anolis rodriguezii* (see Fitch and Seigel 1984) on the basis of a single specimen (MCZ 26963). It was later described as a distinct endemic species, *A. villai*, by Fitch and Henderson (1976) on the basis of 93 specimens (KU 159646–716, MPM 12650–71) collected between 15–19 February 1976 on Great Corn Island. Köhler (2001) cited seven additional specimens from Great Corn Island (KU 85723–29) as *Norops villai*.

We collected six adult male (MHUL 109–114; Figures 3 D-E) specimens of this species on Great Corn Island. All of them were collected on the slopes (around 100 m elevation) of Mount Pleasant during the day while active on vegetation, mostly on the lower portions of tree trunks. All specimens have extensive tricolored dewlaps similar to that of *Norops dariense* on the mainland, but darkened such that the tricoloration was strongly obscured, in contrast to the information in the original description that described the dewlaps as being solid chocolate brown (likely based on preserved specimens).

Hemidactylus frenatus Schlegel, 1836

This is the first record of this gecko on the Corn Islands. This species, native to Southeast Asia, likely arrived in Central America before the 20th century (Hunsaker 1966), reaching the Caribbean versant by the 1970's (Marcellini 1974).

We captured four specimens of this species (MHUL 115–118; Figure 3F) on Little Corn Island. They were all collected at night while actively hunting insects around the neon lights of a restaurant. The species was common in urbanized areas of both islands.

Lepidodactylus lugubris (Dumèril and Bibron, 1836)

This introduced gecko was first reported from Great Corn Island by Henderson *et al.* (1976) based on collections made by Jaime Villa and deposited in his private collection. *Lepidodactylus lugubris* has proven to be an opportunistic invader, having been found to thrive far from its native homeland in Southeast Asia (Savage 2002).

We collected three specimens (MHUL 119–121; Figure 3G) of this gecko on Great Corn Island and saw several individuals on Little Corn Island (Figure 3H). Although Henderson *et al.* (1976) only recorded a localized population on the island of this colonizer, at present the species is common in urbanized areas on both islands.

Ctenosaura similis (Gray, 1831)

This black iguana first was recorded from Great Corn Island by Barbour and Loveridge (1929) on the basis of two juvenile specimens (MCZ 26968–69). Fitch and Henderson (1976) mentioned the presence of *Ctenosaura similis* on Great Corn Island, but did not provide any voucher

specimens. Köhler (2001) cited 20 more vouchers of this species on Great Corn Island (KU 85759–69, 101436, 128675–82).

We collected three juveniles (MHUL 122–124; Figure 4A) of this species on Little Corn Island at night while they were sleeping on low vegetation. We additionally saw several juveniles and half-grown adults active along the paths during our single daytime survey of Little Corn Island.

Iguana iguana (Linnaeus, 1758)

The green iguana was first recorded from Great Corn Island by Barbour and Loveridge (1929) as *Iguana delicatissima* on the basis of a single adolescent specimen (MCZ 26967).

We acquired two hatchlings (MHUL 125–126) of this species from locals on Great Corn Island, and collected two juvenile specimens (MHUL 127–128) of this species on Little Corn Island. Those from Little Corn Island were collected at night while they were sleeping on low vegetation, and MHUL 125–126 were donated by locals from Great Corn Island that collected them years ago. Juveniles of this species was frequently encountered during the day basking in vegetation on Great Corn Island and were abundant sleeping on low vegetation during the night on both islands (Figures 4B–C).

Marisora magnacornae Hedges and Conn, 2012

The Corn Island skink has only been recorded from Great Corn Island by Barbour and Loveridge (1929) as *Mabuya agilis* on the basis of a single adult male specimen (MCZ 26976). It has been described recently as an endemic species (*Marisora magnacornae*), which is the smallest in this new genus, and is only known from the holotype (Hedges and Conn 2012). We did not observe *M. magnacornae* during our survey.

