Short Notes

Old habits die hard: Mouse handling by a pitviper species on a rodent-free island

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Abstract. The golden lancehead (*Bothrops insularis*) is endemic to Queimada Grande Island off the coast of southeastern Brazil. This pitviper feeds mainly on migratory birds, whereas mainland pitvipers in the genus *Bothrops* usually feed on rodents. Rodents are regarded as a dangerous prey type, and the habitual handling of rodents by pitvipers include its immediate release after the initial bite. However, bird prey is usually held within jaws after the initial bite. Presently there are no rodents in Queimada Grande Island, which is thought to have isolated from the mainland 11 000 yr ago. We staged encounters between *B. insularis* and house mice in the field to evaluate how the snake will behave when introduced to a supposedly unknown prey type. Mice were readily accepted as prey and the predatory behaviour of *B. insularis* was similar to that displayed by mainland pitvipers (strike-release). Although *B. insularis* has several morphological and ecological particularities that likely developed during its isolation on an island (some of these related to a specialized diet and/or arboreal habits), the handling behaviour of potentially dangerous prey such as rodents was retained – an indication of phylogenetic conservatism.

Keywords: *Bothrops insularis*, bird prey, rodent prey, feeding behaviour, Queimada Grande Island, southeastern Brazil.

Viperid snakes prey mainly on small vertebrates, particularly rodents, lizards and frogs (less often birds), with some specialised and small vipers feeding mostly on arthropods (Spawls and Branch, 1995; Greene, 1997). All these animal types are killed by envenomation when a snake bites the prey (Greene, 1997; Cundall, 2009). Studies on captive and free-ranging pitvipers show an invariable handling of rodent prey: the snake lets the prey approach to striking distance, bites it quickly, and releases the prey immediately afterwards (Sazima, 1992; Cundall, 2002; Kardong and Smith, 2002). After release the snake locates the envenomated prey using an odour trail (Golan et al., 1982; Sazima, 1992). This rodent prey handling and locating contrasts with bird and frog prey handling, in which case the prey is usually held within the jaws after the initial bite (Sazima, 1992, 2006). Frog prey is regarded as offering small risk or none at all; additionally, it jumps while fleeing, which would make difficult to or even not allow the snake to retrieve the envenomated prey. The same applies to bird prey, which would fly after the bite; however, birds can inflict some risk to the snake by pecking or scratching while held in the snake's jaws (Hayes et al., 2002).

The golden lancehead (*Bothrops insularis*) is endemic to a small island in southeastern Brazil, Queimada Grande Island (Marques et al., 2002a; Martins et al., 2008). The main prey of *B. insularis* are medium-sized migratory birds, which the snake holds within its jaws in most instances (Marques et al., 2002a; Martins et al., 2002). Besides birds, this pitviper preys on frogs and lizards, which are also held within its jaws after the initial bite (Amaral, 1921a; Martins et al., 2002). There are no rodents on Queimada Grande, and the only recorded mam-

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mals are small to medium-sized bats (Marques et al., 2002a). Bearing this in mind, we raised the question as to how *B. insularis* would behave when introduced to rodent prey. Would the snake treat the rodent as potential prey or a risk to avoid? If treated as prey, would the rodent be held as other prey of this snake? We hypothesized that rodents would be treated as prey and the snake would release the bitten rodent (phylogenetic conservatism, see Perry and Pianka, 1977), and we tested this hypothesis in the field. Queimada Grande Island is approximately 43 ha and lies 33 km off the coast of São Paulo, southeastern Brazil (Amaral, 1921b; Martins et al., 2008). A low Atlantic forest covers about 24 ha of the island, and the remaining areas are bare rock and open areas covered mostly with grasses; these grassy areas are a result of forest removal (see figures in Martins et al., 2008).

From a total of 19 field expeditions to the island to study the habits of the golden lancehead, we recorded natural predation on birds in three of them. In six of these expeditions, we staged prey encounters with 11 individual snakes in the field. Prey in two of the expeditions were non-native, Bengalese finches *Lonchura striata* ($N = 4$), and prey in the remaining four were house mice *Mus musculus* (brown pelage strain) ($N = 7$). Mass of preys used in our trials ranged 10-16 g for the finches and 18-22 g for the mice, values that are within the range of natural bird and other vertebrate prey (8-44 g) we found in gut contents of *B. insularis* during dietary studies (unpublished data). The same holds true for size ranges. We staged encounters with birds to check whether a free-ranging lancehead would accept non-native prey similar to wild prey. Both prey types were unrestrained and released about 20 cm from an ambushing snake (Sazima, 1992, 2006). We refrained from using a larger number of prey because of ethical reasons and because this number was deemed adequate as the snakes' behaviour varied little or not at all. Both birds and mice were handled with care to minimize distress. Additionally, we only used males to prevent any prey that might have escaped from a snake predatory attempt from populating the island, as could happen with a fertilized female. The encounters were videotaped and photographed and two of the best videotaped sequences are on a DVD housed at the Laboratório de Ecologia e Evolução of the Instituto Butantan.

