REPTILES & AMPHIBIANS

Living near Water: Ecological Observations of the Ecuador Sipo, *Chironius grandisquamis* (Peters 1869) (Squamata: Colubridae) in the Middle Magdalena River Valley, Colombia

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Abstract.—More than 40 species of snakes inhabit the humid forests of the Middle Magdalena River Basin of Colombia, yet studies on the basic aspects of snake ecology and natural history in this region are scarce. We searched for Ecuador Sipos (*Chironius grandisquamis*) during six years (2014–2019) of 6–24-day visual-encounter surveys by day and night in both rainy and dry periods. In 2,967 person-hours, we recorded 16 individuals, half during rainy and half during dry periods. Fourteen of the 16 encounters were in the evening and two in the morning. Snakes recorded during the day were foraging on the ground, whereas those recorded at night were inactive and perched in vegetation. Most inactive individuals had selected perches along streams flanked by riparian forests; ten were in shrubs and four in trees on branches 120–600 cm above the ground. We also record predation on a northern rainfrog (*Craugastor metriosistus*) on the forest floor during the day.

Natural history serves as a foundation for understanding the basic biology, ecology, evolution, and conservation status of organisms (Greene and Losos 1988; Greene 2005; Anderson 2013, 2017). Natural history can be broadly defined as organisms' descriptive ecology and ethology, which address the locations and functions of species in the environment, and which includes their interactions (Greene 1994, 2005). Natural history studies of snakes have increased in recent decades due to long-term field studies and new analyses of specimens in biological collections.

In Colombia, the Middle Magdalena River Basin (mMRB) supports a rich snake fauna, particularly in humid forests to elevations of 1,500 m asl, where more than 40 species have been recorded (Lynch 2012; Lynch et al. 2016), including the largest terrestrial reptilian predators (species with total lengths that can exceed 2 m: Boa Constrictor, *Boa constrictor*; Terciopelo, *Bothrops asper*; Sipo, *Chironius carinatus*; Ecuador Sipo, *C. grandisquamis*; Black Mussurana, *Clelia Clelia*; Black-tailed Cribo, *Drymarchon melanurus*; Warty Bushmaster, *Lachesis acrochorda*; Shropshire's Puffing Snake, *Phrynonax shropshirei*; and Tropical Chicken Snake, *Spilotes pullatus*) (Savage 2002; Solórzano 2004; Pizzato 2005; Carrasco et al. 2011; Torres-Carvajal et al. 2018). Nevertheless, studies on basic natural history of snakes in this region are scarce (see Medina-Rangel 2013) and most of the available information is anecdotal.

Snakes of the genus *Chironius* comprise a Neotropical clade (Torres-Carvajal et al. 2018) of large oviparous, aglyphous species that includes both predominantly terrestrial and arboreal taxa. These snakes are fast active foragers that feed mostly on amphibians (Dixon et al. 1993; Roberto and Souza 2020), and generally hunt by day and rest at night in trees or bushes (Dixon et al. 1993). The Ecuador Sipo (*Chironius grandisquamis*) is one of the largest species in the genus (maximum recorded total length 2,718 mm) with males longer than females (Dixon et al. 1993). This species is distributed across lowlands and pre-montane rainforests at elevations of 0–2,370 m asl from northern Honduras to western Colombia and Ecuador (including Gorgona Island) (Dixon et al. 1993; Savage 2002; Solórzano 2004; Urbina-Cardona et al. 2008; Rodríguez-Guerra and Carvajal-Ramos 2019). Ecuador Sipos in the mMRB comprise the eastern-most populations in the species' range (see Dixon et al. 1993). Herein we provide information on habitat and microhabitat

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use by *C. grandisquamis* in the pre-montane humid forests of the mMRB based on six-years of herpetological monitoring in the region.

Materials and Methods

Study area.—We conducted fieldwork in the buffer zone of the hydroelectric project Miel I, in the municipalities of Norcasia, Samaná, and Victoria, Department of Caldas, Colombia. The study sites are at elevations of 600–930 m asl, with an average annual temperature of 23.1 °C and a mean rainfall of 2,139 mm per year between 2011 and 2019 (Fig. 1). This region is in the pre-montane pluvial rainforest life zone of Holdridge (1982) (adapted by Espinal 1987 for Colombia), or the tropical humid zonobiome of the Middle Magdalena River Valley (Rodríguez et al. 2006). A description of the area is in Rojas-Morales et al. (2018).

