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Following in the Footsteps of Chapman Grant: Novel Observations of the Virgin Islands Boa (*Chilabothrus granti*) in the British Virgin Islands

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***Abstract.*—The Virgin Islands Boa (*Chilabothrus granti*) is an endangered species distributed in scattered populations on the eastern end of Puerto Rico and the Puerto Rico Bank. Populations are well characterized in Puerto Rico and the U.S. Virgin Islands, but no systematic surveys have been published from the British Virgin Islands and several anecdotal island reports remain unverified. We conducted 24 surveys on three islands (Tortola, Virgin Gorda, and Jost Van Dyke) from 30 January to 2 February 2023, and 3 to 7 March 2024. We searched appropriate habitats nocturnally and diurnally, aided by sightings from locals and social media. Survey and informal effort yielded 31 boas encountered, including 27 on Tortola and four on Jost Van Dyke. We did not detect boas on Virgin Gorda. This is the first confirmed sighting of the species from Jost Van Dyke (verification of anecdotal reports) and the first systematic survey of the British Virgin Islands. We provide updated distribution and abundance data, a novel size record, and morphometric data. We further emphasize the need for continued and expanded surveys in the British Virgin Islands to fill gaps in the known range of this species as well as assess remaining population sizes.**

Key Words.—Boidae; Caribbean; conservation; morphometrics; snake; survey effort

Introduction

The British Virgin Islands (BVI) are a political unit comprised of approximately 36 islands and cays (small islands) on the eastern end of the Puerto Rican Bank (PRB), the fourth-largest Greater Antillean bank in the Caribbean (Fig. 1). This small island chain has a total subaerial area of approximately 155 km^2, with Tortola being the largest island at 62 km^2 (Potter and Potter 1995). When sea levels were lowest, the entire PRB was exposed and the Virgin Islands were connected, with the most recent complete connection having ended approximately 8–17K years ago (Lighty et al. 1982; Fairbanks 1989). Hence, the herpetofaunal compositions are quite similar across the PRB and some species are shared with eastern Puerto Rico (Heatwole and MacKenzie 1967; Rivero 1998; Thomas 1999; Perry and Gerber 2006, 2011).

The herpetofauna diversity of the BVI is comprised of at least 35 species and has been well documented through general herpetofauna surveys, literature searches, local reports, or a combination of these (e.g., Grant 1932; Maclean et al. 1977; Mayer and Lazell 1988; Perry and Gerber 2011; Mayer 2012). Some of those species, however, are likely either extinct or extirpated (e.g., Puerto Rican Crested Toad, *Peltophryne lemur*; Virgin Islands Giant Anole, *Anolis roosevelti*), introduced, or considered cryptogenic (Perry and Gerber 2006, 2011; Perry 2009; Kessler 2010). The status and distribution of some species of herpetofauna, such as *Cyclura* and *Anolis*, are well known (Mayer 2012); however, some cryptic species are poorly documented. Among the latter, very little is known about the status and distribution of the Virgin Islands Boa (*Chilabothrus granti*) in the BVI, where no systematic surveys of the species

