



Distribution and ecological aspects of *Anolis* (Squamata, Dactyloidae) on the main campus of the Universidad Autónoma de Santo Domingo, Santo Domingo, Dominican Republic

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Abstract

We document four species of *Anolis* from the main campus of Universidad Autónoma de Santo Domingo: *Anolis distichus* (Cope, 1891), *A. cybotes* (Cope, 1862), *A. porcatus* Gray, 1840 and *A. sagrei* Duméril & Bibron, 1837. *Anolis distichus* was the most abundant species, with 176 individuals, followed by *A. cybotes* with 26, *A. porcatus* with 13, and *A. sagrei* with 2 individuals. We include details on the distribution and some ecological aspects of these species.

Keywords

Caribbean, introduced species, lizards, urban ecology

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Introduction

Anolis Daudin, 1802 is a genus of lizards in the family Dactyloidae and are native to the Americas; there are approximately 436 species (Uetz 2019). This genus is the most diverse among amniote tetrapods in the world. Caribbean anole lizards have been studied since the 18th century, with one of the first studies made by Lockwood (1876) on the “chamaeleons” of Florida.

Williams (1972) coined the term “ecomorph” for anoles of the West Indies, defining it as a species within the same niche or habitat, and with morphology and behavior but not necessarily close phylogenetically. Since then, anoles have been excellent models for studies focusing on adaptative radiation and convergent evolution (Williams 1983; Langerhans et al. 2006).

Hispaniola (Dominican Republic and Haiti) has more than 56 documented species of *Anolis* (Hedges 2020) found in every land ecosystem, representing every ecomorph, and occupying several niches. Gabot et al. (2020) reported the hybridization between two species of anoles on Hispaniola, where *Anolis porcatus* is allopatric with *A. chlorocyanus* and *A. cyanostictus*. Reyes et al. (2018) produced a checklist the herpetofauna of the campus of the Autonomous University of Santo Domingo (UASD) and Sano and Montero (2018) analyzed the tree preferences of two species of anole lizards. Here, we contribute to the knowledge of the ecological dynamics and population structure of anoles on the UASD campus, part of the urban area of Santo Domingo, Dominican Republic.

Methods

The main campus of UASD is on avenida Alma Mater in the Distrito Nacional, Santo Domingo (Dominican Republic; ca 18°27'39"N, 069°55'06"W; Fig. 1). Its area is 2.89 km². The average temperature range is 25–35.5 °C and the relative humidity is 88–90% (ONAMET 2020).

We used a 50 m long measuring tape, an Extech 4465 Hygro-Thermometer for recording the ambient temperature and humidity, and a Crison 638 Pt precision thermometer for the internal temperature of the sampled individuals. We used Excel 2016 for our data analysis and Google Earth Pro v. 2.0 to generate the maps.

For sampling, we used the methodology of Reyes et al. (2018). We traced seven transects (Fig. 1), each of 50 m long, in selected areas based on light, tree coverage, and human disturbance. Each transect was then divided into 10 sub-transects of 5 m each. For each of these sub-transects, we actively searched in April 2018 for species of anoles for 3–5 minutes during two periods, 11:00 am–1:00 pm and 4:00 pm–6:00 pm. On each subtransect, the data recorded were species, sex, stage of development (juvenile or adults), position at the moment of observation, substrate, approximate height above ground where found, internal temperature (when captured; captures were made by hand), ambient temperature, and humidity.

To identify individuals to species, we used images and morphological descriptions by Hedges (2020) and in the Reptile Database (Uetz 2019), as well as support from Sixto Inchaustegui, a specialist.

To obtain data about the thermal niche, we compared the temperature close to the substrates where individuals

were found at capture (ca 50cm) to cloacal temperatures, which were obtained using the Crison 638 Pt thermometer probe to a depth of ≤1 cm.

