

## Short Communication

# Extractivism of palm tree fruits: A risky activity because of snakebites in the state of Acre, Western Brazilian Amazon

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### Abstract

**Introduction:** We present here the risk from snakebites because of palm extractivism in western Amazonia. **Methods:** The data were extracted from a cross-sectional sample study, from January 2016 to April 2018, at the Juruá Regional Hospital of Cruzeiro do Sul (Acre). **Results:** There were 14 *Bothrops* incidents involving males, most of them occurring during the harvesting of “açai” (*Euterpe precatoria*). **Conclusions:** During the harvesting of “açai,” there is the risk of the presence of *B. atrox* on the ground near the palm tree, and of *B. bilineatus* at the top of the palm tree.

**Keywords:** Snakebite. *Bothrops*. Occupational hazard. Epidemiology.

The extractivism of non-timber forest products in the Amazon region represents a significant part of the region's economy and is an important source of income for a number of traditional populations, the main products being “babaçu,” “açai,” and Brazil nuts<sup>1</sup>. Among the risks to which the extractivists are vulnerable to during these forest activities are accidents involving venomous animals, especially those involving snakes<sup>2,3,4</sup>. Because the period of the year when these activities generally occur coincides with the rainy season, when snakes are more active<sup>5,6</sup>, the vulnerability of these workers is considerable<sup>2</sup>. In this paper, we present the results of a study on snake envenomings in Brazil, covering a wide distributional area, where snakebites represent an occupational health problem for rural, indigenous, and riverine populations<sup>7</sup>.

In Acre, open palm forests make up a dominant type of vegetation cover in some places, mainly in the region of Alto

Juruá, characterized by the presence of “açai” plantations (*Euterpe precatoria* Mart.), “buriti” plantations (*Mauritia flexuosa* Mart.) and “bacaba” plantations (*Oenocarpus bacaba* Mart.)<sup>8</sup>. Palm forests occur on both solid ground and in alluvial areas, and may be associated with patches of dense forest or forest with bamboo<sup>8</sup>. In all, there are at least 31 palm species in this region, five of which are widely used by indigenous and non-indigenous populations (“açai” - *Euterpe precatoria*; “buriti” - *Mauritia flexuosa*; “auricuri” - *Attalea phalerata* Mart. Ex Spreng; “jaci” - *A. butyracea* (Mutis ex L.f.), and *Phytelephas macrocarpa* Ruiz & Pav.)<sup>9</sup>. In addition to the extractivism of fruits, palm hearts, and oilseeds, some palm trees are also used in the construction of dwellings, to obtain fibers, and for medicinal purposes<sup>9</sup>.

In the region of Alto Juruá, 13 species of venomous snakes are known, including seven that are true corals (*Leptomicrurus narducci*, *Micrurus annellatus*, *M. hemprichii*, *M. lemniscatus*, *M. remotus*, *M. spixii*, and *M. surinamensis*), five lanceheads (*Bothrocophias hyoprora*, *Bothrops atrox*, *B. bilineatus*, *B. brazili*, and *B. taeniatus*), and the bushmaster (*Lachesis muta*)<sup>10</sup>. In spite of this diversity of venomous snakes, the most abundant and main cause of snakebites in the region is that of *Bothrops atrox*<sup>10</sup>. On floodplains, which are areas that flood seasonally or

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are influenced directly by streams, palm trees such as “açai” and “buriti” are abundant<sup>8</sup>. Some species of venomous snakes (e.g., *Bothrops atrox* and *B. bilineatus*) are common in the vicinity of aquatic environments in these forest areas<sup>5,6</sup>.

We present here epidemiological aspects and circumstances of snakebites occurring in the region of Alto Juruá, in the state of Acre, Brazilian Amazon, associated with palm trees or their extractivism.