Thecadactylus rapicauda (Houttuyn, 1782)

This gecko has only been recorded from Great Corn Island by Barbour and Loveridge (1929) as *Thecadactylus rapicaudus* on the basis of a single specimen (MCZ 26961). We did not observe *T. rapicauda* during our survey.

Scincella cherriei (Cope, 1893)

This skink was recorded first from Great Corn Island by Köhler (2001) as *Sphenomorphus cherriei* on the basis of five specimens (KU 85970, 174111–14). Linkem *et al.* (2011) proposed including this species within the genus *Scincella*. We did not observe *S. cherriei* during our survey.

Gonatodes albogularis (Dumèril and Bibron, 1836)

This is the first record of this lizard in the Corn Islands. We collected one male (MHUL 129; Figure 4D), one female (MHUL 130; Figure 4E), and one subadult (MHUL 131) of this species on Great Corn Island, and two males (MHUL 132–133; Figure 4F) and two females (MHUL 134–134) on Little Corn Island. This species was common on both islands, both in the vicinity of houses as well as in secondary forests.

Sphaerodactylus argus Gosse, 1850

This Caribbean gecko was first recorded from Great

Corn Island by Thomas (1975) as *Sphaerodactylus argus* on the basis of a series of 20 specimens collected by J. Villa (field numeration JV 66203–19, 66067–69). Harris and Kluge (1984) examined 29 specimens (AMNH 97023–29; KU 85627, 101378; UMMZ 173055–74) of this species from Great Corn Island. We did not observe *S. argus* during our survey.

Sphaerodactylus millepunctatus Hallowell, 1861

This gecko has only been recorded from Great Corn Island by Harris and Kluge (1984) and McCranie and Hedges (2012) on the basis of a single specimen (UMMZ 173052). We did not observe *S. millepunctatus* during our survey.

Holcosus undulatus (Wiegmann, 1834)

This lizard was first recorded from Great Corn Island by Barbour and Loveridge (1929) who described it as a distinct subspecies, *Ameiva festiva miadis*, on the basis of six specimens (MCZ 26970–75). Peters and Donoso-Barros (1970) and Villa (1983) referred to this subspecies as *A. undulata miadis*, although they provided no additional vouchers. Köhler (2001) recorded 84 additional specimens from Great Corn Island (KU 85985–86007, 101268–311, 128683–99) as *A. undulata*. Harvey *et al.* (2012) proposed including this species within the genus *Holcosus*.

We collected two females (MHUL 136–137) of this species on Great Corn Island and one female (MHUL 138) on Little Corn Island. We saw several more adult and juvenile specimens of *Holcosus undulatus* on Great Corn Island, both near houses as well as on the secondary-growth slopes of Mount Pleasant (Figure 4G). MHUL 138 (Figure 4H) constitutes the first record of this species for Little Corn Island and is the only specimen we saw on the island during our short visit. It was found active during the day at ground level within some low vegetation along the steep cliff coastline of the southeastern portion of the island.

DISCUSSION

While we have presented new additions to the lizard diversity of the Corn Islands, it is possible that some of these species had been introduced prior to the Peters' expedition in 1927, or by the time Villa sampled the islands. However, some of our newfound species were frequently observed throughout these islands in disturbed areas, including those in and around buildings (*i.e.*, *Gonatodes albogularis* and *Hemidactylus frenatus*), so had they been present at the time of the previous surveys in any significant numbers they surely would have been detected. In addition, human interaction between the islands and the mainland has increased significantly since earlier studies, affording invasive taxa (such as *H. frenatus*) greater opportunity to undertake multiple colonization events to reinforce the stability of current populations.

