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Feeding Biology and Endoparasites Associated with *Sibon nebulatus* (Dipsadidae; Dipsadini) From Rainforest Enclaves in Ceará, Northeast Brazil

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Abstract.*—The genus *Sibon* comprises 23 valid snake species found in Central America and northern South America. These snakes are specialized in consuming mollusks, both with and without shells, as well as other soft-bodied invertebrates and the eggs of anuran amphibians. Within this genus, the Cloudy Snail-Eating Snake (*Sibon nebulatus*, *sensu lato*) is the most widely distributed in the Neotropical region and remains one of the least studied, particularly regarding parasite ecology. Therefore, we describe its feeding and parasite biology. We examined 83 individuals, including specimens from recent collections and preserved in herpetological collections. All specimens originated from four *Brejos de Altitude* (Tropical Pluvio-nebular Subperinifoliate Forests) in the state of Ceará, northeastern Brazil. We expected that this species would specialize in gastropods and host helminth parasites similar to other species in its tribe. We added 67 new occurrence records for *Sibon nebulatus* and found that it was a specialist predator of terrestrial gastropods, mainly without shells, presenting a low food niche amplitude. Gastropods of the family Veronicellidae were its main prey, as occurs in other species of the genus and tribe. We added three unpublished records of parasites infecting this species: *Cruzia* sp., *Oswaldocruzia* sp. and *Mesocoelium monas*. In addition, we did not find correlations between the body measurements of the host or sex and parasite abundance. Our results contribute to the understanding of the ecology of an understudied Neotropical snake species.

Key Words.—diet; foraging; helminths; molluscivory; parasites; snake

Introduction

Diet is one of the primary dimensions of the niche of an animal, influencing its feeding behavior, activity period, and habitat utilization (Vitt 2013). The study of the diet of an organism provides data about the energy sources it uses to complete its life cycle, as well as its natural history and ecological roles within its habitat (Vitt 2013). Therefore, studying the feeding ecology of a species is one way to understand the processes that operate in the ecosystem it inhabits (Carreira 2002).

Parasitism is another important ecological aspect (Silva and Müller 2012) and is closely linked to the diet of an individual (Luque and Poulin 2008). The investigation of parasitism is important for understanding ecological aspects, parasite/host relationships, and it also directly influences population dynamics and community structure (Campião et al. 2015; Quirino et al. 2018). Parasitism also allows for robust inferences about local diversity because parasite richness may reflect a great diversity of hosts, and parasites can affect host fitness and the way the host interacts with the community (Lafferty 2012; Gómez and Nichols 2013).

Although snakes exploit a wide variety of prey, some lineages have evolved remarkable dietary specializations, making them excellent models for studying feeding adaptations. Among reptiles, snakes exhibit the most substantial morphological adaptations for specialized mollusk consumption (malacophagy), with approximately 200 species that consume terrestrial and aquatic gastropods (Ferreira and Salomão 2004). Several species in the Dipsadidae family, including species of the genera *Sibon, Dipsas, Tropidodipsas*, and *Plesiodipsas,* are

Figure 1. A Cloudy Snail-Eating Snake (*Sibon nebulatus*) from Planalto da Ibiapaba, Ceará-Brazil. (Photographed by Robson W. Ávila).

highly specialized, with certain types of mollusks being the most prevalent items in their diets (Ferreira and Salomão 2004). The genus *Sibon* comprises 23 snake species distributed in Central America and northern South America (http://www.reptile-database.org). They are specialists in consuming mollusks with and without shells, other soft-bodied invertebrates, and the eggs of anuran amphibians (Ryan 2004; Montgomery et al. 2007; Ray et al. 2011; Lewis 2013).

The Cloudy Snail-Eating Snake (*Sibon nebulatus*, *sensu latu*; Fig. 1) is the most widely distributed species within the genus (http://www.reptile-database.org) with a geographic range extending from southern Mexico to northeastern Brazil (http://www.reptile-database.org). Based on morphological and molecular evidence, however, Fouquet et al. (2025) restricted the distribution of *S. nebulatus sensu stricto* to northern South America. In Ceará, *Sibon nebulatus* is found in humid forest enclaves (popularly known as Brejos de Altitude) and rarely along the coastal zone (Borges-Nojosa and Caramaschi 2003; Loebmann and Haddad 2010). As with other non-venomous snake species, little is known about the biology and ecology of *Sibon nebulatus,* with no work focused on its feeding and parasite biology to date.

