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Injuries Caused by Freshwater Stingrays in the Western Amazon: Folk Medicine and Beliefs

Greiciane Amorim da Silva[1], Aline Nayara Poscai[2*], and André Luis da Silva Casas[3]

[1]Programa de Pós-Graduação em Saúde Coletiva. Campus Universitário Rio Branco, Universidade Federal do Acre, Rio Branco, Brazil. [2]Laboratório de Pesquisas de Elasmobrânquios, Universidade Estadual Paulista "Júlio de Mesquita Filho", Praça Infante Dom Henrique, São Vicente, Brazil. [3]Laboratório de Anatomia e Fisiologia Comparada, Campus Cruzeiro do Sul, Universidade Federal do Acre, Estrada do Canela Fina, Cruzeiro do Sul, Brazil.
[*]aline.poscai@gmail.com

Abstract The envenomation caused by freshwater stingrays is one of the most frequent injuries related to aquatic animals in South America. Such injury is severe with skin necrosis as a probable result of the sting and subsequent intense pain. Here, we characterized the accidents caused by freshwater stingrays in Juruá Valley, Acre, Brazil, with reports of people who had suffered injuries. Data collection was performed in nearby communities in the Juruá River and its tributaries through a semi-structured questionnaire. Bathers and fishermen were the main group affected, and injuries were mainly in the lower limbs. The results were similar to those previously reported for other regions of Brazil, except for the treatment applied. Severe pain, edema, erythema, necrosis, and ulceration of the wound are some of the symptoms reported by the injured population. Most of the treatment is based on folk remedies, such as human urine, hot boiled egg, medicinal plants, and nonprescription drugs. In most cases, injuries usually occur in remote areas which favor the use of folk remedies, but the accidents are still neglected by the population itself because of the low lethality. Therefore, educational activities and prophylactic measures should be carried out with a standardization of first aid and late measures. In addition, the correct use of medicinal plants and folk remedies could be a strong ally to ensure a safe and affordable care for the population.

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Introduction

The family Potamotrygonidae comprises the only group of elasmobranchs restricted to freshwater environments (Carvalho et al. 2011; Compagno and Cook 1995). They are divided into four genera: *Paratrygon*, *Potamotrygon*, *Plesiotrygon*, and *Heliotrygon*. They have approximately 38 species occurring in the major river systems of South America (Carvalho et al. 2016; Cruz 2009; Fricke et al. 2020; Garrone Neto and Haddad 2010). Three Potamotrygonidae species inhabit the Juruá River Basin, an important waterway in state of Acre: *Paratrygon aiereba*, *Potamotrygon motoro*, and *Potamotrygon marquesi* (Lasso et al. 2013; Silva and Loboda 2019) (Figure 1).

Freshwater stingrays present similar habits to marine species, presenting one or more stingers located on the dorsal portion of the tail, a main characteristic of the Myliobatiformes order (Haddad 2008; Rosenberger 2001). Stingers are bilaterally retroserrated, composed by modified dermal denticles, covered by glandular and integument tissues, and abundant in toxin-secreting cells (Haddad et al. 2004), which are responsible for the envenomation recorded in injuries caused by these organisms.

Accidents usually produce an extremely painful injury that frequently causes necrosis and ulceration in tissues underlying the wound, due to the proteolytic action of the venom. Additionally, there is the possibility of retaining fragments of stingers in the wound, as well as triggering an infectious process (Antoniazzi et al. 2011; Haddad et al. 2004; Lameiras

Figure 1 Species with occurrence in the state of Acre. **A** *Potamotrygon motoro*, **B** *Paratrygon aiereba* with tail mutilation (photograph by André Luis da Silva Casas in 2014), and **C** *Potamotrygon marquesi* (adapted from Silva and Loboda 2019).

et al. 2013). In most cases, injuries cause a temporary or permanent physical incapacity, and the injured may develop sequelae in the affected limb (Haddad 2004; Lameiras et al. 2013). Lethal wounds occur mainly in cases in which stingers reach vital organs (Antoniazzi et al. 2011).