When Peters' expedition surveyed Little Corn Island for a week in 1927, the searchers found the island to be void of lizard fauna. It would seem unlikely that the same persons who were able to collect eleven species of lizards on one island would miss all species present in significant numbers on a smaller island. Any newly colonized species might have remained undetected (as some species may

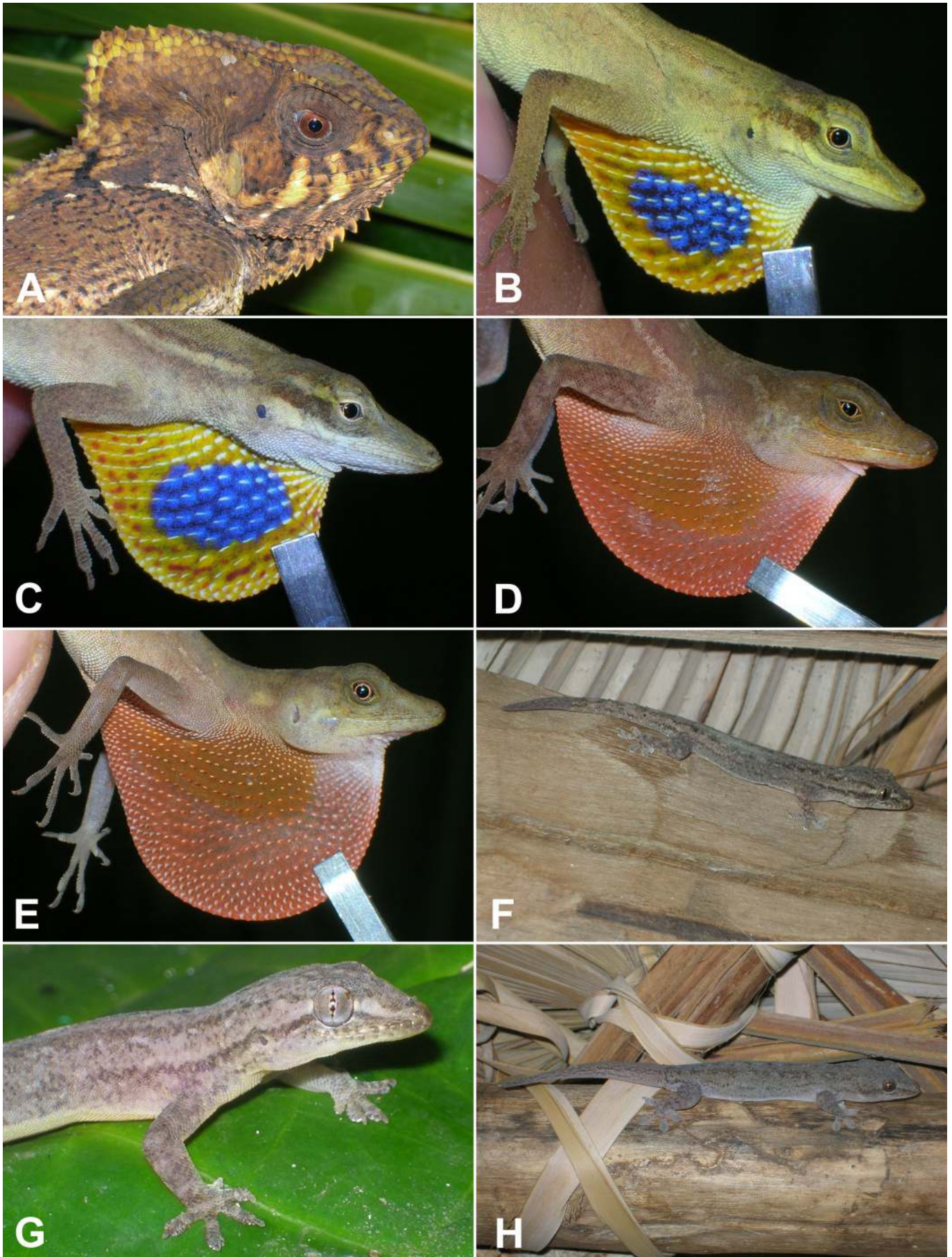


FIGURE 2. Images of lizard species from the Corn Islands, Nicaragua. (A) Female *Corytophanes cristatus* from Great Corn Island; male *Norops unilobatus* from (B) Great Corn Island, and (C) Little Corn Island; (D, E) male *N. villai* from Great Corn Island; (F) *Hemidactylus frenatus* from Little Corn Island; and *Lepidodactylus lugubris* from (G) Great Corn Island, and (H) Little Corn Island.