Results

We recorded four species of *Anolis*: *A. distichus*, *A. cybotes*, *A. porcatius*, and *A. sagrei*. A total of 221 individuals were counted and included 176 *A. distichus*, 30 *A. cybotes*, 13 *A. porcatius*, and two *A. sagrei*.

Squamata

Dactyloidae Fitzinger, 1843

Anolis distichus (Cope, 1891)

Figure 2A

Materials examined. REPÚBLICA DOMINICANA • ♂110, ♀ 66; Santo Domingo, Distrito Nacional, Ciudad Universitaria; 18°27'38"N, 069°55'02"W; 18°27'37"N, 069°55'2"W; 18°27'42"N, 069°55'12"W; 18°27'46"N, 069°55'09"W; 18°27'35"N, 069°54'55"W; 18°27'43"N, 069°54'52"W; 18°27'45"N, 069°54'47"W; 19 m a.s.l.; 9 April 2018; Frías-Victoriano obs.; on tree trunks, ground and peripheral walls (Fig. 3A).

Identification. Small, with brown to green metachrosis and with dorsal longitudinal stripes in some cases. Dewlap yellow to red, sometimes white. A trunk and ground anole (Cope 1891).

Global and local distribution. *Anolis distichus* is mainly found in the United States, Bahamas and Hispaniola (Cope 1891). It is widely distributed in the Dominican Republic where it is known from every province. We

