Morphology and diet of two sympatric colubrid snakes, *Chironius flavolineatus* and *Chironius quadricarinatus* (Serpentes: Colubridae)

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Abstract. The morphometry and diet of two sympatric species of *Chironius* (*C. flavolineatus* and *C. quadricarinatus*) from Brazilian Cerrado are described. The two snake species differ in external morphology, as *Chironius flavolineatus* was the largest species (body, tail and eyes) whereas *C. quadricarinatus* the heaviest. Each species also showed marked sexual size dimorphism. In terms of dietary ecology, both species feed exclusively on frogs with a heavy preference for hylids and may have tendency to eat small items, as noticed in other colubrine species. These two snake species showed a brownish colour pattern and exhibited no ontogenetic variation, suggesting that juveniles and adults use similar substrates. *Chironius flavolineatus* and *C. quadricarinatus* present a semi-arboreal habit, with active foraging behaviour, feeding in the ground most of time. *Chironius flavolineatus* uses higher vegetation for resting and, based on morphological results, seems to be more arboreal than *C. quadricarinatus*.

Keywords: Cerrado, *Chironius*, food habits, morphometrics, Serpentes, sexual dimorphism, South America.

Introduction

Snake morphology can be influenced by habitat use, diet, and reproductive constraints (Vitt and Vangilder, 1983; Martins and Oliveira, 1999). Often, body shape is related to substrate use (Cadle and Greene, 1994; Marques, 1998; Lillywhite and Henderson, 2001; Martins et al., 2001). Thus, morphometric measurements can provide insights on the substrate use and possibly ontogenetic and intraspecific differences in diet (Arnold, 2001; Hartmann and Marques, 2005). These measurements are easily obtained from preserved animals in scientific collections and show little difference in size and mass from live specimens (Reed, 2001).

The colubrid snake genus *Chironius* Fitzinger, 1826 is endemic of the Neotropical region comprising 20 species distributed from Nicaragua to southern Brazil, northern Argentina and

Uruguay (Dixon, Wiest and Cei, 1993; Hollis, 2006). This genus is composed by diurnal, semi-arboreal, frog-eating snakes (Dixon, Wiest and Cei, 1993; Marques and Sazima, 2004). Two of the species, *C. flavolineatus* (Jan, 1863) and *C. quadricarinatus* (Boie, 1827) occur mainly in the Brazilian Cerrado, a landscape with a predominance of open vegetation (Eiten, 1978; Ab'Saber, 2003; Faria and Araujo, 2004), and are broadly sympatric with each other. *Chironius flavolineatus* is distributed from east of Marajó Island, State of Pará to savanna areas of northeastern Brazil, although it is more common in Central, Northwestern, and Southwestern Brazil whereas *C. quadricarinatus* occurs in Central, Northwestern, and Southwestern Brazil (cf. Peters and Orejas-Miranda, 1970; Dixon, Wiest and Cei, 1993).

Some ecological information are available for Atlantic Forest species (*Chironius bicarinatus*, *C. exoletus*, *C. fuscus*, *C. foveatus* and *C. laevicollis*) (Dixon, Wiest and Cei, 1993; Marques, Eterovic and Sazima, 2001; Marques and Sazima, 2004; Rodrigues, 2007) but, apart from anecdotal information of *C. flavolineatus* and *C. quadricarinatus* (e.g. Dixon, Wiest and Cei, 1993; Feio et al., 1999; Argôlo, 2004; Marques et al., 2005), no study has been published on the

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ecology of these snakes. The present work provides new information on morphometry, sexual dimorphism, diet, and inference of substrate use of these two sympatric species.

Materials and methods

We examined 338 specimens (*Chironius flavolineatus n =* 167; *C. quadricarinatus*, *n =* 171) housed in the following herpetological collections: Museu Nacional, Universidade Federal do Rio de Janeiro (MNRJ), Rio de Janeiro, RJ; Instituto Butantan (IBSP), São Paulo, SP; Universidade Estadual de Campinas (ZUEC), Campinas, SP; Museu de Ciências e Tecnologia, PUCRS (MCP), Porto Alegre, RS; Coleção Herpetológica da Universidade de Brasília (CHUNB), Brasília, DF; Museu de Zoologia da Universidade Federal de Viçosa (MZUFV), Viçosa, MG; Museu de Ciências Naturais da PUC Minas (MCN-R), Belo Horizonte, MG. The examined specimens and localities are listed in the appendix.

The following data were taken from each specimen (measures were modified from Vitt, 1987 and Oliveira, 2003): (1) sex; (2) snout-vent length (SVL); (3) tail length (TAL); (4) head length (HL); (5) eye diameter (ED); (6) body mass (M); (7) reproductive maturity or immaturity; and (8) stomach contents. Males were considered mature if they had enlarged testes and opaque defferent ducts (Shine, 1982). Females were considered mature if they had either ovarian follicles in secondary vitellogenesis or oviduct eggs (Shine, 1980a); the total (TL = SVL + TAL) and trunk lengths (T = SVL − HL) were also calculated.

All food items in the stomach were removed and identified (*sensu* previous Frost et al., 2006; Grant et al., 2006) to the lowest possible taxonomic level. Additionally, each item was measured and weighed. Vestigial items were also compared by linear regressions to complete specimens deposited in Museu Nacional, UFRJ to estimate their length and mass (cf. Hirai and Matsui, 2001). We performed simple regression in order to verify a tendency of prey choice (see Marques and Sazima, 2004; Hartmann and Marques, 2005) for these snake species. For these regression analyses, only adults (frogs and snakes) were used.