In Brazil, stingray accidents are considered a public health problem (Evangelista and Azevedo 2016; Haddad 2003; Haddad et al. 2013; Sá-Oliveira et al. 2011). According to the Information System for Notifiable Diseases (SINAN), most of the injuries caused by fish in the country involved freshwater stingrays, especially from the Potamotrygonidae family (Reckziegel et al. 2015). The most affected people are fishermen, who are handling these animals daily, and bathers, especially during the dry season (Haddad et al. 2004). These accidents are considered underreported, as they occur predominantly in remote areas (Garrone Neto and Haddad 2010; Haddad 2003; Reckziegel et al. 2015).

Currently, therapeutic approach is basically the use of analgesics, anti-inflammatories, warm water, and antibiotics to prevent secondary infections, gangrene, and tetanus (Garrone Neto and Haddad 2010; Lameiras et al. 2013). However, places that have access to health services are scarce or non-existent, therapies based on popular beliefs and natural products are often the only affordable and low-cost alternative available, but few studies have focused on folk medicine (Bussmann and Sharon 2006; Dey et al. 2017; Haddad et al. 2013; Lima et al. 2019; Matias et al. 2013; Schmeda-Hirschmann et al. 2014). Thus, ethnobiology is crucial to identify strategies used by traditional populations, as well as to understand their

Figure 2 Fish Market Calixto Alves in Cruzeiro do Sul municipality. **B** Interviews being conducted with the local population nearby Fish Market Calixto Alves. **C–D** Interviewees with the questionnaire in the Fish Market Calixto Alves. Photographs by André Luis da Silva Casas, 2014.

relationship with the available biological resources, through their beliefs, oral tradition, non-verbal language, and all knowledge systems (Albuquerque et al. 2019).

Therefore, the present study aimed to characterize injuries caused by freshwater stingrays through interviews and a questionnaire with populations of three municipalities in the mesoregion of Juruá Valley, in the Western Amazon (Acre, Brazil). Furthermore, this study emphasizes the cultural knowledge in the use of natural resources and folk medicine to treat injuries through the documentation of their beliefs and perceptions about the accidents.

Methods

Study Location

The state of Acre is located in the extreme north of Brazil, in the western Brazilian Amazon, occupying an area of 153.194 km^2. It is composed of 22 municipalities and divided into two large mesoregions: Acre Valley and Juruá Valley (Instituto Brasileiro de Geografia e Estatística 2010; Rodrigues et al. 1997). The latter has approximately 129,170 inhabitants and comprises the municipalities of Cruzeiro do Sul, Mâncio Lima, Rodrigues Alves, Marechal Thaumaturgo, Porto Walter, Tarauacá, Feijó, and Jordão (Rodrigues et al. 1997).

The study included populations predominantly composed of riverside inhabitants near Juruá River and its tributaries and fishermen. Riverside communities are located in rural areas, riverbanks, or lakes, in which the people depend on hunting, fishing, agriculture, and the sale of natural products for subsistence (Gama et al. 2018; Instituto Brasileiro de Geografia e Estatística 2010).

The region is also known for its intense fishing activity that contributes to local and regional commerce, being an important sector for economy, with a high number of commercial and subsistence fishermen (Santos and Santos 2005). Most of these activities occur in riverside communities far from the main urban centers, known as rubber plantations or *seringais*. A symbolic, cultural, and historical heritage from rubber plantation activities has dictated the Acre state economy and colonization since the beginning of the twentieth century (Carneiro 2015).

Data Collection

Interviews proceeded between 2014 and 2015 and were based on the active search for cases in riverside communities, fishermen's associations, fish markets, and health units in the municipalities of Cruzeiro do Sul, Mâncio Lima, and Rodrigues Alves (Figure 2). In this study, individuals that have suffered freshwater stingray injuries were considered.

The interviews were semi-structured, including questions about the characteristics of the accident and the use of folk remedies to treat injuries, detailing what they were, use, purposes, and therapeutic effectiveness according to the interviewed. In addition, free interviews and informal conversation were carried out, where graphic material from books by Haddad (2008) Lasso et al. (2013), were shown as additional material in an attempt to identify the species involved in the accidents.

Analyses

Descriptive analysis of freshwater stingray accidents was carried out, in which the frequency distribution (absolute and relative) were analyzed according to gender, activity, seasonality, period of the accident, search for medical care, injury site, symptoms, sequel, locality, treatment, type of treatment, and medicinal plants. Survey data was entered into 2016 Microsoft Excel and analyzed statistically in the Statistical Package for the Social Science (Windows version 22.0). Scientific nomenclatures of the botanical species were verified with the databases of Tropicos (2020).