Data were obtained through a transversal study, with consecutive sampling, from January 2016 to April 2018, based on data from the Epidemiological Surveillance Sector of the Juruá Regional Hospital, located in Cruzeiro do Sul, which is the main health unit that attends to victims of snakebites in this region. The Alto Juruá Region is located in the extreme west of the State of Acre and is comprised of the municipalities of Mâncio Lima, Cruzeiro do Sul, Rodrigues Alves, Porto Walter, and Marechal Thaumaturgo. In this region, the main activities are fishing, fish farming, production of manioc flour (“cassava”), extractivism (“açai,” “buriti,” “pupunha,” and “cupuçu”), as well as family agriculture (bean, corn, rice, vegetables, banana plantations)<sup>10</sup>.

All patients who reported that the accident was related to the extractivism of palm products were included in this study. The causative snake was identified when it was brought to the hospital by the patient. In cases where the snake was not identified, a clinical-epidemiological study was performed. Although *Bothrops* contact with humans resulting in envenomings is generally diagnosed based on the clinical-epidemiological profile, positive predictive value of this type of identification reaches 97.8-100% compared to immunoassay techniques using monoclonal antibodies because of the high prevalence of this species causing injuries<sup>11,12</sup>; such a high value indicates an excellent level of accuracy and internal validity of the dependent variable used in this study. In these cases, the patients or the persons accompanying them who witnessed the event were interviewed, to obtain information that could identify the snake more accurately and the circumstances by which the accident occurred. To facilitate this, a board containing photographs of snakes was shown to the patient, and with the use of a tape measure, the size of the snake was estimated. This study was approved by the Committee of Ethics in Research with Human Beings of the Tropical Medicine Foundation Doctor Heitor Vieira Dourado (2,084,630 / 2017).

During the study period, 303 cases were recorded, of which 14 (4.6%) were associated with palm trees or with the extraction of their resources (Table 1). Only male individuals were affected in the envenomations and only *Bothrops* envenoming was registered. The species of snakes involved were *B. atrox* and *B. bilineatus* and most of the snakebites occurred during “açai” harvesting (*E. precatoria*) (64.3% of cases) (Table 1, Figures 1 and 2). The anatomical regions of the bites were most often the feet (35.7%), followed by the legs (21.4%) hands (21.4%), arms (14.3%), and thorax (7.1%) (Table 1; Figures 2C and 2D). Most of the snakebites were classified as mild (57.1%), followed by moderate (35.7%) and only one severe (7.1%) (Table 1). Snakebites occurred mainly during the day (87.5%) and most of

them in the morning (62.5%). Snakebites during the harvesting of “açai” occurred during the months of November to May, a period that coincides with the ripening and harvesting of the fruits of this palm in the region.

Of the patients interviewed, only half were wearing rubber boots at the time of the incident. In two cases, the snake was 1.5 m long and the bite was on the leg above the boot. One snake (50 cm in length) was able to pierce the boot and bite the foot, and another victim was bitten on the arm when he walked past a spiny palm (*Bactris* sp.) where the snake was at a height of one meter. It is known that *B. bilineatus* hunts and rests on vegetation, including palm leaves (Figures 1 and 2), which is a substrate where *B. atrox* juveniles may also occur<sup>5,6</sup>. The latter was involved in one of the cases that did not involve extractive activity. It involved a child, who was walking at night in “buriti” palms located in a hollow near an aquatic environment, which is a place and time where *B. atrox* usually hunts<sup>2,5,6</sup>.

Palm trees may attract small mammals (rodents and marsupials), which feed on the fruits that fall to the ground, and those with arboreal habits feed on the tops of trees<sup>13</sup>. *Bothrops atrox* is sometimes found on the ground, between the bases of the trunks of the “buriti” (*M. flexuosa*)<sup>14</sup>. Oliveira and Martins<sup>5</sup> observed two individuals of *B. atrox* in ground hunting activity under “buriti” (*M. flexuosa*), where there were many fallen fruits. *Bothrops atrox* juveniles are more frequently found on vegetation up to 1.5 m in height and preferentially feed on frogs, whereas adults are more frequently on the ground (Figure 2A) and hunt more for rodents<sup>5</sup>. Two of the *B. atrox* specimens involved in the snakebites were adults (1.5 m) and were on the ground, whereas the other two were 50 cm long, with one on the ground and the other on a fallen trunk beside a palm tree.