We calculate sexual size dimorphism index (SSD) (cf. Shine, 1994) in order to recognize a tendency for male-male combat in species. The degree of SSD was calculated as (mean adult SVL of the larger sex/mean adult SVL of the smaller sex) − 1 (see Gibbons and Lovich, 1990; Shine, 1994).

All linear measures were taken with a dial calliper to the nearest 0.01 mm, except for snout-vent and tail lengths, which were taken with a flexible ruler to the nearest 1.0 mm. Body mass was recorded to the nearest 0.01 g (cf. Martins et al., 2001). Gravid females were excluded from this analysis to avoid bias. The sample included only mature specimens and statistics analyses were made using STATISTICA program for Windows version 6.0 (Statsoft, 2001). Intersexual and interspecific variation were evaluated under MANOVA, in the case of SVL, and MANCOVA, in case of TAL (with SVL as covariate), HL (with T as covariate), M (with TL as covariate) and ED (with HL as covariate) (Zar,

1999). Interactions were checked in all tests and described when present. All variates were natural log transformed. We used a significance index of $P < 0.05$ for all analyses.

Results

Morphometrics

Variation between sexes. — In terms of morphological variation, some differences between sexes in each snake species were evident. Females of both species were significantly larger than their respective males ($F_{1,252} = 13.53$; $P < 0.001$; table 1). However the reverse was found in both species when examining tail length and eye size, as males had significantly longer tails ($F_{1,213} = 8.72$; $P < 0.01$; table 1) and larger eyes ($F_{1,249} = 5.74$; $P < 0.05$; table 1). In contrast, no sexual dimorphisms were found when examining variation in head size and body mass.

The proportions of tail length correspond to 39.9% and 38.9% of total length in males and females of *C. flavolineatus*, respectively, while in *C. quadricarinatus* this proportion was 37.8% and 36.9% in males and females, respectively.

Variation between species. — Our morphological data showed consistent differences between snake species: *Chironius flavolineatus* was larger (SVL) than *C. quadricarinatus* ($F_{1,252} = 46.82$; $P < 0.001$), and the former had longer tails ($F_{1,213} = 129.98$; $P < 0.001$) than the latter species. Relative head size in *C. quadricarinatus* appeared to be larger than in *C. flavolineatus* ($F_{1,249} = 84.53$; $P < 0.001$; table 1). However the marginally significant interaction ($F_{1,249} = 4.21$; $P = 0.04$) may confound these results. As to body mass, *C. quadricarinatus* was significantly heavier than *C. flavolineatus* ($F_{1,179} = 20.10$; $P < 0.001$; table 1). *Chironius flavolineatus* had larger eyes than *C. quadricarinatus* ($F_{1,249} = 30.82$; $P < 0.001$).

Diet

Prey taxa. — *Chironius flavolineatus* and *C. quadricarinatus* fed exclusively on anurans,

Table 1. Morphometric aspects of adults *Chironius flavolineatus* and *C. quadricarinatus*. Mean ± SD. Measures in millimeter (mm). Mass in gram (g).

Measures	*Chironius flavolineatus*		*Chironius quadricarinatus*	
	♀	♂	♀	♂
Snout-vent length (SVL)	714.28 ± 64.59 $r = 606$-894; $n = 68$	670.95 ± 77.18 $r = 507$-880; $n = 40$	645.16 ± 57.29 $r = 478$-812; $n = 91$	621.60 ± 69.11 $r = 504$-77; $n = 57$
Tail length (TAL)	450.95 ± 42.14 $r = 350$-566; $n = 57$	438.54 ± 51.00 $r = 325$-552; $n = 37$	375.36 ± 33.44 $r = 300$-471; $n = 72$	377.37 ± 38.48 $r = 268$-464; $n = 52$
Total length (TL)	1158.35 ± 99.46 $r = 963$-1382; $n = 57$	1100.27 ± 116.82 $r = 832$-1384; $n = 37$	1016.04 ± 91.49 $r = 780$-1272; $n = 72$	998.75 ± 99.71 $r = 814$-1168; $n = 52$
Head length (HL)	24.29 ± 2.11 $r = 18.85$-28.72; $n = 67$	23.52 ± 2.69 $r = 18.22$-30.58; $n = 40$	24.83 ± 2.59 $r = 19.16$-31.92; $n = 90$	23.73 ± 2.37 $r = 19.42$-28.02; $n = 57$
Mass (M)	81.15 ± 33.03 $r = 30$-157; $n = 47$	69.0 ± 30.4 $r = 26$-155; $n = 40$	60.50 ± 19.94 $r = 24$-148; $n = 72$	54.7 ± 19.2 $r = 22$-95; $n = 57$
Eye diameter (ED)	5.00 ± 0.51 $r = 3.77$-6.15; $n = 67$	4.97 ± 0.51 $r = 4.04$-5.99; $n = 40$	4.84 ± 0.50 $r = 3.81$-6.31; $n = 91$	4.78 ± 0.45 $r = 3.72$-5.81; $n = 57$
Trunk length (T)	689.84 ± 63.40 $r = 585.30$-865.70; $n = 67$	647.43 ± 74.80 $r = 488.78$-851.17; $n = 40$	617.52 ± 60.83 $r = 379.92$-781.10; $n = 90$	598.71 ± 68.83 $r = 480.58$-746.17; $n = 57$

mostly from the family Hylidae (71.1% and 80.0% of all items, respectively; table 2). Leptodactylid frogs were also consumed by both snake species (table 2). Three prey items were identified in two *C. flavolineatus*: *Scinax* cf. *fuscovarius*, *Scinax* sp. (tibia, tarsus, and foot) and *Scinax* gr. *ruber* (upper arm, forearm, and hand); and three neonates of *Thoropa miliaris* (two complete and one represented by thigh, tibia, tarsus, and foot). Most prey items were swallowed head-first in both *C. flavolineatus* (65.0%) and *C. quadricarinatus* (60.0%).