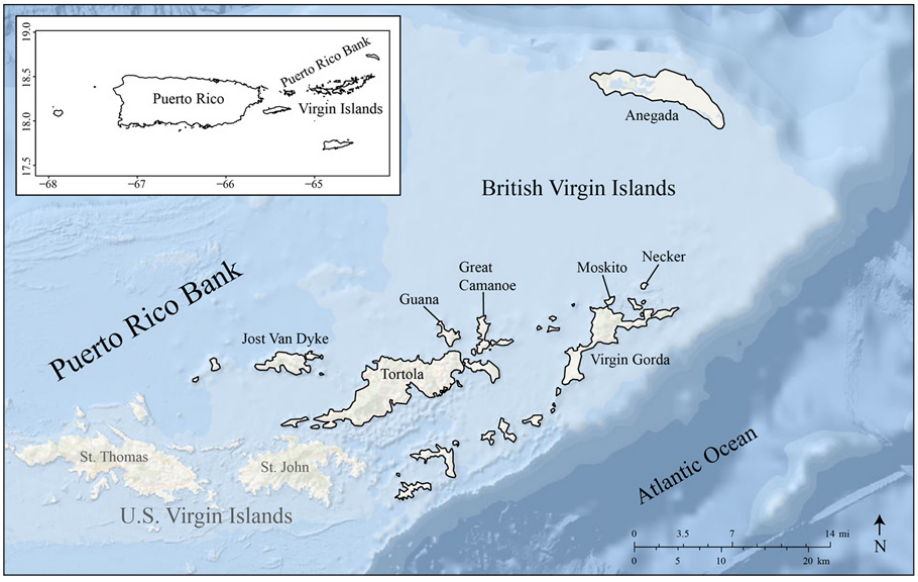

Figure 1. Map of the eastern end of the Puerto Rican Bank, showing the extent of the British Virgin Islands outlined in black. The greater Puerto Rico region is shown in the inset box. The U.S. Virgin Islands are shown to the lower left. Islands mentioned in the text are labeled.

have been published. This is likely because of the relative crypsis of this nocturnal species, as well as its general rarity across its range (Reynolds et al. 2023). The species is listed as Endangered on the U.S. Endangered Species List (under the previous taxon *Epicrates monensis*) and was assessed as Endangered on the International Union for the Conservation of Nature (IUCN) Red List (U.S. Fish and Wildlife Service [USFWS] 1980; Platenberg 2021). Owing to their status and recently documented population declines, recovery efforts were reinvigorated by the North Carolina Zoo and government partners in 2017 (Reynolds et al. 2023).

The type specimen for *C. granti* was collected from Tortola by Chapman Grant in 1932 (Museum of Comparative Zoology R-33947) and later described by Olive Stull as *Epicrates inornatus granti*, who considered it to be a subspecies of the Puerto Rican Boa (*Epicrates inornatus*; Stull 1933). In 2015 the species was elevated to *Chilabothrus granti* based on molecular genetic data, albeit with minimal sampling from the BVI (Reynolds et al. 2015; Rodríguez-Robles et al. 2015). To date, no systematic surveys of Tortola (or other islands in the BVI) have been published, despite this being the type locality for the species.

This small species of boa attains an average adult length of 60–80 cm snout-vent length (SVL), although adults can reach over 1 m SVL (Reynolds et al. 2023). Virgin Islands Boas are a nocturnal species, which feed primarily on *Anolis* lizards (USFWS 1986), but have also been documented to consume other lizards, birds (Tolson and Henderson 1993), and rats (Sheplan and Schwartz 1974). Like many other *Chilabothrus*, this species normally reproduces every other year with females giving birth to 2–10 offspring, but they have reproduced annually under human care. Although *C. granti* occurs on numerous islands across the PRB, it is found primarily in subtropical dry forests and coastal forests with appropriate connectivity between the understory and connected canopy (Nellis et al. 1983; Platenberg and Harvey 2010).

Chilabothrus granti currently has a highly disjunct distribution. Populations are scattered across the Puerto Rico Bank, including eastern Puerto Rico, the U.S. Virgin Islands (USVI), and the BVI (Fig. 1; Reynolds et al. 2023). The species was thought to be absent from Puerto Rico until the 1980s when it was discovered on Cayo Diablo, a small cay off the east coast of Puerto Rico (Tolson and Piñero 1985). Another population was discovered in the early 1990s in the municipality of Río Grande in northeast Puerto Rico (Tolson 1991; García 1992). Both populations are considered extremely small and of limited distribution (USFWS 2009). Natural populations of *C. granti* are also present on Culebra Island (PR) and the island of St. Thomas (USVI), and the most

recent population estimates have ranged between 500–1,500 individuals (see review in Reynolds et al. 2023). Initial recovery efforts began in the 1990s with translocations for the species, which created two new populations. One population was introduced on Cayo Ratones, a small cay off the east coast of Puerto Rico very close to Cayo Diablo, and another on an unnamed (for security reasons) USVI Cay off the east coast of St. Thomas (USFWS 2009). The Cayo Ratones population is currently considered extirpated following several surveys that have failed to detect the species, probably owing to several major hurricanes and the re-colonization of rats (USFWS 2022). The USVI Cay population, which had an estimated population of 200 individuals, has experienced a population decline, with estimates in 2018 and 2019 of 80–100 individuals (Smith, in press). The Virgin Islands Department of Planning and Natural Resources (DPNR) is conducting standardized, ongoing surveys of the USVI Cay population (Smith, in press).

