Vipers in the state of Acre, western Brazilian Amazon: a review

Viperídeos no estado do Acre, Amazônia ocidental brasileira: uma revisão

Víboras en el estado de Acre, Amazonia occidental brasileña: una revisión

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ABSTRACT

Snakes of the family Viperidae are distributed in many different ecosystems, generally being the most abundant species in snake surveys and studies on snake assemblages in Brazil. These species are medically important as they can cause snakebites and are responsible for approximately 99% of envenomings in humans in Brazil. Considering the ecological importance of snakes in terrestrial ecosystems, mainly as important predators in food webs, and in public health due to the risks of snakebites, here we review the information available in the literature about vipers in the state of Acre, western Brazilian Amazon. Six species of vipers were already recorded for Acre, with Bothrops atrox being the most abundant, present in various types of habitats and being the main species involved in snakebites. Bothrops bilineatus is the most common snake found in a floodplain forest in the protected area Japiim Pentecoste, a factor probably associated with prey availability. The other four species of vipers (Bothrocophias hyoprora, Bothrops brazili, B. taeniatus and Lachesis muta) are less frequent and associated with unflooded forests. Although we found in the literature several studies involving vipers in Acre, there is a need for more studies on these snakes in the region, addressing their ecology, ethnoherpetological questions and snakebites, including research on their ecology and behavior in the field, genetic variation and differentiation among populations and species, and biochemical composition of venoms.

Keywords: reptilia, squamata, serpentes, crotalinae, Brazil.

RESUMO

As serpentes da família Viperidae estão distribuídas em diversos ecossistemas, sendo geralmente as espécies mais abundantes em levantamentos de serpentes e estudos sobre taxocenoses de serpentes no Brasil. Essas espécies são importantes do ponto de vista médico, pois podem causar acidentes ofídicos, e são responsáveis por aproximadamente 99% dos acidentes com humanos no Brasil. Considerando a importância ecológica das serpentes nos ecossistemas terrestres, principalmente como importantes predadores nas cadeias alimentares, e na saúde pública devido aos riscos de acidentes ofídicos, revisamos aqui as informações disponíveis na literatura sobre viperídeos no estado do Acre, Amazônia ocidental brasileira. Já foram registradas seis espécies de viperídeos para o Acre, sendo Bothrops atrox a mais abundante, presente em vários tipos de habitats e sendo a principal espécie envolvida em acidentes ofídicos. Bothrops bilineatus smaragdinus é a serpente mais comum em uma floresta de várzea na área protegida Japiim Pentecoste, fator provavelmente associado à disponibilidade de presas. As outras quatro espécies de viperídeos (Bothrocophias hyoprora, Bothrops brazili, B. taeniatus e Lachesis muta) são menos frequentes e associadas a florestas de terra firme. Embora tenhamos encontrado na literatura diversos estudos envolvendo viperídeos no Acre, há necessidade de mais estudos sobre essas serpentes na região, abordando sua ecologia, questões etno-herpetológicas e acidentes ofídicos, incluindo pesquisas sobre sua ecologia e comportamento em campo, variação e diferenciação genética entre populações e espécies, e composição bioquímica de venenos.

Palavras-chave: reptilia, squamata, serpentes, crotalinae, Brasil.