Feeding frequency. — Prey items were found in 17 specimens (10.2%) of *Chironius flavolineatus* (males and females) and in 18 specimens (10.5%) of *C. quadricarinatus*. Four specimens of *C. flavolineatus* (two individuals with two prey items each and two others with three prey items) and two of *C. quadricarinatus* (with two prey items each) contained more than one prey in stomach. One (8.3%) gravid female with prey was found in *Chironius flavolineatus* while five

were recorded in *C. quadricarinatus* (35.7%). Stomach item proportion in no gravid females was 91.7% in *C. flavolineatus* ($n = 11$) and 64.3% in *C. quadricarinatus* ($n = 9$).

Prey length: Ratios of prey size to predator SVL average 0.05 ($SD = 0.02$, range 0.02-0.08, $n = 10$) in *Chironius flavolineatus* and 0.07 ($SD = 0.02$, $r = 0.04$-0.09, $n = 6$) in *C. quadricarinatus* (table 3). In both species prey size was not significantly correlated with snake snout vent-lenght (*C. flavolineatus*: $F_{1,8} = 0.08$; $P = 0.78$; *C. quadricarinatus*: $F_{1,4} = 0.43$; $P = 0.55$; fig. 1) or head size (*C. flavolineatus*: $F_{1,8} = 2.54$; $P = 0.15$; *C. quadricarinatus*: $F_{1,3} = 6.30$; $P = 0.09$; fig. 2).

Prey mass body: Ratios of prey mass to predator mass average 0.05 ($SD = 0.06$, $r = 0.00$-0.21, $n = 10$) in *Chironius flavolineatus* and average 0.11 ($SD = 0.09$, $r = 0.03$-0.19, $n = 6$) in *C. quadricarinatus* (table 3). It was not possible to estimate the mass of

Table 2. Prey items in stomach of *Chironius flavolineatus* and *C. quadricarinatus* with literature notes.

	Chironius flavolineatus (n = 17)	*Chironius quadricarinatus* (n = 18)
AMPHIBIA		
HYLIDAE		
Hypsiboas albopuncatus	1	2
Hypsiboas bischoffi	1	
Hypsiboas cf. *lundii*		1
Hypsiboas raniceps	1	
Scinax cf. *fuscovarius*	2	
Scinax cf. *x-signatus*	2	
Scinax gr. *Ruber*	1	3
Scinax sp.	6	5
Not identified	3	6
Literature data	10	7
(Dixon, Wiest and Cei, 1993)		
	27 (71.1%)	24 (80%)
LEPTODACTYLIDAE		
Physalaemus cf. *cuvieri*	1	
Physalaemus cf. *fuscomaculatus*		1
Thoropa miliaris (juv)	3	
Not identified	1	
Literature data	4	1
(Dixon, Wiest and Cei, 1993)		
	9 (24%)	2 (6.7%)
Not identified family	1	2
Literature data	1	2
(Dixon, Wiest and Cei, 1993)		
	2 (5.3%)	4 (13.3%)
TOTAL	38	30

Physalaemus cf. *fuscomaculatus* and *P*. cf. *cuvieri*. There was no significance correlation between prey mass and snake mass in *C. flavolineatus* ($F_{1,8} = 0.20$; $P = 0.67$) and in *C. quadricarinatus* ($F_{1,4} = 0.81$; $P = 0.42$) (fig. 3).

Discussion

Female body size in snakes is highly correlated with clutch size (Parker and Plummer, 1987). Thus, females only begin to reproduce when they reach an enough body reserve to produce and carry their eggs or embryos (Shine, 1978a; Bell, 1980; Bonnet and Naulleau, 1996; Aubret et al., 2002; Bonnet et al., 2002; Shine, 2003). Therefore, female snakes are often under selective agents to have larger size (SVL) than males (Shine, 1994), in conformity with the data herein presented.

Shine (1994) argued that the sexual size dimorphism (SSD) may be used to indicate tendency of occurrence of male-male combat. This index is expressed by positive (if females are larger) or negative (if males are larger) value. Shine (1994) suggests that male-male combat favour the evolution of large body size in male snakes. In fact, Shine (1994) predicts that combat is present among all species with males larger than females. A high association between occurrence of male-male combat and degree of SSD has been reported and many recent studies on Neotropical snake species has used such index to infer absence or presence of combat (see Pizzatto and Marques, 2002; Alves, Argôlo and Jim, 2005; Hartmann and Marques, 2005; Marques et al., 2006; Pizzatto and Marques, 2006; Marques and Muriel, in press). For species of *Chironius* in which com-

Table 3. Prey size (SVL) and mass size, ratio of prey size to snake snout vent length (RPS), and ratio of prey mass to snake mass (RPM) in *Chironius flavolineatus* and *C. quadricarinatus*. Estimated values are show in bold.

