REPTILES & AMPHIBIANS

A Community-driven Checklist: Snakes of Paraíso Canton, Cartago, Costa Rica

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Abstract.—Declining amphibian and reptile populations in Costa Rica, particularly at mid-elevations, underscore the urgent need for updated herpetofaunal inventories in vulnerable, anthropogenically disturbed areas like the Central Valley. This study documents the snake assemblage of the Paraíso Canton, Cartago Province, Costa Rica, utilizing primarily citizen-science data to assess diversity, distribution patterns, and the effectiveness of this data-collection method. Data were collected from June 2022 to February 2025 via Facebook groups, iNaturalist, personal communications, and visual surveys by the author. All that were used had precise locality data and photographic identification. Alpha- and beta-diversity were estimated using Simpson and Wilson-Shmida indices, respectively, and species richness was assessed with rarefaction curves and Chao1 estimates. The canton exhibits high snake diversity, probably reflecting its heterogeneous topography. A total of 51 species of snakes were recorded from 526 observations, most from citizen scientists. Species accumulation curves suggest that the inventory is relatively complete, although rare species continue to be detected. Alpha diversity indicated low species dominance and even distribution. This study substantially enhances our understanding of snake diversity in Paraíso, increasing recorded species from eight to 51.

Considering its relatively small size, Costa Rica has one of the greatest diversities of amphibians and reptiles in the Neotropics (Savage 2002). However, the alarming rate in the decline of amphibians in recent decades (e.g., Luedtke et al. 2023) has necessitated the acquisition of updated information in affected areas (Stuart et al. 2004; Arias and Bolaños 2014; Acosta Chaves et al. 2015). Some Costa Rican localities have seen declines as great as 40% in amphibian diversity (e.g., Lips 1998; Pounds et al. 2003; Whitfield et al. 2007; Abarca 2012a), phenomena that also have been observed in reptiles on local and global scales (e.g., Mullin and Seigel 2009; Barquero González et al. 2020).

Reptile population declines are believed to be caused by a combination of factors similar to those proposed for amphibian declines: habitat destruction, introduced invasive species, environmental pollution, disease, unsustainable use, global climate change, and reductions in amphibian prey availability (Gibbons et al. 2000; Whiles et al. 2006; Whitfield et al. 2007). Also, although habitat deterioration, reduction of prey availability, introduction of invasive species, and direct human pressure (i.e., killing snakes) have been proposed as potential drivers (Reading et al. 2010; Cox et al. 2022), more effort to understand and address these factors is crucial for snake conservation (Reading et al. 2010).

In Costa Rica, herpetofaunal declines have been observed largely at elevations above 400 m asl (Lips et al. 2003; Pounds et al. 2006) and some mid-elevation areas, such as lower tropical montane forest (Bolaños and Ehmcke 1996; Whitfield et al. 2007; Abarca 2012b), in particular, the Central Valley of Costa Rica, with the greatest human population density in the country (INEC 2012). This region is located in the aforementioned elevational range and the herpetofauna of the area is especially vulnerable to anthropogenic disturbances.

Some areas of the Central Valley, especially around critical geobiological barriers such as the Talamanca Mountain Range are especially in need of biological inventories to promote management, education, and conservation efforts (Arias and Bolaños 2014). Only a few checklists (e.g., for the Río Macho Biological Reserve; Acosta Chaves et al. 2015) have been published for localities in and around the Central Valley.

Using citizen science as a tool to characterize the snakes of the Central Valley and the northern section of the Talamanca Mountain Range can illustrate how a relatively small geographical area can host a diverse snake assemblage. We herein provide a checklist of the snakes of Paraiso Canton, Cartago Province, Costa Rica.