Table 1 The Characteristics of accidents caused by freshwater stingrays in the Juruá Valley, Brazil, between 2014–2015.

Characteristics	Category	N (%)
Gender	Female	29 (22)
	Male	103 (78)
Activity	Fishing	51 (38.7)
	Recreation	69 (52.3)
	Others	12 (9)
Seasonality	Summer	107 (81)
	Winter	25 (19)
Period of the accident	Morning	49 (37.1)
	Afternoon	70 (53)
	Evening	13 (9.9)
Search for medical care	Yes	26 (19.7)
	No	106 (80.3)
Injury site	Upper limbs	3 (2.3)
	Lower limbs	128 (97)
	Trunk	1 (0.7)
Symptoms[1]	Bleeding	20 (15.1)
	Chronic pain	125 (94.7)
	Edema	107 (81)
	Erythema	107 (81)
	Necrosis	74 (56)
	Ulcers	57 (43.2)
	Fever	9 (6.8)
	Vomit	3 (2.3)
Sequel	Yes	36 (27.3)
	No	96 (72.7)
Locality	Urban area	39 (29.5)
	Semi-urban area	31 (23.5)
	Rubber plantations	55 (41.7)
	Unreported	7 (5.3)
Alternative treatment	Yes	111 (84)
	No	21 (16)
Type of alternative treatment[2]	Plants	34 (30.6)
	Others	67 (60.4)
	Unreported	10 (9)

[1]Frequency of citation.

[2]Data on the 111 cases that opted for alternative treatment.

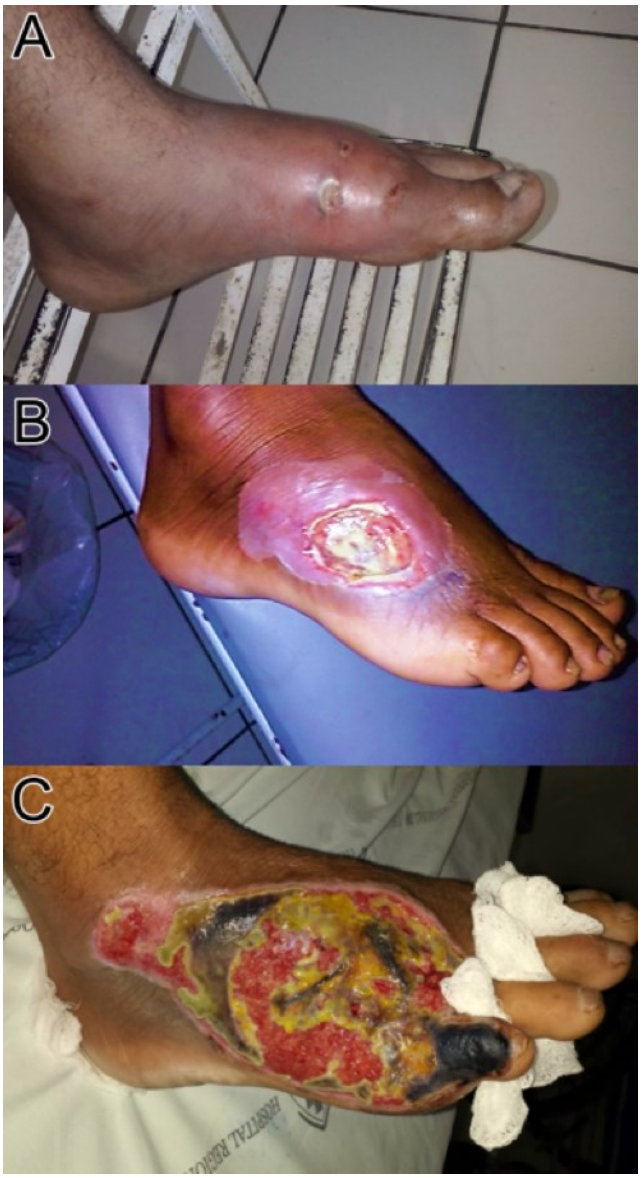

Figure 3 The Injuries caused by freshwater stingrays. **A** Injury observed in a victim from Mâncio Lima, Acre, with edema, erythema, and infection caused by the sting. **B** Secondary infection and ulceration on the right foot of a victim from Rodrigues Alves, Acre. **C** Victim presenting a seven-day lesion, with ulceration, necrosis, and infection. Photographs by Greiciane Amorim da Silva, 2014 .