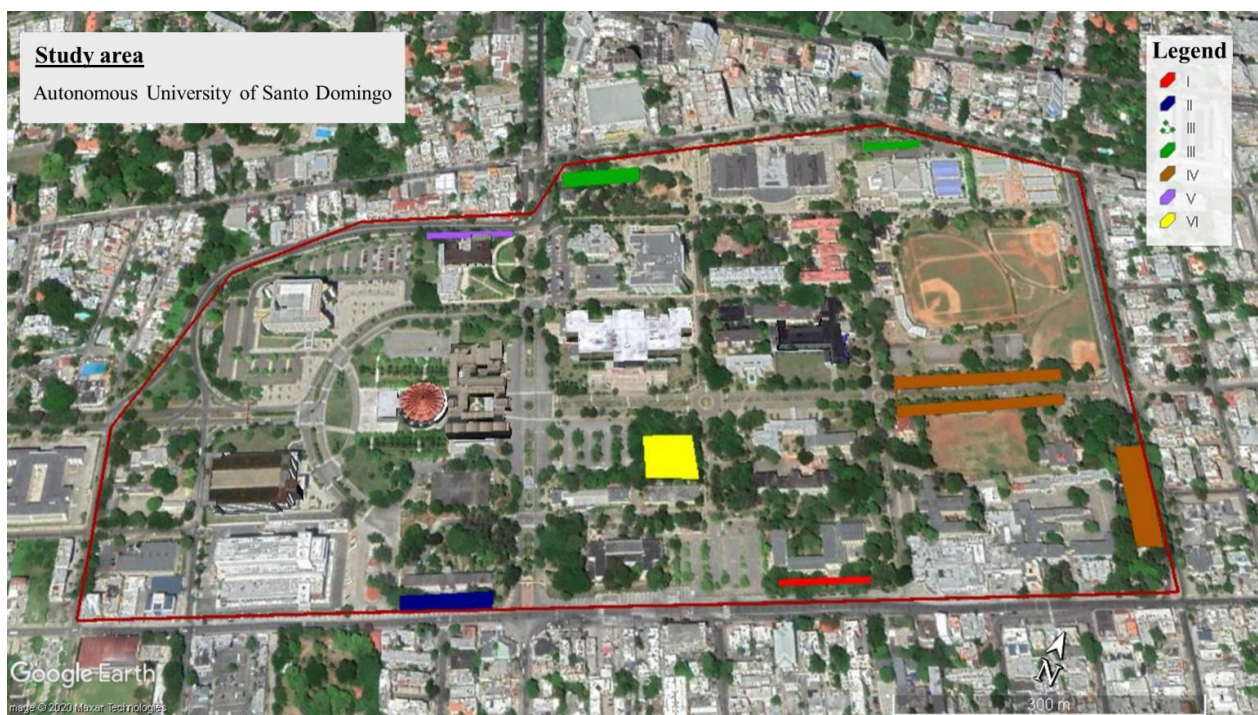


Figure 1. Main campus of the Universidad Autónoma de Santo Domingo with the traversed transects marked. I = near Antigua Biblioteca; II = behind Nueva Universidad; III = next to Comedor Universitario and on Facultad de Artes' park; IV = next to UASD's baseball field and behind Marion's hospital. V = behind Facultad de Ciencias Economicas y Sociales; VI = on "Embajadas". Map data 2020 © Google.

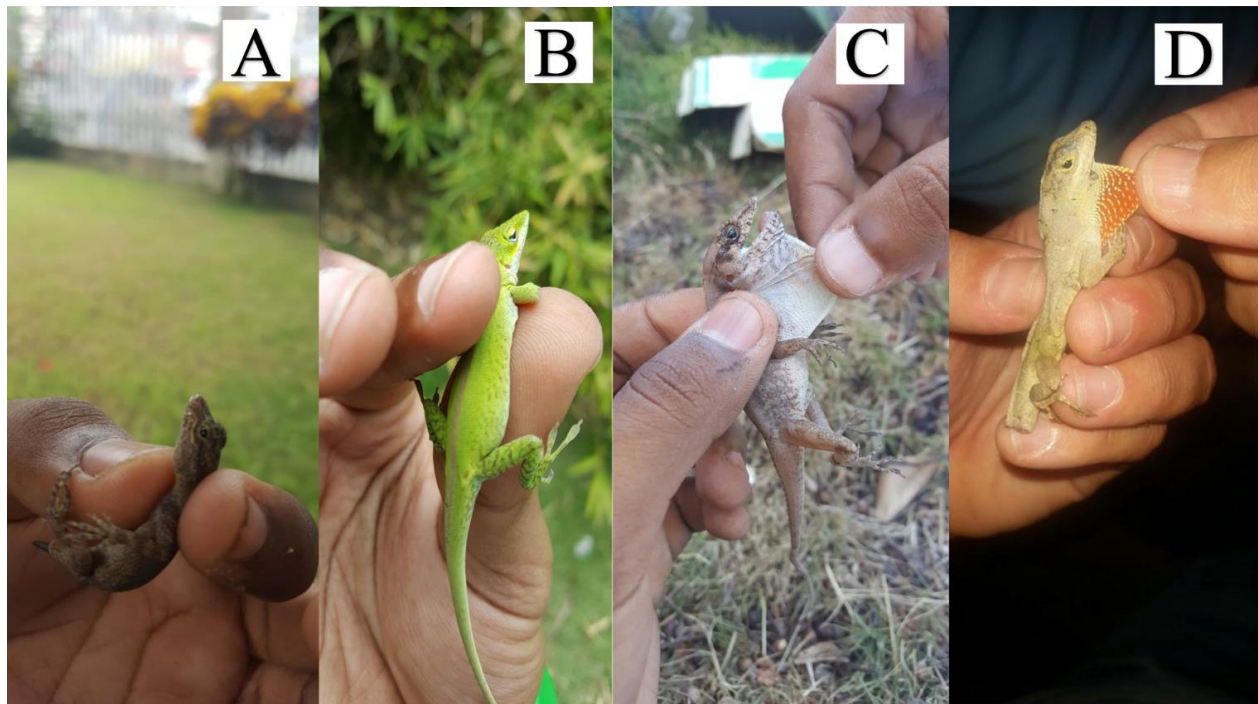


Figure 2. *Anolis* species on the campus of UASD, Santo Domingo. **A.** *A. distichus*. **B.** *A. porcatius*. **C.** *A. cybotes*. **D.** *A. sagrei*.

mainly was found this species in the central zone of the UASD campus, but it is widely distributed on the campus (Fig. 4).

