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Ecology of *Bothrops neuwiedi pauloensis* (Serpentes: Viperidae: Crotalinae) in the Brazilian Cerrado

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ABSTRACT.—We provide ecological information on *Bothrops neuwiedi pauloensis* (Amaral, 1925) regarding geographical distribution, habitat use, biometry, feeding habits, and reproduction, based on field studies and analysis of 175 preserved specimens. *Bothrops n. pauloensis* is endemic to the Brazilian Cerrado, where it occurs in open, seasonally dry savannas. Sexes are dimorphic in body length, relative tail length and relative body mass, but not in relative head length or diet. A wide array of prey, from centipedes to rodents, is consumed, and there is an ontogenetic dietary shift from ectotherms to endotherms. Prey-predator mass ratios ranged from 0.006–0.571. Although prey mass increased with snake mass, large snakes also ate many small prey. There was no difference in relative prey mass between sexes. Reproduction was highly seasonal, with a long vitellogenic period. Embryos were found only from October to December (rainy season). Litter size ranged from 4–20, and was dependent on female size. Although *B. n. pauloensis* occupies seasonally dry savannas, its ecological characteristics are similar to those described for *Bothrops* species inhabiting forested habitats.

The *Bothrops neuwiedi* species complex is currently divided into 12 subspecies occurring in open habitats south of the Amazon basin (Hoge, 1965; Campbell and Lamar, 1989), mostly in the Cerrado morphoclimatic domain, the second largest Neotropical ecosystem (Eiten, 1972). Taxonomic studies underway (V. X. Silva, pers. comm.) indicate that *B. n. pauloensis* (Fig. 1A) may be considered a full species in the future, as may other populations in the *neuwiedi* complex. It was suggested that populations assigned to *B. n. pauloensis* are restricted to humid and cool regions in southern São Paulo state (Hoge, 1965; Campbell and Lamar, 1989).

Although early *Bothrops* were probably forest inhabitants (Martins et al., in press), which orig-

inated in Central America (Parkinson, 1999), the genus is now widespread in South America, with about 40 species occupying a wide array of habitat types such as lowland evergreen forests, montane semideciduous forests, savannas, and montane open formations (Hoge, 1965; Campbell and Lamar, 1989). Snakes of the genus *Bothrops* are generally common, conspicuous members of Neotropical communities (see Campbell and Lamar, 1989; Martins and Oliveira, 1998; pers. obs.), and up to five species may be found in sympatry (pers. obs.).

Apart from anecdotal information (Vanzolini, 1948; Amaral, 1978) and few specific studies (Leloup, 1975, 1984; Sazima, 1992; Martins and Oliveira, 1998), very little has been published on the natural history of *Bothrops*. For example, there are no detailed studies on the species of

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FIG. 1. Upper: Young female (283 + 34 mm) *Bothrops neuwiedi pauloensis* (IB 59934) resting inside a wide cavity under a termite mound in *campo limpo* (cerrado grassland). Lower: a general view of a *campo sujo* (grassy scrubland), the typical habitat of the subspecies, at Emas National Park, central Brazil.

Bothrops occurring in open habitats such as Cerrado and Caatinga (that together account for about 3 million km² in Brazil). An accelerated and unprecedented rate of destruction of the Cerrado ecosystem has occurred in the last few decades, caused mainly by the expansion of agriculture and cattle grazing in central Brazil (Myers et al., 2000). Thus, studies on Cerrado faunal components are of urgent importance for conservation (Greene, 1989; 1994; Colli et al., 1998). Here we provide ecological information on *B. n. pauloensis* regarding geographical distribution, habitat use, biometry, feeding habits, and reproduction.

