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First record of mating of *Bothrops insularis* (Serpentes: Viperidae) in nature, with comments on sexual behaviour

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The golden lancehead *Bothrops insularis* (Amaral, 1921) is an arboreal and diurnal species endemic to the Queimada Grande Island, São Paulo state, southeastern Brazil (-24.4874 °S, -46.6744 °W). Female *B. insularis* reproduce seasonally; vitellogenesis occurs from late summer to spring, courtship occurs mainly in winter, ovulation occurs in early spring, and parturitions occur in summer (Marques et al., 2013). Studies with *B. insularis* in nature have been conducted for decades in all seasons (Hoge et al., 1959; Marques et al., 2013). Marques et al. (2013) reported ten courtships of *B. insularis* in nature between 1995 and 2008. All photographic records and observations to date show only the tactile-chase phase of the courtship and copulatory behaviour (*sensu* Gillingham et al., 1977). However, there is no record of effective copulation in nature. Mating of *B. insularis* has only been recorded in captivity (Marques et al., 2013). Moreover, there is no sex identification of the individuals involved in those courtships. The lack of identification of males and females is mainly due to the fact that most female *B. insularis* show hemiclitoris (a structure similar to the male hemipenis) (Hoge et al., 1959; Bohme, 1995), making it difficult to identify the sex of the individuals in the field. Here, we provide the first record of mating of *B. insularis* in the wild.

Two individuals of *B. insularis* were found in copulation on 1 August 2014, at 11:10 AM, on the soil surface, 2 m away from the trail (-24.4797 °S, -46.6760 °W). The mean air temperature during the copulation varied from 27.7°C to 30.0°C. The difference in body size between the individuals was quite evident, which enabled us to identify the male and female (Fig. 1). The female was larger than the male and was partially coiled, with its head and anterior body slightly lifted. The male was much smaller and remained on the posterior dorsal region of the female body with its tail curved around the female cloaca (Fig. 1A). We also noticed that the male's tail was curved ventrally underneath the female's tail (Fig. 1B). Both individuals were aligned, with their heads pointed in the same direction (Fig. 1C). The snakes had their tails entwined, and we could observe that the female cloaca was quite dilated (Fig. 1D).

Our record corroborates the observations made by Amaral (1921), who reported copulations in captivity in winter (August-September) and during the daytime. Marques et al. (2013) also reported copulation in captivity in June (early winter). In females, vitellogenesis occurs in autumn-winter and is synchronous to the mating period (Marques et al., 2013). Thus, the mating season of *B. insularis* is in winter, unlike its species of the genus *Bothrops*, which mate in autumn (Almeida-Santos and Salomão, 2002). As in *B. jararaca*, adult male *B. insularis* are generally smaller than adult females (Marques et al., 2013). However, some of the courtship records of *B. insularis* do not show noticeable evidence of size dimorphism between the individuals (see Almeida-Santos and Salomão, 2002; SAS, pers.

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Figure 1. Copulation of *Bothrops insularis* at the Queimada Grande Island. (A-D): Copulatory behaviour sequence showing the male mounted on the female and the intertwined tails (arrow). Note the clear difference in body size between the male and the female.

obs.). In these cases, body sizes and head sizes of the courting individuals are similar to those of the courted females. Given that those courtships did not turn into effective copulation (as reported here), the sex of the individuals is unknown. Also, female *B. insularis* show hemiclitoris and the existence of a pseudocopulation behaviour between females (Crews and Fitzgerald, 1980) cannot be rejected. Thus, due to the extended mating season of *B. insularis* and the increased number of vitellogenic females in late winter and spring (Marques et al., 2013), the pseudocopulation behaviour in females could stimulate vitellogenesis by triggering reproductive neuroendocrine mechanisms, as seen in some lizards (Crews and Fitzgerald, 1980) and snakes (Whittier and Crews, 1986). Further behavioural studies should be conducted on the Queimada Grande Island to test this hypothesis.

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