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John G. Himes[1] and Kevin M. Enge[2]

[1]*Louisiana Military Department, 6090 West Range Road, Pineville, Louisiana 71360, United States.*
E-mail: dibamus1@yahoo.com

[2]*Florida Fish and Wildlife Conservation Commission, 1105 SW Williston Road, Gainesville, Florida 32601, United States*. *E-mail*: Kevin.Enge@MyFWC.com

Habitat diversification and natural history observations in *Norops utilensis* (Squamata; Dactyloidae) on Isla de Utila, Honduras

The Utila Anole, *Norops utilensis* (Köhler, 1996), a poorly known member of the *Norops pentaprion* group, is "known to occur only at low elevations on the eastern end of Isla de Utila" (McCranie and Köhler, 2015: 196). Although *N. utilensis* currently is not listed by the IUCN (www.iucnredlist.org; accessed 11 October 2017), Johnson et al. (2015) assessed it a high Environmental Vulnerability Score (EVS = 19), and Gutsche et al. (2004) and McCranie and Köhler (2015) referred to this species as critically endangered.

Gutsche et al. (2004: 301) reported that, "since 1995 only 13 specimens of *N. utilensis* have been seen or collected," and also noted (p. 297) that this anole occurs "exclusively in a specialized habitat – the highly dynamic and salty mangrove swamps," where it utilizes trunks, limbs, and the branches of trees at heights from 0 to 6 m above the ground. This habitat consists predominantly of Black Mangrove (*Avicennia germinans*) and Red Mangrove (*Rhizophora mangle*), as reported by Fickert and Grüninger (2010). Reproduction in *N. utilensis* within *R. mangle* habitat has been documented (Gutsche et al., 2004; Hallmen et al., 2012; McCranie and Köhler, 2015).

Here we report 18 field observations (4 males, 9 females, and 5 sex undetermined) of this little known species outside of mangrove environments, and present evidence for a range extension and habitat diversification within the island. We also provide brief comments on its distribution, and include such unrecorded aspects of its behavior and natural history as niche partitioning, diurnal habitat use, and nocturnal sleeping sites. A substantial degree of habitat diversification was the most noteworthy finding, as we document the presence of *N. utilensis* a considerable distance away from mangrove habitat. Furthermore, we record the sympatric occurrence of both species of anoles endemic to Isla de Utila (*N. utilensis* and *N. bicaorum*) for the first time, and provide photographs of both sexes for *N. utilensis* (Figs. 1, 2). We consider this information of significant importance for future research and conservation planning for these anoles on the island.

Fig. 1. (Left) A male *Norops utilensis*, alert but in sleeping position, found in a fragmented patch of broad-leaf forest adjacent to the Kanahau Utila Research & Conservation Facility, Isla de Utila, Honduras. (Right) A manual extension of the large dewlap reveals its "geranium pink" coloration. © Tom W. Brown

Fig. 2. (Left) A female *Norops utilensis* in a similar position and from the same locality as in Fig. 1. (Right) Note the manually extended dewlap, which comparatively is noticeably smaller in size than that of males. © Tom W. Brown

Study Methods

We conducted diurnal and nocturnal Visual Encounter Surveys (VES) at various locations and habitats across Isla de Utila, in an effort to gather broad-range data on the abundance, distribution, and ecology of the island's endemic anoles. The information we present for *N. utilensis* results from preliminary and opportunistic observations facilitated through the research of *N. bicaorum*, a project supported by the Mohammed bin Zayed Species Conservation Fund (www.speciesconservation.org). All encountered individuals had GPS points (WGS 84) taken to plot their distribution, as well as identifying the habitat type based on plant composition. When applicable, we collected morphometric data for captured individuals, and used a Kestrel 5500 weather station to take the microclimate variables (Temperature, Relative Humidity and Wind speed) for the anole positions.

Distribution

Norops utilensis previously was known only from "near sea level to 8 m elevation" on the eastern side of Isla de Utila (McCranie and Köhler, 2015: 198). We conducted herpetological surveys within a wide range of relevant Red, Black, and White mangrove habitats similar to those described above for *N. utilensis*: Ironbound (16.121233°N, -86.899123°W) 33 visits; Big Bight pond (16.0952333°N, -86.8838333°W) 3 visits; Aliah's channel (16.07966°N, -86.98255°W) 7 visits; and Turtle Harbour (16.113160°N, -86. 941234°W) 5 visits; the last locality is the only recognized protected terrestrial area on Isla de Utila. Despite the number of total visits to these sites (from March of 2016 to July of 2017), we were unable to locate *N. utilensis* in these areas.

