REVISTA DELOS DESARROLLO LOCAL SOSTENIBLE

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

DOI: 10.55905/rdelosv17.n54-014

Originals received: 03/05/2024
Acceptance for publication: 04/01/2024

Wirven Lima da Fonseca
Master in Ecology and Natural Resource Management
Institution: Universidade Federal do Acre (UFAC)
Address: Rio Branco - Acre, Brazil
E-mail: wirvenlima.pw@outlook.com

Marllus Rafael Negreiros de Almeida
Master in Environmental Sciences
Institution: Universidade Federal do Acre (UFAC)
Address: Rio Branco - Acre, Brazil
E-mail: rafaelbio2011@gmail.com

Ageane Mota da Silva
Doctor in Biodiversity and Biotechnology
Institution: Instituto Federal do Acre (IFAC)
Address: Cruzeiro do Sul - Acre, Brazil
E-mail: ageane.silva@ifac.edu.br

Reginaldo Assêncio Machado
Doctor in Zoology
Institution: Universidade Federal do Acre, Campus Floresta (UFAC)
Address: Cruzeiro do Sul - Acre, Brazil
E-mail: reginaldo.machado@ufac.br

Marcio Martins
Doctor in Ecology
Institution: Universidade de São Paulo, Instituto de Biociências (USP)
Address: São Paulo - São Paulo, Brazil
E-mail: martinsmrc@usp.br

Paulo Sérgio Bernarde
Doctor in Zoology
Institution: Universidade Federal do Acre, Campus Floresta (UFAC)
Address: Cruzeiro do Sul - Acre, Brazil
E-mail: snakebernarde@hotmail.com

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, 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.

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 hyoprora, 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 seldon 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).

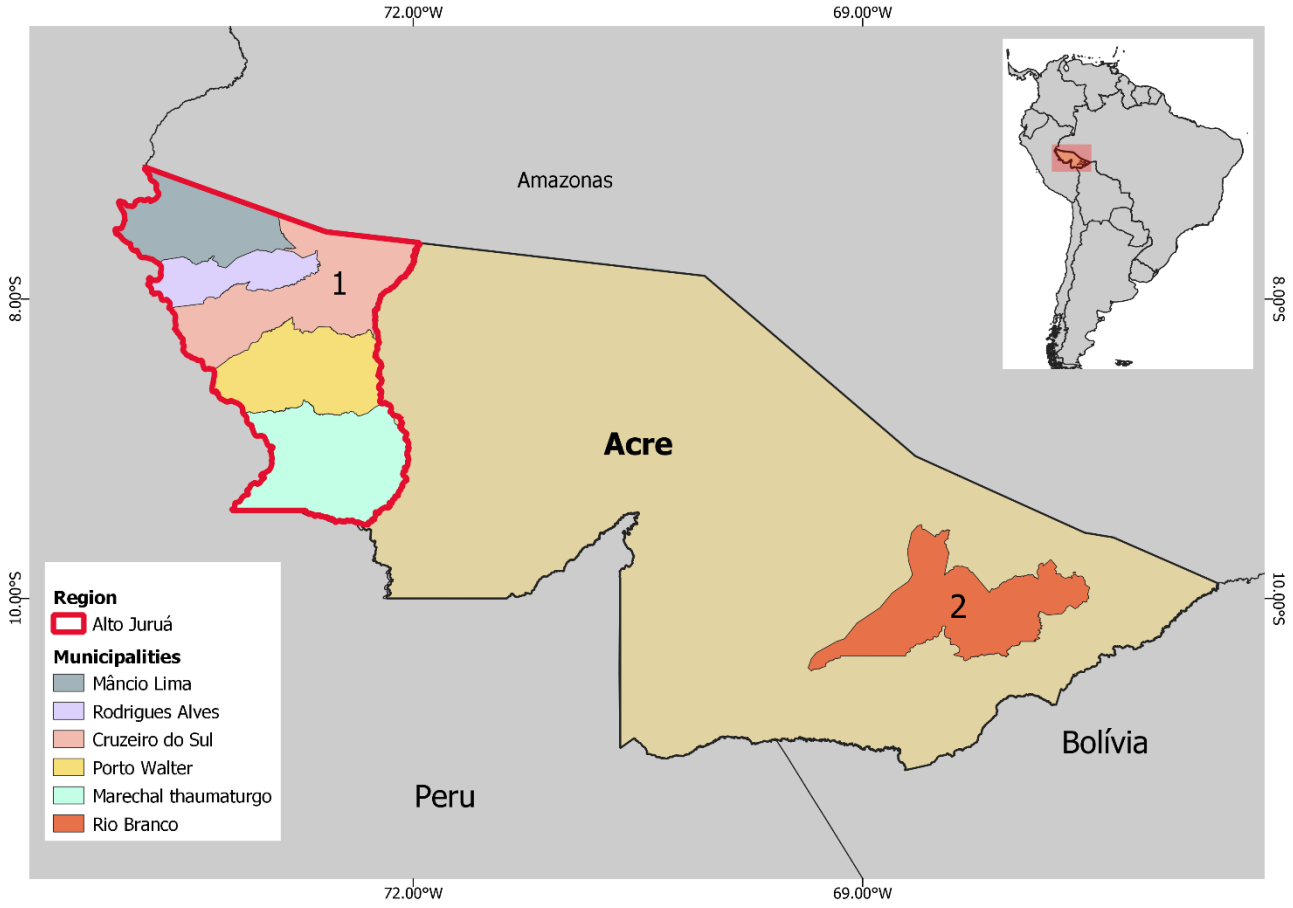
Considering the ecological importance of snakes in terrestrial ecosystems, mainly as important predators in food webs, and in public health due to the risks of snakebites, here we