RESUMEN

Las serpientes de la familia Viperidae se distribuyen en muchos ecosistemas diferentes, siendo generalmente la especie más abundante en estudios de serpientes y estudios sobre ensamblajes de serpientes en Brasil. Estas especies son médicamente importantes, ya que pueden causar...
mordeduras de serpiente y son responsables de aproximadamente el 99% de los envenenamientos en humanos en Brasil. Teniendo en cuenta la importancia ecológica de las serpientes en los ecosistemas terrestres, principalmente como depredadores importantes en las redes tróficas, y en la salud pública debido a los riesgos de mordeduras de serpiente, aquí revisamos la información disponible en la literatura sobre las víboras en el estado de Acre, oeste de la Amazonía brasileña. Seis especies de víboras ya se registraron para Acre, siendo Bothrops atrox la más abundante, presente en varios tipos de hábitats y siendo la principal especie involucrada en las mordeduras de serpiente. Bothrops bilineatus es la serpiente más común que se encuentra en un bosque de llanuras aluviales en el área protegida de Pentecostés de Japón, un factor probablemente asociado con la disponibilidad de presas. Las otras cuatro especies de víboras (Bothrocophias hydropora, Bothrops brazili, B. taeniatus y Lachesis muta) son menos frecuentes y se asocian con bosques no inundados. Aunque encontramos en la literatura varios estudios que involucran víboras en Acre, hay una necesidad de más estudios sobre estas serpientes en la región, abordando su ecología, cuestiones etno-herpetológicas y mordeduras de serpientes, incluida la investigación sobre su ecología y comportamiento en el campo, la variación genética y la diferenciación entre poblaciones y especies, y la composición bioquímica de los venenos.

Palabras clave: reptilia, squamata, serpentes, crotalinae, Brasil.

1 INTRODUCTION

The Amazon covers an area of approximately 6.7 million km² and corresponds to around 50% of the planet's remaining forests (WWF, 2023). It is the largest tropical rainforest in the world and is associated with the functioning of several ecosystems, playing great importance in maintaining biodiversity, the hydrological cycle and carbon sequestration (Fearnside, 2018). This biome and its rich biodiversity are threatened, mainly due to deforestation to advance the agricultural frontier (Nobre et al., 2016) and forest fires (McLauchlan et al., 2020).

A total of 176 species of snakes are known to occur in the Brazilian Amazon, of which nine are vipers (Marques et al., 2023). Vipers are distributed in many different ecosystems (Martins et al., 2001), generally being the most abundant species in snake surveys and studies on snake assemblages in Brazil (Martins; Oliveira, 1998; Zanella; Cechin, 2006; Sawaya et al., 2008; Hartmann et al., 2009). Most species in this group have a generalist diet (Martins et al., 2002) and are capable of occupying different types of habitat (Martins et al., 2001; Campbell; Lamar, 2004). These species are medically important as they can cause snakebites and are responsible for approximately 99% of envenomings in humans in Brazil (Bernarde, 2014).
Six species of vipers are recorded in the state of Acre: *Bothrocophias hyoprora* (Amaral, 1935), *Bothrops atrox* (Linnaeus, 1758), *B. bilineatus smaragdinus* Hoge, 1966, *B. brazili* Hoge, 1954, *B. taeniatus* Wagler, 1824 and *Lachesis muta* (Linnaeus, 1766) (Bernarde *et al.*, 2017; Guedes *et al.*, 2023). Some species are considered rare because they are seldom found in the field (*e. g.*, *B. hyoprora, B. brazili* and *B. taeniatus*) and occur mainly in primary forests (Campbell; Lamar, 2004; Cisneros-Heredia *et al.*, 2006), while others, because they are abundant where they occur (*e. g.*, *B. atrox* and *B. b. smaragdinus*), are the main species involved in snakebites in some regions (*e. g.*, Moreno *et al.*, 2005; Mota-da-Silva *et al.*, 2019a).

The species *B. hyoprora, B. atrox, B. brazili* and *L. muta* show nocturnal activity and terrestrial habits, with records of juveniles of *B. atrox* on vegetation at heights of up to 1.5 m (Oliveira; Martins, 2001; Turci *et al.*, 2009). They are found mainly in primary forests, except for *B. atrox*, which also occurs in secondary forests and disturbed areas (Martins; Oliveira, 1998; Campbell; Lamar, 2004; Turci *et al.*, 2009; Bernarde *et al.*, 2011a). They range in size from 80 cm in *B. hyoprora* (Campbell; Lamar, 2004) to 3.15 m in *L. muta*, which is the largest venomous snake in South America (Barrio-Amoróz *et al.*, 2020). They have a robust body and short tail (Martins *et al.*, 2001), these characteristics being observed in most terrestrial species of these genera (Campbell; Lamar, 2004).