Habitat and ecology at UASD. *Anolis distichus* was found on tree trunks (72% of individuals), peripheral walls (24%), and the ground (4%) (Fig. 4A). *Azadirachta indica* (Meliaceae) was the species of tree where *A. distichus* was found most often, followed by *Ficus* spp. (Moraceae) and *Simarouba glauca* (Simaroubaceae). We found the internal temperature of five out of seven individuals to be higher than the ambient temperature (Fig. 5). A total of 110 males and 66 females were found (Fig. 6).

Anolis cybotes (Cope, 1862)

Figure 2C

Materials examined. REPÚBLICA DOMINICANA
• ♂14, ♀12; Santo Domingo, Distrito Nacional, Ciudad

Universitaria; 18°27'33"N, 069°55'03"W; 18°27'41"N, 069°55'12"W; 18°27'45"N, 069°55'9"W; 18°27'52"N, 069°54'57"W; 18°27'43"N, 069°54'52"W; 18 m a.s.l.; 9 April 2018; Rojas-González obs.; on the ground.

Identification. Body robust, with big head, brown with clear lateral lines. Dewlap white. Ventral scales usually keeled. A trunk and ground anole (Uetz 2019).

Global and local distribution. *Anolis cybotes* is native to Hispaniola and adjacent islands and has been introduced to Suriname and Florida (Uetz 2019). In the Dominican Republic, this species is widely distributed, although not as much as *A. distichus*. At the UASD campus, *A. cybotes* was not found in the central area, but on the periphery (Fig. 4).

Habitat and ecology at UASD. We found *A. cybotes* on the ground close to rocks and walls. In three of four

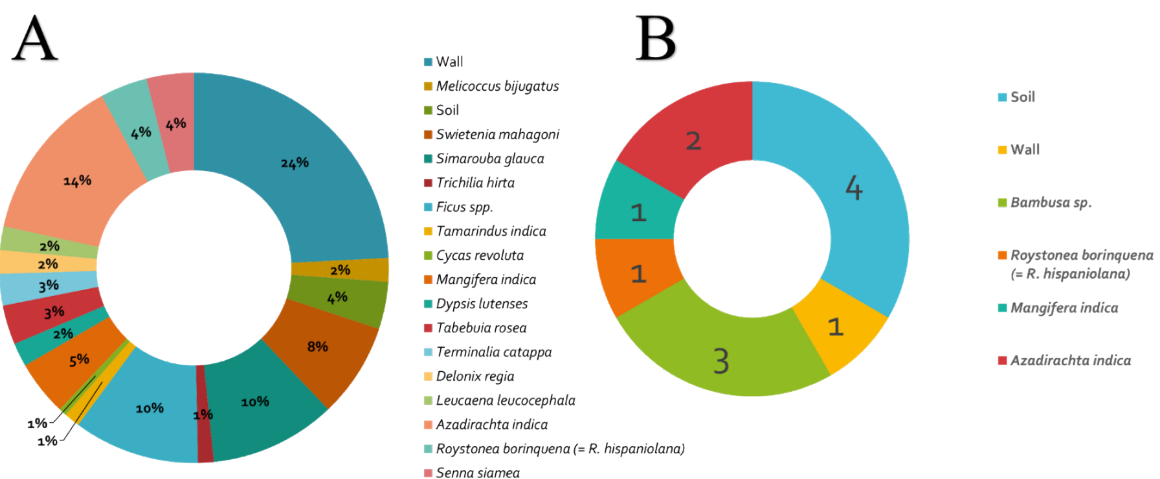


Figure 3. Substrate preferences by *Anolis* species on the campus of UASD, Santo Domingo. **A.** *A. distichus*. **B.** *A. porcatius*.