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 a 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 a 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 açaí 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 açaí fruits), and from fruit collectors stung by *B. atrox* on the ground at the base of açaí 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 açaí barry 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.

ACKNOWLEDGMENTS

We thank the National Council for Scientific and Technological Development (CNPq) for the research productivity fellowships to MM (#309772/2021-4) and PSB (#311509/2020-7), the São Paulo State Research Support Foundation (FAPESP) for a research grant to MM (#2020/12658-4). This study was funded in part by the Coordination for the Improvement of Higher Education Personnel – Brazil (CAPES) – Financial Code 001 for WLF and by the Acre Research Support

Foundation – FAPAC (Government of the State of Acre), National Council for Scientific Development and Technological - CNPq (Process 401519/2023-6) and CONFAP.

REFERENCES

AVILA-PIRES, T. C. S. *et al.* Squamata (Reptilia) from four sites in southern Amazonia, with a biogeographic analysis of Amazonian lizards. **Boletim do Museu Paraense Emílio Goeldi de Ciências Naturais**, Belém, v. 4, n.2, p. 99-118, 2009.

BARRIO-AMORÓS, C. L. *et al.* The Bushmasters (*Lachesis* spp.): queens of the rainforest. An overview of the taxonomy, distribution, natural history, lore, and conservation of the largest vipers in the world. **Reptiles & Amphibians**, Writtle, v. 27, n. 3, p. 358-381, 2020.

BERNARDE, P. S. **Serpentes peçonhentas e acidentes ofídicos no Brasil**. São Paulo: Anolisbooks, 2014, 223p.

BERNARDE, P. S.; ALMEIDA, M. R. N. The Brazil's Lancehead (*Bothrops brazili*): An Uncommon Pit Viper of the Amazonia. **Wilderness & Environmental Medicine**, New York, v. 31, n. 1, p. 126-127, 2020.

BERNARDE, P. S.; GOMES, J. O. Serpentes peçonhentas e ofidismo em Cruzeiro do Sul, Alto Juruá, Estado do Acre, Brasil. **Acta Amazonica**, Manaus, v. 42, n.1, p. 65-72, 2012.

BERNARDE, P. S. *et al.* Herpetofauna da área do Igarapé Esperança na Reserva Extrativista Riozinho da Liberdade, Acre – Brasil. **Biota Neotropica**, Campinas, v. 11, n. 3, p. 117-144, 2011a.

BERNARDE, P. S. *et al.* Squamata, Serpentes, Viperidae, *Bothrocophias hyoprora* (Amaral, 1935): distribution extension in the state of Acre, northern Brazil. **Check List**, Sofia, v. 7, n. 6, p. 813-814, 2011b.

BERNARDE, P. S. *et al.* Herpetofauna da floresta do baixo rio Moa em Cruzeiro do Sul, Acre – Brasil. **Biota Neotropica**, Campinas, v. 13, n. 1, p. 220-244, 2013.

BERNARDE, P. S. *et al.* **Serpentes do Alto Juruá, Acre - Amazônia brasileira.** Rio Branco: Edufac, 2017. 166p.

CAMPBELL, J. A.; LAMAR, W. W. **The Venomous Reptiles of the Western Hemisphere**. Ithaca: Cornell University Press, 2004. 976p.

CISNEROS-HEREDIA, D. F. *et al.* Distribution and natural history of the Ecuadorian toad-headed pitvipers of the genus *Bothrocophias* (Squamata: Serpentes: Crotalinae). **Herpetozoa**, Viena, v. 19, n. 1/2, p. 17-26, 2006.

COSTA, T. N. *et al.* Injuries caused by fish to fishermen in the Vale do Alto Juruá, Western Brazilian Amazon. **Revista da Sociedade Brasileira de Medicina Tropical**, Uberaba, v. 53, n. 4, e20180495, 2019.

