

**INJURIES CAUSED BY THE OCELLATE FRESHWATER STINGRAY
POTAMOTRYGON MOTORO IN LACUSTRINE COMMUNITIES IN EASTERN
AMAZON BIOME TERRITORY**

**ACIDENTES CAUSADOS PELA ARRAIA FLUVIAL *POTAMOTRYGON MOTORO*
EM COMUNIDADES LACUSTRES EM TERRITÓRIO DO BIOMA ORIENTAL DA
AMAZÔNIA**

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ABSTRACT

The injuries caused by freshwater stingrays are common among fishermen. The raya *Potamotrygon motoro* en the features a stinger with a sharp edge and serrated tips spread bilaterally, the stingers have toxins that promote vasoconstriction, causing immediate pain and ischemia. These accidents extensive and could keep victims unable to work from weeks to months. Considering the impact the injuries in riparian fishing communities' livelihoods, this study aimed to analyze reports of envenomation caused by the freshwater stingray *Potamotrygon motoro* in two municipalities localize in the Eastern Amazon biome territory (Baixada Maranhense Ramsar site) in the municipality of Penalva and Viana. The methodology consisted in analyses descriptive and transversal, troght of the application of 40 semi-structured questionnaire in artisanal fishermen in order to obtain clinical and epidemiological data related to the accidents caused for *P. motoro* in ffisherman artisanal. Forty fishers injured by freshwater stingrays were interviewed. Pain and edema were the symptoms common to all fishermen, followed by skin necrosis (70%). Victims often adopt unusual self-treatments, based on traditional and cultural knowledge, such as the use of urine, herbs, smoke of burlap bags and human feces. The number of injuries in each fisherman varied from 2 to 4 times (50%) to up to 10 times (12.5%). The results show that injuries caused by *P. motoro* are frequent in Penalva and Viana, reinforcing the

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need for public health agencies to establish preventive educational actions and provide better qualification for health professionals to perform the appropriate treatment for the injuries.

Keywords: Animals poisonous. Fish. Occupational health. Environmental health.

RESUMO

Os ferimentos causados por arraias de água doce são comuns entre os pescadores. A raia *Potamotrygon motoro* apresenta um ferrão com uma ponta afiada e pontas serrilhadas espalhadas bilateralmente, os ferrões possuem toxinas que promovem a vasoconstrição, causando dor imediata e isquemia. Esses acidentes são extensos e podem manter as vítimas impossibilitadas de trabalhar por semanas a meses. Considerando o impacto das injúrias na subsistência de comunidades ribeirinhas de pescadores, este estudo teve como objetivo analisar relatos de envenenamento pela arraia *Potamotrygon motoro* em dois municípios localizados no bioma Amazônia Oriental (sítio Ramsar da Baixada Maranhense) no município de Penalva e Viana. A metodologia consistiu em análises descritivas e transversais, a partir da aplicação de 40 questionários semiestruturados em pescadores artesanais a fim de obter dados clínicos e epidemiológicos relacionados aos acidentes causados por *P. motoro* em pescadores artesanais. Quarenta pescadores feridos por arraias de água doce foram entrevistados. Dor e edema foram os sintomas comuns a todos os pescadores, seguidos de necrose cutânea (70%). As vítimas costumam adotar auto tratamentos inusitados, baseados em conhecimentos tradicionais e culturais, como o uso de urina, ervas, fumaça de saco de estopa e fezes humanas. O número de lesões em cada pescador variou de 2 a 4 vezes (50%) a até 10 vezes (12,5%). Os resultados mostram que as lesões por *P. motoro* são frequentes em Penalva e Viana, reforçando a necessidade dos órgãos públicos de saúde estabelecerem ações educativas preventivas e proporcionarem melhor qualificação dos profissionais de saúde para realizar o tratamento adequado das lesões.

Palavras-chave: Animais venenosos. Raias. Saúde ocupacional. Saúde ambiental.