Materials and Methods

Study site.—Paraíso Canton in Cartago Province (9.73083, 83.76278), created on 28 July 2021 with an area of 411.91 km^2, is divided into six districts: Paraíso, Santiago, Orosi, Cachi, Llanos de Santa Lucía, and Birrisito (Fig. 1; INDER 2016). Elevations range from 700 m asl in the lower areas of the Santiago and Orosi Districts to 3,491 m asl in the south-

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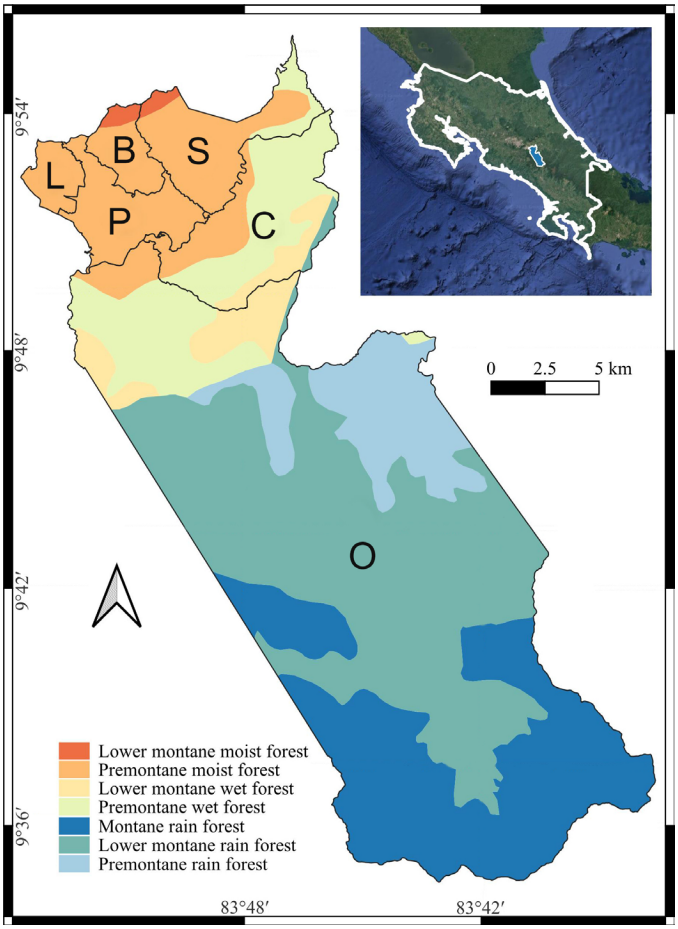


Figure 1. Map of Paraíso Canton, Cartago, Costa Rica, showing district borders and Holdrige life zones. O = Orosi, S = Santiago, C = Cachí, P = Paraíso, L = Llanos de Santa Lucía, B = Birrisito.

ern portion of Orosi District (INDER 2016; SINAC 2020). Average annual precipitation varies between 1,400 mm and 8,500 mm, and includes areas in Orosi District with some of the greatest rainfall in the nation (INDER 2016; SINAC 2020). Paraíso encompasses seven Holdridge Life Zones (Holdrige 1967): premontane moist forest, lower montane moist forest, premontane wet forest, lower montane wet forest, premontane rainforest, lower montane rainforest, and montane rainforest (INDER 2016) (Fig. 1).

Paraíso is located within the Central Conservation Area (ACC), with the Tapantí-Macizo de la Muerte National Park covering more than half of the canton with mature forest and other important conservation areas like the Río Macho Forest Reserve, the Interurban Riparian Biological Corridor Sub-basin Reventado Aguacaliente (COBRI SURAC), the Volcanica Central Talamanca Biological Corridor, and several private reserves scattered in and around Paraíso (INDER 2016; SINAC 2020). The canton also has small urban communities, rural areas dominated by agriculture, small towns, and discontinuous patches of forest.

Data acquisition.—From 31 November 2024 to 27 February 2025, I searched for data generated by citizens via Facebook groups, iNaturalist, and personal communications supplemented by my personal observations. Each of these four sources are detailed below. To ensure the data are both comprehensive and reliable, I included only records with precise locality data at the district level and photographs that allowed for species-level identification. For all sources, the database included the group where the record was posted (Facebook only), the district where it was found, a link to the observation (Facebook and iNaturalist), upload date, the snake's status (road-killed, killed by other means, or alive), identification of the species, and the photograph(s) provided by the citizen scientist or author. All posts available during the search period that met these requirements were included regardless of the publication date. If one individual snake was addressed multiple times, only the least recent post was included. Species were identified using dichotomous keys in Savage (2002) and the field guides by Leenders (2019) and Solórzano (2022).