Results

Accidents and Beliefs Related to Freshwater Stingrays

A total of 132 interviews were conducted, including 29 women and 103 men. The accident involving freshwater stingrays was described as emotionally unpleasant, extremely painful, and a long-term recovery experience. Accidents occurred mainly during leisure (52.3%) and fishing (38.7%) activities, while the period corresponding to the ebb and flow of rivers represented the highest number of cases (81.0%). About 90.0% of accidents occurred during the day, especially in the afternoon (53.0%). The largest number of cases (41.7%) occurred in rubber plantations. The most affected limbs were lower (97.0%), upper (2.3%), and the trunk (0.7%), more specifically the hip (Table 1).

In most cases, the sting was considered unexpected and aggressive. The main symptom was pain (94.7%), characterized as unbearable and uninterrupted, with reports of fainting and lack of control of the urethral and anal sphincters. Edema and erythema were reported by 81% of the individuals, while 56.0% reported skin necrosis, and 43.2% reported wound ulceration (Figure 3). At least 9.1% of the victims reported systemic symptoms, such as fever (6.8%) and vomiting (2.3%). In addition, 27.3% reported sequelae such as long-term pain, numbness, tremors, and amputations of the affected limb (Table 1). The average duration of wound healing was three months.

Considering the severity of the injury, it is natural that the trauma produces a feeling of fear, which combined with misinformation, generates many beliefs and myths associated with freshwater stingrays and the injuries caused by them. Some people, for example, described them as "aggressive and treacherous" animals, that hide in the water to attack anyone who crosses their path. Others mentioned the existence of a "mother stingray" in the region that "embraces" people and is capable of turning over canoes and boats to kill by drowning. Some people also claim that the best way to "escape" from the stingers is to take the seed of a plant called *jarina* (*Phytelephas macrocarpa*) with them, which theoretically would keep stingrays away.

In addition, freshwater stingrays are considered to be a "hinder" because, according to fishermen, they repel other fish, as well as damage the fishing lines by either ripping of breaking the fishing gear.

Due to the extreme fear that surrounds these animals, many stingrays are killed or have their tails mutilated to remove stingers, being thrown back into the rivers. Few fishermen reported returning the intact animal to its habitat when caught, while the majority stated that they prefer to kill or cut its tail to prevent future accidents. Besides this, the interviewees stated that they occasionally feed on stingrays. Curious

reports from fishermen, regarding the consumption of these fish, claim that residents of Rodrigues Alves municipality developed the "fishing with their feet," in which they prefer to be stung rather than lose the animal, ensuring food.

Folk Medicine and Use of Medicinal Plants to Treat Injuries Caused by Freshwater Stingrays

Thirty-four interviewees (30.6%) reported that the use of plants for phytotherapeutic purposes in the region is common to treat symptoms. Twenty species of medicinal plants were mentioned, among them, tobacco (*Nicotiana tabacum* [11.9%]), *caapeba* (*Cissampelos glaberrima* [8.9%]), and *copaíba* (*Copaifera officinalis* [8.9%]). Leaves and sap were the most used parts of the medicinal plants being mentioned 19 and seven times, respectively. Regarding traditional use, infusion was cited 13 times, followed by direct application, mentioned nine times, and bath, referred eight times. The main purposes of using plants were to heal (34.4%), to decrease edema (24.1%), to reduce pain (17.2%), cleaning the wound (13.7%), and blood stagnation (3.4%).

According to reports, plants were prepared in their own houses. The people demonstrated uncertainty about the time of use, dosage for adults and children, possible side effects, and contraindications of the plants. All respondents who used these plants stated that they received recommendations from relatives or friends, and they believe that the use of these plants is more beneficial than pharmaceutical drugs. Table 2 describes the plant species mentioned for the treatment of injuries caused by freshwater stingrays in the mesoregion of Juruá Valley, Acre, with details of the family to which they belong, scientific name, local popular name, vegetable drugs, form of traditional use, and purpose of use.