MATERIALS AND METHODS

Most of the field observations are from Emas National Park (ENP), in southwestern Goiás, central Brazil. Emas National Park (18°17'S, 52°59'W, 800 m average altitude) is a large (ca. 130,000 ha) preserved tract of Cerrado, mostly covered by grassy scrubland (*campo sujo*, Fig. 1B) and cerrado grassland (*campo limpo*). Addi-

tional snake searches were performed at two other Cerrado reserves: Itirapina Ecological Station (IES), São Paulo (22°15'S, 47°49'W, 750 m average altitude; about 2500 ha), and preserved Cerrado areas around Brasília (BRA; mostly at IBGE Biological Reserve, 15°57'S, 47°53'W, 1000 m average altitude; about 1350 ha), Distrito Federal. Itirapina Ecological Station is covered mostly by grassy scrubland (*campo sujo*), with patches of wet grasslands, gallery forests, and open savannas (*campo cerrado*). The Cerrado areas around Brasília are dominated by dense savannas (*cerrado sensu stricto*), although grasslands, gallery forests and wet grasslands are also present. Other similar areas in the vicinities of the main study sites were used in sporadic searching activities and opportunistic observations. For an overview of Cerrado vegetation, see Anonymous (1999) and Eiten (1972). The seasonally dry tropical climate in ENP and in most of the range of *B. n. pauloensis* is typical of central Brazil, showing distinct wet (October–May) and dry seasons (June–September; see Colli and Pinho, 1997). Detailed descriptions of habitats of Emas National Park, the main study site, are available in Redford (1985).

Snakes were obtained in the field through time constrained search (TCS, only at night; Martins and Oliveira, 1998), road sampling (Fitch, 1987), and opportunistic encounters (all the snakes found in situations other than searching activities), from July 1997 to July 2000. Almost all snakes found in the field were collected, except those in very poor condition (e.g., some roadkills). For each individual found, we recorded (1) time and date of encounter, (2) type of habitat and microhabitat, and (3) type of activity when they are seen at first (moving, ambush, resting). Time-constrained search was performed mainly at night, when higher encounter rates are usually obtained (Martins and Oliveira, 1998). Most searching activities were performed in recently burned areas or shortly after prescribed fires, since the removal of grassy cover by fire made snakes more visible in the field. During TCS, we searched for snakes above ground, as well as in shelters (e.g., ground cavities, under termite mounds). Preventive prescribed fires were used at ENP during the period of this study; patches of cerrado vegetation are burned in the beginning of the dry season (May–June) to avoid the propagation of wildfires. At IBGE, some patches of natural vegetation are periodically burned, as a part of a study on the effects of fires on the Cerrado vegetation.

Laboratory studies were based on the examination of 175 museum or freshly killed specimens from several localities in the Brazilian cerrado, covering most of the range of *B. n. pauloensis* in central and southeastern Brazil (ex-

amined material and localities listed in the Appendix 1). Museum specimens were analyzed only if incorporated in collections without having been kept in captivity. Most of the museum specimens analyzed were deposited at the herpetological collection of Instituto Butantan (IB), and additional specimens were examined at Universidade de Brasília (CHUNB), Museu Nacional do Rio de Janeiro (MNRJ), and Museu de História Natural da Universidade Estadual de Campinas (ZUEC).

For each preserved specimen, the following data were recorded (1) snout-vent length (SVL); (2) head length (HL, according to Forsman, 1994); (3) tail length (TL, all to the nearest 0.5 mm); (4) body mass (prey and/or litter removed) to the nearest 1 or 2 g; (5) prey type in the gut (if present); (6) sex; (7) sexual maturity; (8) number of ovarian embryos; and (9) diameter of largest ovarian follicles or encapsulated oviducal embryos (to the nearest 0.5 mm). Males were considered mature if they had enlarged testes or opaque efferent ducts, whereas females were considered mature if they had either oviductal eggs or ovarian follicles > 5 mm (Shine, 1980). Methods for detecting prey in the lower intestine follow Daltry et al. (1998). To obtain a larger dietary sample and to avoid introducing bias against quickly digested items (e.g., amphibians), we use combined information from food items found in the stomach and in the hindgut (Schoener, 1989). Whenever possible, prey mass was inferred by comparison with reference specimens of similar size (Greene, 1989), either obtained in collections or in the field (e.g., lizards, centipedes, and amphibians from the study areas). Direction of ingestion was also recorded.

Two geographical samples (central and southeastern Brazil) were compared to detect geographic variation in biometry. We have made no test to detect geographical variation in feeding habits, because our geographical samples were not collected in similar ways. Snakes from central Brazil were killed the same day they were found, whereas those from southeastern Brazil were kept in captivity for short periods, which could result in bias against quickly digested prey. However, as we have studied taxonomically well-defined populations, which inhabit similar habitats (probably with similar prey availability), we assume that geographical differences in diet do not exert a strong effect on our results.