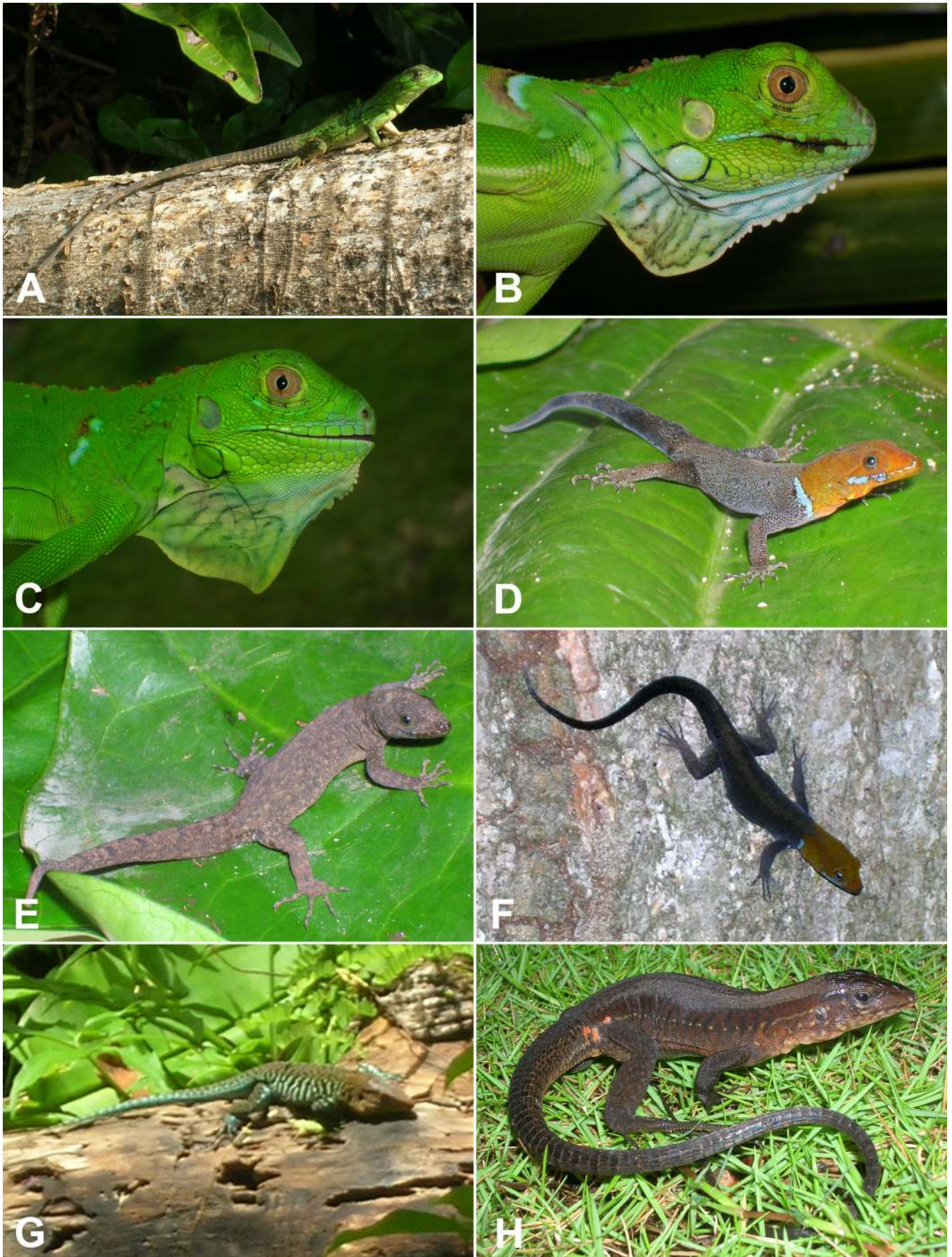


FIGURE 3. Images of lizard species from the Corn Islands, Nicaragua, continued. (A) Juvenile *Ctenosaura similis* from Little Corn Island; juvenile *Iguana iguana* from (B) Great Corn Island and (C) Little Corn Island; *Gonatodes albogularis* from (D-male, E-female) Great Corn Island, and (F-male) Little Corn Island; and *Holcosus undulatus* from (G-male) Great Corn Island, and (H-female) Little Corn Island

have remained undiscovered during our visit to the Corn Islands), but the human population of Little Corn Island was less than a dozen, indicating that the majority of the herpetofauna present at the time of the 1927 survey had arrived to the island without anthropogenic assistance. Since all lizard species found on Little Corn Island are known to be tolerant of human disturbance, they probably reached the island as the human population of Little Corn Island began to increase. None of the recorded lizard species are endemic to Little Corn Island, and given that the most proximate land mass is Great Corn Island, it can be inferred that Great Corn Island was the origin for all populations currently present on Little Corn Island.

Of the seven new records of lizard species on Little Corn Island, four were already present on Great Corn Island in 1927 (*Ctenosaura similis*, *Holcosus undulatus*, *Iguana iguana*, and *Norops unilobatus*). This leaves a span of time of more than 80 years during which they could have invaded Little Corn Island, if not prior to the 1927 survey. All of these species were observed fairly close to human development (although not as integrated into an urban setting as the three gecko species found), a lifestyle that would have facilitated the immigration to Little Corn Island on the countless number of boats that have travelled between the two