INTRODUCTION

Injuries caused by aquatic animals are common among amateur and professional fishers.^{1,2,3,4,5,6,7,8,9} The majority of these trauma occurs when fishers stand on or manipulate fishes while removing them from the fishing gear.^{6,8,9,10} Various aquatic animals have the potential to harm humans, but the most common causers are jellyfish, sea urchins and fish, including the stingrays¹¹.

Encounters with freshwater stingrays are commonly reported in riparian fishing communities.⁵ Freshwater stingrays can have one to four stingers, covered with glandular tissue that produces toxins, in the dorsal surface of the tail³. Thus, stingray

injuries are often a traumatic combination of the sting penetration through skin and muscles, and the immediate envenomation of the area³. In addition to the severe pain, the toxins can cause skin necrosis and secondary bacterial or fungi infections - in some cases leading to amputations or death.^{2,4,9,10}

Most of the accidents in riparian fishing communities are caused by the ocellate river freshwater stingray, *Potamotrygon motoro* (Müller & Henle, 1841). *Potamotrygon motoro* is the most broadly distributed species of stingray in tropical and subtropical freshwater systems of South America, including most regions of Brazil¹². This species is probably the main causer of stingray injuries in Brazil, however reports are scarce. Although the Brazilian Ministry of Health made compulsory the notification of accidents involving venomous aquatic animals via epidemiological disease surveillance reporting forms, most accidents occur in remote areas where the health system is frequently inefficient or absent, resulting in a deficient protocol to properly record and treat freshwater stingray injuries.^{9, 10}

Considering the direct impact of freshwater stingray injuries in riparian fishing communities' livelihoods, this study aimed to evaluate the frequency and severity of injuries caused by *Potamotrygon motoro* in two municipalities of the Eastern Amazon biome territory. In addition, the studied aimed to describe the main epidemiological and clinical aspects of injuries caused by the only species of freshwater stingray present in the region and provide information for effective treatment of injured people.

MATERIALS AND METHODS

Study area

The Brazilian Amazon coast, which stretches from the state of Amapá to Maranhão, is drained by a series of small and medium-sized rivers in the Amazon River basin. Along the Pindaré-Mearim river basin there is only one species of freshwater streak, *Potamotrygon motoro*¹³.

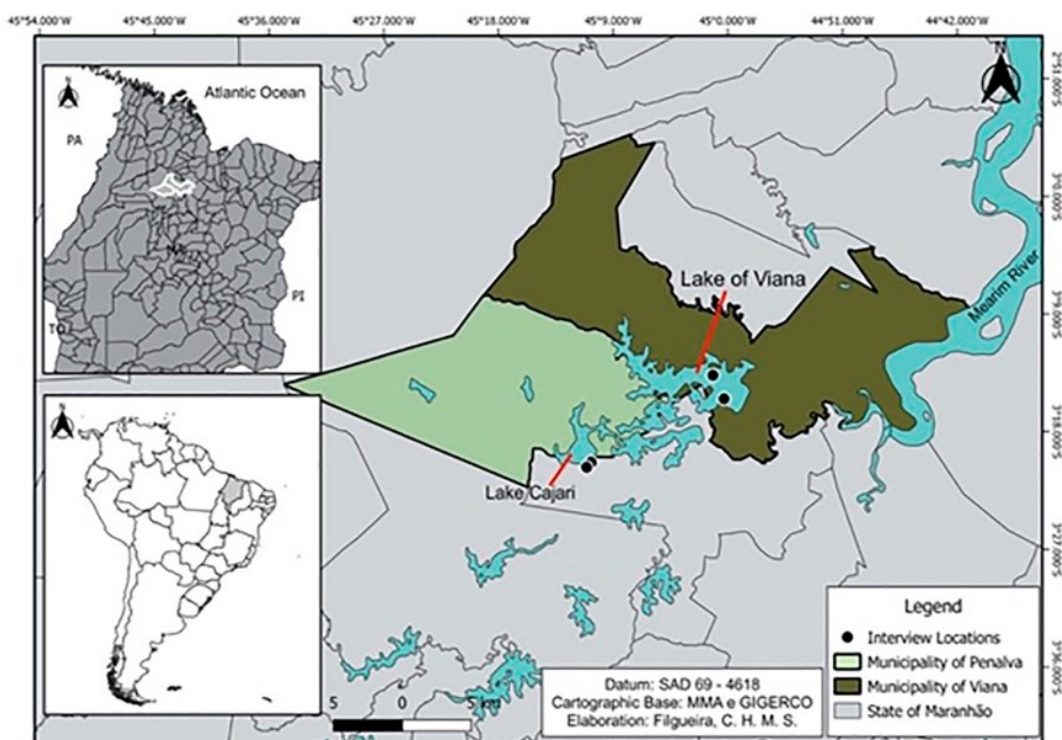
The study was carried out in the municipalities of Viana (population: 51,249) and Penalva (population: 37,833). These municipalities are in the Eastern Amazon biome territory, more specifically at micro-region locally known as Baixada Maranhense Ramsar site¹⁴.