To detect differences between the number of snakes found with road sampling during wet and dry seasons, as well as during daytime and at night, we generated expected numbers after correcting for unequal sampling efforts (Seigel, 1992). We determined the relative sampling ef-

fort by dividing the distance driven in each season/period by the total distance driven. Using a null hypothesis of equal activity between seasons/periods, we then generated the expected number of snakes active in each season/period by multiplying the total number of snakes found active by the relative sampling effort for each season/period.

Sexual dimorphism in body length was compared via one-way ANOVA on SVL. All other biometrical comparisons between sexes or geographical samples used the residuals of the regression of log-transformed variables, compared via one-way ANOVA (see Forsman, 1994). Regression residuals were used to provide size-corrected variables (Forsman, 1994) and will be referred to as relative variables. Relative head length was obtained via the residuals of the regression of log-transformed head length on log-transformed trunk length (SVL-HL). Relative tail length was obtained via the residuals of tail length (TL) on SVL. Relative mass was compared through the residuals of body mass on total length (SVL+TL). Log-transformed variables, including litter size and female body length in fecundity analysis were used as these provide linear distributions and reduce heteroscedasticity (see King, 2000). Sexual variation in diet was tested using Fisher's exact test; sexual variation in relative prey mass was tested using ANCOVA with SVL as the covariate. We tested for ontogenetic dietary shift by comparing the SVL of individuals that ate endothermic prey with the SVL of those that ate ectothermic prey using a Kruskal-Wallis ANOVA (see Rodriguez-Robles et al., 1999). Significance level for statistical tests was $\alpha = 0.05$. Means and standard deviations are reported as $\bar{x} \pm SD$. All statistical analyses were performed using Statistica (StatSoft, Statistica for Windows, Release 5.1 J. StatSoft, Inc., Tulsa, OK, 1998).

RESULTS

Habitat Use and Activity.—A total of 83 individuals of *B. n. pauloensis* were observed in the field, 75 of them at ENP: 44 (59%) during TCS (see below), 23 (31%) during road sampling, and eight (10%) opportunistically. Eight individuals were found at IES and BRA: one during TCS, five opportunistically at the former, and two opportunistically at the latter. A total of 863.5 person-hours (p-h) of nocturnal TCS were performed in the three study areas. Sampling effort in interfluvial habitats (grasslands, grassy scrublands, open or dense savannas) ranged from 82–303 p-h and 0–0.266 snakes were encountered per hour at the three sites. By contrast, 94–122 p-h yield no snakes in gallery forests/wet grasslands. During TCS of interfluvial habitats (total of 550.8 p-h of search), no snake

TABLE 1. Prey of *Bothrops neuwiedi pauloensis* from central and southeastern Brazil.

Prey type		Number of records
Centipedes	<i>Scolopocryptops miersi</i>	1
	<i>Scolopendra</i> sp.	2
	<i>Otostigmus</i> sp.	3
	unidentified centipedes	4
Amphibians	<i>Scinax fuscovarius</i>	1
	Hylidae	2
Lizards	unidentified frogs	7
	<i>Cercosaura ocellata</i>	5
	<i>Mabuia</i> sp.	2
	<i>Tropidurus</i> sp.	2
	Lizard eggs	2
Snakes	Gymnophthalmidae	3
	unidentified lizards	3
	<i>Apostolepis assimilis</i>	1
Birds	unidentified snakes	4
	<i>Volatinia jacarina</i>	1
Mammals	unidentified birds	2
	<i>Callomys tener</i>	1
	<i>Gracilinanus agilis</i>	1
	Chiroptera	1
	unidentified mammals	21

was found at BRA (82.7 p-h), and the encounter rate at ENP (0.266) was much higher than that at IES (0.003 snakes/p-h).

Of the 45 individuals of *B. n. pauloensis* found during nocturnal TCS, 26 (mostly juveniles) were inside small burrows in the ground or under termite mounds (including five snakes found sheltered shortly after a fire), 24 of them evidently in ambush posture and at least two resting (Fig. 1A). Nineteen were on the ground: five moving, 12 in ambush posture, and two killed, one by a burrowing owl (*Athene cucularia*; see Valdujo and Nogueira, 2000), and another by a prescribed fire.