While there have been several studies in the USVI and numerous surveys conducted elsewhere in the range (e.g., Tolson 1996; Platenberg and Harvey 2010), occupancy and distribution are poorly known for *C. granti* in the BVI (Reynolds et al. 2023). Verified reports exist from the type locality of Tortola (Grant 1932) and Great Camanoe Island (Barker et al. 2009), but reports from Virgin Gorda, Jost Van Dyke, and Guana Island remain unverified (see Materials and Methods for description of verified and unverified reports). Grant (1932) described the boa as being found on Virgin Gorda, but without further details and with no specimens. Despite a lack of data from targeted or standardized surveys, most publications describe the boa with the term Common Snakes due to anecdotal reports by residents (Lazell 2005). Such perceived commonness by locals, however, might be inflated by misidentification of two of the common diurnal snake species encountered in BVI, the Puerto Rican Racer (*Borikenophis portoricensis*) or the Puerto Rican Garden Snake (*Magliophis exiguus*).

Recently, some priority conservation action items have been initiated, which include targeted surveys within poorly known populations and collecting genetic samples from underrepresented areas (USFWS 2009; Virgin Islands Boa Workshop participants, unpubl. info.). Here we describe the first targeted surveys for *C. granti* in the BVI, focusing on the three largest islands of Tortola, Virgin Gorda, and Jost Van Dyke (Fig. 1). We report updated distribution and abundance data, novel size records, and morphometric data. We further describe the need for additional surveys to fill in the remaining gaps in the known range of this species, particularly on smaller islands.

Materials and Methods

We searched for locality information for *C. granti* from the few existing museum records, publications, and gray literature reports, and then crowd-sourced anecdotal records through social media and local partners. We used satellite imagery to identify intact forests closely resembling known habitats across the range, with support and information from the Ministry of Natural Resources and Labour of the British Virgin Islands. We first visited potential *C. granti* localities diurnally and assessed them based on habitat suitability and accessibility, prioritizing Virgin Island National Park properties and some private lands when the landowner granted access.

We conducted nocturnal surveys targeting *C. granti* on Tortola (30 January to 2 February 2023; 3 March 2024), Virgin Gorda (4–5 March 2024), and Jost Van Dyke (6–7 March 2024). Survey sites comprised public lands, national parks, and private property. We performed multiple surveys along seven survey routes on Tortola (n = 12), six routes on Virgin Gorda (n = 8), and four routes on Jost Van Dyke (n = 7; Table 1). Specific coordinates of each site are not included owing to concerns regarding poaching; instead, a survey route ID number is provided (Table 1). Start and end times varied but surveys started no earlier than 1850 and ended no later than 2315. When possible, we used Time-constrained Surveys (about 1 h) but also used rapid assessments of specific sites depending on the habitat quality, accessibility, if there were reports from residents, or if we were searching during a release of previously captured boas. We recorded GPS coordinates at the beginning and end points to track the distance of each survey. We performed these surveys while walking or driving slowly using headlamps and flashlights to look for boas. For surveys on foot, we also counted the number of prey items (*Anolis* sp.) and the number of invasive rodents, for example, Black Rats (*Rattus rattus*). We recorded temperature and humidity each survey evening using a handheld weather meter (Kestrel Meter 3000, Nielsen-Kellerman, Boothwyn, Pennsylvania, USA), along with weather conditions, cloud cover, and precipitation for the prior 12 h. Many of these data are collected routinely as part of a standardized effort across the range of the species for

future analysis.

