

Reproduction and Activity of the Snail-Eating Snake, *Dipsas albifrons* (Colubridae), in the Southern Atlantic Forest in Brazil

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Abstract

The reproduction and activity of *Dipsas albifrons* (Sauvage, 1884) from the southern Atlantic Forest, Brazil, were studied by analysing 144 preserved specimens. Females attained larger body sizes than males. Contrary to other Dipsadini of lower latitudes, reproduction in *D. albifrons* is seasonal with vitellogenesis and oviposition occurring in the rainy season and the hatching of the juveniles occurring at the end of the rainy season. Similar to other Dipsadini, clutch size in *D. albifrons* is relatively small, ranging from one to eight eggs. Clutch size was significantly correlated to female body size. Adult males and females showed a bimodal activity pattern. Seasonal variation in climate, reproductive cycles and feeding are considered to be the main factors responsible for the observed activity trend.

Keywords: *Dipsas*, sexual dimorphism, reproductive cycle, fecundity, oviposition, activity pattern.

Introduction

The genus *Dipsas* includes approximately 20 species distributed in Central and South America (Peters & Orejas-Miranda, 1970). Species of *Dipsas* are nocturnal, semi-arboreal and malacophagous (Greene, 1997). Information on feeding biology, habitat and defensive tactics (Fig. 1) are available for many species of *Dipsas* (e.g., Sazima, 1989; Duellman, 1990; Sazima & Haddad, 1992; Martins & Oliveira, 1998), but reproductive data are restricted to few species from lower latitudes (e.g., Zug et al., 1979; Porto & Fernandes, 1996) where there is little variation in climate.

Apparently, species of *Dipsas* from lower latitude reproduce continuously (cf. Zug et al., 1979; Porto & Fernandes, 1996) and geographic distribution is a factor that may influence activity and reproductive cycles in these snakes (Gibbons & Semlitsch, 1987; Seigel & Ford, 1987). The Atlantic Forest extends from 5 to 29°S along the coast of Brazil and five species of *Dipsas* occur in this ecosystem: *D. albifrons*, *D. catesbyi*, *D. incerta*, *D. indica petersi* and *D. neivai* (Marques et al., 2001a, A.J.S. Argôlo, pers. comm.). There is little information on reproduction and activity patterns for these species. Of these, *D. albifrons* is well represented in herpetological collections from the extreme southern distribution of the genus. In the present study, we characterize two natural history traits for *D. albifrons* (Fig. 1) based on preserved specimens and one clutch maintained in captivity, from higher latitudes in the Atlantic Forest.

Material and methods

We analysed 144 preserved specimens of *Dipsas albifrons* housed in the herpetological collection of the Instituto Butantan (IB) in São Paulo, Brazil. The specimens were collected in northeastern Santa Catarina state (Jaraguá do Sul, Corupá, Blumenau and Joinville; between 48°50' and 49°14'W, and 26°18' and 26°55'S), in southern Brazil. For each specimen we recorded: (1) snout-vent length (SVL), (2) the size of the largest ovarian follicle, and (3) number of vitellogenic follicles or oviductal eggs. We considered that males were mature when they had enlarged testes or opaque efferent ducts (see Shine, 1977). Females with SVL above the size of the smallest female presenting vitellogenic folli-

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cles (>5 mm; Shine, 1980) were considered sexually mature. One gravid female provided data on the period of oviposition and hatching. Eggs were incubated in moist vermiculite at 22–26°C. The activity of *D. albifrons* was inferred from monthly sampling frequency, based on collection dates of specimens housed in the Instituto Butantan (see Marques et al., 2001b for discussion about this method).

Results

The smallest mature male measured 325 mm SVL and the smallest female was 400 mm SVL. Mature males ranged from 325 to 540 mm SVL ($\bar{x} = 435.9$, $sd = 57.7$, $n = 50$) and mature females ranged from 400 to 590 mm SVL ($\bar{x} = 470.5$, $sd = 45.5$, $n = 63$). Mature females were significantly larger than mature males ($t = 3.5$; $df = 111$; $P = 0.0005$).

Most females with vitellogenic follicles (> 5 mm) were found from September to December, and individuals with eggs in the oviducts were collected from September to February (Fig. 2). The smallest female with eggs in the oviducts had SVL of 470 mm. The clutch size based on the number of eggs or vitellogenic follicles ranged from one to eight ($\bar{x} = 3.9 \pm 1.8$, $n = 33$), and were significantly correlated with female SVL (Fig. 3). One captive female laid two eggs on 1 December 2000 and hatching occurred on 6 March 2001. The single neonate obtained measured 162 mm SVL and 56 mm tail length. Most specimens of *D. albifrons* were collected during spring and summer (October–March; Fig. 4). There is a significant difference in the number of adult snakes collected among seasons ($F_{(3,8)} = 4.84$, $P = 0.03$). Most adult males were collected from October to March whereas females were more frequent from October to February (Fig. 4). Immature individuals were collected in almost all months, with no activity peak.