A total of 4575 km of road sampling was performed at ENP: 3169 km during daytime, resulting in four individuals found (0.001 snakes/km) and 1406 km at night, when seven specimens were observed (0.005 snakes/km). After correction for uneven sampling effort, the number of snakes found in the wet season was significantly higher than expected, whereas in the dry season, it was lower than expected (10 and

4.08 in the wet season and 1 and 6.92 in the dry season, respectively; $\chi^2 = 13.65$, $P < 0.001$). The number of snakes found at night was significantly higher than expected, whereas during daytime, it was lower than expected (7 and 3.38 at night and 4 and 7.62 during daytime, respectively; $\chi^2 = 5.59$, $P = 0.018$).

Biometry.—Body size ranged from 188 + 40 mm (SVL + TL; juvenile male) to 823 + 115 mm (mature female). Sexual size dimorphism was evident in *B. n. pauloensis* ($F_{1,65} = 58.14$, $P \ll 0.01$), with mature females (mean SVL 656 ± 71 mm; range 475–823 mm) being larger than mature males (mean SVL 545 ± 71 mm; range 430–685 mm). Mature females had greater relative masses ($F_{1,52} = 7.09$; $P = 0.01$) and shorter tails ($F_{1,63} = 29.22$; $P \ll 0.01$) than males. Relative head size was not different between mature males and females ($F_{1,64} = 3.29$; $P = 0.07$). There was no difference in body size ($F_{1,82} = 2.13$; $P = 0.14$) or relative head size ($F_{1,63} = 1.64$; $P = 0.20$) between mature snakes from central and southeastern Brazil.

Diet.—Sixty-nine prey items (Table 1) were found in 61 snakes (35%) of 175 specimens of *B. neuwiedi pauloensis* analyzed (Table 2). The percentage of fed snakes rose to 45% when only the 92 specimens obtained in the field are considered; this percentage in the 83 museum specimens analysed was 24%. Main prey types included mammals (35% of prey found), lizards (25%), centipedes (14%), anurans (14%), snakes (7%), and birds (4%). Seven snakes had more than one prey in the entire gut, and only two of them had more than one prey in the stomach (both juveniles; one with a centipede and two lizard eggs, and another with two lizards). Of 19 prey for which direction of ingestion could be recorded, 17 were ingested head first.

Prey-predator mass ratio ranged from 0.006–0.571 (0.189 ± 0.196, $N = 17$). Although prey mass increased with snake mass, the relationship between prey mass and predator mass was not significant ($F_{1,15} = 2.23$, adjusted $r^2 = 0.071$, $P = 0.156$), probably because adults continued feeding on relatively small prey. There was no difference between male and female prey mass ($F_{1,13} = 0.01$, $P = 0.930$). Snakes that consumed endotherms were significantly larger than those

TABLE 2. Contribution of main prey groups to the diet of juvenile and adult *Bothrops neuwiedi pauloensis*.

Age group	With prey	No. of prey	Centipedes	Anurans	Lizards	Snakes	Mammals and Birds
Juveniles	34	39	7	7	14	5	6
N = 68	(50%)		(18%)	(18%)	(36%)	(13%)	(15%)
Adults	27	30	3	3	3	0	21
N = 107	(25%)		(10%)	(10%)	(10%)		(70%)

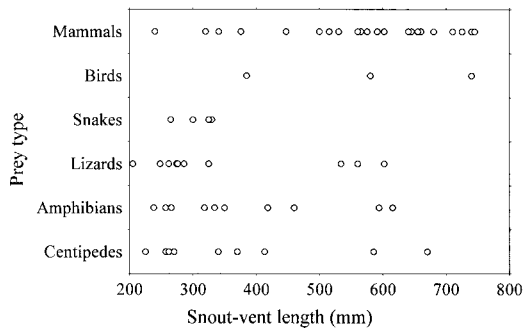


FIG. 2. Relationship between prey type and snake body size in *Bothrops neuwiedi pauloensis* from Brazilian Cerrado.