Snake species	Prey species	SVL	RPS	MASS	RPM
Chironius flavolineatus	*Hypsiboas albopunctatus*	**54.24**	0.07	**9.96**	0.10
	Hypsiboas bischofii	43.46	0.07	3.00	0.05
	Hypsiboas raniceps	**64.34**	0.08	**17.44**	0.21
	Physalaemus cf. *cuvieri*	**30.12**	0.04	**X**	X
	Scinax cf. *fuscovarius*	39.41	0.06	2.21	0.03
	Scinax cf. *fuscovarius*	31.78	0.05	1.48	0.02
	Scinax cf. *x-signatus*	30.61	0.05	1.70	0.04
	Scinax cf. *x-signatus*	34.70	0.05	2.00	0.02
	Thoropa miliaris (juv)	20.79	0.03	0.60	0.01
	Thoropa miliaris (juv)	17.57	0.02	0.39	0
	Thoropa miliaris (juv)	X	X	0.31	0
Chironius quadricarinatus	*Hypsiboas albopunctatus*	**54.11**	0.09	**9.89**	0.19
	Hypsiboas albopunctatus	**56.46**	0.09	**10.98**	0.18
	Hypsiboas cf. *lundii* (juv)	**27.87**	0.04	**2.00**	0.03
	Scinax gr. *ruber*	44.78	0.06	4.50	0.07
	Scinax gr. *ruber* (juv)	33.42	0.05	1.82	0.03
	Scinax sp.	45.10	0.09	6.44	0.18

bat reported (Starace, 1998 for *C. carinatus*; Almeida-Santos and Marques, 2002 for *C. bicarinatus*), males are larger than females and attain maximum length (cf. Dixon, Wiest and Cei, 1993; Rodrigues, 2007). Although a very few species with smaller males than females show male combat (Shine, 1978b), the positive SSD value obtained for *C. flavolineatus* and *C. quadricarinatus* suggest absence of male-male combat in both species (cf. Shine, 1994). Besides, females of *C. flavolineatus* and *C. quadricarinatus* were larger and attained maximum length. Moreover, a courtship involving six males probably competing for copulation with one female was reported to *C. flavolineatus* (Feio et al., 1999). Thus, ritual combat behaviour may not be wide spread in *Chironius* genus.

In snakes, substrate use is commonly associated with body morphology including length, mass, and some anatomical structures (Peters, 1960; Marx and Rabb, 1972; Dixon, Thomas and Greene, 1976; Savitzky, 1983; Greene, 1989). In the present study, tail represents almost 40% of total length (mean of both sex and species). This value is similar to other *Chironius* species (Rodrigues, 2007) and other arboreal colubrid species (see Lillywhite and Hen-

derson, 2001). Sexual dimorphism in tail length was found in both species. Since males have hemipenes and associated muscles situated in base of tail, they should have the longest tail (King, 1989). The presence of large eyes, slender body, and long tail can be indicative of arboreal substrate use (Cadle and Greene, 1994; Lillywhite and Henderson, 2001; Hartmann and Marques, 2005). *Chironius flavolineatus* and *C. quadricarinatus* may therefore be associated with arboreal habitats in Cerrado domain (the South American savanna).

Our study shows that males had significantly larger eyes than females. Sexual size dimorphism in eye diameter is known for other *Chironius* species from Atlantic Forest (Rodrigues, 2007) and other colubrids (e.g., *Dendrelaphis* see Greene, 1997). Here, we interpreted this dimorphism with possible greater mobility and other exclusive male activities (e.g. search for females).