*Bothrops b. smaragdinus* and *B. taeniatus* have primarily arboreal habits and nocturnal activity, and are found close to the ground and in the understory in forests (Martins *et al.*, 2001; Turci *et al.*, 2009; Souza *et al.*, 2013; Fonseca *et al.*, 2019a). They are moderate-sized compared to other Amazonian vipers, with *B. b. smaragdinus* rarely exceeding 1 m in length, while *B. taeniatus* can reach up to 1.5 m (Campbell; Lamar, 2004). Both have a slender body and a relatively long, prehensile tail, with a smaller relative body mass compared to other terrestrial vipers (Martins *et al.*, 2001). Despite being uncommon throughout its distribution, in a floodplain forest in Alto Juruá, *B. b. smaragdinus* may be one of the most abundant (Turci *et al.*, 2009; Fonseca *et al.*, 2019a). On the other hand, this arboreal snake was not found in studies in some unflooded forests in the Alto Juruá region (*e. g.*, Avila-Pires *et al.*, 2009; Bernarde *et al.*, 2011a; Fonseca *et al.*, 2019b).

Considering the ecological importance of snakes in terrestrial ecosystems, mainly as important predators in food webs, and in public health due to the risks of snakebites, here we
review the information available in the literature about vipers in the state of Acre, western Brazilian Amazon.

2 STUDIES INVOLVING VIPERS IN ACRE

In the state of Acre (Figure 1), the first study involving vipers (Figure 2) was by Pierini et al. (1996) who analyzed antibodies present in victims of snakebites in different extractive and indigenous communities in the Alto Juruá region. In this study, residents were also interviewed about the circumstances of snakebites, first aid procedures and the popular names given to the snakes that caused the bites. The results of the presence of antibodies to the venom showed that the snake *B. atrox* was the main species causing snakebites (86% of cases), followed by *L. muta* (14%).

Figure 1 - Map of South America highlighting the state of Acre in Brazil and the location of the Alto Juruá region (1) and the municipality of Rio Branco (2).

Source: Prepared by the authors.
Figure 2 - Viperid species occurring in the state of Acre. A) *Bothrocophias hyoprora*; B) *Bothrops atrox*; C) *Bothrops bilineatus smaragdinus*; D) *Bothrops brazili*; E) *Bothrops taeniatus*; F) *Lachesis muta*.

Source: Wirven Fonseca.
The results of two expeditions carried out to the Alto Juruá Extractive Reserve in an unflooded forest area located in the municipality of Marechal Thaumaturgo was published by Souza et al. (2002), who also presented several indigenous legends about snakes. The authors recorded 16 species, three of which were vipers (B. atrox, B. brazili and L. muta). Local people used the common names surucucu and surucucu-do-barranco for B. atrox.

In a study on the clinical and epidemiological aspects of snakebites that occurred in Rio Branco, Moreno et al. (2005) found that B. atrox was the main snake causing snakebites, corresponding to 41.2% of the species taken to the hospital. The viper L. muta had three ‘cases confirmed by the patients’ signs and symptoms.

Turci et al. (2009) carried out a study on B. atrox and B. b. smaragdinus in a floodplain forest (Area of Relevant Ecological Interest Japiim Pentecoste) in Cruzeiro do Sul in the Alto Juruá region, observing that B. b. smaragdinus is found during time-limited searches more often than B. atrox. Although B. atrox tends to be the most common viper in the Amazon (e.g., Martins; Oliveira, 1998; Campbell; Lamar, 2004), these authors observed that in this location B. b. smaragdinus is more frequent than B. atrox.

In Porto Walter, a municipality located in the Alto Juruá region, Avila-Pires et al. (2009) carried out a survey of squamate reptiles and recorded B. atrox and L. muta among 20 snake species sampled.

