

Distribution and natural history notes on *Norops bicaorum* (Squamata: Dactyloidae) endemic to Isla de Utila, Honduras

Norops bicaorum Köhler, 1996, is an understudied species of anole assigned to the *Norops lemurinus* species subgroup (Köhler and McCranie, 2001; Nicholson et al., 2012). This species is endemic to Isla de Utila, in the Honduran department of Islas de la Bahía, which is the westernmost of the three major Bay Islands and part of the Cayos Cochinos archipelago (McCranie et al., 2005). Currently, *N. bicaorum* is known only from Lowland Moist Forest at elevations from sea level to 20 m on the eastern portion of the island (Wilson and Townsend, 2006; McCranie and Köhler, 2015). Despite its restricted distribution, the conservation status of *N. bicaorum* has not been assessed by IUCN (www.redlist.org; accessed 15 April 2017); Johnson et al. (2015), however, calculated its EVS (Environmental Vulnerability Score) as 17, placing it in the middle portion of the high vulnerability category. Herein we document an expansion in the distribution of this species, and document previously unreported aspects of its natural history. All geographic coordinates were recorded in datum WGS 84.

Distribution

In contrast to information reported in McCranie and Köhler (2015), we found individuals of *Norops bicaorum* to occur at a slightly higher elevation, and to inhabit fragmented patches of palm and tropical broad-leaf forest in an area known as Pumpkin Hill (16.12003°N, -86.88223°W). During repeated visual encounter surveys at Pumpkin Hill from April to June of 2016, we observed > 30 different individuals of *N. bicaorum* along a 200 m transect, suggesting that a large and dynamic population occurs in this area. We recorded a maximum elevation for *N. bicaorum* as 74 m, an increase of 54 m from that reported by McCranie and Köhler (2015).

We conducted preliminary surveys at several locations across Isla de Utila, including at Alijah Channel (16.07966°N, -86.98255°W), Ironbound (16.121233°N, -86.899123°W), Big Bight (16.0952333°N, -86.8838333°W), as well as in tropical coastal forest (16.071377°N, -86.953372°W) and mature White Mangrove (*Laguncularia racemosa*) habitat on the South Shore (16.081313°N, -86.943696°W). We confirmed the presence of *N. bicaorum* at each of these sites, a significant increase in distribution considering that the species only had been recorded from the eastern portion of the island. Importantly, none of these observations occurred in areas of Red Mangrove (*Rhizophora mangle*), Black Mangrove (*Avicennia germinans*) or swamp forest, the habitat type Fickert and Grüniger (2010) indicated for these localities. Instead, in these areas we found pockets of appropriate coastal hardwood/palm forest habitat. These geographical records indicate that the distribution of *N. bicaorum* is greater than previously thought, and likely encompasses most of the suitable and accessible habitat on the island. This distributional expansion is not surprising, considering that the central and western portions of Isla de Utila have not been surveyed extensively for herpetofauna (McCranie and Köhler, 2015).

In addition, we did not locate any *N. bicaorum* during surveys at the Turtle Harbor Wildlife Refuge (16.113160°N, -86.941234°W), the only terrestrial “protected” habitat zone on Isla de Utila. Whereas individuals might have evaded our search efforts, this area likely is unable to support a large population of *N. bicaorum*, as it consists primarily of wet Neotropical savanna, swamp forest, or Red- and Black Mangrove formations. We believe that additional areas of old-growth broad-leaf/palm forest must be protected for large populations of *N. bicaorum* to persist indefinitely.

Habitat Use

Norops bicaorum has been observed using various habitat types on the island, ranging from preferred old growth broad-leaf/palm forest to secondary forest, coastal vegetation, White Mangrove (*Laguncularia racemosa*), and disturbed areas such as gardens, roadsides, and vegetated agricultural fringes. Their highest population density appears to be in old hardwood/broad-leaf palm forest, where many individuals can be found active throughout the day on the sides of trunks and while they sleep at night. This species, however, is not confined to this “trunk ecomorph,” as previously suggested by Nicholson et al. (2012), with regard to the six “ecomorph classes” proposed by Williams (1983). Indeed, many anoles have become specialized to inhabit a narrow ecological niche (Schoener, 1968; Roughgarden, 1974; Schettino et al. 2010), but in the case of Isla de Utila *N. bicaorum* instead is active among

and capable of exploiting many layers within forest structures. This behavior likely has arisen because of the lack of natural sympatric anole competitors. In support, its natural co-inhabitants on the island are the endemic *N. utilensis* (Köhler, 1996), which occurs almost exclusively high in the trees of Red- and Black Mangrove forest formations (Gutsche et al., 2004; Hallmen and Huy, 2012), and *N. sericeus*, which rarely is encountered in forest formations or above heights of 1 m (Henderson and Fitch, 1975). Although our personal observations of both species suggest otherwise (TWB, GL, unpublished), we consider *N. utilensis* and *N. sericeus* to be too small morphologically to act as competitors. With little competition and habitat restrictions, we found *N. bicaorum* inhabiting almost every detectable layer from the ground up to a higher canopy layer, with individuals observed perched and sleeping on palm fronds and branches at a height above 5 m. This capacity to exploit the canopy also is seen in escape responses, and although individuals initially will rely on camouflage, they will dash and spiral up tree trunks to escape predators and avoid capture.