Chironius flavolineatus have larger eyes, larger body, and longer tail than *C. quadricarinatus*, suggesting that the former can be more arboreal than the latter; however, it does not seem to be strictly arboreal. Observations in nature showed that *C. flavolineatus* usually for-
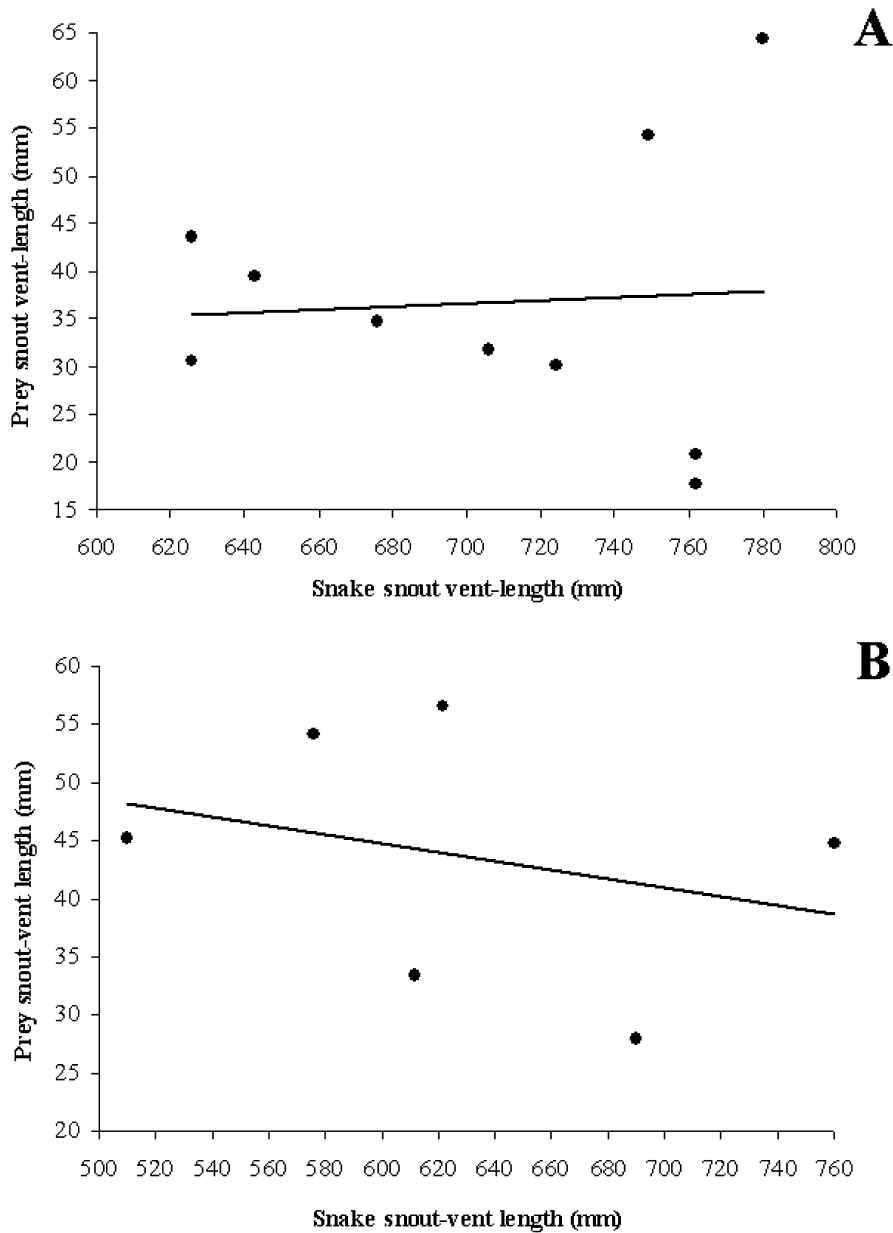
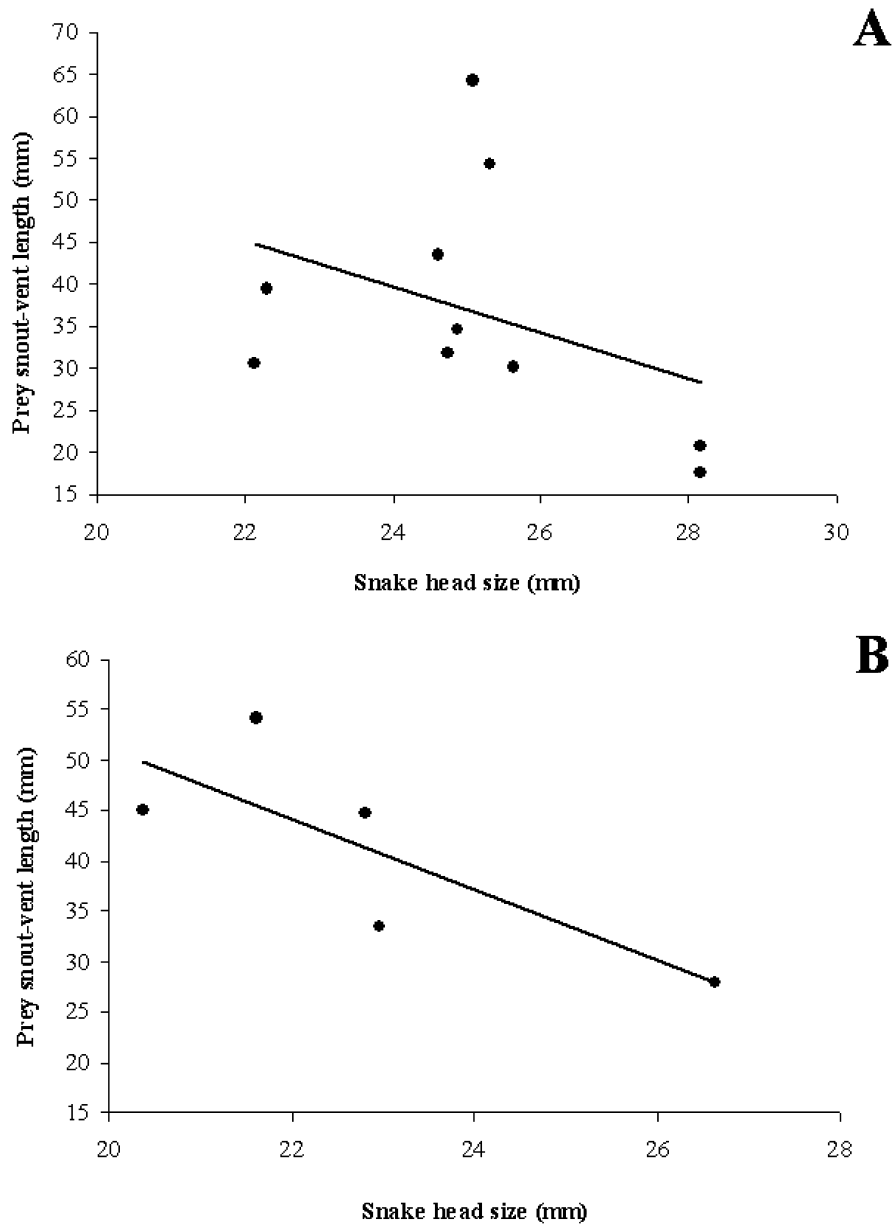**Figure 1.** Relationship between snake size (SVL) and prey size (SVL) in *Chironius flavolineatus* (A) and *C. quadricarinatus* (B).

age on ground (C. Nogueira; H. Ferrarrezzi; R.J. Sawaya; C.R. de Abreu; D.S. Fernandes; R.A.K. Ribeiro; L.V. da Silva Campos Filho, pers. comm.) and can rest at night in vegetation ca. 2 m above ground (Sawaya, 2004).