The first list of snakes for the state of Acre was published by Silva et al. (2010), based on specimens deposited in the Herpetological Collection of the Federal University of Acre in Rio Branco. These authors examined 303 specimens and recorded 59 species of snakes, three of which were vipers. The most represented species in the collection was B. atrox (29 specimens), followed by B. b. smaragdinus (four) and L. muta (two). This study also provided information about snake diets through the examination of stomach contents and in four specimens of B. atrox they found two marsupials, an amphibian (Hylidae) and a lizard of the genus Plica (Tropiduridae).

The first survey of snakes in Acre with considerable sampling effort conducted monthly over a period of 18 months and employing various sampling methods (time-limited search, pitfall traps and accidental records), was carried out by Bernarde et al. (2011a) in the Riozinho da Liberdade Extractive Reserve in the municipality of Tarauacá. The area studied by Bernarde et
al. (2011a) corresponded to an unflooded forest, with 42 species of snakes recorded, among them, two vipers (B. atrox and L. muta).

The genus Bothrocophias comprises two species of Amazonian vipers in Brazil, with B. microphthalmus being less frequently found with only one record in Rondônia (Nogueira et al., 2019). In Acre, B. hyoprora was recorded for the first time at the Serra do Divisor National Park by Bernarde et al. (2011b) and so far it is only known in the state in this locality.

Bernarde and Gomes (2012) evaluated the SINAN files (Notifiable Diseases Information System) of cases of snakebites treated at the Hospital Regional do Juruá, in Cruzeiro do Sul, during the period from August 2007 to July 2009. These authors showed that the cases of snakebites supposedly caused by L. muta were mistakenly overestimated, representing 51% of the total, with the majority of these being Bothrops. This is due to the fact that the common name “surucucu” is given in western Amazonia to B. atrox and “pico-de-jaca” or "surucucu pico-de-jaca" for L. muta, generating confusion among health professionals who learned that “surucucu” would be L. muta. Furthermore, this study highlighted the occurrence of erroneous records of accidents supposedly caused by the rattlesnake Crotalus durissus Linnaeus, 1758, as this species of viper does not occur in the state of Acre (see Nogueira et al., 2019). Bernarde and Gomes (2012) observed the need to train health professionals in Alto Juruá in relation to the identification of snakes involved in snakebites.

A herpetofaunal survey was conducted monthly in a floodplain forest area over a 17-month period (May 2008 and September 2009) in the lower Rio Moa forest by Bernarde et al. (2013) which currently corresponds to a protected area, the Japiim Pentecoste Area of Relevant Ecological Interest. In this study (using time-limited search, pitfall traps, active search and accidental encounters) 35 species of snakes were recorded, two of which (B. atrox and B. b. smaragdinus) were vipers.

The viper B. taeniatus, with relatively fewer records among the species of the genus Bothrops in the Amazon (Nogueira et al., 2019), was recorded for Acre at the Estação Ecológica do Rio Acre in the municipality of Assis Brasil by Souza et al. (2013).

Melo-Sampaio and Maciel (2018) observed an adult individual of B. atrox in a hunting posture 4 m high on a palm leaf at night in the Zoobotanical Park of the Federal University of Acre in Rio Branco. This was the largest recorded height of an adult specimen of B. atrox on vegetation.
In Porto Walter, a herpetofaunal survey was carried out in unflooded forest by Fonseca et al. (2019a), recording 20 species of snakes. In this study, only one viper was recorded, *B. atrox*, with seven specimens, being the most abundant snake.

Mota-da-Silva et al. (2019a) carried out a study with patients bitten by snakes in a hospital in Cruzeiro do Sul, interviewing them about the circumstances of the snakebite and analyzing the snakes involved. *Bothrops atrox* was the species most involved in snakebites, representing 83.4% of cases, followed by *B. b. smaragdinus*, with 5.3%. Most cases of snakebites with *B. atrox* were with small snakes (20–50 cm), representing 54.1% of cases, followed by medium-sized individuals (5–100 cm) making up 31.2% of accidents and the others, with large snakes (101–165 cm) with 14.7% of bites. These authors concluded that *B. atrox* offspring are responsible for most of the snakebites due to their higher abundance in nature and their smaller size, making them more difficult for humans to see.