Behavioral Observations

We encountered active *Norops bicaorum* of both sexes most commonly perched at the base of tree trunks, frequently in a downward-facing position at a height of approximately 0.5–2.5 m. Males typically perch in the upper portion of this range, vertically positioned on the trunk with the head held high. Accordingly, we observed individuals with raised nuchal crests and dorsal ridges extending their dewlaps while engaging in territorial displays with neighboring rivals on adjacent tree trunks (Fig. 1A). The crests and ridges only were raised during territorial confrontation with rival males, and female interactions consisted solely of dewlap extensions and head bobbing, before edging gradually closer and repeating this behavior. The dewlap of females is entirely lacking, or rudimentary and considerably smaller in size, and often is paler in coloration than that of males (Fig. 1B). Unlike what is seen in the displays of other anole species (e.g., Clause and Brown, 2017), *N. bicaorum* does not perform push-ups, but typically remains motionless when displaying, bobbing the head between the dewlap extensions. Additionally, we did not observe physical confrontations between males.

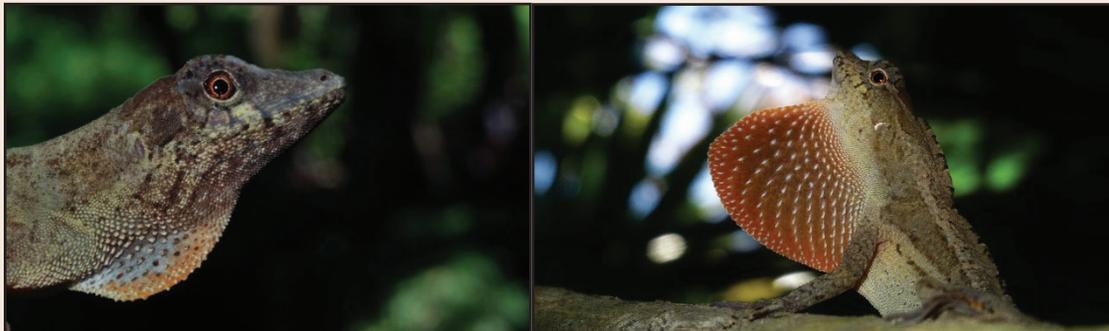


Fig. 1. Dewlap size and coloration of male (A) and female (B) *Norops bicaorum*, an anole endemic to Isla de Utila, Departamanto de Islas de la Bahía, Honduras. © Tom W. Brown

During nocturnal surveys, we observed most *N. bicaorum* sleeping in a downward-facing position on the outer fronds of large fan palms, often < 5 m from their last recorded diurnal location. Their orientation varied depending on the sleeping site, with the choice apparently influenced by the presence of rain or wind. Nonetheless, the flimsy yet sturdy Tique Palm (*Acoelorrhaphe wrightii*) leaves were the most common sleeping sites observed, but we also found individuals using thin branches, hanging vines, broad leaves, palm/tree trunks and barbed wire (Fig. 2). Previous studies on anole sleeping habits suggest that these apparently vulnerable positions can permit the perception of external stimuli, such as the proximity of predators (Singhal et al., 2007).

Norops bicaorum also appeared to exhibit site fidelity, as during a four-week period in April of 2016 we found individuals repeatedly on the same palm tree trunks and in almost identical positions during near daily and nightly visits to the Pumpkin Hill site. In particular, this fidelity was apparent in regard to the choice of sleeping perches. We found numerous individuals using the same sleep site repeatedly, and if not sequentially, they often would use

it in alternation between a few sites. The longest consecutive use of a single sleeping perch was six nights (23–30 April 2016; TWB, pers. observ.). Based on these observations, we assume that individuals of this species inhabit small, localized territories, and exhibit a degree of fidelity to their perch sites. A detailed mark-recapture and tracking study, however, is needed to confirm and further understand these behavioral dynamics.