Facebook.—I conducted manual searches on posts by selected local snake identification groups, using keywords on the app's integrated search tool. The groups were selected based on number of members, including only those most frequently used, with the exception of the group "Serpientes de Paraíso" (https://www.facebook.com/share/g/1EV2yddJF7/; ~550 members), which was created specifically for the community to post records from the canton. Three other local snake identification groups were used: "Snakes of Costa Rica 'Serpientes'" (https://www.facebook.com/share/g/15ctjn6MTz/; ~77,000 members), "Serpientes de Costa Rica" (https://www.facebook.com/share/g/14ZSbnZV3T/; ~38,000 members), "Snake Identification Costa Rica" (https://www.facebook.com/share/g/1GwfELNTpw/; ~28,000 members), and "Costa Rica Snakes, Species, ID's, photos" (https://www.facebook.com/share/g/15MMfnoSTE/; ~8,000 members). Key words were the names of the province, canton, and the districts within its borders and important tourist sites and towns (e.g., "Cartago," "Cartago Paraiso," "Paraiso," "Llanos de Santa Lucia," "Orosi," "Cachi," "Birrisito," and "Santiago") as well as notable places in Paraíso (e.g., "Tapanti," "Ujarras," "El Copal," and "Rio Macho").

iNaturalist.—Using the app's integrated search mode in the "Explore" option, I searched for observations by taxon "Serpentes" and location "Paraíso, CA, CR." Location maps of the canton show only observations from within its borders. Several observations using these filters still did not correspond specifically to Paraíso, since many were assigned to a greater area like "Costa Rica." To include an observation it must have a location with less than a kilometer of inaccuracy or its specific location was provided via personal communication to confirm that the snake was seen inside the canton.

Personal communications with the author.—From December 2023 to February 2025, contacts by local residents via Facebook Messenger and WhatsApp shared snake sightings around Paraíso. These observations were added to the database if they met the same requirements as for iNaturalist. If an observation was shared using other platforms, only the first was included.

Author's personal observations.—In addition to citizen-science observations, I included my personal sightings for richness analysis and for the checklist. Observations were documented as encounters with snakes during non-standardized visual-encounter surveys across Paraiso. The oldest record was from June 2022 and the newest from February 2025. These observations also met the aforementioned requirements.

Data analysis.—I performed all data analysis using R version 4.4.2 (R Core Team 2024) and RStudio version 2025.05.1+513 (Posit Team 2025). Alpha diversity was estimated for each district using the dominance Simpson index (1/D) and beta diversity between districts was estimated following the Wilson-Shmida similarity index (βws) (Wilson and Shmida 1984). Species rarefaction curves and Chao1 estimate were obtained using the R package "vegan" version 2.6-10 (since updated to version 2.7-2; Oksanen et al. 2025) and "iNEXT" version 3.0.1 (since updated to version 3.0.2; Hsieh et al. 2025).

Results

I recorded 51 species in 34 genera and five families (Table 1; Fig. 2). Of the 526 observations used, most came from Facebook (n = 198, ~37.6%) with personal communications (n = 129, 24.5%), my own encounters (n = 119, ~22.6%), and iNaturalist (n = 80, ~15.2%) contributing the rest. Eighteen species were detected exclusively via citizen-science data (Facebook, personal communications, and iNaturalist) and three exclusively via my observations (Table 1). Three of the 51 species were detected after the time established in the methodology; *Sibon dimidiatus*, *S. longifrenis*, *Tantilla slevini*, and *Urotheca myersi* were recorded later by me in the highlands of Orosi District. The last species recorded after the established time was *Atropoides picadoi*, which was seen by a local in Santiago District and reported through Facebook. These species were added to establish the total diversity of the canton, but not considered for statistical analysis, indices, and species-accumulation curves.

Table 1. Species of snakes and numbers of individuals detected in each of the districts of Paraíso Canton, Cartago, Costa Rica. O = Orosi, S = Santiago, C = Cachí, P = Paraíso, L = Llanos de Santa Lucía, B = Birrisito. An asterisk (*) denotes species detected exclusively via citizen science data (see text), two asterisks (**) denote species detected exclusively during visual surveys by the author, and three asterisks (***) denote species found after the study period but before completion of the manuscript (see text).