The hunting behavior of *B. b. smaragdinus* was studied by Fonseca et al. (2019b), who carried out 72 nocturnal observations of 32 individuals in a floodplain forest at Japiim Pentecoste Area of Relevant Ecological Interest in Cruzeiro do Sul. On 38 occasions, the snakes were hunting from an ambush posture using tail luring behavior (Sazima, 1991). This was the study that recorded the most individuals of a snake species in nature performing the behavior of tail luring without the use of staged encounters. These authors showed that individuals of *B. b. smaragdinus* have a white or brown tail tip and that it is not correlated with sex or the stage of development of the snake, with the tail luring behavior being used by juveniles and adults.

Mota-da-Silva et al. (2019b) reported on a person bitten by a juvenile *B. atrox* after cutting it into three parts with a machete in Cruzeiro do Sul. The man handled the cut snake thinking it was dead and was then bitten on the finger.

The association of snakebites with açai fruits extraction was reported by Mota-da-Silva et al. (2019c), who observed cases of people bitten by *B. b. smaragdinus* on the top of acai trees or on the tree next to it (sometimes climbed to reach nearby açai fruits), and from fruit collectors stung by *B. atrox* on the ground at the base of açai and other palm trees. These authors concluded that these snakes hunt by waiting on the ground (*B. atrox*) close to palm trees, where there are fallen fruits that attract small mammals, and high up in the vegetation close to açai berry clusters (*B. b. smaragdinus*), which can cause snakebites in collectors.
Although Souza et al. (2002) and Bernarde and Gomes (2012) observed that the popular name “surucucu” is one of those used to designate *B. atrox* in Acre, this pattern was not the same in a new study by Mota-da-Silva et al. (2019d). Through interviews with patients bitten by *B. atrox* at the Juruá Regional Hospital, Mota-da-Silva et al. (2019d) observed that the name “jararaca” is given preferably to newborns and juveniles and “surucucu” to adult individuals of *B. atrox*. Human populations inhabiting rural areas in Acre tend to consider the different stages of development of this snake as two distinct species.

Silva et al. (2020a) interviewed residents who carry out activities (extractivism, hunting, fishing) in a floodplain forest in ARIE Japiim Pentecoste and correlated the information with a study on snakes conducted in that location. Of 100 people interviewed, 63 reported having found snakes during extraction of fruits from palm trees (mainly açaí), with *B. atrox* on the ground up to 4 m high and *B. b. smaragdinus* between 2 and 25 m above the ground. During nocturnal searches, these authors recorded 36 individuals of *B. b. smaragdinus* and 27 from *B. atrox*, corroborating the data from Turci et al. (2009), who also observed a greater number of vipers in the same location and as the only vipers found in this floodplain ecosystem.

In relation to snakebites caused by *B. atrox*, Costa et al. (2020), in a study conducted in a hospital environment in Cruzeiro do Sul, observed that small snakes are mainly associated with mild and moderate snakebites, with a greater presence of hemorrhagic manifestations, while larger specimens are responsible for serious cases and characterized by local effects (necrosis, edema, blistering, compartment syndrome and infection).

Sachett et al. (2020) presented a clinical report of two cases of snakebites in patients that progressed to stroke in Cruzeiro do Sul, one of which was caused by a juvenile of *B. atrox*.

Another viper that is uncommon in the Amazon and generally associated with drier forests is *B. brazili* (Campbell; Lamar 2004). Bernarde and Almeida (2020) recorded three individuals of this species in unflooded forest in the Serra do Divisor National Park.