Data collection and analysis.—We conducted herpetological monitoring during both rainy (March–May and September–November) and dry periods (December–February and June–August) from 2014 to 2019 (Fig. 1). Fieldwork was not standardized by time. During sampling periods 6–24 days over the course of the six-year study, we spent a total of 2,967 person-hours sampling the sites (245 person-hours in 2014, 322 in 2015, 568 in 2016, 608 in 2017, 424 in 2018, and 800 in 2019).

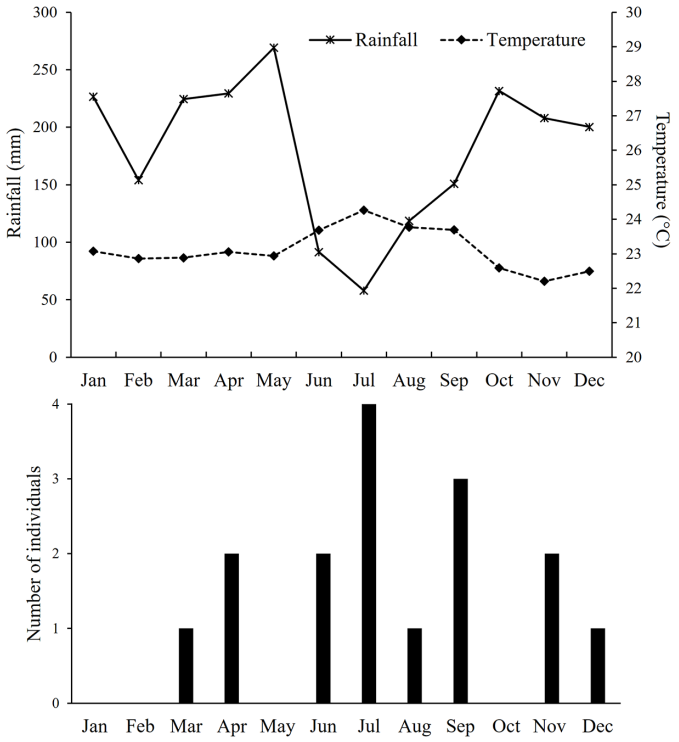

Fig. 1. Variation of mean monthly rainfall and temperature for 2014–2019 in the study area (upper), and number of observed and captured Ecuador Sipos (*Chironius grandisquamis*) per month for the same period (lower). Climatic data were obtained from the Berlín Climatological Station, Samaná Municipality, Department of Caldas, Colombia (elev. 889 m asl).

We performed diurnal (0800–1100 h) and nocturnal (1800–0200 h) visual encounter surveys (Dorcas and Wilson 2009) in major habitat types that included shrubland, riparian forest, secondary forest, and primary forest. Two or three researchers walked slowly while searching for snakes in visually accessible microhabitats (defined herein as the specific locality within a major habitat where the snake was active or resting; see Cadle and Greene 1993 for an extended discussion). For sightings of *C. grandisquamis*, we classified microhabitats as ground (including leaf litter), tree branch, and shrub branch since all individuals were observed or captured in such situations.

When possible, we captured snakes and measured snout-vent length (SVL) and tail length (TL) to the nearest millimeter with a measuring tape, and weight to the nearest 0.1 g using a precision scale. For each individual, captured or not, we estimated and classified the perch height as low (≤ 200 cm), medium (200–600 cm), or high stratum (≥ 600 cm) and measured the distance to the nearest body of water using a decameter on a straight wooden rod. We classified individuals as active when they were moving (i.e., foraging) and as inactive when motionless, coiled or not, with no signs of activity for at least 15 min. We sexed the captured individuals based on the keels of the paravertebral scale rows (strongly keeled in males vs. weakly keeled in females; Dixon et al. 1993; Savage 2002) and a thickened tail base as evidence of hemipenes. Because our data are limited and sampling was seasonally discontinuous, we present only descriptive statistics (mean ± SD and range) for our observations.

Results

In total, we recorded 16 Ecuador Sipos (6 males, 2 females, and 8 individuals of undetermined sex because we failed to capture them or we were unable to sex them by tactile and visual inspection; Table 1). Only seven individuals were captured. Male SVL = 1,027 ± 412 mm (444–1,400 mm), TL = 547 ± 202 mm (255–699 mm), and weight = 355.3 ± 224.8 g (24.4–520.0 g) (n = 4); the largest female had SVL = 1,335 mm, TL = 638 mm, and weighed 490.0 g (Table 1). We observed an ontogenetic change; a juvenile male had a light brown dorsum (lighter ventrolaterally) with transverse whitish bands (Fig. 2A), a small individual (SVL 1,064 mm, TL 663 mm) had a dark brown dorsum with creamy yellow transverse bands (Fig. 2B), and the largest male captured (SVL 1,400 mm, TL 699 mm) had a dark brown dorsum with reddish-brown transverse bands restricted to the anterior part of the body (Fig. 2C). The smallest individuals had an intense red iris (n = 3), whereas the iris was dark brown in adults (Fig. 2).