Upon encountering *C. granti*, we gently hand-captured individuals and placed them in a snake bag marked with an identification number. We recorded time, GPS coordinates, height of snake capture if not on the ground, and behavior on a datasheet upon capture. The following morning, we measured both SVL and total length (TL) of boas, and we weighed them. We determined sex by cloacal probing and the presence (males) or absence of spurs (females). We collected tail clips (2–3 mm) from each individual as part of routine data collection for the species for future DNA analysis and preserved them in 95% ethanol. We sanitized the excision site and all associated collection equipment before collection and sealed the excision site with skin glue. We implanted an 8-mm Passive Integrated Transponder (PIT tag; Biomark, Inc. Boise, Idaho, USA) in boas of appropriate weight (typically > 50 g) subcutaneously along the lateral midline at a depth of about 1.5 cm. The implant site was within the posterior third of the body, anterior to the vent. We then released all boas at the site of capture within 24 h. We used Welch's Two Sample *t*-tests to compare SVL and weight between sexes. Statistical methods were done using R 4.5.1

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Results

We performed 27 surveys on three islands that yielded 28 observed boas, with data collected on 27 boas (Table 1). One individual was too high up in the canopy for us to capture it. Of the 27 surveys, 23 were conducted by four surveyors, two were conducted by five surveyors, and seven surveyors conducted two. The mean survey time (n = 27) was 46 min for a total of 21.2 h. Accounting for the number of surveyors resulted in 90.5 effort-hours. Most of the surveys were conducted on Tortola (n = 12; 9.9 h of surveys; 49.2 effort-hours), followed by Virgin Gorda (n = 8; 5.9 h of surveys; 23.7 effort-hours) and Jost Van Dyke (n = 7; 4.4 h of surveys; 17.7 effort-hours).

Surveys on Tortola yielded 24 boa encounters over five nights with a boa capture rate of 0.49 boas/effort hour. We found four boas on Jost Van Dyke over two nights of sampling, with a boa capture rate of 0.23 boas/effort-hour. We found no boas on Virgin Gorda after 23.7 h of effort. The rate of encounter, including effort on all three islands, was 0.31 boas/effort-hour.

We observed three additional boas on Tortola outside of the focal surveys. One live individual was reported through our social media crowdsourcing, as it was found by a homeowner in a flowerpot during

Table 1. Description of Virgin Islands Boa (*Chilabothrus granti*) surveys conducted on three islands in the British Virgin Islands.

Location	Dates of surveys	Survey route name	Number of surveys	Boas observed	Total survey time (min)	Total survey effort (min)	Method of survey
Tortola	30, 31 January 2023; 3 March 2024	TT1	4	7	204	816	Walking (2); Vehicle (2)
Tortola	30, 31 January 2023	TT2	2	5	123	492	Walking
Tortola	31 January 2023	TT3	1	4	60	240	Walking
Tortola	1 February 2023	TT4	2	3	120	600	Walking
Tortola	2 February 2023	TT5	1	0	37	259	Walking
Tortola	2 February 2023	TT6	1	0	35	245	Walking
Tortola	3 March 2024	TT7	1	2	15	60	Vehicle
Virgin Gorda	4, 5 March 2024	VGT1	2	0	60	240	Walking
Virgin Gorda	4, 5 March 2024	VGT2	2	0	130	520	Combination
Virgin Gorda	4 March 2024	VGT3	1	0	60	240	Vehicle
Virgin Gorda	4 March 2024	VGT4	1	0	30	120	Vehicle
Virgin Gorda	5 March 2024	VGT5	1	0	47	188	Vehicle
Virgin Gorda	5 March 2024	VGT6	1	0	28	112	Walking
Jost Van Dyke	6, 7 March 2024	JVDT1	4	4	182	728	Walking
Jost Van Dyke	6 March 2024	JVDT2	1	0	25	100	Vehicle
Jost Van Dyke	7 March 2024	JVDT3	1	0	38	152	Walking
Jost Van Dyke	6 March 2024	JVDT4	1	0	20	80	Combination

the day. Another individual was found dead on the road (DOR) and was also reported to us through our social media crowdsourcing. A third individual was found DOR during the day while driving to evaluate sites. We investigated each of these and collected data on the live boa and one DOR boa.