We analyzed the diet (number of prey, trophic niche breadth, and the Relative Importance Index of feeding items) and parasitology (prevalence, abundance, mean infection intensity, and relationships of these values with SVL) of *Sibon nebulatus* in the Brejos de Altitude of Ceará, northeastern Brazil. We expected that this species would exhibit a narrow trophic niche, specializing in the consumption of gastropods, primarily those without shells, because congeners and other malacophagous dipsadines predominantly consume gastropods. We expected this species to exhibit a narrow trophic niche, specializing in the consumption of gastropods, primarily those without shells, and to host a helminth fauna composed mainly of digenetic trematodes because gastropods commonly serve as intermediate hosts for these parasites.

Materials and Methods

Study site.—We collected *Sibon nebulatus* from 10 sampling points within four rainforest enclaves (Planalto da Ibiapaba; Maciço de Baturité; Serra de Maranguape; and Serra da Aratanha), known as Brejos de Altitude (relictual reliefs with elevations of at least 600 m, covered by remnants of Atlantic and Amazon rainforests; de Medeiros and Cestaro 2020), in the state of Ceará, northeastern Brazil (Fig. 2). Planalto da Ibiapaba has the highest average annual rainfall in the state (e.g., São Benedito with 2,063 mm, Ibiapina with 1,745 mm, and Ubajara with 1,441 mm), and lowest annual average temperature, ranging from 22°–26° C (https://www.funceme.br/areas/monitoramento/grafico-de-chuvas-dos-postos-pluviometricos). Maciço de Baturité, conversely, is characterized by different climates at various elevations, with higher areas having average annual temperatures of 22.6° C and a climate classified as hot and sub-humid tropical with mean annual rainfall of 1,090 mm (Funceme 2007). Serra de Maranguape, a pre-littoral residual massif with a maximum elevation of 920 m, is located in the Metropolitan Region of Fortaleza with annual precipitation exceeding 1,300 mm and an average temperature between 23°–26° C (Ceará 2002). Its vegetation is characterized by Tropical Rain Subcaducifolia Forest (dry forests) and Tropical Pluvio-Nebular Subperennial Forest (wet forests; Fernandes 1998). Finally, Serra da Aratanha is a forest enclave with humid topoclimates, inserted in the semi-arid Caatinga region (Instituto Chico Mendes de Conservação da Biodiversidade [ICMBio] 2012). The average temperature is around 26° C, with a Hot Humid Tropical climate and a rainy season from January to May (ICMBio 2012).

Specimen collection.—Most individuals used in this study (n = 80) were housed in the Coleção Herpetológica da Universidade Federal do Ceará (CHUFC) and from recent collections (n = 3), as detailed below. We collected two specimens at the