We encountered eight individuals during the rainy season (3 in March–May and 5 in September–November) and eight during the dry season (one in December–February and 7 in June–August) (Table 1; Fig. 1). Fourteen of the 16

Table 1. Habitats, microhabitats, and measurements of Ecuador Sipos (*Chironius grandisquamis*) found in the Middle Magdalena River Valley of Colombia.

Date	Time (h)	Habitat	Microhabitat	Perch height (cm)	Distance to water (cm)	Sex	SVL (mm)	TL (mm)	Weight (g)	Activity
01 Jul 2014	1935	Riparian forest	Shrub branch	300	0	Male	1,200	570	463	Inactive
01 Jul 2014	1935	Riparian forest	Shrub branch	350	0	Female	1,335	638	490	Inactive
02 Jul 2014	1940	Riparian forest	Shrub branch	370	0	Male	1,400	699	520	Inactive
02 Jul 2014	2010	Riparian forest	Shrub branch	350	0	Male	—	—	—	Inactive
05 Aug 2014	2020	Secondary forest	Tree branch	350	300	Female	1,090	535	390	Inactive
05 Nov 2014	1920	Riparian forest	Shrub branch	350	0	Male	1,064	663	414	Inactive
01 Apr 2015	1852	Secondary forest	Tree branch	600	0	Undetermined	—	—	—	Inactive
01 Apr 2015	2049	Secondary forest	Shrub branch	300	0	Undetermined	785	317	277	Inactive
25 Jun 2015	2112	Secondary forest	Shrub branch	200	150	Undetermined	—	—	—	Inactive
26 Jun 2015	1940	Shrubland	Shrub branch	120	0	Male	—	—	—	Inactive
27 Sep 2016	1126	Riparian forest	Ground	0	10	Male	444	255	24.4	Active
29 Mar 2019	1939	Riparian forest	Tree branch	200	0	Undetermined	—	—	—	Inactive
25 Sep 2019	0900	Dense forest	Ground	0	1000	Undetermined	—	—	—	Active
26 Sep 2019	1937	Dense forest	Shrub branch	—	0	Undetermined	—	—	—	Inactive
07 Dec 2019	1928	Riparian forest	Tree branch	—	0	Undetermined	—	—	—	Inactive
14 Nov 2019	1920	Riparian forest	Shrub branch	—	0	Undetermined	—	—	—	Inactive

records were in the evening (1852–2112 h) and two were in the morning (0900–1126 h). Both snakes encountered during the day were moving on the ground (Fig. 3), whereas those recorded at night were inactive on vegetation (Figs. 3–5). Twelve of the 14 individuals observed at night were on perches along streams flanked by riparian forests that did not exceed 100 m in width (Figs. 4, 5A). Nocturnal perches were on shrub (n = 10) or tree (n = 4) branches at heights of 317 ± 124 cm (120–600 cm; n = 11) above the ground (Figs. 3–5). Six individuals were in the medium stratum (345 ± 23 cm), three in the lower stratum (173 ± 46 cm), and one in the upper stratum 600 cm above the ground (Table 1).

At night, snakes were coiled on branches with the head on or next to the body (Fig. 5B). On one occasion, we observed a pair on the same bush about 100 cm apart, but saw no interaction between them during 45 min of continuous observation (Fig. 5C). When illuminated by flashlights, both began moving quickly through the vegetation (Fig. 5D). At 1940 h on 2 August 2014, we attempted to capture an individual perched on a bush 370 cm above the ground, but it moved quickly through the branches before dropping into the stream and hiding under a rock, where it remained underwater for 15.26 min. We captured it when it emerged from the water. Like other captured snakes, it employed various defensive behaviors, including cloacal discharge and attempting to bite when handled.

In addition to encounters during our surveys, we observed predation by an adult *C. grandisquamis* (~1,200 mm total length) on a northern rainfrog (*Craugastor metriosistus*) at 0917 h on 27 July 2020 in Santa Barbara Sector, Norcasia Municipality, Department of Caldas, Colombia (5.5799°N, 74.9336°W; elev. 526 m asl). We were initially alerted by the distress call of the frog, which had been partially ingested by the snake when we found them. The frog was swallowed head-first in approximately one minute.