Colour patterns (such as green or brown) are predominant in arboreal species, rendering their bodies cryptic against backgrounds of green foliage or branches (Lillywhite and Henderson, 2001). An ontogenetic study in two *Chironius* spp. (*C. laevicollis* and *C. scurrulus*) demonstrated that a different colour pattern in juveniles and adults were associated with differences in use of substrate (Marques and Sazima,

Figure 2. Relationship between snake head size (HL) and prey size (SVL) in *Chironius flavolineatus* (A) and *C. quadricarinatus* (B).

2003). *Chironius flavolineatus* and *C. quadri-carinatus* show a similar dorsal colour pattern (brownish) with no ontogenetic variation in both species, which conflicts with previous authors' observation (Dixon, Wiest and Cei, 1993) for *C. quadricarinatus*. As a whole, it is possible that juveniles and adults use similar substrates.

The dietary data recorded for *Chironius flavo-lineatus* and *C. quadricarinatus* in the present study are consistent with previous informa-tion published on the ecology of this genus (Dixon, Wiest and Cei, 1993; Marques and Sazima, 2004; Marques et al., 2005). Lizards and birds are occasionally eaten by some *Chi-*
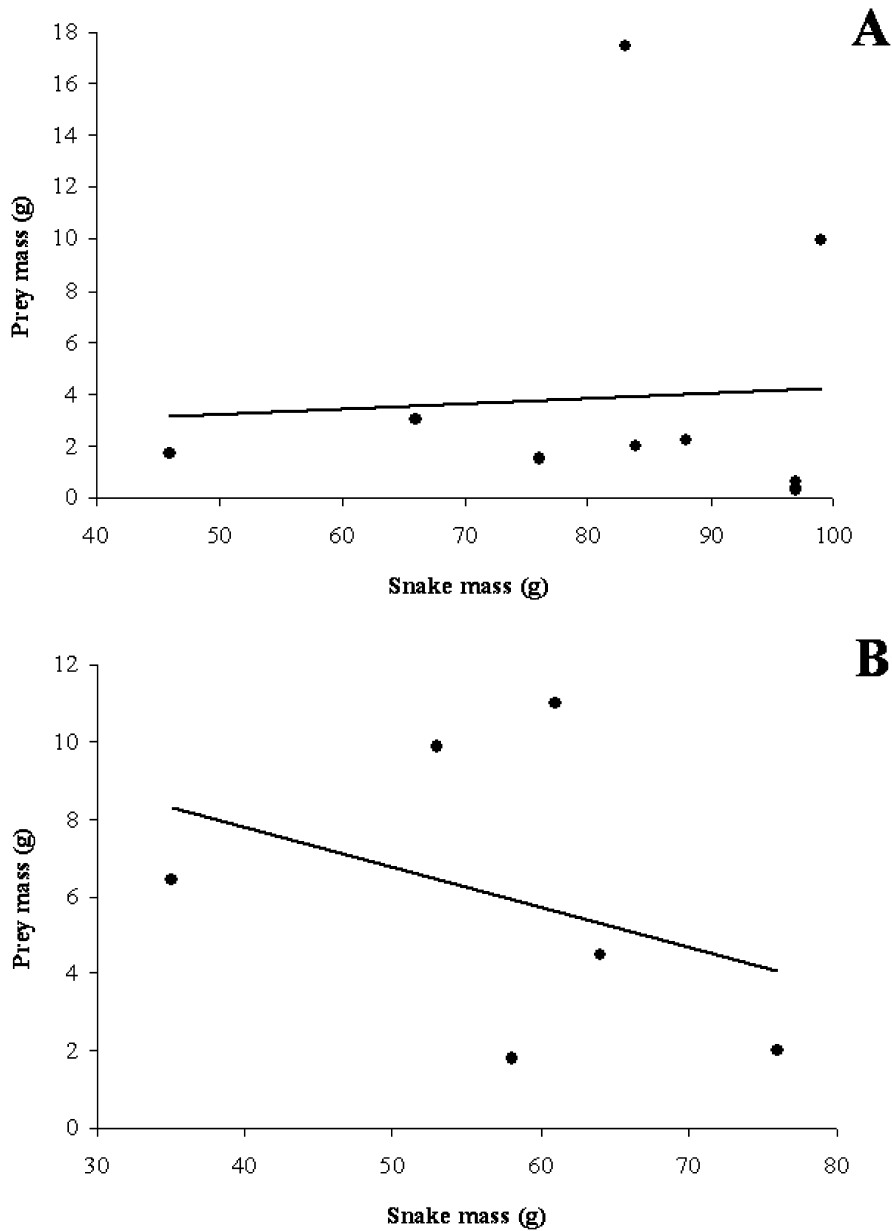
Figure 3. Relationship between snake mass and prey mass in *Chironius flavolineatus* (A) and *C. quadricarinatus* (B).