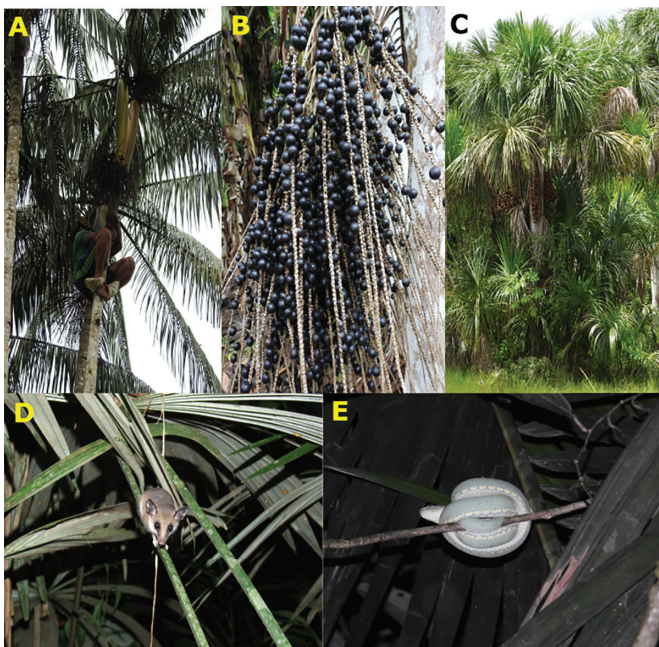
In two snakebites, probably caused by *Bothrops bilineatus*, the victims were harvesting “açai” by climbing up the palm tree to a height of 4 and 8 meters and the snake was on a branch of a neighboring tree. Turci et al.<sup>6</sup> observed this species hunting at night at heights of up to 7 meters and also sleeping during the day on the leaf of a palm tree (Figures 1E and 2B). During the day, individuals of *B. bilineatus* can be found sleeping on vegetation between heights of 50 cm and 1.7 m<sup>6</sup>, within the height range of a person, who may bump into the snake and consequently be bitten. In addition to frogs and lizards, this species also feeds on small mammals<sup>6,14</sup>, and can hunt these animals on tree branches near palm trees (Figure 1E). Because of the arboreal habit of this snake, it was expected that the bites would occur mainly in the upper regions of the body, which was observed in both cases (arm and trunk) (Figure 2D). Usually, *B. bilineatus* is uncommon in the Amazonian snake inventory studies, but in the forest of the Baixo Moa River in Alto Juruá, which is rich in palm trees (*Astrocaryum jauari*, *Bactris* sp., *Euterpe precatoria*, *Iriartea deltoidea*, *I. stenocarpa*, and *Mauritia*), this snake and *B. atrox* were abundant<sup>6</sup>.

Male individuals are more affected in snakebites associated with palm extractivism, and these occur more often during “açai” harvesting, probably because it is the most frequent activity in relation others. During the harvesting of “açai,”

**TABLE 1:** Cases of snakebites that occurred in the region of Alto Juruá, Acre, Brazilian Amazon, and were associated with palm trees.