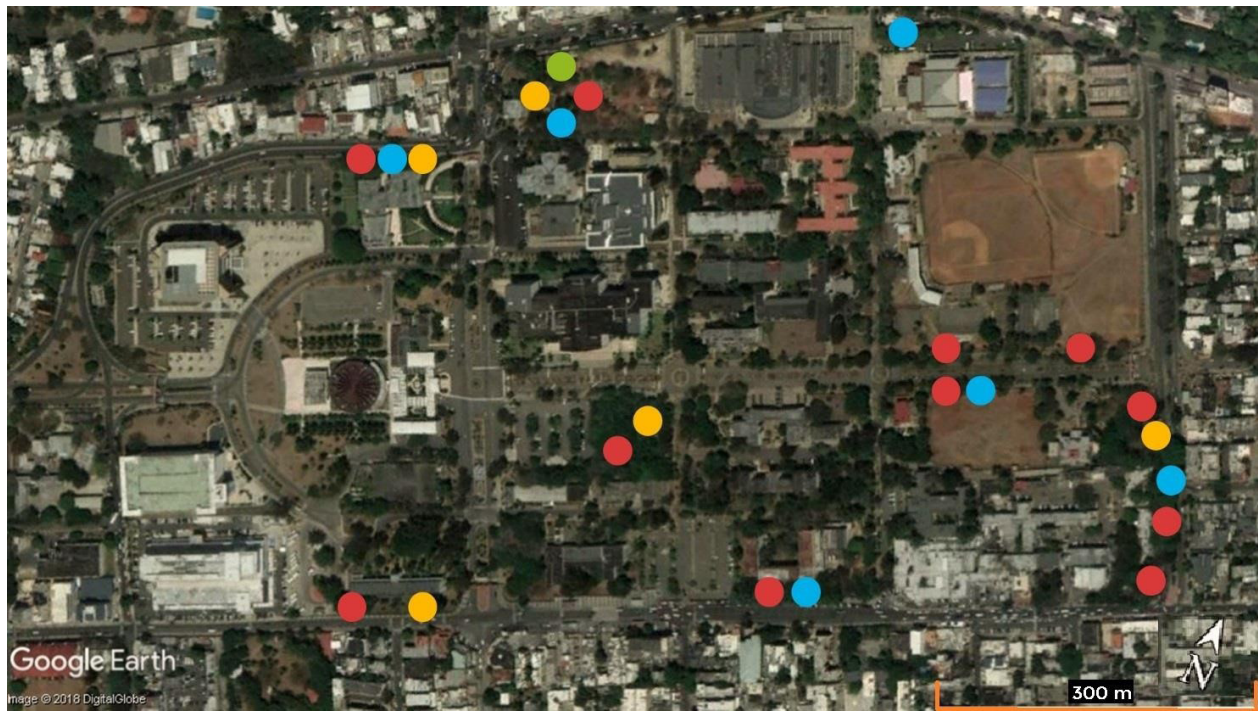


Figure 4. Distribution of *Anolis* species on the campus of UASD, Santo Domingo. Blue: *A. cybotes*. Yellow: *A. porcatus*. Red: *A. distichus*. Green: *A. sagrei*. Map data 2018 © Google.

individuals the internal temperature was lower than the ambient temperature (Fig. 5). A total of 14 males and 12 females were sampled (Fig. 6).

Anolis porcatus Gray, 1840

Figure 2B

Materials examined. REPÚBLICA DOMINICANA • ♂7, ♀5; Santo Domingo, Distrito Nacional, Ciudad Universitaria; 18°27'44"N, 069°54'47"W; 18°27'42"N, 069°55'11"W; 18°27'45"N, 069°55'09"W; 18°27'38"N, 069°55'01"W; 18°27'45"N, 069°54'46"W; 18 m a.s.l.; 16 April 2018; Rosa-Delgado obs.; on trees, the ground, and walls (Fig. 3B).