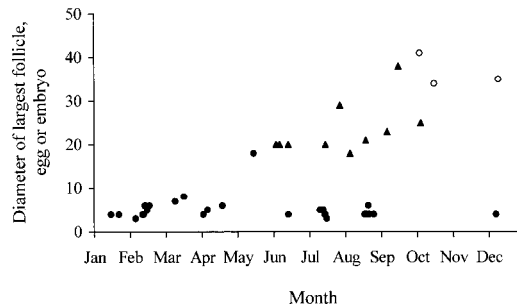


FIG. 3. Seasonal variation in the diameter of the largest follicle (dots), oviductal egg (triangles) or encapsulated oviductal embryos (circles) of 41 adult females of *Bothrops neuwiedi pauloensis*.

that preyed on ectotherms ($H_{1,67} = 23.85, P \ll 0.001$; Fig. 2).

No significant difference was detected in the frequency of fed snakes in the dry (51.1%) and wet (50.7%) seasons (Fisher's exact test, $P = 0.56$). No sexual difference in the consumption of ectothermic and endothermic prey was evident (15 and 14 ectotherms, and 13 and 10 endotherms, in females and males, respectively; Fisher's exact test, $P = 0.475$). There was no difference in the consumption of endothermic and ectothermic prey between dry and wet seasons (21 and 14 ectotherms, and 14 and 10 endotherms, in wet and dry season, respectively; Fisher's exact test, $P = 0.555$).

Reproduction.—The smallest gravid female was 625 + 65 mm long. The reproductive cycle of *B. n. pauloensis* is markedly seasonal (Fig. 3). Vitellogenesis apparently starts around March; from June to October embryos were in early stages of development and were fully developed in December. Thus, parturition seems to be restricted to the rainy season. Litter size ranged from 4–20 (9.27 ± 4.10 eggs, $N = 15$, including two females that gave birth in captivity, M. R. Duarte, pers. comm.) and was positively correlated with female size ($F_{1,13} = 9.15$, adjusted $r^2 = 0.368, P < 0.01$; Fig. 4).

DISCUSSION

Our habitat and distribution data (and also of V. X. Silva, pers. comm.) indicate that *B. n. pauloensis* inhabits warm to moderately cool areas (elevation up to 1100 m in the Brasília region) of central and southeastern Brazil. Among the many available habitat types in the Cerrado, *B. n. pauloensis* seems restricted to dry open formations, being apparently absent in riparian habitats such as wet grasslands or gallery forests (see results for *Bothrops neuwiedi* in Borges and Araújo, 1998). In several Cerrado areas of central and/or southeastern Brazil, *B. n. pauloensis* occurs in sympatry with *B. n. goyazensis*

(found only in dry habitats), *B. alternatus* (dry and wet habitats), *B. itapetiningae* (only dry habitats), and *B. moojeni* (mostly in wet habitats; pers. obs.). Although the ancestor of *Bothrops* was probably a forest inhabitant (Martins et al., in press), most species in the *alternatus* (which also includes *B. itapetiningae*) and *neuwiedi* species groups inhabit open areas, whereas those in the *atrox* group (which includes *B. moojeni*, see Wüster et al., 1999) are forest inhabitants (see Campbell and Lamar, 1989; Martins et al., in press). This historical factor may be responsible, at least in part, for the habitat partitioning of species of *Bothrops* in the Cerrado.

Although our field data are from recently burned areas, *B. n. pauloensis* may use burrows and cavities even in nonburned areas with dense grass cover. The frequent use of burrows and cavities, especially those associated with termite mounds, is common in many Cerrado animals, including lizards and snakes (Vanzolini, 1948; Vieira and Marinho-Filho, 1998; this study). In *B. n. pauloensis*, this habit may reduce exposure to predators (especially for juveniles), occasional fires, and direct solar radiation. These microhabitats may also represent favor-

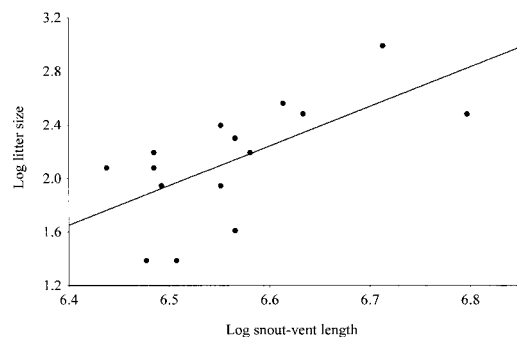


FIG. 4. Relationship between female body length and litter size in *Bothrops neuwiedi pauloensis*.

able foraging sites (many potential prey of *B. n. pauloensis* were commonly observed inside ground cavities) and help in thermoregulation, by decreasing loss of heat at night and providing a relatively constant microclimate (Vanzolini, 1948; Leloup, 1984). The primarily nocturnal activity observed in *B. n. pauloensis* is widespread in the genus *Bothrops* (Leloup, 1984; Campbell and Lamar, 1989; Sazima, 1992; pers. obs.).