FEARNSIDE, P. M. Maintaining carbon stocks in extractive reserves in Brazilian Amazonia. **Desenvolvimento e Meio Ambiente**, Curitiba, v. 48, Edição Especial, p. 446-476, 2018.

FONSECA, W. L. *et al.* Caudal luring in the Neotropical two-striped forest pitviper *Bothrops bilineatus smaragdinus* Hoge, 1966 in the Western Amazon. **Herpetology Notes**, Victorville, v. 12, p. 365-374, 2019a.

FONSECA, W. L. *et al.* Herpetofauna of Porto Walter and surrounding areas, Southwest Amazonia, Brazil. **Herpetology Notes**, Victorville, v. 12, p. 91-107, 2019b.

FONSECA, W. L. *et al.* Habitat use and activity of *Bothrops bilineatus smaragdinus* Hoge, 1966 in the western Brazilian Amazon (Serpentes: Viperidae). **Herpetology Notes**, Victorville, v. 14, p. 567-580, 2021.

FONSECA, W. L. *et al.* First report of male-male combat in free-ranging Amazonian Common Lanceheads (*Bothrops atrox*). **Canadian Journal of Zoology**, Ottawa, v. 100, n.3, p. 239-242, 2022.

GUEDES, T. B. *et al.* Lista de répteis do Brasil: atualização de 2022. **Herpetologia Brasileira**, Belém, v. 12, n.1 p. 56-161, 2023.

HARTMANN, P. A. *et al.* Ecology of a snake assemblage in the Atlantic Forest of southeastern Brazil. **Papéis Avulsos de Zoologia**, São Paulo, v. 49, n. 27, p. 343-360, 2009.

MARQUES, O. A. V. *et al.* **Serpentes da Amazônia: guia ilustrado**. Cotia: Ponto A, 2023. 318p.

MARTINS, M.; OLIVEIRA, M. E. Natural history of snakes in forests of the Manaus region, Central Amazonia, Brazil. **Herpetological Natural History**, Riverside, v. 6, n. 2, p. 78-150, 1998.

MARTINS, M. *et al.* Diversity and evolution of macrohabitat use, body size and morphology in a monophyletic group of Neotropical pitvipers (*Bothrops*). **Journal of Zoology**, Medford, v. 254, n.4, p. 529-538, 2001.

MARTINS, M. *et al.* Ecological and phylogenetic correlates of feeding habits in Neotropical pitvipers of the genus *Bothrops*. *In*: SCHUETT, G. W. *et al.* (eds.). **Biology of the Vipers**. Eagle Mountain: Eagle Mountain Publishing, 2002. p. 307-328.

MCLAUCHLAN, K. K. *et al.* Fire as a fundamental ecological process: Research advances and frontiers. **Journal of Ecology**, London, v. 108, n. 5, p. 2047-2069, 2020.

MELO-SAMPAIO, P. R.; MACIEL, J. M. L. *Bothrops atrox* (Common Lancehead, Jararaca). Habitat use. **Herpetological Review**, Clovis, v. 49, n.1, p. 124, 2018.

MORENO, E. *et al.* Características clínico-epidemiológicas dos acidentes ofídicos em Rio Branco, Acre. **Revista da Sociedade Brasileira de Medicina Tropical**, Uberaba, v. 38, n. 1, p. 15-21, 2005.

MOTA-DA-SILVA, A. *et al*. Ethno-knowledge and attitudes regarding snakebites in the Alto Juruá region, Western Brazilian Amazonia. **Toxicon**, Oxford, v. 171, p. 66-77, 2019a.

MOTA-DA-SILVA, A. *et al.* Envenomation by a juvenile pit viper (*Bothrops atrox*) presumed to be dead. **Revista da Sociedade Brasileira de Medicina Tropical**, Uberaba, v. 52: e20180471, p. 1-2, 2019b.

MOTA-DA-SILVA, A. *et al*. Extractivism of palm tree fruits: A risky activity because of snakebites in the state of Acre, Western Brazilian Amazon. **Revista da Sociedade Brasileira de Medicina Tropical**, Uberaba, v. 52:e-20180195, p. 1-4, 2019c.

MOTA-DA-SILVA, A. *et al.* Popular names for bushmaster (*Lachesis muta*) and lancehead (*Bothrops atrox*) snakes in the Alto Juruá region: repercussions for clinical-epidemiological diagnosis and surveillance. **Revista da Sociedade Brasileira de Medicina Tropical**, Uberaba, v. 52:e-20180140, p. 1-4, 2019d.

MOTA-DA-SILVA, A. *et al.* Epidemiological and clinical aspects of snakebites in the upper Juruá River region, western Brazilian Amazonia. **Acta Amazonica**, Manaus, v. 50, n.1, p. 90-99, 2020.