Mota-da-Silva et al. (2020) studied the clinical and epidemiological aspects of snakebites in the Alto Juruá region, recording the snake *B. atrox* as the main species involved and no cases of snakebites by *L. muta* during the an one-year study. These authors recorded a greater occurrence of snakebites during the rainy season, a period that coincides with increased reproductive activity of snakes and higher availability of their prey.
An ethno-herpetological study conducted on populations that carry out activities in floodplain forests in ARIE Japiim Pentecoste by Silva et al. (2020b), corroborated the study by Mota-da-Silva et al. (2019d) that residents see juvenile and adult individuals of B. atrox as distinct species, represented by the respective ethnospecies jararaca and surucucu. These authors also observed that residents know more about the effects of envenoming by juvenile specimens of B. atrox, which cause more hemorrhagic conditions and by adult individuals responsible mainly for local effects (e. g., edema, necrosis) rather than accidents caused by other species (e. g., B. b. smaragdinus, L. muta and Micrurus spp.), possibly due to the higher frequency of snakebites caused by B. atrox.

Fonseca et al. (2021) studied the ecology of B. b. smaragdinus in a floodplain forest at ARIE Japiim Pentecoste, using nocturnal time-constrained search. The occurrence of B. b. smaragdinus was significantly correlated with the frequency of three amphibian species [Osteocephalus leprieuri (Duméril & Bibron, 1841), O. taurinus Steindachner, 1862 and Scinax ruber (Laurenti, 1768)], which are part of their diet, and was inversely correlated with rainfall.

Results from a study on the snake assemblages in the unflooded forest area of Resex Riozinho da Liberdade were provided by Turci et al. (2021), with seven individuals of B. atrox and two of L. muta found during the study. Juvenile individuals of B. atrox (5) were found on low vegetation and adults (2) on the ground, corroborating data on substrate use by this species (e. g., Oliveira; Martins, 2001; Turci et al., 2009).

In the floodplain forest of ARIE Japiim Pentecoste, combat behavior was observed between two male individuals of B. atrox (120 and 130 cm long) by Fonseca et al. (2022). This was the first record of this behavior for this species in nature.

Sachett et al. (2022) provided a clinical report of a case of envenoming caused by the snake L. muta in the municipality of Brasiléia. This was the first confirmed case of L. muta snakebite in Acre and denotes the low frequency of this type of accident (e. g., Mota-da-Silva et al., 2019a) probably due to the low population density of this snake (e. g., Campbell; Lamar, 2004; Turci et al., 2021).

Ortega et al. (2023) and Rodrigues et al. (2023) carried out interviews with residents of different communities in Acre and through the recognition of snake species on photographic plates and the popular names attributed to the snakes by interviewees, they also observed that the
snake *B. atrox* is the main species involved in snakebites and also in bites during the extraction of palm tree, mainly by *B. b. smaragdinus* during açaí fruits collection.

3 FINAL CONSIDERATIONS

Six species of snakes of the family Viperidae occur in Acre state, with *B. atrox* being the most abundant, present in various types of habitats and the main species involved in snakebites. In the floodplain forest of ARIE Japiim Pentecoste in Cruzeiro do Sul, this snake is the second most common.

*Bothrops bilineatus smaragdinus* is the most common snake found in a floodplain forest in ARIE Japiim Pentecoste, a factor probably associated with the availability of prey (amphibians of the family Hylidae), including during the dry season. In unflooded forests this viper is also present, although with a lower frequency. It is the second species of venomous snake most involved in cases of snakebites in Acre and these can occur during the extraction of açaí fruits.

The other four species of vipers (*B. hyoprora, B. brazili, B. taeniatus* and *L. muta*) are less frequent and associated with unflooded forests. Due to their relatively lower frequency, there are no clinical reports of snakebites in humans (*B. hyoprora, B. brazili* and *B. taeniatus*) or only one case recorded in the literature for Acre (*L. muta*).

Although the bibliographical survey carried out in this study has obtained several studies involving vipers in Acre, there is a need for more studies on these snakes in the region, addressing their ecology, ethno-herpetological questions and snakebites, including research on their ecology and behavior in the field, genetic variation and differentiation among populations and species, and biochemical composition of venoms.

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REFERENCES