islands over the past century. Boat traffic between the islands occurs daily with the possible exception of limitation by inclement weather. Some iguanids (i.e., *C. similis* and *I. iguana*) are often eaten in Nicaragua and elsewhere in Latin America, and were probably introduced to Little Corn Island (and perhaps to Great Corn Island, too) as a source of food. Perhaps coincidentally, no adults of either species (*C. similis* and *I. iguana*) were observed by us on either island, an indication that individuals of any size might be consumed by human inhabitants of the islands.

The lizard taxa on Little Corn Island likely arrived incidentally as construction materials and agricultural commodities were transported from Great Corn Island to Little Corn Island. It is unclear how much gene flow is presently occurring among any lizard populations between the two islands if at all. Population genetic analyses could reveal more information about the amount of gene flow between the islands. Even if populations on the two islands are genetically isolated, separation from mainland populations likely occurred first, so the age of colonization of the Corn Islands from the mainland might also be determined for some of the older invasions. If any invasions happened long enough ago for populations to become genetically distinct, there might even be higher rates of endemism on the Corn Islands than previously thought.

The increasing rate of human disturbance on the islands raises concern for the future conservation of not only the lizards and other herpetofauna, but of all native species inhabiting the Corn Islands. In order to promote the native biodiversity and maintain the presence of current species, the natural areas on the Corn Islands need to be protected, or we might risk extinction of some of its endemic species.