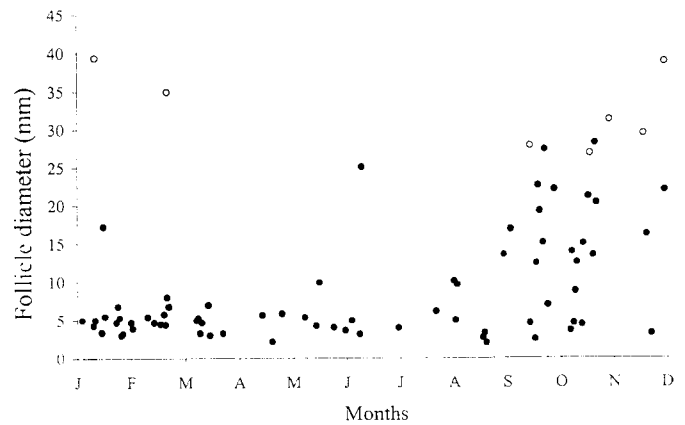


Fig. 2. Seasonal variation in diameter of larger follicles in females of *Dipsas albifrons*. Open circles: eggs in the oviducts.

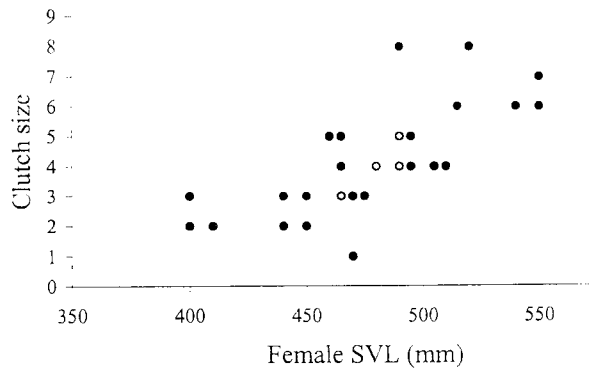


Fig. 3. Relationship between female snout-vent length and clutch size in *Dipsas albifrons*. Closed circles: vitellogenic follicles; open circles: eggs in the oviducts; $r = 0.72$; $P < 0.05$; $n = 30$.

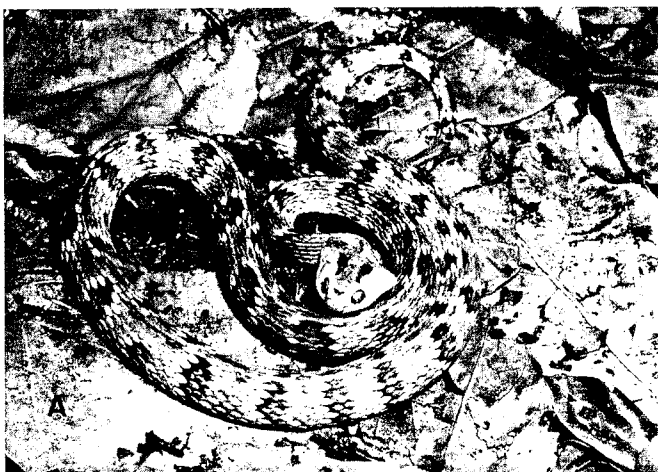


Fig. 1. The snail-eating snake, *Dipsas albifrons*, from Jaraguá do Sul, Santa Catarina (IB 58679, female, SVL = 492 mm, tail length = 167 mm), in defensive display. Note triangulation of head and S-coil posture of anterior part of the body.

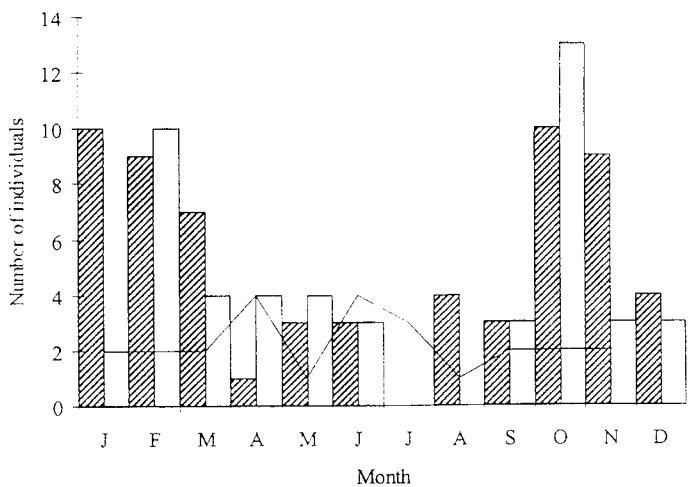


Fig. 4. Number of individuals of *Dipsas albifrons* received by the Instituto Butantan from 1930 to 1997. Opens bars: adult females; hatched bars: adult males; lines: number of immatures (females < 400 mm SVL, males < 325 mm SVL).