	District						
Taxon	**O**	**S**	**C**	**P**	**L**	**B**	**Total**
Family Boidae							
Boa imperator	27	8	8	8	1	4	56
Family Colubridae							
Chironius exoletus	28	1	3	2	1	1	36
Dendrophidion paucicarinatum	12		1				13
*Drymarchon melanurus**	1						1
Drymobius margaritiferus	3	1		1	3		8
Lampropeltis micropholis	7		3				10
*Leptophis nebulosus**	1						1
Mastigodryas melanolomus	12	6	3	6	1		28
Oxybelis koehleri	1		3				4
*Phrynonax poecilonotus**	2	1	9				12
*Senticolis triaspis**	2	3		2		1	8
*Spilotes pullatus**	1	2	1				4
*Tantilla reticulata**	1						1
*Tantilla ruficeps**	1			1			2
*Tantilla schistosa***	1						1
*Tantilla supracincta***		1					1

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	District						
Taxon	**O**	**S**	**C**	**P**	**L**	**B**	**Total**
Family Dipsadidae							
*Clelia scytalina**	2		1				3
Coniophanes fissidens	1	1					2
Enuliophis sclateri			1	1			2
Erythrolamprus bizona	5	1	2	1	1	1	11
*Erythrolamprus epinephelus**	10						10
Geophis brachycephalus	13						13
Geophis hoffmanni	16	7	1		1		25
Hydromorphus concolor		2	2				4
Imantodes cenchoa	20	1					21
Imantodes gemmistratus	9	4		1	1		15
Imantodes inornatus	3						3
Leptodeira sp. aff. *ornata*	7	5					12
Ninia maculata	29	6	2	18	4		59
*Ninia psephota**	2						2
*Pliocercus euryzonus**			2				2
*Rhadinaea calligaster**	1						1
*Rhadinella godmani***	1						1
Rhadinella serperaster	3						3
*Sibon annulatus**	2						2
*Sibon dimidiatus****							
*Sibon longifrenis****							
*Sibon nebulatus**	2	3					5
Trimetopon pliolepis	7				1		8
*Trimetopon slevini****							
*Urotheca myersi****							
Xenodon angustirostris	2	3	2				7
Family Elapidae							
*Micrurus mosquitensis**			2				2
*Micrurus multifasciatus**	1						1
Micrurus nigrocinctus	13	6	6	5	2	1	33
Family Viperidae							
*Atropoides picadoi****							
Bothriechis lateralis	43		2				45
Bothriechis nigroadspersus	5	5	6				16
*Bothriechis nubestris**	1						1
Bothrops asper	9	12	5	3			29
*Porthidium nasutum**	2						2
Total	309	79	65	49	16	8	526

The six districts yielded different yet statistically similar results (p = 0.4), with the most abundant assemblage in Orosi (n = 309, ~58.7%) and the least abundant in Birrisito (n = 8, ~1.5%) (Table 1). Most of the snakes were reported alive (~85%), with dead snakes (killed or road-killed) accounting for ~12% of observations. The three most frequently killed species were *Bothrops asper* (n = 10, all killed by humans not in vehicles), *Ninia maculata* (n = 7), and *Boa imperator* (n =



Figure 2. Species of snakes found in Paraíso Canton, Cartago, Costa Rica, during this study (photographs by the author except for those listed in parenthesis after each species name): *Boa imperator* (1, Andrey Solís), *Chironius exoletus* (2), *Dendrophidion paucicarinatum* (3), *Drymarchon melanurus* (4, Milton Salazar), *Drymobius margaritiferus* (5, Anthony Abarca), *Lampropeltis micropholis* (6, Gustavo Murillo), *Leptophis nebulosus* (7), *Mastigodryas melanolomus* (8, Reyner Villalta), *Oxybelus koehleri* (9), *Phrynonax poecilonotus* (10), *Senticolis triaspis* (11), and *Spilotes pullatus* (12, Andrey Solís).

6); the cause of death for the other observations were impossible to identify.

In this good but incomplete representation of the ophidiofauna of the canton, Chao1 generated an expected total of 51 species (compared to the 46 recorded in the study) and the curve had not reached the asymptote but is close to the expected value (Fig. 3).