This site comprised of flat wetlands, often flooded by the surrounding rivers, lakes, and lagoons during the rainy season¹⁵. Both municipalities have *low socioeconomic status*, which strongly reflects on the health care and strategies to mitigate health problems¹⁶.

Data collection and analysis

A descriptive clinical and epidemiological analysis of the accidents caused by ocellate river stingray *Potamotrygon motoro* was carried out in riparian fishing communities of the Cajari Lake (Penalva city) and the Viana Lake (Viana city) - the broadest set of intermittent freshwater lakes of the Baixada Maranhense (Figure 1). These places were visited between November 2014 and January 2015. For obtaining clinical and epidemiological data, semi-structured interviews were 40 performed with fishermen injured once or more times by *P. motoro* in each municipality.

Figure 1 – Study area showing Cajari and Viana lakes, Maranhão, Brazil.



The interviews included questions about clinical manifestations, treatments and period of wound healing. All records were uploaded to Microsoft Excel program (*version 16.38/2020*), where all data were organized into qualitative and quantitative categories, then compared using percentage graphs.

Ethical aspects

This study was approved by the Ethics Committee of the Universidade Federal do Maranhão (1.625.949) and followed the National Health Council (NHC) - nº 466/2012 ethical principles for research conducted on humans.

RESULTS

In total, 40 fishers (27 from Penalva and 13 from Viana) were interviewed. The great majority of victims were males (90%). Pain and edema right after the puncture were observed in all the injuries. As for the intensity of pain, this was cited by the fishermen as unbearable (70%), supposable (17.5%) and weak (12.5%). Some fishermen described the pain as "the worst they ever felt in life". Ulcer development occurred approximately 30 days after the envenomation in 52.5% of the victims, while the development of ulcers right after the envenomation was described by 42.5% of the interviewees. The remaining 5% did not observe ulcer development. Necrosis, commonly called "*batoque*" by locals, was strongly emphasized by 75% of the injured fishers (Table 1). The time elapsed for a complete recover of the ulcer varied between one to six months. However, in one particular case, the wound remained open for about two years.

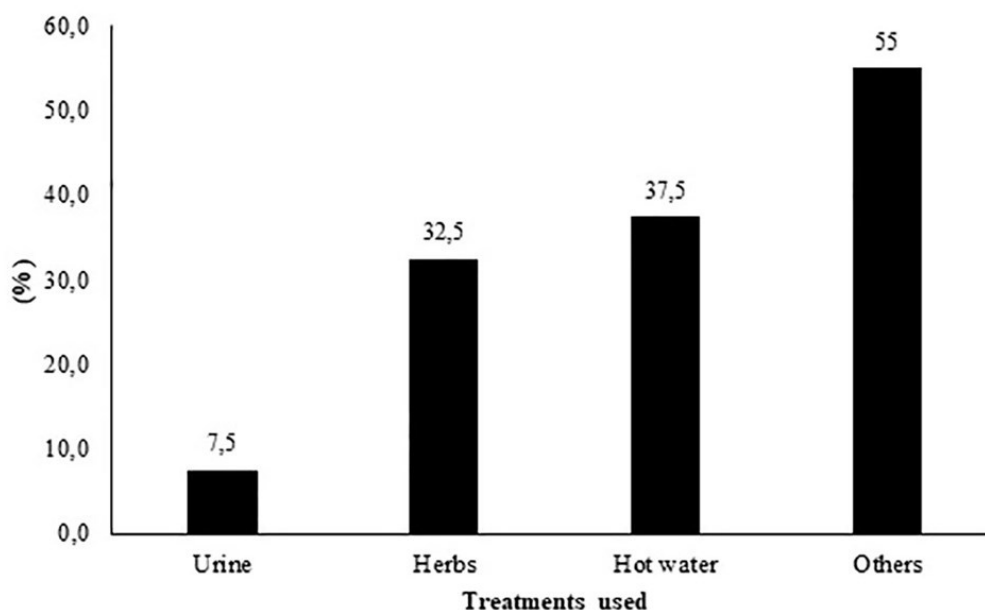
Table 1 – Epidemiological characteristics of the accidents caused by *P. motoro* in the fishing communities of Penalva and Viana.