We collected morphometric data on 29 boas, including boas captured during surveys (n = 27) and boas encountered outside of surveys (n = 2). We did not collect morphometric data for one DOR boa in poor condition or the boa that escaped. We found an almost even sex ratio between males (n = 14) and females (n = 16). Mean SVL of boas was 57.2 ± (standard deviation) 16 cm (range of values, 32.9–109 cm; Fig. 2), with a mean TL of 69 ± 18 cm (40.9–122.5 cm) and a mean weight of 61.6 ± 75.6 g (10.5–335 g; Table 2). Mean male boa SVL was 53.1 ± 12 cm (32.9–74.3 cm) and mean TL was 64.3 ± 12.8

Table 2. Complete morphometrics for all Virgin Islands Boas (*Chilabothrus granti*) encountered in the British Virgin Islands, 2023–2024. For BVI B24, the individual was found dead on a roadway. For BVI B16, the individual was found outside of formal survey effort. For sex, F = Female and M = male; SVL = snout-vent length and TL = total length

Boa ID	Capture Date	Sex	SVL (cm)	TL (cm)	Weight (g)	Location
BVI B1	30 January 2023	F	50.8	60.0	34.0	Tortola
BVI B2	30 January 2023	F	60.2	71.6	54.0	Tortola
BVI B3	30 January 2023	F	87.2	104.6	335.0	Tortola
BVI B6	30 January 2023	F	45.7	56.0	26.0	Tortola
BVI B7	30 January 2023	F	60.5	73.3	55.0	Tortola
BVI B8	30 January 2023	F	34.0	41.5	15.0	Tortola
BVI B10	31 January 2023	F	72.4	88.3	104.0	Tortola
BVI B11	30 January 2023	F	59.4	75.3	64.0	Tortola
BVI B12	31 January 2023	F	56.0	68.3	43.0	Tortola
BVI B20	1 February 2023	F	109.0	122.5	312.0	Tortola
BVI B24	2 February 2023	F*	50.0	54.0	32.0	Tortola
3-3 B1	3 March 2024	F	56.2	68.3	45.0	Tortola
3-3 B2	3 March 2024	F	68.3	85.0	59.0	Tortola
3-3 B3	3 March 2024	F	55.0	68.6	36.0	Tortola
3-6 B1	6 March 2024	F	66.2	82.3	64.0	Jost Van Dyke
3-6 B2	6 March 2024	F	37.6	44.8	12.0	Jost Van Dyke
BVI B4	30 January 2023	M	52.5	65.3	39.0	Tortola
BVI B5	30 January 2023	M	42.5	57.1	14.0	Tortola
BVI B9	30 January 2023	M	48.5	59.2	32.0	Tortola
BVI B14	31 January 2023	M	32.9	40.9	10.5	Tortola
BVI B15	31 January 2023	M	55.5	68.0	46.0	Tortola
BVI B16	1 February 2023	M	74.3	90.5	53.0	Tortola
BVI B17	1 February 2023	M	66.5	70.1	47.0	Tortola
BVI B18	1 February 2023	M	67.4	75.1	66.0	Tortola
BVI B19	1 February 2023	M	56.8	70.0	53.0	Tortola
BVI B21	1 February 2023	M	54.9	67.6	57.0	Tortola
BVI B22	1 February 2023	M	57.0	70.6	53.0	Tortola
3-6 B3	6 March 2024	M	42.8	53.1	11.5	Jost Van Dyke
3-7 B1	7 March 2024	M	38.3	47.8	15.0	Jost Van Dyke