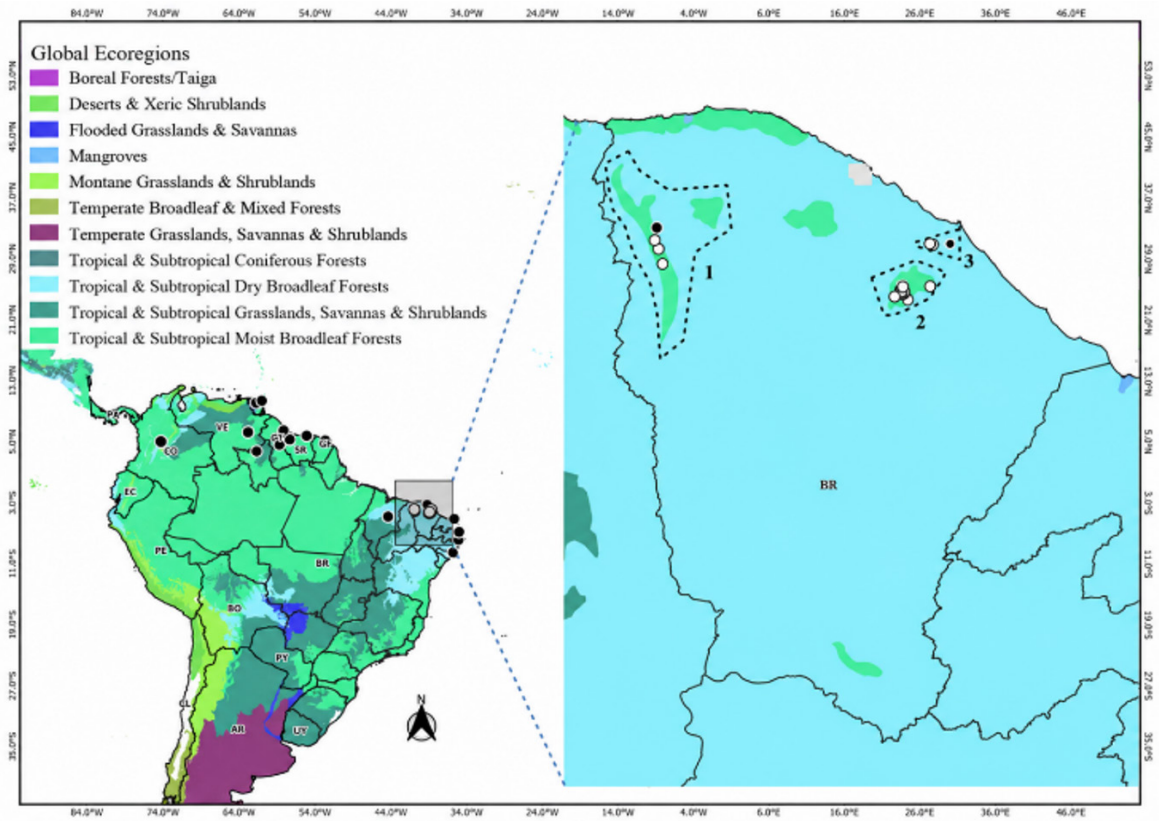

Figure 2. Schematic map of the sampling areas in four Brejos de Altitude (1 = Planalto da Ibiapaba; 2 = Maciço de Baturité; 3 = Maranguape and Pacatuba), Ceará State, northeastern Brazil. The figure also shows the updated distribution of the Cloudy Snail-Eating Snake (*Sibon nebulatus*) *sensu stricto* across South America. Black circles = literature records; white circles = new records.

beginning of the rainy season in March 2022 and one in May 2023, at the end of the rainy season. All specimens were collected in areas of Tropical Pluvio-nebular Subperinifoliate Forest. After collection, we euthanized the animals using lidocaine, fixed in 10% formaldehyde, stored in 70% alcohol, and subsequently deposited in CHUFC.

Laboratory protocols.—We determined the sex of each individual through the examination of their gonads. We considered males reproductive based on the presence of convoluted epididymides, and females based on the presence of eggs or vitellogenic follicles. We determined size at sexual maturity by the presence of follicles or embryos for the smallest female and convoluted epididymides for the smallest male. We removed the digestive tract of each specimen to analyze its content under a stereoscopic microscope, identifying all items found to the lowest possible taxonomic level. We measured length and width of each intact item using a digital caliper (± 0.01 mm), and their volume was estimated using the formula for an ellipsoid (Vitt 1991).

To determine the relative contribution of each prey category, we calculated the Index of Relative Importance for each prey category using the following formula (Powell et al. 1990):

$$RII = F\% + N\% + V\% / 3$$

where F%, N%, and V% represent the percentages of frequency, number, and volume of prey items, respectively. To measure the numerical and volumetric niche breadth, we used the inverse of Simpson's Diversity Index (Simpson 1949):

$$B = \frac{1}{\sum_{i=1}^{n} Pi^2},$$

where n is the total number of prey categories. The results range from 1.0 (using only one category) to n (using all categories in equal proportions).

We inspected the gastrointestinal tract and accessory organs (liver, pancreas, and spleen), as well as the lungs and coelomic cavity, for macroscopic parasites. We carefully collected, cleaned, and then