Norops utilensis is a rather cryptic species and thus difficult to locate, and considering the published observations still might be found at these localities. As a testament to the apparent scarcity of *N. utilensis*, we estimate that during the time it took us to observe 18 individuals of *N. utilensis* across the island, we observed > 350 individuals of *N. bicaorum* across the same sites (TWB, unpublished). We suggest the population density of *N. utilensis* is considerably lower than that of *N. bicaorum*, or that its strict arboreality simply eludes conventional search methods. Nonetheless, we did not observe any anoles in mangrove habitats except for some *N. bicaorum* in areas of White Mangrove (*Laguncularia racemosa*) bordering the coastal forest vegetation; notably, however, areas of Red Mangrove, such as those described by Gutsche et al. (2004), are difficult to access and survey. Despite the apparent scarcity of *N. utilensis*, the strictly arboreal habits of this species provide an impediment to conventional searching methods. Similar to the information provided by McCranie and Köhler (2015), we found that *N. utilensis* occupies a small distribution along the eastern portion of Isla de Utila, and that this species requires conservation planning for its future protection.

Habitat Diversification and Sympatric Resource Use

In stark contrast to the information reported for *N. utilensis* in the literature, we observed a substantial degree of habitat diversification within this species. We encountered *N. utilensis* in an area called Pumpkin Hill (16.12003°N, -86.88223°W), which is the highest point on Isla de Utila (elev. 74 m). At the top of the hill, in an area of *Acoelorrhaphe wrightii* dominated broad-leaf palm forest (Fickert and Grüninger, 2010) between April and May of 2016, we found three individuals of *N. utilensis* occurring sympatrically with large numbers of *N. bicaorum*, a previously unrecorded association between these insular endemics. We observed one individual of *N. utilensis* (found ca. 4.5 m above the ground at ca. 1440 h) for 20 min on the same tree trunk as a male *N. bicaorum* (1 m above the ground), and neither interacted with the other. We observed the second individual at ca. 1100 h, basking on a tangled limb of a tree (*Ficus* sp.) ca. 6 m above the ground, and we encountered the third individual, a female, sleeping in a horizontal position ca. 2 m above the ground in close proximity (ca. < 1.5 m) to a female *N. bicaorum*. As a result of these observations, we report a slight increase in the maximum elevation of *N. utilensis*, from 8 m (McCranie and Köhler, 2015) to 74 m above sea level.

We also observed the sympatric use of habitat between both endemic anoles within the grounds of Kanahau Utila Research & Conservation Facility (KURCF), in a small, semi-disturbed, fragmented patch of tropical broad-leaf/palm forest (16.119383°N, -86.884989°W). On 13 April 2017 at 2030 h, we encountered a male *N. utilensis* sleeping in close proximity (< 70 cm) to a male *N. bicaorum*, while sharing the fronds of the same plant (*A. wrightii*) at respective heights of 3.4 m and 2.7 m above the ground. We identified the individuals as separate species based on their distinct dewlap and body coloration (see, Figs. 1, 2).

On 14 April 2017 at 1300 h, we observed the same male *N. utilensis* seen the previous day on the side of a large broad-leaf trunk (which contacted the fronds of the above-mentioned *A. wrightii*), basking in a sun-lit section at a height of ca. 7 m above the ground and occasionally moving around the trunk before reappearing. The same male *N. bicaorum* seen the previous day was moving along the base of this tree at heights between 0.5 and 2 m, but he also descended occasionally to forage at ground level on the leaf-litter. Although we observed both individuals for ca. 2 h, neither showed any interaction. On several other occasions in April of 2017, we observed individuals of both species active during the day on the same tree, appearing to be mostly separated from one another by the heights each used for foraging