A generalist diet based on small vertebrates and centipedes is also widespread in *Bothrops*, although some species feed mostly or even exclusively on mammals, including at least one subspecies of the *neuwiedi* group, *B. n. urutu* (Martins et al., in press). Although historical factors may also be involved, differences in the diet of generalists may reflect prey availability, snake body size, and predatory cost (Martins et al., in press). For example, the higher frequency of lizards in the diet of *B. n. pauloensis* (25%), when compared to *B. n. pubescens* (7%) from southern Brazil (M. T. Almeida, pers. comm.), may reflect differences in prey availability in the habitats where these subspecies occur (interfluvial cerrado in the former and deciduous forests in the latter).

The lack of seasonal variation in feeding frequency of *B. n. pauloensis* indicates that this subspecies forages successfully during the dry season, probably as a consequence of constant availability of mammals and lizards throughout the year in the study areas (pers. obs.). Furthermore, even during unfavorable weather conditions both predators and prey use the same microhabitat (ground cavities).

Seasonal reproductive cycles, with recruitment at the onset of the rainy season, as exhibited in this study, are apparently widespread in *Bothrops* (Leloup, 1975; Solorzano and Cerdas, 1989; Sazima, 1992; Martins and Oliveira, 1998; pers. obs.). Several authors suggested that seasonal reproductive cycles in tropical snakes would be selected so that neonates would occur in synchrony with an increased availability of potential prey (mainly frogs; Andrade et al., 1996; Martins and Oliveira, 1998). However, both snakes and their potential prey could respond to other environmental factors (rainfall and/or humidity, temperature). Furthermore, reproductive seasonality occurs even in species of *Bothrops* inhabiting less seasonal environments (e.g., Martins and Oliveira, 1998), indicating potential phylogenetic effects. Discussions of a possible causal relationship between prey availability and reproductive seasonality in tropical snakes will remain speculative, until detailed data on the biology of many snakes and their prey are available.

Bothrops neuwiedi pauloensis exhibits low fe-

cundity compared to other congeners (e.g., *Bothrops jararaca*, *Bothrops moojeni*, *Bothrops jararacussu*; see Leloup, 1974; Sazima, 1992; pers. obs.). This is probably a consequence of the relatively small body size attained by snakes in the *neuwiedi* complex, because there is a strong, positive correlation between fecundity and body size in snakes (Seigel and Fitch, 1984).

Species of *Bothrops* are conspicuous faunal components of Brazilian Cerrados, where they play a significant role in local animal communities. Although the Cerrado occupies a large portion of Brazil (almost 2 million km²), more than 40% of its natural habitats have been destroyed in the last few decades, making this region one of the priority areas for conservation in the Neotropics (Myers et al., 2000). Thus, detailed studies on additional species of Cerrado-inhabiting *Bothrops* would be helpful in future efforts towards the conservation of Brazilian Cerrados.

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APPENDIX 1

Material Examined

BRAZIL: DISTRITO FEDERAL: Brasília (IB 59907); GOIÁS: Luziânia (IB 59940), Mineiros (CHUNB 3589, IB 57081–83, IB 58206–22, IB 59903–05, IB 59908–09, IB 59911, IB 59913–27, IB 59930–35, IB 59938, IB 59941, IB 59943–44, IB 60589–90, IB 60592–95, IB 60597–98, ZUEC 01952); MINAS GERAIS: Araguari (IB 57613, IB 58244), Fronteira (IB 57605), Frutal (IB 58550–51), Lagoa Santa (MNRJ 1316), Liberdade (MNRJ 4949), Prata (56949), Sacramento (IB 59945); SÃO PAULO: Agudos (IB 6753), Altinópolis (IB 18162, IB 18734, IB 19073, IB 19097), Analândia (IB 18475, IB 56945, IB 58549); Artur Nogueira (IB 6384), Assis (IB 21324); Avaré (IB 6152, IB 18157, IB 21171, IB 21197, IB 58280–81), Botucatu (IB 56948), Brotas (IB 6318–19), Campo Alegre (IB 11286), Cerqueira César (IB 29202, IB 46100), Corumbataí (IB 08442), Descalvado (IB 18615–16, IB 19057, IB 53510), Engenheiro Coelho (IB 6428), Guataparã (IB 6228), Itirapina (IB 56313), Lagoa Branca (IB 19072, IB 19114), Luís Antônio (IB 59910), Matão (IB 21158), Mogi-Guaçu (IB 17995), Nova Garan-