ronius species (Dixon, Wiest and Cei, 1993; Marques and Sazima, 2004; Rodrigues, 2007), but such was not recorded in either species in this study, although lizards are an abundant resource in the Cerrado (Colli, Bastos and Araujo, 2002). Hylid frogs were the most common prey item for *C. flavolineatus* and *C. quadricarinatus*. Moreover, their diet was composed by noc-

turnal prey (Haddad and Sazima, 1992; Elias, 2003; Guimarães and Bastos, 2003; Giaretta and Facure, 2004; Pimenta, 2004). Considering that both snake species are diurnal active foragers (Marques et al., 2005) whereas hylids are nocturnal, we suggest that prey were captured in their daytime resting places. In fact, Haddad and Sazima (1992) reported an arboreal (all veg-

etation above ground, e.g., bushes, shrubs, and different sizes of tree) or ground rest at daytime for some hylids here found as stomach contents (e.g., *Scinax* spp.). Thus, food and feeding habits also indicate that both species of *Chironius* can use ground, and also arboreal substrates (see above).

The tendency to eat small prey may be a common trait in colubrine snakes (see Seib, 1984; Marques and Sazima, 2004; Marques and Muriel, in press.). Both species of *Chironius* studied here also eat very small prey confirming that pattern. Additionally, both species also swallowed headfirst, which is the most common strategy used by snakes that feeds small size of preys (Greene, 1997).

The proportion of gravid females with stomach contents was very low in comparison to non gravid females, indicating a reduction in foraging activity during this stage in *Chironius flavolineatus* (see Shine, 1980b; Plummer, 1997; Gregory, Crampton and Skebo, 1999; Shine, 2003). However, the sample of specimens with prey contents was not sufficiently large to test this hypothesis.

Similarities with other colubrine species pointed out here, such as proportion on tail length, eye size dimorphism, and tendency to eat small prey, shows us that morphology and diet may be conservative.

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Appendix

Specimens Examined:

Chironius flavolineatus – MATO GROSSO: Xavantina (MNRJ 9273-75). **TOCANTINS:** Palmas (CHUNB 21959-60). **BAHIA:** Corumbá de Goiás (IBSP 49828). **GOIÁS:** Cristalina (IBSP 45195); Formosa (CHUNB **19698**); Itumbiara (IBSP 42851); UHE Serra da Mesa, Minaçu (MCP 8192-96, 8219, 8227-28, 8426-27, 8568); Pirenópolis (CHUNB 3632); Uruaçu (MNRJ 7495). **DISTRITO FEDERAL:** Brasília (CHUNB 3633; MNRJ 3242). **GOIÁS/MINAS GERAIS:** UHE Queimados (Luziânia-GO; Unaí-MG) (MNRJ 10929). **MINAS GERAIS:** Antonio Carlos (IBSP 18838, 19633, 22683, 24056); Barra Feliz (IBSP 17304); Belo Horizonte (MCNR 440); Conceição do Mato Dentro (MCNR 534); Cruzília (IBSP 30978); Jaíba (MZUFV 943-44, 946); João Pinheiro (MNRJ 12900-01); Juiz de Fora (IBSP 32266, 33044, 33180); Matias Cardoso (IBSP 67911); Miguel Burnier (IBSP 16587); Nova Lima (MCNR 1466, 1474); Nova Ponte (MNRJ 4696); Perdões (MCNR 509); Poço de Caldas (IBSP 42435; ZUEC 2013); Presidente Olegário (MNRJ 6702); Santa Bárbara (IBSP 30000, 55525); Três Corações (IBSP 34154); Uberlândia (MCNR 1290). **MINAS GERAIS/SÃO PAULO:** UHE Igarapava (Rifaina, Igarapava-SP; Conquista, Uberaba e Sacramento-MG) (MCNR 791-93). **SÃO PAULO:** Agudos (IBSP 31520, 31555, 32066, 34314, 46183); Andradina (IBSP 19553); Angatuba (IBSP 32774, 45714, 46124); Américo Brasiliensi (ZUEC 2470); Araçatuba (IBSP 25297, 25362, 31801, 32555); Araçariguara (IBSP 56960); Araraquara (IBSP 16580, 16588); Avaré (IBSP 58747); Bauru (IBSP 34476, 59585); Bento de Abreu (IBSP 23288); Birigui (IBSP 28828); Boa Esperança do Sul (IBSP 41106); Boituva (IBSP 18134, 32168); Brotas (IBSP 67874; ZUEC 1021); Buri (IBSP 20939); Capão Bonito (IBSP 33577, 43210); Catanduva (IBSP 23186); Catinguá (IBSP 16375); Cesário Longe (IBSP 43069); Colômbia (IBSP 32250); Descalvado (IBSP 23456, 43653, 64916); Fernandópolis (IBSP 32666); Franca (IBSP 1183, 1815, 27878); Glicério (IBSP 22922); Guararapes (IBSP 32676); Ibitinga (IBSP 23367); Indaiatuba (IBSP 57466); Inúbia Paulista (IBSP 33472); Itapetininga (IBSP 45756, 55645); Itapeva (IBSP 28487); Itú (IBSP 46970, 59006, 68527, 70687); Ituverava (IBSP 32100); Jaboticabal (IBSP 11820, 50599); Jaú (IBSP 27775); Lins (IBSP 15449, 43624); Matão (IBSP 32580, 32626, 43040); Piedade (IBSP 33609, 58761, 71558); Pilar do Sul (IBSP 59643); Pirassununga (IBSP 27508, 33525, 69494, 69994); Pratânia (ZUEC 994); Ribeirão Branco (ZUEC 1585); Ribeirão Preto (IBSP 21811); Rosana (Porto Primavera) (IBSP 43640-41, 43643, 43645); Santa Rita do Passa Quatro (IBSP 31754); São José do Rio Preto (IBSP 16594, 30343, 30813); São Miguel Arcanjo (IBSP 52221); Sorocaba (IBSP 24568, 25326, 24586); Uchôa (IBSP 28082, 28132). **PARANÁ:** Porto Rico (IBSP 31244). **MATO GROSSO DO SUL:** Aquidauana (MNRJ 1511); Campo Grande (IBSP 42295, 42395, 42968-69); Jupiá (IBSP 21653, 21814, 22599, 22607, 21902, 29369); Nioaque (IBSP 40423); Paranaíba (IBSP 46116).