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LITERATURE CITED

- Barbour, T. and A. Loveridge. 1929. Vertebrates from the Corn Islands: reptiles and amphibians. *Bulletin of the Museum of Comparative Zoology* 69(7): 138–146.
- Dowling, H.G. 1952. A taxonomic study of the ratsnakes, genus *Elaphe* Fitzinger, II. The subspecies of *Elaphe flavivirfa* Cope. *Occasional Papers of the Museum of Zoology, University of Michigan* 540: 1–14.
- Duellman, W.E. 1970. *The Hylid Frogs of Middle America*. Volume I. Kansas: Monograph of the Museum of Natural History, University of Kansas. 753 p.
- Duellman, W.E. and M.J. Fouquette. 1968. Middle American Frogs of the *Hyla microcephala* group. *University of Kansas Publications, Museum of Natural History* 17(12): 517–557.
- Dunn, E.R. 1940. Notes on some American lizards and snakes in the Museum of Goteborg. *Herpetologica* 1(7): 189–194.
- Fitch, H.S. and R.W. Henderson. 1976. A new anole (Reptilia: Iguanidae) from Great Corn Island, Caribbean Nicaragua. *Milwaukee Public Museum Contributions in Biology and Geology* 9: 1–8.
- Fitch, H.S. and R.A. Seigel. 1984. Ecological and taxonomic notes on Nicaraguan anoles. *Milwaukee Public Museum Contributions in Biology and Geology* 57: 1–13.
- Harris, D.M. and A.G. Kluge. 1984. The *Sphaerodactylus* (Sauria: Gekkonidae) of Middle America. *Occasional Papers of the Museum of Zoology, University of Michigan* 706: 1–59.
- Harvey, M.B., G.N. Ugueto and R.L. Gutberlet, Jr. 2012. Review of teiid morphology with a revised taxonomy and phylogeny of the Teiidae (Lepidosauria: Squamata). *Zootaxa* 3459: 1–156.
- Hedges, S.B. and C.E. Conn. 2012. A new skink fauna from Caribbean islands (Squamata, Mabuyidae, Mabuyinae). *Zootaxa* 3288: 1–244.
- Henderson, R.W., J. Villa and J.R. Dixon. 1976. *Lepidodactylus lugubris* (Reptilia: Gekkonidae): a recent addition to the herpetofauna of Nicaragua. *Herpetological Review* 7(4): 173.
- Hillis, D.M. and T.P. Wilcox. 2005. Phylogeny of the New World true frogs (*Rana*). *Molecular Phylogenetics and Evolution* 34(2005): 299–314.
- Holdridge, L.R. 1967. *Life zone ecology*. Revised edition. San José: Tropical Science Center. 206 p.
- Hunsaker, D. 1966. Notes on the population expansion of the house gecko, *Hemidactylus frenatus*. *Philippine Journal of Science* 95(1): 121–122.
- INIDE 2008. Instituto Nacional de Información de Desarrollo. *Corn Island en cifras*. Managua: PNUD-UNFPA. 42 p.
- Köhler, G. 1999. The amphibians and reptiles of Nicaragua – a distributional checklist with keys. *Courier Forschungsinstitut Senckenberg* 213: 1–212.
- Köhler, G. 2001. *Anfibios y Reptiles de Nicaragua*. Offenbach: Herpeton. 208 p.
- Köhler, G. 2008. *Reptiles of Central America*, 2nd ed. Offenbach: Herpeton. 400 p.
- Köhler, G. and M. Veselý. 2010. A revision of the *Anolis sericeus* complex with the resurrection of *A. wellbornae* and the description of a new species (Squamata: Polychrotidae). *Herpetologica* 66(2): 207–228.
- Leon, J.R. 1969. The systematic of the frogs of the *Hyla rubra* group in Middle America. *University of Kansas Publications, Museum of Natural History* 18(6): 505–545.
- Linkem, C.W., A.C. Diesmos and R.M. Brown. 2011. Molecular systematics of the Philippine forest skinks (Squamata: Scincidae: *Sphenomorphus*): testing morphological hypotheses of interspecific relationships. *Zoological Journal of the Linnean Society* 163(4): 1217–1243.
- López de la Fuente, J. 1994. *Atlas of Solar Radiation in Nicaragua*. Stockholm, Sweden: Report to the Swedish Development Assistance Program. 56 p.
- Marcellini, D.L. 1974. Acoustic behavior of the gekkonid lizard, *Hemidactylus frenatus*. *Herpetologica* 30(1): 44–52.
- McCranie, J.R. and S.B. Hedges. 2012. Two new species of geckos from Honduras and resurrection of *Sphaerodactylus continentalis* Werner from the synonymy of *Sphaerodactylus millepunctatus* Hallowell (Reptilia, Squamata, Gekkonidae, Sphaerodactylidae). *Zootaxa* 3492: 65–76.
- Nicholson, K.E., B.I., Crother, C. Guyer and J.M. Savage. 2012. It is time for a new classification of anoles (Squamata: Dactyloidae). *Zootaxa* 3477: 1–108.