Date	Species	Snake size*	Age	Sex	Severity grading	Anatomical region	Time**	Activity
9/01/16	<i>Bothrops</i> sp.	-	55	M	L	leg	-	Harvesting "açai" ( <i>E. precatória</i> )
22/01/16	<i>Bothrops</i> sp.	-	26	M	M	foot	-	Harvesting "açai" ( <i>E. precatória</i> )
23/05/16	<i>Bothrops</i> sp.	-	44	M	L	hand	-	Harvesting "açai" ( <i>E. precatória</i> )
06/07/16	<i>Bothrops</i> sp.	-	14	M	L	foot	-	Harvesting "buriti" ( <i>M. Flexuosa</i> )
12/11/16	<i>Bothrops</i> sp.	-	36	M	L	arm	-	Harvesting "açai" ( <i>E. precatória</i> )
24/03/17	<i>Bothrops</i> sp.	-	46	M	M	hand	-	Harvesting "açai" ( <i>E. precatória</i> ) at 8m height
03/01/18	<i>B. bilineatus</i>	43 cm	19	M	M	hand	7:00	Harvesting "açai" ( <i>E. precatória</i> ) at 8m height
04/01/18	<i>B. atrox</i>	50 cm	42	M	L	foot	8:00	Harvesting "bacaba" ( <i>O. mapora</i> )
29/01/18	<i>Bothrops</i> sp.	-	36	M	L	arm	13:00	Walking past a spiny palm ( <i>Bactris</i> sp.) where a snake was at a height of 1 m
10/03/18	<i>Bothrops</i> sp.	-	13	M	S	foot	20:00	Walking under a "buriti" palm ( <i>M. Flexuosa</i> )
26/03/18	<i>B. atrox</i>	50 cm	31	M	L	foot	9:00	Harvesting "açai" ( <i>E. precatória</i> )
06/04/18	<i>B. bilineatus</i>	56 cm	13	M	M	thorax	13:00	Harvesting "açai" ( <i>E. precatória</i> ) at 4m height
07/04/18	<i>B. atrox</i>	150 cm	38	M	M	leg	11:00	Harvesting "açai" ( <i>E. precatória</i> )
16/04/18	<i>B. atrox</i>	150 cm	26	M	L	leg	10:30	Harvesting <i>Chelyocarpus</i> leaves ( <i>C. ulei</i> )

Key: **L**: light, **M**: moderate, **S**: Serious. \*Size of the snake estimated by the patient. \*\*Hour of snakebite.



**FIGURE 1:** (A) Harvesting "açai" ("Peconheiro" or "açai" collector) by climbing "açai" palm (*Euterpe precatória*); (B) Stalk with "açai" fruit (*E. precatória*); (C) "Buriti" plantation (*Mauritia flexuosa*); (D) Small marsupial on palm leaf at night; (E) *Bothrops bilineatus* hunting at a 4 m height on a branch next to palm leaves. Photos: PSB.



**FIGURE 2:** (A) Adult individual (150 cm) of *Bothrops atrox* hunting on the ground (Photo: PSB); (B) *Bothrops bilineatus* sleeping on a palm leaf during the day at 1.4 m height (Photo: Saymon de Albuquerque); (C) Bite caused by adult *B. atrox* specimen (150 cm length) (distance between punctures = 3 cm) (Photo: AMS); (D) *B. bilineatus* bite to the thorax (Photo: AMS).



there is the risk of the presence of adult individuals of *B. atrox* on the ground near the base of the trunk of the palm tree, and of *B. bilineatus* high on branches of trees neighboring the “açai” palm. Because most snakebites occur in the lower limbs, the use of boots can help to avoid them; however, because adult snakes may bite above the height of the boot and even pierce the rubber ones. The use of leather leggings may be more efficient to avoid perforations during the snake’s attack. The use of leather gloves would be another way to prevent bites to the hands. However, there were reports of two individuals of *B. atrox* (57.8 and 100 cm) who were able to perforate leather gloves and inoculate venom<sup>15</sup>.

The demand for resources derived from extractivism of non-timber plants is on the rise<sup>1</sup> and contributes to the conservation of forests. It also represents a source of income for the populations in the Amazon. Together with this demand comes the concern regarding the need for social inclusion of extractive families<sup>1</sup> and new practices need to be adopted such that the risks to the health and safety of harvesters are reduced according to the activity and to each region’s specific needs<sup>4</sup>.

Safer techniques are recommended for the collection of açai to prevent incidents with snakes: the use of boots or leather leggings to protect the legs; the use of leather gloves for hand protection; and a safety belt to prevent falling during climbing. In addition, guidelines on prevention and first aid in case of snakebite for these populations are urgently needed.

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**Conflict of Interest:** The authors declare that there is no conflict of interest.

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