On 1 August 2017 from 1100 to 1120 h, we observed two female *N. utilensis* in a nearby broad-leaf forest patch, which were active on trunks within an area of ca. 30 m^2 that also was occupied by five *N. bicaorum* (2 males, 3 females). Both of the female *N. utilensis* were positioned vertically upward on trunks at an average height of 2.81 m above the ground, and at an average temperature of 30.4°C, relative humidity of 74.6%, and wind speed of 4.1 mph. All of the female *N. bicaorum* were positioned vertically downward on palm trunks at an average height of 0.86 m above the ground, and at an average temperature of 29.6°C, relative humidity of 82.1%, and wind speed of 2.2 mph. The two male *N. bicaorum* also were in the same position as the females, and their respective average values were 1.68 m, 29.7 °C, 77%, and 3.2 mph. Although a larger sample size would be desirable to support and supplement this data, an initial examination of the values seems to corroborate our hypothesis for a vertical niche separation between both anole species, as well as between the sexes in *N. bicaorum.*

Sleeping Observations

On 1 May 2017 from 2100 to 2200 h, we observed the sleeping sites of five individuals of *N. utilensis* on the grounds of KURCF, all within an area of ca. 25m^2; previously, the description of sleeping sites for *N. utilensis* had not been reported. We found one male on the surface of an *A. wrightii* at a height of ca. 4 m above the ground, in a downward position facing the tip of the frond. We found another male in a similar position at a height of 1.5 m, as well as another male sleeping horizontally between two broad-leaves touching a barbed wire fence at a height of ca. 1m above the ground (Fig 1.). We located an additional individual (sex undetermined) at a height of ca. 5m, sleeping on a thin vine that was swaying in the wind. Finally, we encountered a female *N. utilensis* sleeping on the underside of an *A. wrightii* frond at a height of ca. 3.5 m above the ground. We suggest that sleeping on the underside of a leaf demonstrates the arboreal/climbing abilities of this species, and to the best of our knowledge is an unusual (and perhaps undocumented) sleeping posture for anoles.

Additionally, between February and May of 2017, we observed six individuals of *N. utilensis* along a road ca. 500 m from KURCF, and between August and September found two females in a lower elevation patch of forest in the Pumpkin Hill vicinity; we located six of the eight individuals at night. We collected basic morphometric data on four of the females we encountered (snout–vent length [SVL] = 54–57 mm, body mass = 3.4–3.7 g); the SVL was consistent with the 57 mm maximum length for females reported by McCranie and Köhler (2015: 196).

General Discussion

The observations of *Norops utilensis* in dry hardwood forest habitat were unexpected and unusual, especially considering the large population of *N. bicaorum* in this area (Brown et al., 2017) and the significant distance from mangrove habitat. *Norops utilensis* was thought to be one of two lizard species on the island found exclusively in brackish mangrove swamps (along with *Ctenosaura bakeri*; see Gutsche, 2005), and by definition is an arboreal species that inhabits mangrove swamps (Köhler, 1996; Gutsche et al., 2004). In contrast to the impression that *N. utilensis* avoids competition from *N. bicaorum* by specializing in mangrove habitats, our observations suggest that *N. utilensis* is capable of inhabiting a select niche within an *N. bicaorum* dominated broad-leaf palm forest habitat, and apparently avoids inter-specific competition by occupying the higher understory and canopy layer during the day. Although we observed *N. bicaorum* occupying the canopy and understory niche at the Pumpkin Hill site, this rarely was at a height > 5 m above the ground, and often was the result of climbing as a means to escape. Most individuals of *N. bicaorum* have been observed foraging at heights from 0 to 2 m above the ground (Brown et al., 2017), whereas those of *N. utilensis* generally have been observed at greater heights (3 to > 7 m). Previous research of anole communities found sympatrically occurring species to be separated by narrowly defined niches (Losos 1994; Irschick et al. 2005; D'Cruze and Stafford 2006). Although further research is needed to understand the interspecific relationships of Utila's anoles, obviously these species are capable of sympatric occurrence and avoiding direct competition within the same habitat, even while contemporaneously using such resources as *A. wrightii*, an important and abundant palm that provides ideal understory sleeping sites for both species. The sympatric occurrence and resource partitioning between these two insular endemics had not been documented.