Variables	Penalva		Viana		Total	
	N	%	N	%	N	%
Gender	24	88.8	12	92.3	36	90.0
Male	3	11.1	1	7.6	4	10.0
Female						
Main symptoms	27	100	13	100	40	100
Intense pain	27	100	13	100	40	100
Edema	20	74.0	10	76.9	30	75
Necrosis						
Time of treatment (month)	9	33.3	8	61.5	17	42.5
≤ 1	15	55.5	5	38.4	20	50
1 a 6	2	7.4	0	0	2	5
6 a 12	1	3.7	0	0	1	2.5
≥ 12						
Search for medical treatment						
Yes	16	59.3	38.5	38.5	21	52.5
No	11	40.7	8.0	61.5	19	47.5

In Viana, most victims (61.54%) chose not to seek for professional health assistance, while in Penalva most victims (59.26%) got specialized hospital care. In both study sites, victims who sought hospital care received antibiotic treatments (e.g. benzathine penicillin, meracillin and sulfadiazine). In many cases, prescribed antibiotics were inappropriately used, with tablets transformed in powder for direct use on the wound. Regardless of specialized assistance in local hospitals and use of prescribed medication, 72.5% of the interviewees mentioned the use of popular therapeutic measures (Figure 2). The most popular treatment was the smoke of burned burlap bags (20%), followed by potato starch, stingray fat, local healers spit, alcohol, caiman leather (*Caiman* spp.), gasoline, banana sap, lemon, ox eye, cashew powder, and even human feces.

Thus, even after receiving hospital care, injured fishermen are often motivated to use popular treatments. Among the respondents, the most commonly used treatments to reduce pain were the immersion of the wounded limb in hot water, urine or herbs infusions, as desperate measures to alleviate pain.

Figure 2 - Percentage of the treatment types used after ray envenomation in Penalva and Viana-MA fishing communities.



Accidents caused by *Potamotrygon motoro* in artisanal fishermen in the exercise of their work function are common (Figures 3).

Figure 3 – Victims of envenomations caused by freshwater stingrays (A1 e A2); (B) Fisheries landing site (Cajari Lake, Penalva-MA).



However, there were no reports of serious manifestations, such as amputation of limbs or deaths in the study sites. The most serious injury was reported in Penalva, where a fisher had his leg pierced by *P. motoro*, which caused extensive bleeding.

DISCUSSION

The data obtained in this study demonstrates a high occurrence of injuries with freshwater stingrays together with a serious lack of appropriate basic sanitary and health measurements by both the population and cities' health systems. As a result, injuries likely had major impacts on fishers and their families' livelihoods, since this prevented them to work and provide monetary income. Since this is the first retrospective epidemiological study conducted in the Maranhão state that reports injuries caused by *P. motoro*. This situation probably occurs in all areas with occurrence of freshwater stingrays and fishing effort, even if its small.