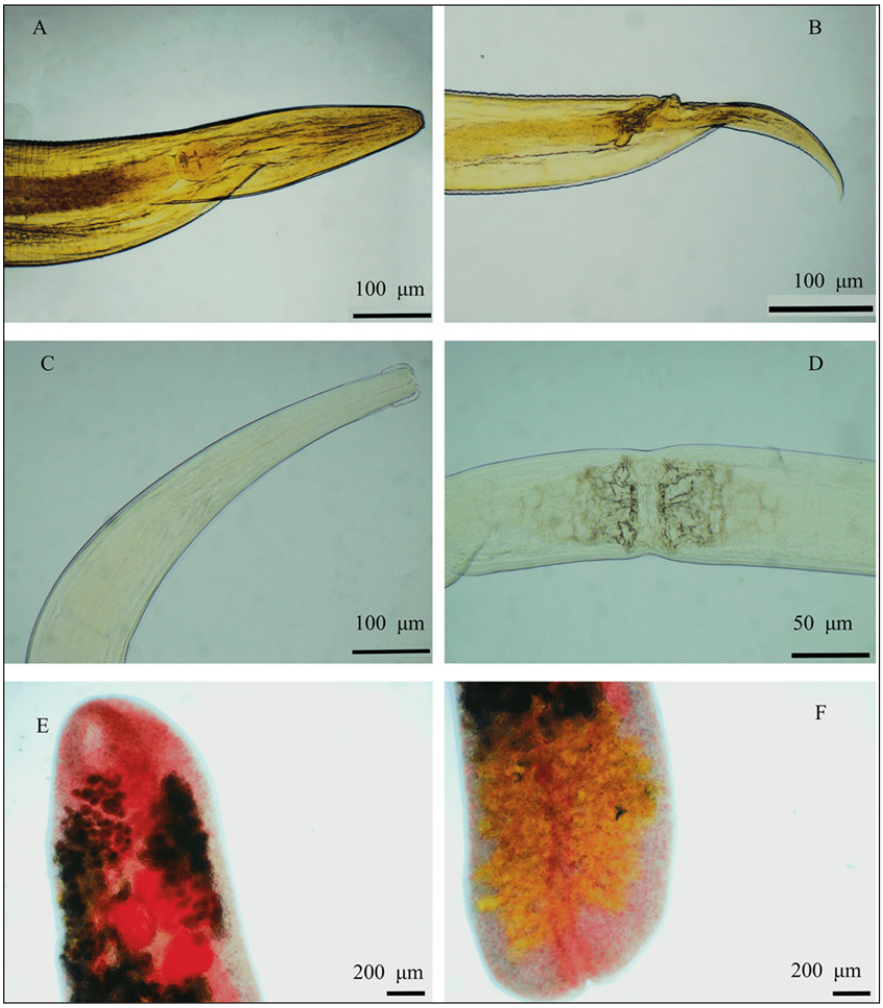

Figure 3. Photomicrographs of parasites associated with the Cloudy Snail-Eating Snake (*Sibon nebulatus*) from rainforest enclaves (*Brejos de Altitude*) in Ceará state, Brazil. (A) Anterior view of *Cruzia* sp. larvae. (B) Posterior view of *Cruzia* sp. larvae. (C) Anterior view of *Oswaldocruzia* sp. (D) Vulva of female *Oswaldocruzia* sp. (E) Anterior view of *Mesocoelium monas*. (F) Posterior view of *Mesocoelium monas*. (Photographed by Átilas Rodrigues de Sousa).

transferred to 70% alcohol solution all observed helminths for subsequent analyses. We then subjected them to treatments specific to their taxonomic group to visualize internal structures of taxonomic importance: nematodes were cleared in phenol, whereas trematodes and cestodes were stained with carmine and cleared with eugenol. We deposited helminth specimens in the Parasitological Collection of the Federal University of Ceará (CP-UFC). Subsequently, we studied the helminths through the preparation of temporary slides for identification, aided by identification keys. We calculated mean abundance, prevalence, and mean infection intensity for observed parasites (Bush et al. 1997). Data normality was assessed using the Shapiro–Wilk Test. Because parasite abundance did not meet the assumptions of normality, we tested the relationship between parasite abundance and host snout-vent length (SVL) using Spearman's Rank Correlation and compared parasite abundance between sexes using the Mann–Whitney U Test. We performed all statistical analyses in R (R Core Team 2024).

Results

We analyzed 83 *Sibon nebulatus* stomachs: 44 from males (32 adults and 12 juveniles) and 38 from females (29 adults and nine juveniles). Of the 83 stomachs we analyzed, 16 (19.3%) contained prey. We found that *Sibon nebulatus* fed solely on mollusks. Most identifiable food items exhibited the following characteristics: (1) the absence of

Table 1. Number (n), frequency (F), volume (V), and relative importance index (RII) of prey items found in the stomach of the Cloudy Snail-Eating Snake (*Sibon nebulatus*), Ceará, Brazil (1987–2022).