Fig. 2. Resting or sleeping positions used by *Norops bicaorum*. Perching sites include thin vines and branches, but especially the fronds of the Fan Palm (*Acoelorrhaphe wrightii*). © Tom W. Brown

Diet

On two consecutive occasions, 10 min apart from each other on 14 May 2016, we saw a female perched at a height of 1.5 m on the trunk of a Tique Palm (*Acoelorrhaphe wrightii*), running vertically down the trunk and jumping to the ground to catch invertebrate prey; in this case, a jumping spider (*Corythalia* sp.) and a cricket (Gryllidae). We also observed other individuals descending to the ground from their trunk perches (0.5–2 m) to chase and capture prey items, including a lacewing (Neuroptera: Chrysopidae), a dragonfly (Odonata: Anisoptera), a cockroach (Blattodea: Blattidae), a caterpillar (Lepidoptera), and a parasitic wasp (Hymenoptera: Ichneumonoidea). In all instances, the initial movement of the invertebrate prey triggered predation, followed by the common approach-pause-strike method (see Moermond, 1981), in which the *N. bicaorum* quickly moved close to the prey item before briefly pausing to orient its head in preparation for the strike. In the majority of observations, after rapidly seizing its prey the individual retreated to the closest trunk base or would reassume its original position while manipulating, chewing, and swallowing. Based on these observations, trunk positioning (alongside male displays) apparently is strongly associated with feeding behavior, and allows individuals to scan the leaf-litter for active invertebrates and ambush them with success. Because of the array of invertebrate prey items captured, *N. bicaorum* likely is highly opportunistic and diverse in its dietary habits.

Reproduction

On 27 February 2017 at approximately 1100 h, we observed a pair of *Norops bicaorum* mating in dry hardwood forest habitat near Ironbound (16. 121233°N, -86. 899123°W). During copulation, the anoles were positioned on a mature vine at a height of 3 m. We continued to observe them for 10 min, and during this time the male used its jaws to grasp the female behind the neck, while holding on to her body with the limbs and tail (Fig. 3). When we returned after 1.5 h, the male was no longer present but the female was resting at a similar height 4 m away from the original position. Although we cannot accurately define the breeding or reproductive season for this species, we found hatchlings and juveniles from March through to September. This observation is consistent with reports in wild-caught captive populations, as Beest and Hartman (2003) documented year-round reproduction, with females depositing a single egg in the terrarium substrate every 15 days (McCranie and Köhler, 2015).



Fig. 3. A pair of *Norops bicaorum* observed copulating on a mature vine.

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Threats

Likely snake predators of *Norops bicaorum* include *Leptophis mexicanus*, *Mastigodryas melanolomus*, *Oxybelis aeneus*, and *O. fulgidus*, all of which have been observed at the Pumpkin Hill and Ironbound sites. Another species, *Imatodes cenchoa*, is a nocturnal predator that feeds largely on anoles, and although this species has been reported from the island, we did not observe any individuals during our study. Domestic cats also have been observed catching and eating anoles in rural and urban areas.

A potentially major competitor and threat to the species includes the notoriously invasive anole, *N. sagrei*. Currently, this species only has only been observed in the streets, gardens, and vegetated patches throughout the Utila Town; most notably, a high density is present along the main harbor on the island (likely its point of introduction). To date, no individuals have been observed in Utila's broad-leaf forest habitats, which is fortunate because this species possibly could outcompete *N. bicaorum*. Conversely, as documented in many cases, the population of this invader will not remain confined (Kraus, 2009; Meshaka, 2011; Kamath et al. 2013). Instead, we expect that the population of *N. sagrei* will increase rapidly in synergism with continued deforestation and human related development across the island.

Presently, deforestation is taking place and likely will continue to increase with the pace of development in the areas surrounding Pumpkin Hill, as most of the natural habitat is privately owned and available for purchase. McCranie and Köhler (2015: 276) noted that *N. bicaorum* should be considered as Near Threatened in accordance to IUCN Redlist categories, and appears to be declining in altered habitat, "still remaining common, but seemingly down from its former exceedingly abundant category." This decline almost certainly is the result of disturbance and habitat change caused by the removal of forest habitats. Indefinite development and continuation of such practices eventually will endanger *N. bicaorum* populations across the island.

The documentation of these observations comes at a critical time for the conservation of *N. bicaorum*, and indeed for the herpetofauna of Isla de Utila. Although these observations are preliminary, they highlight the gaps in species-specific knowledge and the importance of further population and behavioral studies. We hope that the information we present will inform and inspire future research on this charismatic endemic and its function within the island's ecosystem.