Identification. Robust and large; typically bright green,

but changing to brown when in danger. Dewlap pink in males. A trunk and crown anole (Gabot-Rodriguez 2020).

Global and local distribution. *Anolis porcatus* is native to Cuba, but has been introduced to Florida, Hispaniola, Brazil, and the Canary Islands (Powell et al. 1990). In the Dominican Republic, this species has been reported from Santo Domingo (Gabot-Rodriguez 2020). On the UASD campus, *A. porcatus* was found mainly on the west side of the campus (Fig. 6).

Habitat and ecology at UASD. We found this species in trees (58%), on the ground (34%), and on walls (8%). *Bambusa* sp. (Poaceae) and *Azadirachta indica* were the species where we found *A. porcatus* most often (Fig. 4B).

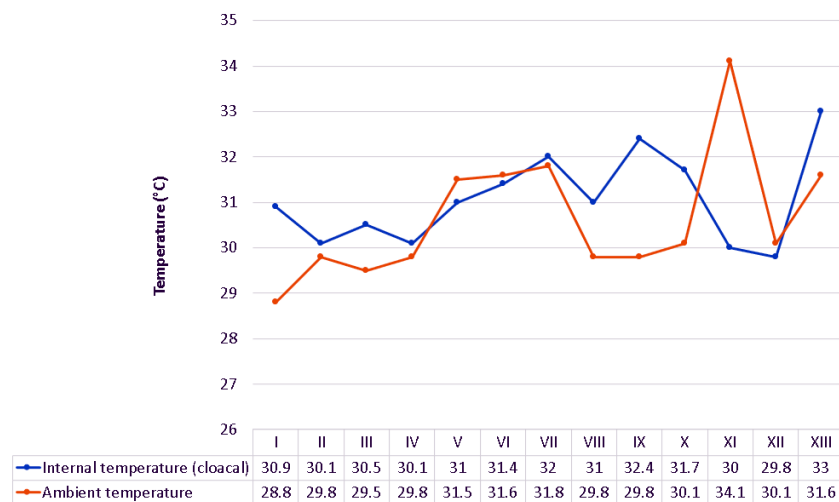


Figure 5. Internal and external temperatures on *Anolis* species on the campus of UASD, Santo Domingo. I–VII = *A. distichus*; VIII–XI = *A. cybotes*; XII–XIII = *A. porcatus*.