- Peralta-Willimas, L. 1991. Diagnóstico de los Recursos Pesqueros. Instituto Nicaraguense de las Regiones Autónomas. Managua: Indera. 52 p.
- Peters, J.A. and R. Donoso-Barros. 1970. Catalogue of the Neotropical Squamata. Part II. Lizards and amphisbaenians. *Bulletin of the United States National Museum* 297: 1–293.
- Peters, J.L. 1929. Vertebrates from the Corn Islands. *Bulletin of the Museum of Comparative Zoology* 69(7): 127–146.
- Roberts, H.H. and J.N. Suhayda. 1983. Wave-current interactions on a shallow reef (Nicaragua, Central America). *Coral Reefs* 1(4): 209–214.
- Roze, J.A. 1967. A checklist of the New World venomous coral snakes (Elapidae) with descriptions of new forms. *American Museum Novitates* 2287(1): 1–60.
- Ryan, J.D., L.J. Miller, Y. Zapata, O. Downs and R. Chan. 1998. Great Corn Island, Nicaragua; p. 95–105 In B. Kjerfve (ed.). *Caribbean coral reef, seagrass and mangrove sites*. Paris: Coastal region and small island papers 3, UNESCO.
- Sabaj-Pérez, M.H. (editor). 2013. Standard symbolic codes for institutional resource collections in herpetology and ichthyology: an Online Reference. Version 4.0 (28 June 2013). Accessible at <http://www.asih.org/>, American Society of Ichthyologists and Herpetologists, Washington, DC.
- Savage, J.M. 2002. The Amphibians and Reptiles of Costa Rica: A Herpetofauna between Two Continents, between Two Seas. Chicago: The University of Chicago Press. 934 p.
- Savage, J.M. and R. Heyer. 1967. Variation and distribution in the tree-frog genus *Phyllomedusa* in Costa Rica, Central America. *Beitrag zur Neotropischen Fauna* 5(2): 11–131.
- Sunyer, J. and G. Köhler. 2010. Conservation status of the herpetofauna of Nicaragua; p. 488–509 In L.D. Wilson, J.H. Townsend and J.D. Johnson (ed.). *Conservation of Mesoamerican amphibians and reptiles*. Utah: Eagle Mountain Publishing.
- Thomas, R. 1975. The *argus* group of West Indian *Sphaerodactylus*. *Herpetologica* 31(2): 177–95.
- Villa, J.D. 1968 [1967]. A new cloubrid snake from the Corn Islands, Nicaragua. *Revista de Biología Tropical* 15(1): 117–121.
- Villa, J.D. 1969. Two New Insular Subspecies of the Natricid Snake *Tretanorhinus nigroluteus* Cope from Honduras and Nicaragua. *Journal of Herpetology* 3(3/4): 145–150.
- Villa, J.D. 1970. Notas sobre la historia natural de la serpiente de los pantanos, *Tretanorhinus nigroluteus*. *Revista de Biología Tropical* 17(1): 97–114.
- Villa, J.D. 1972a. *Anfibios de Nicaragua: Introducción a su sistemática, vida y costumbres*. Managua: Instituto Geográfico Nacional & Banco Central de Nicaragua. 216 p.
- Villa, J.D. 1972b. Amphibians of the Corn Islands, Caribbean Nicaragua. *Caribbean Journal of Sciences* 12(3–4): 195–198.
- Villa, J.D. 1972c. Snakes of the Corn Islands, Caribbean Nicaragua. *Brenesia* 1: 14–18.
- Villa, J.D. 1983. Nicaraguan fishes, amphibians and reptiles: checklist and bibliography. Managua: Universidad Centroamericana. 53 p;
- Villa, J.D. 1984. The venomous snakes of Nicaragua: a synopsis. *Milwaukee Public Museum Contributions in Biology and Geology* 59: 1–41.
- Villa, J.D. 1993. Presence of the tortoise *Geochelone carbonaria* (Reptilia: Testudines) in the Corn Islands, Caribbean Nicaragua. *Revista de Biología Tropical* 4(3): 924–928.
- Villa, J.D., L.D. Wilson and J.D. Johnson. 1988. *Middle American herpetology, a bibliographic checklist*. Columbia: University of Missouri Press. 131 p.
- Wilson, L.D. and D.E. Hahn. 1973. The herpetofauna of the Islas de la Bahía, Honduras. *Bulletin of the Florida State Museum, Biological Sciences* 17(2): 93–150.
- Zweifel, R.G. 1967. The systematic status of the Central American frog *Rana miadis*. *Herpetologica* 23(1): 54–56.