In addition, 64 interviewees mentioned the use folk remedies on the wound, based on recommendations from friends and/or relatives, such as sweetened condensed milk, human urine, boiled egg, pipe ashes, breast milk, hot coffee grounds, sand, hot soap of manioc flour, gasoline, termite smoke, salt water, *sebo-de-holanda* (an animal oil), and boiled soap. Some also stated that the best remedy to treat the symptoms was to heat the stinger (the same that injured) and place on the wound.

Some beliefs reported by the interviewees consisted in placing the affected limb in the female intimate parts of a virgin, theoretically relieving pain caused by the injury. Two interviewees claimed to have performed this practice by the recommendation of family members and described it as ineffective.

Discussion

In the studied areas, fishermen and bathers were mainly affected, which can be attributed to the intense fishing activity, both professional and amateur, and leisure related to the hydrographic basins of the region. In this context, most accidents occurred during the ebb and flow of rivers, a period in which recreational and fishing activities intensify, facilitating contact with the animal. According to Diaz (2008), while waders and undersea divers are most commonly stung on the lower extremity, fishermen are predisposed to injuries in the upper extremity sustained when disentangling stingrays from fishing hooks and trawl nets. Since freshwater stingrays are commonly found hidden in the sand, near margins or in places with a depth less than two meters, the most affected areas were the lower and upper limbs, in which people often stepped on them or due to careless handling (Evans and Davies 1996; Garrone Neto and Haddad 2009; Haddad 2008).

As observed, these accidents resemble the reports regarding the literature on stingray accidents in other Brazilian regions and worldwide (e.g., Clark et al. 2007; Costa et al. 2020; Diaz 2008; Evans and Davies 1996; Garrone Neto and Haddad 2010; Garrone Neto et al. 2005; Haddad et al. 2004, 2012, 2013; Isbister 2001; Myatt et al. 2018; Pierini et al. 1996; Reckziegel et al. 2015; Russell 1959; Sá-Oliveira et al. 2011).

Regarding the severity of the injuries, actually, several studies show the venom intensity present in the stingers of the specimens of Potamotrygonidae family and their ability to cause pain, edema, erythema, necrosis, and ulceration of the wound (Barbaro et al. 2007; Haddad et al. 2004; Magalhães et al. 2006; Monteiro dos Santos et al. 2011; Pedroso et al. 2007). According to Domingos et al. (2011), the severity of the injury is also due to the mechanical action of the stingers, which, in addition to introducing the venom, causes an injury of irregular laceration that allows bacteria to enter, resulting in secondary infections.

The majority of the victims generally live in remote areas and go to the health service later, only when complications evolve. These accidents are considered a problem for the inhabitants of the region but are underestimated by the population itself

Table 2 Plants used on the stings treatment in the Juruá Valley, Brazil, 2014–2015.

Plants	Scientific name	Used parts	Prepare form	Application	N (%)[1]
Pineapple	*Ananas comosus*	Straw	Juice	Anti-inflammatory	1 (2.9)
Açacu	*Hura crepitans*	Sap	Direct Application	Analgesic	1 (2.9)
Açaí	*Euterpe oleracea*	Bark and Sap	Scrape and Direct Application	Anti-inflammatory	1 (2.9)
Rosemary	*Rosmarinus officinalis*	Leaves	Bath and Infusion	Cleaning and Healing	1 (2.9)
Cotton	*Gossypium herbaceum*	Leaves and Bark	Bath and Cataplasm	Cleaning	2 (5.9)
Garlic	*Allium sativum*	Small bulbs	Cataplasm	Cleaning	1 (2.9)
Arnica	*Arnica montana*	Leaves	Infusion	Anti-inflammatory, Cleaning and Analgesic	1 (2.9)
Buriti	*Mauritia flexuosa*	Sap	Direct Application	Healing and Analgesic	2 (5.9)
Caapeba	*Cissampelos glaberrima*	Leaves	Infusion	Anti-inflammatory	3 (8.9)
Cashew	*Anacardium occidentale*	Nut	Oil	Healing and Cleaning	2 (5.9)
Castanha-do-pará	*Bertholletia excelsa*	Nut	Oil	Healing and Anti-inflammatory	1 (2.9)
Onion	*Allium cepa*	Bulb	Cataplasm	Analgesic and Healing	1 (2.9)
Chicória	*Cichorium endivia*	Leaves	Bath	Cleaning	2 (5.9)
Copaíba	*Copaifera officinalis*	Sap	Direct Application	Healing	3 (8.9)
Corama	*Bryophyllum pinnatum*	Leaves	Bath and Infusion	Anti-inflammatory and Healing	1 (2.9)
Crajiru	*Arrabidaea chica*	Leaves	Infusion	Healing	2 (5.9)
Lemon	*Citrus limon*	Juice	Direct Application	Anti-hemorrhagic	2 (5.9)
Malva	*Malva sylvestris*	Flower and Leaves	Infusion	Healing	1 (2.9)
Mastruz	*Chenopodium ambrosioides*	Leaves	Bath	Anti-inflammatory and Healing	2 (5.9)
Tobacco	*Nicotiana tabacum*	Leaves	Infusion and Compress	Analgesic	4 (11.9)