ada (IB 22632), Nova Louzã (IB 6432–33), Patrocínio Paulista (IB 58283–84), Ressaca (IB 6608, IB 6671, IB 6835, IB 6895–97), Restinga (IB 6828), Ribeirão Preto (IB 53511), Salto (IB 56940), São Carlos (IB 21120, IB

21122, IB 56433, IB 59929, IB 59937, IB 60596), São Simão (IB 56097), Santa Cruz da Conceição (IB 24883), Tambaú (IB 56443, IB 59928, IB 59939), Tujuguaba (IB 6392), Trabiju (IB 6285).

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A New *Rhinotyphlops* from Southeastern Turkey (Serpentes: Typhlopidae)

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ABSTRACT.—A new species, closely related to *Rhinotyphlops simoni* of Jordan and Israel, is described. With this species from the Euphrates River Valley in southeastern Turkey, the *R. simoni* species group increases to eight taxa (four species in west-central Africa, two species in northeastern Africa, and two species in the Middle East).

Franzen (2000) reported *Rhinotyphlops* from southeastern Turkey, the northernmost locality for the genus (about 500 km north of known localities for *Rhinotyphlops simoni*). In April 2000, the senior author revisited the locality and collected seven specimens for study. Examination of this material revealed that the Turkish specimens represent an undescribed species closely related to *R. simoni*.

MATERIALS AND METHODS

Measurements (except total length) were made to the nearest 0.1 or 0.01 mm with dial calipers under a dissection microscope. Scale counts, measurements, and visceral definitions follow those of Wallach (1985, 1993a, 1994, 1995, 1998a,b) and Wallach and Ineich (1996). Morphological characters used for comparison include: total length; tail length (as percent of total length); tail length divided by midtail diameter; total length divided by midbody diameter; ventral rostral length (tip of snout to mouth border) divided by head diameter (at posterior edge of rostral); transparent rostral edge divided by ventral rostral length; dorsal rostral length (tip of snout to posterior edge of rostral) divided by dorsal midrostral width; dorsal midrostral width divided by head diameter; frontal width divided by dorsal midrostral width; supralabial imbrication pattern (SIP); condition of superior nasal suture (complete or incomplete); number

of oculars and postoculals; presence or absence of parietals and occipitals; number of transverse scale rows; number of dorsocaudals and subcaudals; number of anterior scale rows (20 scales posterior to the mental); number of midbody scale rows; number of posterior scale rows (10 scales anterior to the vent); presence/absence of apical spine; presence or absence of eyespots; and presence or absence of dorsal pigmentation. The supralabial imbrication pattern (SIP) denotes the overlapping condition of the posterior edges of the second and third supralabials with respect to the preocular and ocular (Wallach, 1993b). In the T-0 pattern, neither the second nor third supralabial's posterior edge overlaps the preocular or ocular; in the T-II pattern, the second supralabial overlaps the preocular.

When describing visceral anatomy, organ length and organ midpoint values (MP) represent percent of snout-vent length (% SVL); ratios of lengths of two visceral characters are presented as decimals. "Gaps" represent distances between two organs (posterior tip of cranial organ to anterior tip of caudal organ) as % SVL; "intervals" represent organ gaps plus length of both organs (anterior tip of cranial organ to posterior tip of caudal organ) as % SVL; and "distances" represent measurements between organ midpoints (organ midpoint of cranial organ to organ midpoint of caudal organ) as % SVL. Name of organ standing alone indicates organ length as % SVL; anterior and posterior tips of organ so indicated. Anterior liver "extension"

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