Discussion

Microhabitat use in snakes is related to foraging (e.g., Cundall and Greene 2000; Martins et al. 2002; Turci et al. 2009) and the need to avoid predation (e.g., Martins 1993; Martins et al. 2008). Our observations suggesting that *C. grandisquamis* is most frequently encountered in vegetation along streams coincides with data from studies of southern Central American populations (Savage 2002; Solórzano 2004; McDiarmid and Savage 2005) and undoubtedly reflects the species' largely amphibian-based diet (Dixon et al. 1993; Savage 2002; Solórzano 2004; Roberto and Souza 2020), although these snakes also feed on small lizards, birds, and rodents (Scott 1969; Visco and Sherry 2015).

Finding snakes in nature can be difficult due to their elusive nature and cryptic behavior, often non-continuous distributions and low population densities. Consequently,

Fig. 2. Ontogenetic dorsal color change in Ecuador Sipos (*Chironius grandisquamis*) from the Middle Magdalena River Valley, Department of Caldas, Colombia: Juvenile (top); small adult (SVL 1,064 mm, TL 663 mm) (middle); large adult (SVL 1,400 mm, TL 619 mm) (bottom). Photographs by Mateo Marín M. (top) and Julián Andrés Rojas (middle and bottom).

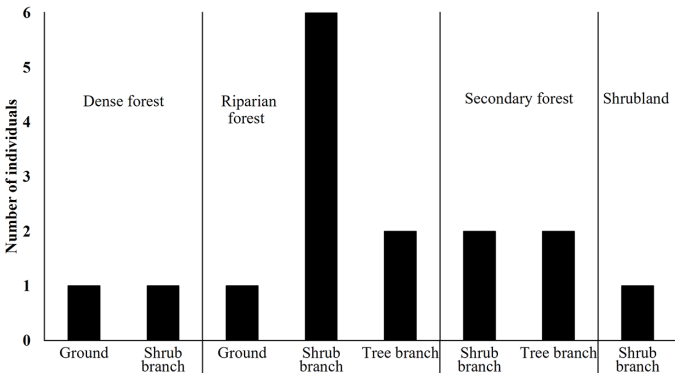

Fig. 3. Frequency of Ecuador Sipos (*Chironius grandisquamis*) encountred in habitats and microhabitats in lowland humid forests of the Middle Magdalena River Valley, Department of Caldas, Colombia.

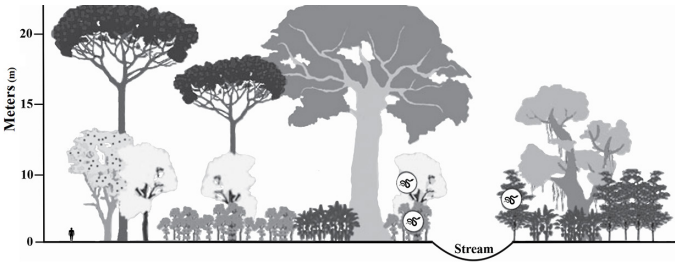

Fig. 4. Schematic showing the nocturnal spatial distribution of Ecuador Sipos (*Chironius grandisquamis*) at study sites in the Middle Magdalena River Valley, Department of Caldas, Colombia. The human figure represents an individual 1.7 m in height.

long-term monitoring is necessary to obtain information concerning natural history, including habitat and microhabitat preferences (Seigel and Collins 1993; Seigel and Mullin 2009). *Chironius grandisquamis* appears to be abundant in the humid forests of southern Central America (Savage 2002; Solórzano 2004; McDiarmid and Savage 2005). In contrast, this species is infrequently recorded in lowland humid and premontane forests of northern South America. Urbina-Cardona et al. (2008) recorded one individual on Gorgona Island in 192 hours of sampling and we found only a few individuals during almost 3,000 hours over a period of six consecutive years.

The high diversity of amphibians (Díaz-Ayala and Zuluaga-Isaza 2015) and other small vertebrates (potential prey for *C. grandisquamis*) and the presence of well-preserved forested habitats and abundant permanent water sources in the study area (see Rojas-Morales et al. 2018, 2019) would suggest that this is suitable habitat for the species. However, activity patterns and use of cryptic microhabitats in complex vegetative communities could easily result in the non-detection of many individuals, generating a bias in the observed abundance. We therefore recommend additional long-term field studies combined with analyses of preserved specimens in scientific collections to provide valuable information on the natural history of *C. grandisquamis* and other Neotropical snakes (e.g., Marques and Sazima 1997; Albuquerque et al. 2007; Sawaya et al. 2008; Guedes et al. 2014).

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Fig. 5. Habitat of the Ecuador Sipo (*Chironius grandisquamis*) in the riparian forest along the stream "La Clara," Norcasia Municipality, Department of Caldas, Colombia (A). A single male (B) and two individuals (C & D) on branches of shrubs at heights over 3 m. Photographs by Julián Andrés Rojas M.

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