Indeed, fishing is one of the main sources of income in Penalva and Viana, Maranhão which is characterized by the use of canoes and small wooden boats¹⁴. To avoid stranding or damaging engines in the shallow shores of Cajari and the Viana Lake, fishers normally push their canoes until a safe depth to only then ignite the motor or start paddling. It is during these short walks in the water that fishers become more vulnerable to encounters with *P. motoro*.^{6,8,9,10} As an aggravating factor, fishing activities often begin or end at nighttime – when the visibility is very low and the

chances to stand on a camouflaged *P. motoro* increase. Fishers are also vulnerable while handling specimens caught in fishing nets^{6,8,9,10}.

Most accidents occur with male fishers. This occurs because men historically perform fishing activities, while women usually perform domestic activities¹⁷. A similar pattern has also been found for other areas of the Amazon biome such as Acre¹⁸, Amazonas¹⁹. Since freshwater stingrays occur throughout the Neotropical region and fishing is mostly performed by men, this similar trend is likely to be widespread¹². While stings are a conserved anatomical feature of freshwater batoid species, *P. motoro* is probably the commonly involved in such negative incidents¹⁰.

In addition to the sting morphology with a sharp edge and serrated tips spread bilaterally, *P. motoro* stingers have toxins that promote vasoconstriction, causing immediate pain and ischemia^{1,6,9,10}. Most of the interviewees described the pain as unbearable. Necrosis was cited by 75% of interviewees - differing from previous studies that reported necrosis in 100% of cases^{10,16}. Necrosis are often aggravated by secondary bacterial infections^{1,6}. Furthermore, *P. motoro* toxins have also been reported to induce systemic rhabdomyolysis in mice, with stronger effects than *P. iwamae*²⁰.

The occurrence of secondary infections in *P. motoro* wounds is often linked to delay in seeking for proper medical treatment¹⁹. If victims wait more than 24 hours to be treated with antibiotics, the chances of contracting a secondary infection are higher.^{1,3,6,8,9,10,13} Thus, it is likely that the victims assisted properly might reduce the risk of contracting secondary infections. Viana has approximately one ambulatory for every 1500 habitants, while Penalva only has one ambulatory for every 3800 habitants¹³. Fishers from Penalva have proportionately sought medical treatment more often than those from Viana, yet levels of secondary infections were similar. This might occur due to the lack of knowledge on treating injuries caused by *P. motoro* even by health professionals.^{1,2,6} Thus, even after receiving hospital care, injured fishermen are often motivated to use popular treatments. Among the respondents, the most commonly used treatments to reduce pain were the immersion of the wounded limb in hot water, urine or herbs infusions. When questioned about the use of uncommon treatments, interviewees stated that "when a one is injured by a stingray, the pain is so intense that the person will desperately seek for anything that could possible relieve the pain".

Similar results were obtained by Silva et al.¹⁸, with 94.7% of the injured people showing chronic pain, 81% showing edema and erythema, and 56% of the injuries yielding necrosis. Additionally, 84% of the interviewed people sought alternative treatments, which included the use of medicinal plants and other substances. When comparing such unusual substances with the ones the interviewees answered in the present study, we highlight the use of human urine and gasoline in both areas. Generally, alternative treatments seem to be employed according to the traditional widespread knowledge of each community and they includes a wide array of things ranging from boiled soap and breast milk¹⁸ to burned burlap bags and human feces as shown in the present study.

Notwithstanding, the only alternative treatment with some level of effectivity is the immersion of the injured limb in hot water (about 45° C) shortly after the accident

relieve pain since *P. motoro*'s toxin is thermolabile. In addition, as the toxin favors vasoconstriction, the high-water temperature helps in the vasodilation of the affected limb, thus relieving pain.^{1,6,8,9,10} However, it alone is not enough to speed the healing process since the wound is highly susceptible to secondary infections that take a long time to heal.

Indeed, the healing process can take from weeks to months and, in the most serious injuries, victims can get incapacitated for more than a year. Therefore, the high frequency of accidents involving *P. motoro* is a health and social problem for communities in the Baixada Maranhense, since fishing is one of the main sources of family income.^{21,22}

In these regions, communities and health professionals lack the necessary knowledge to avoid accidents and the bare minimal infrastructure to properly treat wounds.