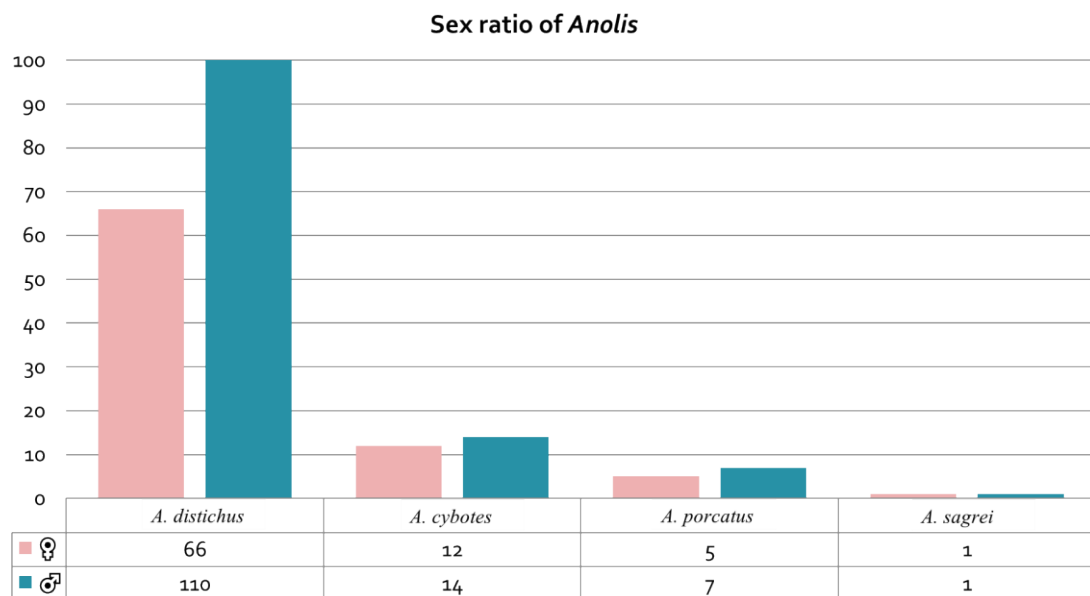


Figure 6. Distribution of *Anolis* species on the campus of UASD, Santo Domingo. Blue: *A. cybotes*. Yellow: *A. porcatus*. Red: *A. distichus*. Green: *A. sagrei*. Map data 2018 © Google.

The internal temperatures of only two individuals were measured (Fig. 5). A total of seven males, five females, and one of indeterminate sex were found.

Anolis sagrei Duméril & Bibron, 1837

Figure 2D

Materials examined. REPÚBLICA DOMINICANA • ♂1, ♀1; Santo Domingo, Distrito Nacional, Ciudad Universitaria; 18°27'46"N, 069°55'09"W; 22 m a.s.l.; 11 April 2018; Araujo-Calzado obs.; on the ground.

Global and local distribution. *Anolis sagrei* is native to Cuba and Bahamas but has been introduced to some Caribbean islands, Central and South America, Mexico, USA, and even two Asian countries (Taiwan and Singapore) (Uetz 2019). In the Dominican Republic, it was first seen at La Romana (Landestoy et al. unpubl. data). On the USAD campus, we recorded *A. sagrei* only once, in the northern part of the campus (Fig. 4).

Identification. Small, bright brown or sometimes gray, spotted, and head with white and black marks. Dewlap intensely red. A trunk and ground anole.

Habitat and ecology at UASD. We found *A. sagrei* on the ground. We did not record the internal temperatures of the one male and one female found.

Discussion

In our study, *Anolis* lizards were found mainly in the green areas of the UASD campus. Comparing the number and abundance of anole species found in our study to other urban areas of Santo Domingo, we found that UASD had a lower diversity and abundance. Ramirez-Gomez (2018) recorded six species of *Anolis* at the Universidad Nacional Pedro Henriquez Ureña; she found a greater number of individuals of *A. distichus* (400) and *A. cybotes* (110) but fewer *A. porcatus* (≤ 10). Reyes et

al. (2018) found 226 individuals of all species of *Anolis*, which is more than us, but they recorded fewer *A. porcatus* (six individuals). Sano and Montero (2018) found fewer individuals of *A. distichus* (47) than us, but a greater number of *A. cybotes* (46 individuals). These differences in the numbers of species and individuals may be due to the season, the amount green areas at each locality, and amount of human disturbance.

Anolis sagrei has been present in Hispaniola since at least 2009 when it was first seen in La Romana; it was first spotted at the UASD campus in 2018 (Landestoy et al. unpubl. data). Our study adds to the previous published (Reyes et al. (2018) and unpublished records (Landestoy et al. unpubl. data) of *A. sagrei* on the campus. We found the same number of individuals as Reyes et al. (2018).

We found a higher male-to-female ratio for every species, except *A. sagrei*. For *A. distichus* our results differ from Arias (1989), who recorded a greater number of females than males at three stations in Parque Mirador del Sur (Santo Domingo).

According to Hertz (1980), the differences between internal and ambient temperatures between and within species may be due to environmental stresses or activities at the time. We observed on various substrates and most individuals were actively foraging or running, which can increase the internal temperature.

Given that the trees on the UASD campus and in urban parks in Santo Domingo are planted, the substrate preference of *Anolis* species on and off campus may vary. Sano and Montero (2018) observed that anoles preferred *Delonix regia* (Fabaceae), *Terminalia catappa* (Combretaceae), and *Swietenia mahagoni* (Meliaceae) in an area very near our study area.