Alpha diversity is shown in Table 2. Beta diversity with the Wilson-Shmida similarity index showed that some dis-



Figure 2 (continued). Species of snakes found in Paraíso Canton, Cartago, Costa Rica, during this study (photographs by the author except for those listed in parenthesis after each species name): *Tantilla reticulata* (13, Jonathan Vega-Coto), *Tantilla ruficeps* (14), *Tantilla schistosa* (15, Reyner Villalta), *Tantilla supracincta* (16, Diego Aviles), *Clelia scytalina* (17, Reyner Villalta), *Coniophanes fissidens* (18), *Enuliophis sclateri* (19), *Erythrolamprus bizona* (20), *Erythrolamprus epinephelus* (21), *Geophis brachycephalus* (22), *Geophis hoffmanni* (23), *Hydromorphus concolor* (24).

tricts are equal in terms of species turnover (Cachí and Santiago Districts, βws = 0) whereas others have relatively high differences (e.g., Birrisito and Orosi, βws = 0.783) (Table 3). *Boa imperator*, *Chironius exoletus*, *Erythrolamprus bizona*, and *Micrurus nigrocinctus* were recorded in all districts (Table 1).

I recorded three instances of range expansion, one from a relatively common species and two from rarely seen snakes,



Figure 2 (continued). Species of snakes found in Paraíso Canton, Cartago, Costa Rica, during this study (photographs by the author except for those listed in parenthesis after each species name): *Imantodes cenchoa* (25), *Imantodes gemmistratus* (26), *Imantodes inornatus* (27), *Leptodeira* sp. aff. *ornata* (28, Reyner Villalta), *Ninia maculata* (29), *Ninia psephota* (30, Abraham Otoya), *Pliocercus euryzonus* (31), *Rhadinaea calligaster* (32), *Rhadinella godmani* (33, Reyner Villalta), *Rhadinella serperaster* (34, Reyner Villalta), *Sibon annulatus* (35), *Sibon dimidiatus* (36, Reyner Villalta).

all confirmed by herpetofauna expert Juan Abarca-Alvarado. A *Sibon longifrenis* was seen moving on some branches along a rural road near Tapantí-Macizo de la Muerte National Park, Orosi Sector, Cartago, Costa Rica (9.7771, -83.7757; elev. 1,283 m asl, RAJ 00030). These snakes are commonly encountered at lower elevations near this site, but the previous elevational limit was 800 m asl (Savage 2002; Leenders 2019). This record substantially extends the vertical range of the spe-



Figure 2 (continued). Species of snakes found in Paraíso Canton, Cartago, Costa Rica, during this study (photographs by the author except for those listed in parenthesis after each species name): *Sibon longifrenis* (37, Reyner Villalta – RAJ 00030), *Sibon nebulatus* (38), *Trimetopon pliolepis* (39), *Trimetopon slevini* (40 – RAJ 00031), *Urotheca myersi* (41 – RAJ 00032), *Xenodon angustirostris* (42), *Micrurus mosquitensis* (43, Reyner Villalta), *Micrurus multifasciatus* (44), *Micrurus nigrocinctus* (45), *Atropides picadoi* (46, Jean F. Montero), *Bothriechis lateralis* (47), *Bothriechis nigroadspersus* (48).



Figure 2 (continued). Species of snakes found in Paraíso Canton, Cartago, Costa Rica, during this study (photographs by the author except for those listed in parenthesis after each species name): *Bothriechis nubestris* (49, Andrey Solís), *Bothrops asper* (50), *Porthidium nasutum* (51).

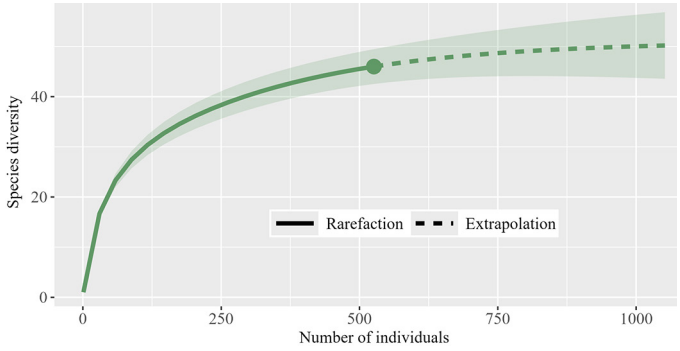


Figure 3. Species accumulation curve based on the Chao1 extrapolating method using numbers of individuals observed.

Table 2. Alpha diversity of the snake assemblage of Paraíso Canton, Cartago, Costa Rica. Species richness includes observations of *Sibon dimidiatus*, *S. longifrenis*, *Trimetopon slevini*, *Urotheca myersi*, and *Atropoides picadoi* recorded after conclusion of this study but before completion of this manuscript.