[1]Frequency of use.

because of their frequency and low lethality (Garrone Neto and Haddad 2010; Haddad 2003; Reckziegel et al. 2015). Pierini et al. (1996) carried out a survey of accidents caused by venomous animals in the Juruá Valley, Acre, and as reported, in many hospitals of Brazilian Amazonian regions, the most common cause of seeking care after freshwater accidents were stingrays. Recently, Casas et al. (2016) reported 39 incidents in the first months of 2014 related to freshwater stingrays in the Western Brazilian Amazon.

Some people reported beliefs involving freshwater stingrays, resulting in mutilation and slaughter of these species in the region. However, they are not animals that usually attack humans, using their stingers only in self-defense (Haddad et al. 2013). They have an ecological importance within the Amazon ichthyofauna, as they serve the ecological role of apex predators, contributing to the balance and dynamics of their natural environments (De Oliveira et al. 2016; Duncan et al. 2010). Some beliefs related to stingrays, such as the Maori culture and Polynesian people, consider these animals sacred and divine (Te Kete Ipurangi 2020). For the Kamaiurá, Brazilian indigenous people from the Upper Xingu River, stingrays are used in a ritual of power and strengthening of sorcerers. In addition, practices of feeding the spirit of the stingray were thought to be a means of avoiding being hurt by them during fishing (Junqueira 2004).

Although it is not considered a common practice in the region, it was reported that freshwater stingrays are used as food resource. The use of these animals for food purposes is still treated, in many places, as a taboo or atypical. In Trobriand islands, for example, beliefs involving stingrays make its consumption

forbidden for the inhabitants (Meyer-Rochow 2009). On the other hand, riverside populations of Santa Isabel do Rio Negro and Barcelos, in the state of Amazonas, avoid the consumption of elasmobranchs. They consider by taste, smell, and appearance, an unpleasant meat, even causing aversion by the association with the "bad smell" of urine (Silva 2007). In the Rio Negro basin, also in the Amazon, rays are caught for consumption, being eviscerated and exported to markets in the Southeast of Brazil (Araújo 2005; Duncan et al. 2010).

Many interviewees reported using folk remedies on the wound. This type of therapy is also cited by Haddad et al. (2012), who carried out a study about fish accidents, including stingrays, in the state of São Paulo. The interviewees reported the use of gasoline, human urine, herbs, chrome mercury, tobacco, garlic, olive oil, alcohol, and a catfish eye placed on the wound as treatments. In another study, Haddad et al. (2013), stated that the treatment of wounds caused by freshwater stingrays is associated with various folk remedies, superstitions, and legends. Among them are human urine, catfish eye, and placing the affected area in female external genitalia, described as an infallible method for pain control, according to the interviewees. The use of urine, herbs, oils, and specific herbal medicines were also pointed out for the treatment of injuries (Sá-Oliveira et al. 2011). In a recent study carried out in the Western Brazilian Amazon, accidents with stingrays were the third most frequently reported, and the first aids measures applied by the riverside population were for example, placing the wound into the female genitalia, sweetened condensed milk, coffee grounds with cotton tea, coffee powder, *acaçu* milk (*Hura crepitans*), hot asphalt, and termite mound smoke (Costa et al. 2020).