Food item	n	F (%)	V (%)	RII
Veronicellidae	22	84.6	63.8	77.7
Gastropoda	4	15.3	36.1	22.3
Total	26	–	–	–
Niche breadth	1.35	–	1.60	–

a palial cavity; (2) the presence of the mantle organized into notum, hyponotum, and perinotum; (3) a diorchic reproductive system; and (4) a male apparatus with the presence of a typical penial gland (Veronicellidae). Additionally, opercula were found in four stomachs, which were then identified as Gastropoda. The indices of relative importance were 77.7 for Veronicellidae and 22 for Gastropoda. The most frequent item was Veronicellidae, found in 9.9% of the stomachs (Table 1). *Sibon nebulatus* exhibited a narrow dietary niche (1.35), being a specialist of slugs from the Veronicellidae family.

Out of the 83 snakes we examined, 50 were infected with at least one species of parasite, resulting in a total prevalence of 60.4%. We recovered 412 helminths from specimens (Table 2). The helminth fauna of *S. nebulatus* consisted of three taxa: *Cruzia* sp., *Oswaldocruzia* sp., and *Mesocoelium monas* (Fig. 3). The most prevalent taxon (31.5%) was *Cruzia* sp. and the most abundant (mean abundance = 7.0; Table 1). Host SVL and parasite abundance were not significantly correlated ($\rho = 0.166$, $n = 35$, $P = 0.340$). When comparing parasite abundance between sexes, mean parasite load was higher in females (mean = 5.39) than in males (mean = 2.40) when the dataset included one extremely parasitized female (about 50 parasites), but this difference was not significant ($W = 207.5$, $P = 0.147$). After excluding this outlier, female mean abundance decreased substantially (mean = 2.63; Fig. 4), converging with the male mean (2.40), and the difference also was not significant ($W = 188.5$, $P = 0.230$).

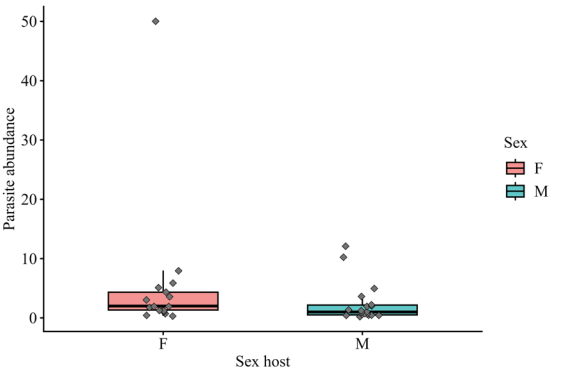

Figure 4. Median parasite abundance of male (M) and female (F) Cloudy Snail-Eating Snakes (*Sibon nebulatus*). Each box represents the interquartile range (25%–75%), the horizontal line indicates the median, and the whiskers correspond to the minimum and maximum values within 1.5 times the IQR.

Discussion

Sibon nebulatus is a gastropod specialist, ingesting relatively small prey, a pattern also reported for some of its congeners (Ryan 2004; Montgomery et al. 2007; Ray et al. 2011; Lewis 2013) and other Dipsadini snakes (e.g., Neuwied's Tree Snake, *Dipsas neuwiedi*, and Brazilian Slug-eating Snake, *D. mikanii*; Pilate 2017). There are only a few reports on the diet of *Sibon* species, and most studies point to slugs or snails as prey (Savage 2002; Solórzano 2004). Kofron (1987) recorded slug remains in the digestive tract of Cope's Snail Sucker (*Sibon anthracops*), whereas Solórzano (2002, 2004) mentioned that a juvenile Argus Snail Sucker (*Sibon argus*) consumed unidentified eggs of centronelids, slugs, and snails, and a captive Stejneger's Snail Sucker (*Sibon longifrenis*) was reported to feed on an oligochaete. *Sibon argus* also feeds on the Emerald Glass Frog (*Espadarana prosoblepon*; Ryan and Lips 2004) and the Limon Giant Glass Frog (*Sachatamia ilex*; Ray et al. 2012). *Sibon longifrenis* consumes eggs of the White-Spotted Glass Frog (*Cochranella albomaculata*; Montgomery et al. 2007). In the same work, Ryan and Lips (2004) indicated that *Sibon*

Table 2. Helminths associated with the Cloudy Snail-Eating Snake (*Sibon nebulatus*) collected in Ceará state, Brazil. Abbreviations are DS = development stage, A = adult, L = larvae, IR = infection range, NH = number of helminths, P = prevalence, MA = mean abundance ± standard error (SE), MII = mean infection intensity ± SE, and SI = site of infection: STO = stomach; SGI = small intestine; and LGI = large intestine.