Metric	Value
Species Richness (S)	51
Simpson's Index (D)	0.056
Simpson's Diversity (1-D)	0.944
Pielou's Evenness (J')	0.837

cies. *Trimetopon slevini* was known from the Atlantic slope of the Central Mountain Range, and the Pacific slopes of the Tilarán and Talamanca mountain ranges (Leenders 2019). One individual was detected at 1730 h on 3 August 2025, resting under a rock next to a road near Río Macho Forest Reserve, Orosi, Cartago, Costa Rica (9.7854, -83.8653; elev. 1,501 m asl, RAJ 00031), representing the first record of the species for the Atlantic slope of Talamanca. *Urotheca myersi* is another secretive fossorial snake known only from a handful of records on the southern Pacific slope of the Talamanca Montain Range (Barrio-Amorós 2020). A road-killed individual was found on the main road of Tapantí-Macizo de la Muerte National Park, Orosi Sector, Cartago, Costa Rica (9.7533, -83.7831; elev. 1,289 m asl, RAJ 00032), representing the first known locality of the species from the Atlantic slope of Talamanca.

Table 3. Wilson & Shmida beta diversity results for the six districts of Paraíso Canton, Cartago, Costa Rica. O = Orosi, S = Santiago, C = Cachí, P = Paraíso, L = Llanos de Santa Lucía, B = Birrisito.

Site	B	C	L	O	P	S
B	0.000	0.492	0.267	0.783	0.412	0.615
C	—	0.000	0.248	0.261	0.182	0.000
L	—	—	0.000	0.608	0.073	0.319
O	—	—	—	0.000	0.502	0.292
P	—	—	—	—	0.000	0.227
S	—	—	—	—	—	0.000

Discussion

Citizen science was effective, generating a considerable number of records (18 species were observed exclusively via citizen-science data, illustrating the utility of using sources based on observations by citizens. In addition to the usefulness of citizen science as a data-collection tool, Bonney et al. (2016) proposed that the inclusion of methods used in scientific investigations could provide a greater degree of understanding science to citizens and generate more support for scientific research.

Using citizen science and visual surveys were not applied equally in all districts and localities in the canton, and this affected the spatial distribution of data, creating a bias that might explain why Orosi accounts for more than half of the total records, whereas other districts like Birritisto have few observations. In the case of Orosi, tourists, both locals and foreign, might generate more observations, but the ease of

sampling that area compared to the other districts might also be a factor. Orosi also has the greatest forest coverage in Paraíso, mainly because of the influence of protected areas such as Tapantí-Macizo de la Muerte National Park, Río Macho Forest Reserve (INDER 2016), private reserves, fincas, and lodges. Less frequently visited districts such as Birrisito and Llanos de Santa Lucía have less forest coverage, more urbanization (INDER 2016) and also are more difficult to survey because of social instability.

Most records of snakes were of live animals, but a substantial percentage (~12%) were either directly or road-killed, indicating that environmental education efforts are still needed to reduce human persecution of snakes. Also, Yue et al. (2019) used citizen-collected data to evaluate and mitigate road-mortality. Students from the University of Costa Rica (UCR, TCU-777) and I have conducted some awareness-raising efforts by giving educational talks at public academic centers around the canton. We also created a digital, cost-free illustrated guide to the snakes of Paraíso using the results of this study to aid the community in snake identification and biology (https://www.researchgate.net/publication/379819994_Guia_Ilustrada_Serpientes_del_Canton_de_Paraiso).

The species accumulation curve indicates that ~90% of the expected species were detected. The number of documented species in Paraíso is likely to increase, as rare and/or secretive species (e.g., *Trimetopon slevini* and *Urotheca myersi*) were detected after the time allotted to this study. Additional species are presumed to inhabit the canton based on biology and ecological requirements (Savage 2002; Leenders 2019; Solórzano 2022). In particular, more species might be detected by increasing sampling effort, surveying less frequently visited areas, and including methods such as pitfall traps, drift fences, or surveys of canopies better able to detect cryptic species (Ramírez Arce et al. 2019).