Previous to our observations, the farthest distance recorded for the occurrence of *N. utilensis* from a mangrove swamp was 250 m, where an individual was found on a fencepost adjacent to broad-leaf forest (Hallmen et al., 2012). Additionally, McCranie and Köhler (2015: 277) noted that *N. utilensis* "needs to have its remaining

mangrove habitat in Utila protected from human destruction or it might not survive for the long term". However, they proceeded to acknowledge that "*N. utilensis* had recently been found several times outside of mangrove habitat, hopefully signifying an adaptation to other habitat types as its primary habitat is altered". Our observations suggest that *N. utilensis* is a more adaptable species than previously recorded, providing definitive evidence confirming the presence of individuals at a considerable distance (> 1.5 km) from the nearest mangrove habitat, where they occupy broad-leaf/palm forest and disturbed secondary growth adjacent to agricultural fields. Apparently, this species also can occur in broad-leaf forest, like other members of the *N. pentaprion* group (Avila-Pires, 1995; Lee, 1996; Savage, 2002). Our observations might significantly impact future conservation strategies for *N. utilensis*, as the distribution of this species no longer is limited to mangrove habitat.

Threats

The eastern portion of the island, and especially the road to Pumpkin Hill, currently is being developed and many of the larger trees and surrounding roadside vegetation is being removed to provide improved access. The vegetated fences along the road, however, seemingly act as important biological corridors. Such degree of deforestation and clearance of the natural habitat along the road could have a severe negative impact, as mature trees and remnant patches of forest appear essential for both of the endemic insular anoles to persist in areas adjacent to agricultural lands. Both mangrove and hardwood forest are increasingly threatened habitats on Isla de Utila, as most of these lands are privately owned and increasingly are being sold for development. We argue that the community of Utila must quickly recognize the importance of terrestrial habitats for its biodiversity, or risk further fragmenting the island's unique wildlife populations.

Conservation

Ideal conservation actions for *N. utilensis* would be to immediately prevent further unsustainable habitat modifications within its restricted core range on the eastern side of Isla de Utila. Such actions could be most easily achieved through the purchase of suitable properties that contain high populations of anoles, and by designating and protecting the land as a private nature reserve. Although the hardwood broad-leaf forest habitat on Isla de Utila is an important component of the island's biodiversity, currently none of this habitat has been designated for protection. Preliminary biodiversity research conducted through KURCF suggests that the broad-leaf habitats are crucial to the survival of many invertebrate, herpetofaunal, bird, and mammal species (especially bats). We find it encouraging that such a wide range of biodiversity (including *N. utilensis* and *N. bicaorum*) could be candidates for conservation by initiating protection of these unique island habitats.

The occurrence of *N. utilensis* in tropical palm and broad-leaf forest should have great implications on future conservation strategies for this anole, by providing a valued update and a foundation for conducting needed research in the future. We hope our observations on the natural history of this species, including its greater level of adaptability and interactions with a congener, contributes new and valuable information on Utila's little known endemic anoles.

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Tom W. Brown[1], Daisy Maryon[1,2], and George Lonsdale[1,2]

[1]*Kanahau Utila Research and Conservation Facility, Isla de Utila, Isla de Bahia, Honduras. E-mail*: browntb@outlook.com (TWB, Corresponding author)

[2]*University of South Wales, Pontypridd, United Kingdom.*

Distribution of *Phrynosoma ditmarsi* Stejneger, 1906, with notes on habitat and morphology

The Rock Horned Lizard (Camaleón de Piedra, in Spanish), *Phrynosoma ditmarsi*, is a poorly known Mexican endemic species with a distribution restricted to the state of Sonora. The International Union for Conservation of Nature (IUCN) has categorized this species as Data Deficient (Frost et al., 2007), but using the Environmental Vulnerability measure (EVS) Wilson et al. (2013) assessed this species with a score of 16, placing it in the middle portion of the high vulnerability category; these authors regarded *P. ditmarsi* as highly vulnerable to environmental degradation because of its narrow geographic and ecological distribution. The Secretaría del Medio Ambiente y Recursos Naturales (SEMARNAT) listed this species as threatened (amenazada) in 2002, but in 2010 did not indicate a protected status (SEMARNAT, 2002, 2010).

Initially, this species was collected on the Carl Lumholtz expeditions to Mexico in 1890–91, with the locality recorded as "Sonora." The type specimens were collected in 1897 "a short distance over the border of Arizona, in