Endoparasites	DS	IR	NH	P	MA ± SE	MII ± SE	SI
Nematodes							
Oswaldocruzia sp.	A	2–2	4	1.6	0.09 ± 0.1	1.4 ± 0.9	STO, SGI
Cruzia sp.	L	1–77	301	31.5	7.0 ± 1.8	8.3 ± 6.3	STO, LGI
Trematode							
Mesocoelium monas	A	1–70	107	8.3	2.48 ± 1.6	10.7 ± 6.7	STO, SGI, LGI

nebulatus may feed on eggs of the Red-eyed Tree Frog (*Agalychnis callidryas*). Furthermore, Ray et al. (2011) recorded that *Sibon argus* also feeds on eggs of the same species. Quirino et al. (2024) recorded *Sibon nebulatus* preying on snail *Cyclodontina maranguapensis* in Ceará-Brazil.

Only 19.3% (16) of the stomachs we analyzed contained identifiable food items. It is often challenging to find food items in snake stomachs. Although prolonged periods between capture and fixation in museum specimens may reduce the likelihood of detecting stomach contents due to digestion or regurgitation, even wild-caught snakes frequently have empty stomachs at the time of capture (Greene 1997). The proportion of individuals with stomach contents also varies among species according to differences in feeding frequency, prey type, and ecological traits (Greene 1997). This time interval might be sufficient for freshly ingested prey found in stomachs to go through the complete digestion process. Additionally, mollusks have bodies high in water content, which shortens the digestion time, especially mollusks without shells (Pilate 2017). These factors could explain the low frequency of prey found in this study.

Sibon nebulatus was shown to be a specialist in consuming mollusks from the family Veronicellidae. This family includes 23 genera with over 100 species of exclusively terrestrial, herbivorous pulmonate gastropods, characterized by their nocturnal and synanthropic habits, lack of shells, and distinctive external morphology, as well as their wide distribution (Pilate 2017). Species in Veronicellidae are of great agricultural, medical, and veterinary importance. Some species within this family are considered significant agricultural pests due to their attacks on a wide range of crops, particularly legumes, brassicas, and solanaceous plants (Ramos-de-Souza et al. 2021). In Brazil, slugs have been identified as pests in bean plantations in the states of Minas Gerais, Sergipe, Bahia, and São Paulo (Ramos-de-Souza et al. 2021). Mollusks can act as vectors in the dissemination of parasitic worms that affect domestic animals, livestock, and wildlife, playing a role in the proliferation of zoonoses due to their dispersal ability (Ramos-de-Souza et al. 2021). The importance of reptile predation in regulating snail populations has been largely overlooked, both in natural ecosystems and altered environments. Furthermore, the idea of using reptiles as a form of natural control to manage snail populations that damage agriculture has been underestimated, although it can be extremely beneficial to humans (Pilate 2017). This potential can be harnessed to control agricultural pests in agroforestry plantations, for example, contributing to coexistence between snakes and humans living in rainforest enclaves, where human perceptions and interactions with the local species remain poorly understood. We found that *Sibon nebulatus* is a paratenic (transport) host for *Cruzia* sp. (Nematoda) and a definitive host for the nematode *Oswaldocruzia* sp. and the trematode *Mesocoelium monas*. The genus *Cruzia* includes parasites inhabiting the intestines of lizards (Lacerda et al. 2023) and snakes (Ubelaker and Younus 1965). Encysted larvae of *Cruzia* sp. have been recorded in terrestrial mollusks in Brazil (Ramos-de-Souza et al. 2021; Lacerda et al. 2023). Therefore, one possible route of infection by *Cruzia* sp. for *Sibon nebulatus* could be through feeding, as gastropods constitute the primary food items consumed by snakes of this genus (Ryan 2004; Montgomery et al. 2007; Ray et al. 2012; Lewis 2013). The nematode worms *Cruzia tentaculata* and *C. tropidodipsi* have been previously reported infecting mollusks and dipsadine snakes (*Dipsas mikanii* and the Banded Snail Sucker, *Tropidodipsas fasciata*) by Ubelaker and Younus (1965) and Souza et al. (2021).