Introduced species such as *A. porcatus* may eventually prove a threat native anole species by out competing

(Arias 1989), which could cause declines in populations of the native lizards. Additional study of these species is necessary to help prevent declines in endemic and native species and the potential hybridization, as documented by Gabot-Rodriguez et al. (2020).

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Authors' Contributions

JAR designed the study, wrote manuscript, and made the analyses. NR and LR identified lizards, took temperatures, and prepared the figures. EF and JA identified lizards and wrote parts of the manuscript.

References

- Arias IA (1989) *Anolis cholorocyanus* y *Anolis porcatus* (Lacertilia, Iguanidae) en la Ciudad de Santo Domingo. Undergraduate thesis, Universidad Autonoma de Santo Domingo, Santo Domingo, Dominican Republic, 237 pp.
- Cope ED (1861) Notes and descriptions of anoles. *Proceedings of the Academy of Natural Sciences of Philadelphia* 13: 208–219.
- Gabot-Rodriguez E, Inchaustegui SJ, Fenninger M, Feldmeyer B, Köhler G (2020) Natural Hybridization between two species of Green Anoles: Morphological and Genetic evidence. *Novitates Caribaea* 15: 73–96. <https://doi.org/10.33800/nc.vi15.217>
- Hedges SB (2020) Caribherp: West Indian amphibians and reptiles. <http://www.caribherp.org>. Accessed on: 2020-5-01.
- Hertz PE (1980) Comparative physiological ecology of the sibling species *Anolis cybotes* and *A. marcanoi*. *Journal of Herpetology* 14 (1): 92–95. <http://doi.org/10.2307/1563888>
- Langerhans RB, Knouft JH, Losos JB (2006) Shared and unique features of diversification in Greater Antillean *Anolis* ecomorphs. *Evolution* 60: 362–369. <https://doi.org/10.1554/05-314.1>
- Lockwood S (1876) The Florida chameleon. *American Naturalist* 10: 4–16.
- Powell R, Jolley ML, Taylor CV, Parmelee JS, Smith DD (1990) Range expansion by an introduced anole: *Anolis porcatus* in the Dominican Republic. *Amphibia-Reptilia* 11: 421–425. <https://doi.org/10.1163/156853890X00113>
- Ramírez-Gómez R (2018) Inventario de los anfibios y reptiles presentes en el campus de la Universidad Nacional Pedro Henríquez Ureña. Libro de Resúmenes del III Congreso Estudiantil de Investigación Científica y Tecnológica, Santo Domingo, República Dominicana, 101–102.
- Reyes FO, Jiménez-Orozco C, Rojas JA, Piña Y, Cabrera J, Fortuna J, Rosa A, Sanó B, Ortiz F (2018) Inventario de la herpetofauna del Campus Central de la UASD. Libro de Resúmenes del III Congreso Estudiantil de Investigación Científica y Tecnológica, Santo Domingo, República Dominicana, 106–107.
- Sano B, Montero L (2018) Preferencia arbórea de dos especies de *Anolis* en tres comunidades vegetales del Parque Iberoamérica. XVII Jornada de investigación Científica. UASD, Santo Domingo, República Dominicana, 27–28.
- Uetz P (2019) *Anolis*. The reptile database. <http://www.reptile-database.org>. Accessed on: 2020-05-01.
- Williams EE (1972) The origins of faunas: evolution of lizard congeners in a complex island fauna: a trial analysis. *Evolutionary Biology* 6:47–89. https://doi.org/10.1007/978-1-4684-9063-3_3
- Williams EE (1983) Ecomorphs, faunas, island size, and diverse end points in island radiations of *Anolis*. In: Huey RB, Pianka ER, Schoener TW (Eds) *Lizard ecology: study of a model organism*. Harvard University Press, Cambridge, Massachusetts, USA, 326–370.