APPENDIX

Key to the lizard species of the Corn Islands (modified from Savage 2002 and Köhler 2008):

- 1a. No movable eyelids 2
1b. Movable eyelids present 7
- 2a. A series of greatly expanded lamellae under fingers and toes; digits markedly compressed dorsoventrally; pupil vertically elliptical 3
2b. Lamellae not greatly expanded under fingers and toes; digits cylindrical or subcylindrical in cross section; pupil round 5
- 3a. Claws at tip of dilated area, retractile into distinct longitudinal groove; no preloacal or femoral pores *Thecadactylus rapicauda*
3b. Claws not retractile, on slender compressed terminal phalanx; males with a continuous series of preloacal and femoral pores 4
- 4a. Inner digits with a claw; digits not webbed *Hemidactylus frenatus*
4b. Inner digits on fingers and toes clawless; digits webbed *Lepidodactylus lugubris*
- 5a. Claws retractile into a sheath; terminal scales of digits much larger than other scales 6
5b. Claws not retractile into a sheath; terminal scales of digits about the same size as other scales *Gonatodes albobularis*
- 6a. Dorsum with longitudinal rows of ocellated blotches; 38–50 dorsals between levels of axilla and groin *Sphaerodactylus argus*
6b. Dorsal pattern variable, but without longitudinal rows of ocellated blotches; 47–74 dorsals between levels of axilla and groin *Sphaerodactylus millepunctatus*
- 7a. Venter covered by large rectangular plates *Holcosus undulatus*
7b. Venter covered by large cycloid scales or numerous small to granular rectangular scales 8
- 8a. Body covered by uniform cycloid scales; head covered by enlarged plates 9
8b. Body not covered by cycloid scales; head covered by a mixture of small and enlarged plate like scales 10
- 9a. No supranasals, a single large frontonasal (internasal); one frontoparietal *Scincella cherriei*
9b. Paired supranasals (internasal) present; two frontoparietals *Marisora magnacornae*
- 10a. Lamellae narrow, keeled throughout 11
10b. Lamellae of medial portion of digits expanded, smooth 13
- 11a. Femoral pores present 12
11b. No femoral pores *Corytophanes cristatus*
- 12a. Caudal scales arranged in whorls of large scales separately by small scales; no greatly enlarged scale below angle of jaw *Ctenosaura similis*
12b. Caudal scales not arranged in whorls of large and small scales; a greatly enlarged scale below angle of jaw *Iguana iguana*
- 13a. Pads under fourth toe with only slightly expanded lamellae, only about twice as wide as those on the base of finger; male dewlap chocolate brown with a tricolored pattern *Norops villai*
13b. Pads under fourth toe with greatly expanded lamellae, several times wider than lamellae on base of digit; male dewlap yellow with a central blue large dot *Norops unilobatus*

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