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LITERATURE CITED

- BEEST, P. VAN, AND M. HARTMAN. 2003. De eerste kweek van *Norops bicaorum* – Köhler 1996: *Anolis lemurinus* – Wilson & Hahn 1973. *Lacerta* 61: 3–9.
- CLAUSE, J. K., AND T. W. BROWN. 2017. Additional information on the natural history observations in *Anolis cusuco* (Squamata: Dactyloidae). *Mesoamerican Herpetology* 4: 215–218.
- FICKERT, T., AND F. GRÜNIGER. 2010. Floristic zonation, vegetation structure, and plant diversity patterns within a Caribbean mangrove and swamp forest on the Bay Island of Utila (Honduras). *Ecotropica* 16: 73–92.
- GUTSCHE, N., J. R. MCCRANIE, AND K. E. NICHOLSON. 2004. Field observations on a nesting site of *Norops utilensis* Köhler 1996. (Reptilia, Squamata) with comments about its conservation status. *Salamandra* 40: 297–302.
- HALLMEN, M., AND N. HUY. 2012. Natural History Notes. *Norops utilensis* (Utila Anole). *Herpetological Review* 43: 642–643.
- HENDERSON, R. W., AND H. S. FITCH. 1975. A comparative study of the structural and climatic habitats of *Anolis sericeus* (Reptilia: Iguanidae) and its syntopic congeners at four localities in southern Mexico. *Herpetologica*: 459–471.
- JOHNSON, J. D., V. MATA-SILVA, AND L. D. WILSON. 2015. A conservation reassessment of the Central American herpetofauna based on the EVS measure. *Amphibian & Reptile Conservation* 9(2) [General Section] 1:94 (e100).
- KAMATH, A., Y. E. STUART, AND T. S. CAMPBELL. 2013. Behavioural partitioning by the native lizard *Anolis carolinensis* in the presence and absence of the invasive *Anolis sagrei* in Florida. *Breviora* 535: 1–10.
- KÖHLER, G. 1996. Additions to the known herpetofauna of the Isla de Utila (Islas de la Bahia, Honduras) with description of a new species of the genus *Norops* (Reptilia: Iguanidae). *Senckenbergiana Biologica* 76: 19–28.
- KÖHLER, G., AND J. R. MCCRANIE. 2001. Two new species of anoles from northern Honduras (Reptilia, Squamata, Polychrotidae). *Senckenbergiana Biologica* 81: 235–245.
- KRAUS, F. 2009. *Alien Reptiles and Amphibians: A Scientific Compendium and Analysis*. Springer Science and Business Media B.V., Dordrecht, Netherlands.
- MCCRANIE, J. R., AND G. KOHLER. 2015. The Anoles (Reptilia: Squamata: Dactyloidae: *Anolis*: *Norops*) of Honduras: Systematics, Distribution, and Conservation. *Bulletin of the Museum of Comparative Zoology, Special Publications Series*, No. 1., Cambridge, Massachusetts, United States.
- MCCRANIE, J. R., L. D. WILSON, AND G. KÖHLER. 2005. *Amphibians & Reptiles of the Bay Islands and Cayos Cochinos, Honduras. Bibliomania!* Salt Lake City, Utah, United States.
- MESHAKA, W. E. JR. 2011. A runaway train in the making: The exotic amphibians, reptiles, turtles, and crocodilians of Florida. *Herpetological Conservation and Biology* 6: 1–101.
- MOERMOND, T. C. 1981. Prey attack behaviour in *Anolis* lizards. *Zeitschrift für Tierpsychologie* 56: 128–136.
- 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* 3,477: 1–108.
- ROUGHGARDEN, J. 1974. Niche width: biogeographic patterns among *Anolis* lizard populations. *American Naturalist*: 429–442.
- SCHETTINO, L. R., J. B. LOSOS, P. E. HERTZ, K. DE QUEIROZ, A. R. CHAMIZO, M. LEAL, AND V. R. GONZÁLEZ. 2010. The anoles of Soroa: aspects of their ecological relationships. *Breviora*: 1–22.
- SCHOENER, T. W. 1968. The *Anolis* lizards of Bimini: resource partitioning in a complex fauna. *Ecology*: 704–726.
- SINGHAL, S., JOHNSON M. A., AND J. T. LADNER. 2007. The behavioural ecology of sleep: natural sleeping site choice in three *Anolis* lizard species. *Behaviour* 144: 1,033–1,052.
- WILLIAMS, E. E. 1983. Ecomorphs, faunas, island size, and diverse end points in island radiations of *Anolis*. Pp. 326–370 *In* R. B. Huey, E. R. Pianka, and T. W. Schoener (Eds.), *Lizard Ecology: Studies of a Model Organism*. Harvard University Press, Cambridge, Massachusetts, United States.
- WILSON, L. D., AND J. H. TOWNSEND. 2006. The herpetofauna of the rainforests of Honduras. *Caribbean Journal of Science*. 42: 88–113.

TOM W. BROWN¹, DAISY F. MARYON^{1,2}, MATTHIJS P. VAN DEN BURG³, AND GEORGE LONSDALE^{1,2}

¹*Kanahau Utila Research and Conservation Facility, Isla de Utila, Honduras.*

Email: browntb@outlook.com (TWB, Corresponding author)

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

³*University of Amsterdam, Amsterdam, The Netherlands.*