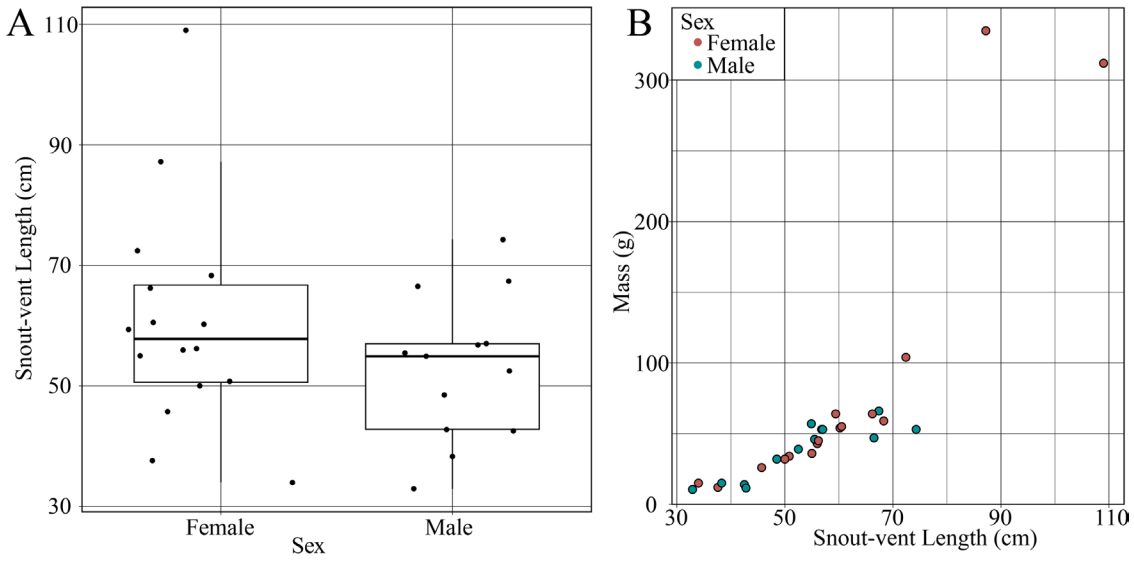

Figure 2. Median body sizes of male and female Virgin Islands Boas (*Chilabothrus granti*) captured in the British Virgin Islands between 2023–2024. (A) Box-and-whisker plots of snout-vent lengths for males and females. The black line inside each box represents the median length, the top of each box is the 75th percentile, and the bottom of each box is the 25th percentile, while the whiskers of each box represent distances of 1.5 times the interquartile range (distance between the 25th and 75th percentiles). (B) Plot of the relationship of body mass to snout-vent length for males (green) and females (red). Note that longer females (> 75 cm) are also very heavy (> 300 g).

cm (40.9–90.5 cm). Mean female boa SVL was 60.5 ± 18.3 cm (34–109 cm) and mean TL was 72.8 ± 21 cm (41.5–122.5 cm; Table 2). Mean male boa weight was 38.2 ± 19.5 g (10.5–66 g) and mean female boa weight was 80.6 ± 97.4 g (12–335 g). Sexes did not significantly differ in SVL (t = -1.32, df = 26.01, P = 0.190) or weight (t = -1.70, df = 16.47, P = 0.110).

Discussion

Our study represents the first formal *C. granti* surveys within the British Virgin Islands and the first published documentation and photographs (Fig. 3) of the species on Jost Van Dyke, BVI. Although there have been scattered reports of *C. granti* in BVI since the initial description by Grant (1932), many were derived from general herpetofauna surveys, happenstance findings, or sightings by locals rather than focal surveys. Besides previously confirmed reports on Tortola, there is only one other island with a confirmed report, Great Camanoe Island (the current easternmost confirmed record), and it only has a single confirmed record. This is not unusual throughout the range of *C. granti*, however, as there are > 75 islands and cays throughout the Puerto Rican Bank but only seven islands have confirmed extant and naturally occurring populations: Puerto Rico (Tolson 1991), Cayo Diablo (Peter Tolson and Piñero, unpubl. report), Culebra (Tolson 1991), St. Thomas (Sheplan and Schwartz 1974), Tortola (Grant 1932), Great Camanoe (Mayer and Lazell 1988), and Jost Van Dyke (this study).