All four birds were accepted as prey. Following the release of a bird, the snake oriented towards the prey and immediately bit and held it within the jaws in manner consistent with observations of foraging on wild birds (fig. 1a). The bird struggled briefly, and when its movement ceased the snake began to swallow it.

All seven mice were accepted as prey. Following the release of a mouse, the snake oriented towards the prey, struck and bit it, and immediately released the rodent by widely opening its jaws and disengaging its fangs (see Cundall, 2009). The envenomated mice travelled a distance of about 1 to 3 m. This distance was about two to six times greater than mice struck by *B. jararaca* were able to travel (Sazima, 1992). We suggest that this difference is related to the venom type of *B. insularis*, which is thought to have evolved to quickly kill birds (Zelanis et al., 2008), not mice. Trailing the envenomated mice was initiated by the snake 10 to 30 sec after the strike, a time similar to that reported for *B. jararaca* under similar conditions (Sazima, 1992). Once the already immobilized mouse was found the snake began to inspect the prey, flicking its tongue and touching the prey's body with its snout – the longest touching bouts were on the nasal-oral and ano-genital regions of the prey. This behaviour was similar to that recorded for *B. jararaca* (Sazima, 1992). Following the inspection, the snake began to swallow the mouse, always headfirst (fig. 1b).

Its dietary specialisation on birds notwithstanding (Amaral, 1921a; Martins et al., 2002), *B. insularis* recognized mice as potential prey despite their absence on the island. Further, it recognized mice as potentially dangerous prey and released them immediately after the initial bite, a behaviour reported for pitvipers that

Figure 1. A golden lancehead (*Bothrops insularis*) holds an already dead tyrannid bird (*Elaenia* sp.) within its jaws shortly after it struck the prey (top); the same snake species swallows a house mouse (*Mus musculus*) it killed during a staged encounter in nature (bottom).

feed on rodents (e.g. Sazima, 1992; Kardong and Smith, 2002; Martins et al., 2002). Because rodents are presently absent from Queimada Grande Island, the mouse handling behaviour of *B. insularis* seems unexpected at first sight (but see below).

Bothrops insularis belongs in a monophyletic group that includes another island endemic, the Alcatraz pitviper *Bothrops alcatraz* (Marques et al., 2002b) and the mainland and widespread *B. jararaca* (Graziotin et al., 2006). The time of speciation of *B. insularis* is thought to have occurred after the last connection with the mainland (Marques et al., 2002a, b), but it could have occurred earlier. Irrespective of the time of speciation, there was time enough for *B. insularis* to develop several differences from the mainland *B. jararaca*, including colour pattern, body size, teeth and skull length, diel activity, arboreal habit, and venom (e.g. Amaral, 1921a, b; Wüster et al., 2005; Zelanis et al., 2008). However, the behaviour of handling the potentially

dangerous rodents was retained. Thus, our data denote phylogenetic conservatism of prey handling, such as demonstrated for other foraging correlates including behaviour (e.g. Perry and Pianka, 1977).

A referee colleague suggested that there is a possibility of commensal rodents to have sporadically reached Queimada Grande Island via fishing or other boats in the last few decades, or even the last few centuries. However, fishermen that work around the island avoid to land there due to their knowledge of the large pitviper population and the almost certain risk of snakebite (other vessel types anchor at large and their occupants do not land). Even in the unlikely event that a rodent do (or did) reach the island from time to time, it would be killed in a short time as the pitvipers occur at any site on the island – even on the rocky shore – and thus the snakes would have no opportunity to become familiar with this potential prey type except for these hypothetical and fleeting encounters.

Acknowledgements. We thank M. Martins for his important photo of a lancehead holding a bird; Antonio A.C.O.R. da Costa; R. Bovo, V.J. Germano, K. Kasperoviczus, L. Pizzatto, M. Rodrigues, R. Zacariotti and K. Zamudio for valuable help in the fieldwork; the CNPq and FAPESP for essential financial support. We also thank two anonymous referees and L. Luiselli for their valuable comments on the manuscript.

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Received: February 16, 2009. Accepted: March 19, 2009.