Although it is very common, the use of products and substances without professional indication or guidance is not recommended, since it can aggravate the clinical condition (Lameiras et al. 2013). There is no definitive and truly functional therapy for these accidents, although control of the clinical situation can be helpful. Since the late fifties, a standard procedure for treatment of stingray injuries was well established. According to Russell (1959), injuries should be irrigated, and a procedure to remove the remaining integumentary sheath was recommended. After that, a qualified person should apply a constriction band above the wound and submerge the extremity in hot water. Currently, it is recommended to remove fragments, wound cleaning, immersion of the injured limb in hot water, tetanus prophylaxis, local anesthetic, and systemic analgesics. Garrone Neto and Haddad (2009), cited that a patient can be treated with resting, intense washing with soap and water, sedatives, and topical antibiotic therapy. Considering that many health professionals do not receive training on the subject in undergraduate courses or in the course of professional activity, it is important to disclose information of this nature (Garrone Neto and Haddad 2010) and also to report those accidents.

In the present investigation, the use of medicinal plants was also mentioned as a viable alternative to treat the injuries. The diversity of plants in the region and its use for medicinal purposes in the culture is an important factor to be considered when discussing the use of alternative therapies for treatment. According to Lewinsohn and Prado (2002), it is estimated that Brazil has 15–20% of the world species diversity in its territory, mainly in the Amazon. The majority is used and cultivated by traditional forest populations for therapeutic and medicinal purposes. In the Amazon, 800 plant species have economic or social value, and of these, 190 are fruit, 20 oil plants, and hundreds of medicinal plants (Santos et al. 2014; Vieira 1999). Since the Declaration of Alma-Ata in 1978, the World Health Organization (WHO) considers medicinal plants as important tools of pharmaceutical care. Several WHO communications and resolutions express the agency's position on the need to enhance the use of these drugs in the health system (Assis et al. 2007; Ministério da Saúde 2009, 2015). The Brazilian Ministry of Health (MS) has policies and programs that support the use of medicinal plants and herbal medicines in basic health care (Ministério da Saúde 2009, 2012), being an important source of treatment, especially in remote areas.

Knowledge about the use of medicinal plant species to treat diseases is passed on from generation to generation from the oldest civilizations (Garlet and Irgang 2001), being often the only therapeutic resource for many communities and ethnic groups, especially in the Amazon (Azevedo and Silva 2006; Cunha 2005). Therefore, the use of medicinal plants as an accessible alternative to treat injuries caused by freshwater stingrays should be considered. Further studies will be needed to validate several therapeutic forms, emphasizing their correct use, risks, and the

need for confirmation of species before their use. This would ensure a safe, affordable, and inexpensive care for accidents in isolated locations and would support the MS National Policy on Medicinal Plants and Medicinal Products (PNPMF), promoting the sustainable use of biodiversity, the development of the chain production, and domestic industry (Ministério da Saúde 2012). However, studies aiming to understand the use of medicinal plants and alternative treatments are necessary in the region in order to raise important information on the applications of potential medicines (Ministério da Saúde 2009, 2012).

Conclusion

The injuries caused by freshwater stingrays in the Juruá Valley region resemble other studies, in which mainly fishermen and bathers are injured, especially during the ebb and flow of the rivers. The lower limbs are the most affected sites, and among the symptoms reported are severe pain, edema, erythema, necrosis, and ulceration of the wound.

The beliefs of the population reveal fear and a perception of an aggressive animal, which attacks unnecessarily, resulting in mutilation and slaughter of these species in the region, indicating the lack of knowledge about the animal and its ecological importance.

The use of folk medicine to treat injuries shows a high number of individuals who often seek these treatments without any insight or professional guidance, highlighting the misinformation about the pathophysiology of the injury, prophylaxis of accidents, first aid, and proper treatment of the injury. However, the use of medicinal plants as an alternative for the treatment of injuries has proven to be a strong ally to guarantee safe and affordable care, but it should be further investigated.

Furthermore, additional studies on the use of medicinal plants in the region are still necessary, especially because there is a lack of health services to these populations that are generally far from the main urban centers. In addition, it is recommended to elaborate on strategies for the conservation of freshwater stingrays through education of riverside population, emphasizing the importance of maintaining the biodiversity of these species.

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Declarations

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