NOBRE, C. A. *et al.* Land-use and climate change risks in the Amazon and the need for a novel sustainable development paradigm. **Proceedings of the National Academy of Sciences (PNAS)**, Whashington, v. 113, n. 39, p. 10759-10768, 2016.

NOGUEIRA, C. C. *et al.* Atlas of Brazilian snakes: Verified point-locality maps to mitigate the Wallacean shortfall in a megadiverse snake fauna. **South American Journal of Herpetology**, Belém, v. 14, n. sp1, p. 1-274, 2019.

OLIVEIRA, M. E.; MARTINS, M. When and where to find a pitviper: activity patterns and habitat use of the lancehead, *Bothrops atrox*, in central Amazonia, Brazil. **Herpetological Natural History**, Riverside, v. 8, n. 2, p. 101-110, 2001.

ORTEGA, G. P. *et al*. Acidentes com animais peçonhentos durante o extrativismo em florestas no estado do Acre, Brasil. **Delos: Desarrollo Local Sostenible**, São José dos Pinhais, v. 16, n. 44, p. 1135-1154, 2023.

PIERINI, S. V. *et al.* High incidence of bites and stings by snakes and other animals among rubber tappers and Amazonian Indians of the Juruá Valley, Acre State, Brazil. **Toxicon**, Oxford, v. 34, n. 2, p. 225-236, 1996.

RODRIGUES, T. S. N. *et al.* Morbidity survey of the history of snakebites in different communities in the alto Juruá, western Brazilian Amazon. **Toxicon**, Oxford, v. 224, p. 107033, 2023.

SACHETT, J. A. G. *et al.* When to think about a *Lachesis muta* envenomation in the Western Brazilian Amazon: Lessons from a case report. **Revista da Sociedade Brasileira de Medicina Tropical**, Uberaba, v. 55:e0027-2022), p. 1-4, 2022.

SACHETT, J. A. G. *et al.* Cerebrovascular Accidents Related to Snakebites in the Amazon – Two Case Reports. **Wilderness & Environmental Medicine**, New York, v. 31, n. 3, p. 337-343, 2020.

SAWAYA, R. J. *et al.* Composição e história natural das serpentes de cerrado de Itirapina, São Paulo, sudeste do Brasil. **Biota Neotropica**, Campinas, v. 8, n. 2, p. 127-148, 2008.

SAZIMA, I. Caudal luring in two neotropical pitvipers, *Bothrops jararaca* and *Bothrops jararacussu*. **Copeia**, v. 1991, n. 1, p. 245-248, 1991.

SILVA, J. L. *et al.* Venomous snakes and people in a floodplain forest in the Western Brazilian Amazon: Potential risks for snakebites. **Toxicon**, Oxford, v. 187, p. 232-244, 2020a.

SILVA, J. L. *et al.* The deadliest snake according to ethnobiological perception of the population of the Alto Juruá region, western Brazilian Amazonia. **Revista da Sociedade Brasileira de Medicina Tropical**, Uberaba, v. 53: e20190305, 2020b.

SILVA, M. V. *et al.* Riqueza e dieta de serpentes do Estado do Acre, Brasil. **Revista Brasileira de Zoociências**, Juiz de Fora, v. 12, n. 2, p. 165-176, 2010.

SOUZA, J. R. D. *et al.* First record of *Bothriopsis taeniata* for the state of Acre, Brazil. **Check List**, Sofia, v. 9, n.2, p. 430-431, 2013.

SOUZA, M. B. *et al. Cobras*. *In*: CUNHA, M. C.; ALMEIDA, M. B. (orgs.). **Enciclopédia da Floresta: o Alto Juruá: práticas e conhecimentos das populações.** São Paulo: Companhia das Letras, 2002. p. 577-600.

TURCI, L. C. B. *et al.* Uso do hábitat, atividade e comportamento de *Bothriopsis bilineatus* e de *Bothrops atrox* (Serpentes: Viperidae) na floresta do Rio Moa, Acre, Brasil. **Biota Neotropica**, Campinas, v. 9, n. 3, p. 197-206, 2009.

TURCI, L. C. B. *et al.* Snake assemblage in an unflooded forest in Western Brazilian Amazon. **South American Journal of Basic Education, Technical and Technological**, Rio Branco, v. 8, n. 1, p. 203-221, 2021.

WWF - WORLD WILDLIFE FOUNDATION. **Por dentro da floresta amazônica**. Available at: https://www.wwf.org.br/natureza_brasileira/areas_prioritarias/amazonia1/bioma_amazonia/. Accessed on: 10 nov. 2023.

ZANELLA, N.; CECHIN, S. Z. Taxocenose de serpentes no Planalto Médio do Rio Grande do Sul, Brasil. **Revista Brasileira de Zoologia**, Curitiba, v. 23, n. 1, p. 211-217, 2006.