Discussion

Sexual dimorphism in body size occurs in most colubrids, including all other Dipsadini for which such information is available (e.g., Shine, 1994; Zug et al., 1979; Martins & Oliveira, 1999). A larger female body size allows the production of larger clutches (cf. Shine, 1993). In snakes which exhibit ritual combat, males are usually larger (Shine, 1978). Although species of the tribe Dipsadini are relatively common in Brazil (e.g., Martins & Oliveira, 1999; Vitt, 1996; pers. obs.), and may show aggregation behavior (Doan & Arriaga, 1999), there are no observations of male combat in the Dipsadini, indicating that such behavior does not occur in this clade.

Vitellogenesis in *D. albifrons* seems to occur mainly at the beginning of the rainy season (spring) whereas the recruitment at the end of the rainy season (summer). This reproductive pattern agrees with those described for other Dipsadini from high latitudes ($> 20^{\circ}\text{S}$), such as *D. petersi*, *Sibynomorphus neuwiedi*, *S. mikanii* and *S. ventrimaculatus* in southeastern Brazil (Marques & Sazima, 2002; J.L. Oliveira, pers. comm.), and for *Sibon sanniola* in Mexico (Kofron, 1983). On the other hand, species of *Dipsas* from lower latitudes ($< 10^{\circ}\text{S}$), seem to show aseasonal reproductive patterns: *D. catesbyi* in Amazonian Peru (Dixon & Soini, 1977; Zug et al., 1979) and *D. neivai* in the northern Atlantic Forest (Porto & Fernandes, 1996). Another Dipsadini, *Imantodes cenchoa*, studied in Amazonian Peru, also may have an aseasonal cycle (Zug et al., 1979). Some authors suggest that populations of Dipsadini from low latitudes (e.g., *D. catesbyi* and *D. pavonina* in Amazonia) reproduce seasonally, but data for these species are meager (cf. Duellman, 1978; Seigel & Ford, 1987; Martins & Oliveira, 1999). Thus Dipsadini from low latitudes of Amazonian and northern Atlantic forests are apparently able to reproduce continuously, whereas those from higher latitudes show seasonal reproduction. Reproductive traits may be conservative in some snake groups (Shine, 1989; Marques, 1996a, b), but other factors may affect the extent of reproductive cycles (Zug et al., 1979; Seigel & Ford, 1987; Marques, 1996b). The restriction of reproductive activity during the rainy season in Dipsadini from higher latitudes may be associated to higher temperatures and precipitation and in their consequences to greater food availability and activity of snakes (cf. Seigel & Ford, 1987), as already suggested for others tropical snakes (Vitt, 1980, 1983).

Fecundity in *D. albifrons* increases with body size, a general trend observed in several snakes (cf. Zug et al., 1979; Shine, 1993; Jordão & Bizerra, 1996; Marques & Puerto, 1998). Nevertheless, when compared to other Neotropical colubrids clutch size in *D. albifrons* was relatively small (see Fitch, 1970; O.A.V. Marques, pers. obs.), but other Dipsadini species also exhibit small clutch sizes: one to five eggs in *Imantodes cenchoa* (Duellman, 1978; Zug et al., 1979; Manzani & Cardoso, 1997; Martins & Oliveira, 1999), one to four in *D. catesbyi* (Zug et al., 1979), one egg in *D.*

pavonina (Martins & Oliveira, 1999), and two to seven in *Leptodeira annulata* (Duellman, 1978; Fitch, 1970; Dixon & Soini, 1986; Martins & Oliveira, 1999). It is possible that small clutch sizes in these species are a consequence of their semi-arboreal habits. Fossorial (e.g., *Atractus*) and terrestrial species (some *Sibynomorphus*) of the tribe Dipsadini seem to produce larger and/or heavier clutches (Martins & Oliveira, 1999; J.L. Oliveira, pers. comm.; O.A.V. Marques, pers. obs.).

Specimens of *D. albifrons* were more frequent during the rainy season (spring and summer), contrary to *Sibynomorphus neuwiedi* from the Atlantic Forest in southeastern Brazil that is more active during cold and dry periods (Marques et al., 2001b). Lower temperatures at localities studied in northeastern Santa Catarina (Nimer, 1989), may be responsible for the decrease in activity of *D. albifrons* in the dry season (autumn and winter; Gibbons & Semlitsch, 1987).

The peak of activity for adult females in October corresponds to the period when they bear enlarged ovarian follicles. This peak may be a result of increased movements searching for thermoregulation sites by these reproductive females (see Marques et al., 2001b). The adult males are mainly active in October and November, probably because they are searching for females to mate (Gibbons & Semlitsch, 1987; Marques, 1996a). The peak of females in February may be a result of increased movements due to feeding activity to recompose energetic reserves after reproductive period. The large activity of males at the end of the rainy season (summer) may be explained in the same way, since reproductive period (in spring) in males is also energetically expensive (cf. Olsson et al., 1997).

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