Chironius quadricarinatus **– MATO GROSSO:** Barra do Garças (IBSP 19957); Barra do Tapirapé (MNRJ 587). **TOCANTINS:** Natividade (IBSP 32586); Santa Isabel (IBSP 12056). **GOIÁS:** Alto Paraíso de Goiás (CHUNB 20327); Aruanã (IBSP 42177); Itumbiara (IBSP 33588,

33590); Luziânia (CHUNB 20328, 20331). **DISTRITO FEDERAL:** Brasília (CHUNB 20323). **GOIÁS/MINAS GERAIS:** UHE Queimados (Luziânia-GO e Unaí-MG) (MNRJ 10926-28; MCNR 1018). **MINAS GERAIS:** Brumadinho (MCNR 642); Carmo do Rio Claro (MNRJ 1841); Cataguases (MCNR 907); Coronel Fabriciano (IBSP 22996, 23124); Frutal (IBSP 37268); Grão Mogol (IBSP 56504); Jacuí (IBSP 64890); Juiz de Fora (IBSP 27832-34, 27950, 29144-45, 31341, 33358, 34201, 40749, 40752-53, 45665); Lagoa Santa (MNRJ 1324); Lima Duarte (IBSP 15323); Machado (IBSP 14362); Ouro Fino (IBSP 15270, 15486, 57303; ZUEC 72); Ouro Preto (MCNR 080); Pirapora (MNRJ 4019); Rio Casca (MNRJ 1967); Rio Pandeiro (IBSP 9168); São Vicente de Minas (IBSP 70580); Sossego (IBSP 28531); Uberaba (IBSP 10948, 31550, 31553); Uberlândia (IBSP 15680, 57351); UHE Irapé (Botumirim) (MCNR 1598). **MINAS GERAIS/SÃO PAULO:** UHE Igarapava (Rifaina, Igarapava-SP; Conquista, Uberaba e Sacramento-MG) (MCNR 152). **SÃO PAULO:** Agudos (IBSP 31487, 44193); Andradina (IBSP 27785, 28928); Aparecida (IBSP 19497, 30314, 30323); Araçatuba (IBSP 27424, 31735, 31746, 32616); Atibaia (IBSP 17511, 19400-01, 58565, 61203); Avaré (IBSP 13165, 23099, 23110); Bauru (IBSP 17035); Bofete (IBSP 70070); Botucatu (IBSP 22481, 59520); Bragança Paulista

(IBSP 30573); Buri (IBSP 18267-68, 18298, 18651); Caçapava (IBSP 29108); Campinas (IBSP 17895, 18461, 58515; ZUEC 70-71, 164, 182, 503, 509, 887, 1020); Campo Alegre (IBSP 846); Campo Largo (IBSP 16583); Capivari (IBSP 70531); Carapicuíba (IBSP 27082, 55386); Cesário Longe (IBSP 66423); Coimbra (IBSP 16571); Conchas (IBSP 790); Cotia (IBSP 5194); Espírito Santo do Turvo (IBSP 66532); Franca (IBSP 315); Guaratinguetá (IBSP 28813); Guarulhos (IBSP 21519, 26904); Jundiaí (IBSP 29491, 62002, 66735, 68137); Lins (IBSP 32496); Nova Odessa (ZUEC 2681); Piedade (IBSP 33610); Pilar do Sul (IBSP 50271, 58291; MCP 7299); Pindamonhangaba (IBSP 18824, 22107-09, 27414, 55637, 60674, 67527, 67875); Rincão (IBSP 28958); São José dos Campos (IBSP 18485, 23716, 26936, 28088, 28098, 28406-07, 29244, 67794, 68601). **MATO GROSSO DO SUL:** Água Boa (IBSP 56803-04); Campo Grande (IBSP 15242, 27784); Corumbá (IBSP 17003, 17045, 17211, 17284-85, 18822, 40932); Dourados (IBSP 24672); Jupiá (IBSP 22030, 22035, 21901, 22208, 22643, 22970, 27642, 29301, 29357, 29550,); Miranda (IBSP 55126); Nova Andradina (IBSP 19142, 27413); Paranaíba (IBSP 46121); Ponta Porã (IBSP 17023, 18296, 23735, 26787, 42398).