The trematode worm *Mesocoelium monas* (Digenea) has a complex life cycle that may involve two intermediate hosts, the first being a mollusk and the second an arthropod or mollusk, with the definitive host usually being a vertebrate (Cribb et al. 2003). The presence of the parasite may be linked to the ingestion of metacercariae in intermediate hosts (Cribb et al. 2003). Because *Sibon nebulatus* consumes mollusks (Rojas et al. 2021), this is likely how infection occurs. Parasites of the genus *Mesocoelium* have been reported in the dipsadines *Dipsas mikania* (no common name), Boulenger's Tree Snake (*Dipsas ventrimaculata*), Bolivian Tree Snake (*Dipsas turgida*), and other species of *Dipsas* (Poumarau 1968; Lunaschi and Drago 2010). Nematodes of the genus *Oswaldocruzia* are parasites with a monoxenous life cycle, and they are mainly reported inhabiting the small intestines of amphibians and reptiles (Kirillova 2020). They are more commonly reported in anurans, but they also parasitize salamanders, lizards and, rarely, snakes (Kirillova 2020, Lacerda et al. 2023). The genus comprises about 90 species (Svitin 2015), and these nematodes are distributed worldwide (Kirillova 2020).

The results of our study coincide with other findings in the literature, with the helminth fauna of *Sibon nebulatus* similar to other malacophagous snakes. Helminth species diversity was low, with a greater predominance of the previously reported *Mesocoelium monas*. Helminth species diversity in reptile communities is influenced by the interaction between evolutionary history and host ecology and is related to the diversity of intermediate and definitive hosts (Zuben 1997). Parasite communities in reptiles are often highly variable, with low species diversity and high dominance of one species (Aho 1990). The richness in these communities depends on opportunities for transmission and infection and is subject to environmental changes, as well as other aspects of community structure (Kennedy 1993).

Body size and sex are factors that can influence parasitism in the hosts because a larger body may provide more resources, and the different metabolism and level of activity between males and females can also affect this relationship (Gorrell and Schulte-Hostedde 2008; Poulin and Leung 2011; Campião et al. 2015). The presence of a single outlier (a female with exceptionally high parasite load) influenced the mean parasite abundance estimated for females. As this specimen was confirmed to be real rather than a recording error, we reported results both including and excluding it. In both cases, no significant difference in parasite abundance between sexes was detected. Likewise, parasite abundance was not significantly correlated with host body size suggesting that sex may not play a major role in determining parasite burden in the studied population, although rare individuals with unusually high infection may occur. We think, however, that future investigations should continue to explore potential variation in parasite abundance and diversity between sexes and among host body sizes.

Regardless of having one of the most diverse herpetofauna in the world, most species in the Neotropics have yet to be sampled for general biology and distribution. Ecological research into local fauna and their role in the environment are essential to understand how the species fit in the ecosystem, as well as their state of conservation. As previously stated, research on diet and parasitism of *Sibon nebulatus* are scarce, despite the species being widely distributed in the Neotropical region. We found that *Sibon nebulatus* has a specialized diet primarily composed of veronicellid slugs and documented three helminth parasite taxa associated with this species. These findings expand current knowledge of its trophic ecology and parasite fauna, providing new insights into predator-prey and host-parasite relationships in Neotropical snakes.

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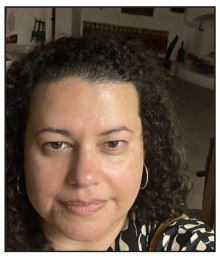

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Appendix

Appendix Table. Additional occurrence records for the Cloudy Snail-Eating Snake (*Sibon nebulatus*) in Ceará, Brazil.