According to Carvalho et al.²³, the lack of use of Personal Protective Equipment increases the risk exposure to these accidents. Fishing professionals need health knowledge and accident prevention measures to avoid and/or minimize complications and possible consequences in the exercise of their profession.

According to Haddad Jr et al.^{8,10}, *P. motoro* injuries can be minimized through educational campaigns within fishing communities. Pamphlets, lectures and workshops with information on how to safely walk while pushing canoes in the water and on how to safely manipulate stingrays caught in fishing hooks or nets would be useful for most fishers. Other measures can be effective in reducing accidents, such as the use of warning signs in areas where *P. motoro* are often sighted.¹⁰ Such educational campaigns should also aim at increasing awareness of the conservation status of freshwater stingrays to avoid fisher retaliation following stingray injuries as has been reported to occur in the Western Amazon¹⁸.

CONCLUSION

Our results highlight a combination of poor healthcare treatment and misinformation regarding preventive and prophylaxis measures as the main aggravating factors. It is necessary that public health agencies in Brazil develop preventive educational actions and prepare health professionals to provide appropriate care and treatment for those patients.

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REFERENCES

1. Haddad Jr V. Medical Emergencies Caused by Aquatic Animals. 1.ed. Genevre-Switzerland: Springer Publishers; 2016.
2. Haddad Jr V. Aquatic animals of medical importance in Brazil, Rev Soc Bras Med Trop, 2003; 36 (5): 591-597.
3. Haddad Jr V, Neto DG, de Paula Neto JB, de Luna Marques F P, Barbaro KC. Freshwater stingrays: study of epidemiologic, clinic and therapeutic aspects based on 84 envenomings in humans and some enzymatic activities of the venom. Toxicon, 2004; 48: 287-294.
4. Haddad VJ, Lastoria JC. Acidentes por mandijubas (mandis-amarelos): aspectos clínicos e terapêuticos. Diagn. tratamento, 2005; 132-133.
5. Garrone Neto, D, Cordeiro RC, Haddad Jr V. Acidentes do trabalho em pescadores artesanais da região do Médio Rio Araguaia, Tocantins, Brasil. Cad. Saúde Pública, 2005; 21, 795-803.
6. Haddad Jr V. Animais aquáticos potencialmente perigosos do Brasil: guia médico e biológico. Animais aquáticos potencialmente perigosos do Brasil: guia médico e biológico. (2ª ed.) São Paulo, 2008. pp. 268-268.
7. Haddad Jr V, Sazima I. Piranha attacks on humans in southeast Brazil: epidemiology, natural history, and clinical treatment, with description of a bite outbreak. Wilderness Environ. Med, 2003, 14 (4):249-254.
8. Haddad Jr V, Fávero Junior EL, Ribeiro FAH, Ancheschi BDC, Castro GIPD, Martins C et al. Trauma and envenoming caused by stingrays and other fish in a fishing community in Pontal do Paranapanema, State of São Paulo, Brazil: epidemiology, clinical aspects, and therapeutic and preventive measures. Rev Soc Bras Med Trop, 2012, 45(2):238-242.
9. Haddad Jr V, Neto DG, Lasso CA, Morales-Betancourt MA, Barriga R, Barbarino A. Envenenamientos causados por rayas de agua dulce (Potamotrygonidae) en Brasil, con notas sobre los países vecinos (Colombia, Venezuela y Ecuador): implicaciones en la salud pública. XV. Rayas de agua dulce (Potamotrygonidae)

de Suramérica. Parte I: Colombia, Venezuela, Ecuador, Perú, Brasil, Guyana, Surinam y Guayana Francesa: diversidad, bioecología, uso y conservación, Bogotá, Colômbia; 2013. pp. 343-360.