The results of this study demonstrate not only a notable diversity of snakes in Paraíso, but also document a heterogeneous distribution of many species across its districts. Also, when compared to the only previous checklist for the area conducted at the now-abandoned Río Macho Biological Station in the Río Macho Forest Reserve in Orosi, the 51 species documented herein was substantially greater than the eight recorded by Acosta Chaves et al. (2015).

Comparisons with other regions in Costa Rica provide an additional context. For instance, 25 species have been reported in San Vito (elev. 1,100–1,500 m asl; Santos-Barrera et al. 2008), 21 species in Monteverde (elev. ~1,100 m asl; Curlis et al. 2020), 10 species in San Isidro de Dota (elev. 689–800 m asl; Arias and Bolaños 2014), and 28 species in the Quebrada González sector of Braulio Carrillo National Park (elev. 433–595 m asl; Ramírez Arce et al. 2019). Although informative, direct comparisons are limited by differences in sampling methods, durations, spatial coverage, and elevational gradients. Paraíso is larger and more ecologically diverse than the other sites listed above.

Alpha diversity indices show a low dominance of common species (D = 0.0561, 1–D = 0.944) and individuals evenly distributed among species (J' = 0.837). This was in sharp contrast with the study conducted in Braulio Carrillo National Park, which noted considerable dominance (D 0.90) of common species at lower elevations (Ramírez Arce et al. 2019). This, along with the species accumulation curve and Chao1 estimate are indicative of considerable species diversity in Paraíso. Wilson and Shmida beta diversity results are biased by the difference in the number of observations across districts, especially in Birrisito, although it still showed relatively high differences in the composition of species across sites. The latter was expected due to locations of the different life zones, which creates a heterogeneous landscape across districts.

The high species diversity reported here also could have been influenced by the methods used. The incorporation of considerable citizen-science generated information facilitated data collection over broader temporal and spatial scales than traditional field surveys alone, allowing for detection of species that might otherwise go unrecorded (Fraisl et al. 2022). Citizen science can therefore play a crucial role in biodiversity inventories, especially in regions with limited research capacity in Paraíso.

In addition to methods, ecological and geographical characteristics of Paraíso likely contributed to its high snake diversity. The canton with its abundance of protected areas spans a wide elevational range and includes a mosaic of ecosystems (SINAC 2020), which would be expected to support a greater number of species by providing diverse habitats and microclimates. Moreover, its location between two major mountain ranges suggests that it is a potential convergence zone for species from multiple herpetological provinces (Savage 2002).

Conclusions

This study, a first effort to understand and conserve snake diversity in Paraíso Canton using citizen science as the main source of records, demonstrates how this undervalued resource enhanced our understanding of snakes. Incorporation of citizen-sourced data expanded the scope of what we learned and increased our awareness of species diversity. However, the bias in the spatial distribution of the data in favor of more readily accessible areas resulted in uneven sampling that must be considered when interpreting the spatial patterns of species distribution and shows a need for future research to explore strategies to address such biases. Nevertheless, the results indicate a high diversity of snakes in Paraíso, exceeding previous records for the region and revealing the ecological importance of the canton within the broader context of the Costa Rican herpetofauna. The observed alpha- and beta-diversity patterns suggest a complex community structure likely influenced by

the heterogeneous environmental conditions present across the different districts.

The documented mortality of snakes due to human interactions remains a concern, emphasizing the need for effective conservation strategies and community engagement. The educational efforts undertaken as part of this study represent important steps towards achieving greater awareness and promoting more positive human-snake interactions.

Although species accumulation analyses suggest a relatively complete inventory, the ongoing detection of unreported species indicates that the snake diversity in Paraíso might still be underestimated. Future research employing a broader array of sampling techniques, particularly those targeting cryptic species and under-sampled areas, is needed to further characterize the region's ophidiofauna.

Acknowledgements

Local and foreign citizen scientists visiting Paraíso made this study possible. Without the help of countless efforts to communicate how useful casual data is for research applicability, this and similar studies would not be possible. Local people and institutions helped in several surveys along the canton and in various environmental educational efforts with their knowledge, time, and dedication. The help from the Natural Resources Oversight Committee (COVIRENAS) and SINAC officers of Tapantí-Macizo de la Muerte National Park was crucial during dialogues with local entities and governmental institutions. Several private reserves offered their properties to be sampled for this study; special thanks to Finca Queverí.

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