Although we cannot yet determine population estimates for Tortola or Jost Van Dyke to compare with existing populations, we can compare capture rates across the range. We obtained a capture rate of 0.49 boas/effort-hour on Tortola, which is higher than published rates for the population in Río Grande, Puerto Rico (0.05–0.27 boas/effort-hour; Garcia 1992; Alberto R. Puente-Rolón, unpubl. report), and Culebra (0.01– 0.72; Garcia 1992; Alberto R. Puente-Rolón, unpubl. report). While we have a good understanding of the natural behavior of this species, much of this is based upon decades of research from just a few small islands in PR and USVI comprising either natural or translocated populations. Although populations of *C. granti* occurring in BVI are associated with sparse development and fragmented habitat, these populations afford more opportunities for research on a larger natural population within a larger and more ecologically variable habitat than in offshore cays.

We also describe the longest and heaviest recorded wild female *C. granti*. The previously published longest female had a total length of 120.3 cm, and the heaviest female was 301 g (Peter Tolson, unpubl.

Figure 3. (A) Sub-adult Virgin Islands Boa (*Chilabothrus granti*) consuming a Puerto Rican Crested Anole (*Anolis cristatellus*) on Jost Van Dyke, British Virgin Islands. (B) Large female *Chilabothrus granti* from Tortola, British Virgin Islands. (Photographed by Dustin Smith).

report). We documented a female from Tortola with a total length of 122.5 cm and a mass of 312 g. Further, this female was missing at least a few centimeters of her tail tip, likely due to a previous injury. We also found a female with a mass of 335 g on Tortola (104.6 cm total length, Fig. 3), a record size for female body mass. During our surveys we received anecdotal reports of large boas (> 2 m in total length). Such a body size is highly unlikely for this species, but we note that we recorded more, and larger, boas during our surveys in Tortola than any other natural population of *C. granti*. The previous record-length female and current record-length male (134.9 cm) were both captured on the USVI cay, where boas were introduced for conservation purposes. It is unknown whether these two individuals were translocated (from St. Thomas) or if they were born on the island (we presume the former). Although boas in that population had a higher body mass index than other islands and longer and heavier *C. granti* than previously recorded, recent studies on the USVI cay have shown that boas are no longer achieving anywhere near these lengths or weights (Reynolds et al. 2023). We postulate that the larger animals we observed on Tortola are due to a combination of larger intact tracts of less-disturbed forests, sufficient and/or more varied prey resources, and larger population sizes.

We conducted these surveys as part of a 5-Year Review (USFWS 2009) and Virgin Islands boa action plan workshops, which began in 2019 and were developed by stakeholders committed to the recovery of the species. While several goals were established, a clear and immediate need for further surveys of understudied areas was identified, particularly for BVI. Although we obtained promising results from our surveys on Tortola, they were limited to the western half of that island (west of Kingston). Thus, further surveys should be conducted east of Kingston and on Beef Island, which is adjacent to Tortola. Our surveys of Jost Van Dyke took place across the island, but only for two nights, and were limited to a few targeted areas across the island. *Chilabothrus granti* were only found on the eastern end of the island, so additional surveys should be conducted throughout the island. Importantly, future *C. granti* survey efforts should focus on Virgin Gorda and Little Jost Van Dyke, as well as Guana, Great Thatch, Moskito, and Necker islands. One verified record exists for Great Camanoe Island, but at least two additional observations from that island are plausible (Lazell 1983; Mayer and Lazell 1988; Barker et al. 2009).

Due to the lack of knowledge and awareness of this species in BVI, creating an education program to raise awareness of the species and its populations across the range would also be beneficial. Such a program could lead to further interest in local communities, primarily targeted at school children and students in higher education. Additional studies evaluating boa temporal and spatial habitat use, relationships between invasive predators and boas, and how abiotic factors affect boa behavior are just a few of the options for local students to fill gaps in the biology and natural history of the species, and to assist with conservation measures across the range.

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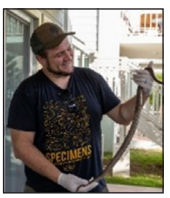

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