10. Haddad Jr V, Cardoso JLC, Neto DG. Injuries by marine and freshwater stingrays: history, clinical aspects of the envenomations and current status of a neglected problem in Brazil. *J. Venom. Anim. Toxins Trop. Dis*, 2013; 19 (1):16.
11. Reckziegel GC, Dourado FS, Garrone Neto D, Haddad Jr V. Injuries caused by aquatic animals in Brazil: an analysis of the data present in the information system for notifiable diseases. *Rev Soc Bras Med Trop*, 2015; 48 (4):460-467.
12. Loboda TS, Carvalho MRD. Systematic revision of the *Potamotrygon motoro* (Müller & Henle, 1841) species complex in the Paraná-Paraguay basin, with description of two new ocellated species (Chondrichthyes: Myliobatiformes: Potamotrygonidae). *Neotrop. Ichhyol.*, 2013; 11(4):693-737.
13. Rincon G, Pereira KCM, Santos CES, Wosnick N, Nunes ARO, Leite RD, Araújo YA, Silva IP, Silva AAG, Nunes JLS. Notes on the occurrence and gender-based morphological aspects of *Potamotrygon motoro* (Elasmobranchii: Potamotrygonidae) in the complex of the Viana lake system- Maranhão, Brazil. *Rev. Nordestina de Biologia*, 2019; 27 (1): 100-119.
14. Ramsar. Ramsar sites information servisse; 2020. Disponível em: <<https://rsis Ramsar.org/ris/1020> >. Accessed on May 27th -2016.
15. Nunes JLS, Piorski NM, Silveira PCA, Almeida ZS. Fisheries Resources of Ramsar Sites of the state of Maranhão (Brasil). In Bilibio, C; Hensel, O & Selbach, JF. Selbach (Org). Sustainable water management in the tropics and subtropics – And case studies in Brazil. Jaguarão: Fundação Universidade Federal do Pampa, Unikassel, PGculto; 2011. v. I, pp. 893-912.
16. Franco JRC. Sistema lacustre Pindaré-Mearim: uma abordagem conceitual. Colóquio Internacional sobre Desenvolvimento Local e Sustentabilidade. Anais, Universidade Estadual do Maranhão, São Luís. 2009. pp. 196-217.
17. Sá-Oliveira JC, Costa EA, Pena FPS. Acidentes por arraias (Potamotrygonidae) em quatro comunidades da Área de Proteção Ambiental – APA do rio Curiaú, Macapá- AP. *Biota Amazôn*, 2011; 1:74-78.
18. Silva GA, Poscai AN, da Silva Casas AL. Injuries Caused by Freshwater Stingrays in the Western Amazon: Folk Medicine and Beliefs. *Ethnobiology Letters*, 2020, 11(1): 1-13.
19. Sachett JAG, Sampaio VS, Silva MS, Shibuya A, Vale FF, Costa PF, et al. Delayed healthcare and secondary infections following freshwater stingray injuries: risk factors for a poorly understood health issue in the Amazon. *Rev Soc Bras Med Trop*, 2018; 51(5):651-659.

20. Lameiras JLV, da Costa OTF, Moroni FT, de Ribamar Araújo J, Caranhas SME, Marques CMA, et al. Systemic rhabdomyolysis induced by venom of freshwater stingrays *Plesiotrygon iwamae* and *Potamotrygon motoro* (Chondrichthyes–Potamotrygonidae) from the Amazon Basin. *Toxicon*, 2014; 77:105-113.
21. Costa CL. Sustentabilidade da Pesca Artesanal no Lago de Viana, Área de Proteção Ambiental da Baixada Maranhense. Dissertação (Mestrado em Sustentabilidade de Ecossistemas). Universidade Federal do Maranhão, São Luís – MA; 2006.
22. Bezerra MS. Avaliação do potencial Turístico Sustentável da Região Lacustre de Viana-Penalva-Cajari – Baixada Maranhense. Dissertação (Mestrado em Sustentabilidade de Ecossistemas). Universidade Federal do Maranhão. São Luís – MA; 2006.
23. Carvalho IEM, da Silva GVF, Wosnick N, Haddad Jr, V, Nunes JLS. Accident caused by *Cetropomus* spp. to an artisanal fisherman: a case report. *Rev. bras. Saúde ocup.*; 2020 (In Press).

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