Voucher (CHUFC)	Locality	Collection date	Latitude	Longitude
3670	Acarape	27 March 2012	-4.221021	-38.704785
3818	Baturité	January 2000	-4.327934	-38.884596
1380	Guaramiranga	9 March 1988	-4.262780	-38.932780
1518	Guaramiranga	16 June 1988	-4.262780	-38.932780
2009	Guaramiranga	12 January 1990	-4.262780	-38.932780
1516	Guaramiranga	22 May 1989	-4.262780	-38.932780
1517	Guaramiranga	16 July 1989	-4.262780	-38.932780
1383	Guaramiranga	27 April 1988	-4.262780	-38.932780
2374	Guaramiranga	28 January 2000	-4.262780	-38.932780
1379	Guaramiranga	16 February 1988	-4.262780	-38.932780

Appendix Table, continued

Voucher (CHUFC)	Locality	Collection date	Latitude	Longitude
1347	Guaramiranga	6 July 1987	-4.262780	-38.932780
1520	Guaramiranga	2 October 1988	-4.262780	-38.932780
1519	Guaramiranga	1 February 1989	-4.262780	-38.932780
4232	Guaramiranga	26 November 1990	-4.262780	-38.932780
2138	Ibiapina	7 March 1998	-3.923333	-40.889444
2788	Maranguape	14 July 1997	-3.880265	-38.708675
3287	Maranguape	19 February 1998	-3.880265	-38.708675
2800	Maranguape	19 February 1998	-3.880265	-38.708675
3632	Maranguape	30 January 2012	-3.880265	-38.708675
3765	Maranguape	21 October 2014	-3.880265	-38.708675
4507	Maranguape	13 March 2020	-3.880265	-38.708675
4508	Maranguape	13 March 2020	-3.880265	-38.708675
4529	Maranguape	19 February 2022	-3.880265	-38.708675
2801	Mulungu	11 January 1998	-4.303500	-38.990833
4265	Mulungu	31 July 2010	-4.303500	-38.990833
4531	Mulungu	18 March 2022	-4.303500	-38.990833
4424	Pacoti	1997	-4.224600	-38.925400
2479	Pacoti	3 January 1999	-4.224600	-38.925400
2796	Pacoti	11 January 1998	-4.224600	-38.925400
2237	Pacoti	10 July 2001	-4.224600	-38.925400
2771	Pacoti	23 November 1997	-4.224600	-38.925400
2459	Pacoti	2 January 1999	-4.224600	-38.925400
2799	Pacoti	7 July 1992	-4.224600	-38.925400
2777	Pacoti	9 April 1998	-4.224600	-38.925400
2621	Pacoti	December 2005	-4.224600	-38.925400
2837	Pacoti	27 June 2006	-4.224600	-38.925400
3715	Pacoti	26 June 2013	-4.224600	-38.925400
2836	Pacoti	27 June 2006	-4.224600	-38.925400
2838	Pacoti	27 June 2006	-4.224600	-38.925400
2773	Pacoti	14 April 1990	-4.224600	-38.925400
2780	Pacoti	August 1990	-4.224600	-38.925400
2795	Pacoti	15 August 1998	-4.224600	-38.925400
2789	Pacoti	18 December 1997	-4.224600	-38.925400
2792	Pacoti	3 April 1990	-4.224600	-38.925400
2793	Pacoti	7 July 1992	-4.224600	-38.925400
2785	Pacoti	11 January 1998	-4.224600	-38.925400
2618	Pacoti	22 October 2005	-4.224600	-38.925400

Appendix Table, continued

Voucher (CHUFC)	Locality	Collection date	Latitude	Longitude
2460	Pacoti	2 January 1999	-4.224600	-38.925400
2175	Pacoti	6 July 1997	-4.224600	-38.925400
2608	Pacoti	9 September 2005	-4.224600	-38.925400
2606	Pacoti	9 September 2005	-4.224600	-38.925400
2778	Pacoti	18 December 1997	-4.224600	-38.925400
3735	Pacoti	17 April 2014	-4.224600	-38.925400
4425	Pacoti	December 1997	-4.224600	-38.925400
2602	São Benedito	20 February 2005	-4.042667	-40.858997
2124	São Benedito	29 November 1997	-4.042667	-40.858997
2776	Ubajara	3 June 1999	-3.854400	-40.921000
2798	Ubajara	2 August 1998	-3.854400	-40.921000
2797	Ubajara	4 June 1999	-3.854400	-40.921000
2106	Ubajara	20 January 1993	-3.854400	-40.921000
2784	Ubajara	2 August 1998	-3.854400	-40.921000
2782	Ubajara	2 August 1998	-3.854400	-40.921000
4036	Ubajara	26 April 2015	-3.854400	-40.921000
4037	Ubajara	26 April 2015	-3.854400	-40.921000
4074	Ubajara	6 December 2014	-3.854400	-40.921000