BRIEF REPORT

Piranha Attacks on Humans in Southeast Brazil: Epidemiology, Natural History, and Clinical Treatment, With Description of a Bite Outbreak

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There are many tales describing ferocious schools of piranha attacking humans, but there are few scientific data supporting such behavior. The very few documented instances of humans attacked and eaten by piranha schools include 3 that occurred after death by other causes (eg, heart failure and drowning). These predaceous fishes, however, do occasionally injure bathers and swimmers in lakes and rivers. The characteristic profile of most injuries is a single bite per victim, generally related to the fish defending its brood. This paper describes an outbreak of piranha bites in a dammed river portion in southeast Brazil. The outbreak was caused by the speckled piranha, *Serrasalmus spilopleura*, a widespread species which benefits from the growing tendency of damming rivers all over Brazil. This article focuses on the epidemiological and clinical aspects of the injuries, as well as on piranha biology, to gain a better understanding of the natural history of bite outbreaks.

Key words: dangerous fish, predaceous carnivores, piranha, *Serrasalmus spilopleura*, bites

Introduction

Piranhas are predaceous, characid freshwater fishes widespread in South American rivers and lakes.¹ About 30 species are currently recognized in the genera *Pygocentrus* and *Serrasalmus*, both of which contain species potentially dangerous to humans.^{1–4} Piranhas are carnivores that feed mostly on fish and small terrestrial vertebrates and occasionally attack their prey in schools.^{1,2} Despite the folklore about these fishes, there are few, if any, reliable records of attacks by piranha schools on large animals, including humans. Additionally, there is a misunderstanding about actual attacks on live humans and scavenging by piranhas on humans already dead due to other causes such as heart failure and drowning.² The most common profile of a piranha injury on humans is caused by a single fish biting only once. The typical bite consists of a single, circular, craterlike wound with laceration of tissues.^{3,4} Injuries caused by piranhas on bathing people occur mostly in dammed wa-

ters because of the proliferation of the fish there^{3,5} as well as their spawning and parental-care behavior.^{5–7} This paper reports an outbreak of piranha bites in a dammed river site in southeast Brazil and focuses on the epidemiological and clinical aspects of the wounds, as well as on piranha biology, to gain a better understanding of the natural history of bite outbreaks.

Methods

The study was carried out in the town of Santa Cruz of Conceição (about 3500 inhabitants) at 645-m altitude, with a warm and wet austral summer and a dry and cold winter, in São Paulo State, southeast Brazil. The area is covered by the *cerrado*, a savannahlike biome. The main river is the Rio Mogi-Guaçu (Paraná-Paraguay Rivers system), which connects with dammed waters of the local neighborhood. Tourists and local people heavily use the dammed portions of the streams in the urban area for recreation (bathing, swimming) during weekends.

The bite outbreak reported here was due to *Serrasalmus spilopleura* (recently identified as *Serrasalmus maculatus*),⁸ the speckled or dark-banded piranha (Figure 1). It is the only piranha species recorded at the study

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Figure 1. An adult speckled piranha, *Serrasalmus spilopleura*, from the outbreak site at the town of Santa Cruz of Conceição, southeast Brazil (constriction marks at fish's midbody were caused by gillnetting). Voucher specimen in the fish collection of the Natural History Museum, Universidade Estadual de Campinas (access number ZUEC 6162). Photo by VH Jr.

site, and it has been known from the main river and its smaller tributaries for some time, albeit in small numbers, and no injury had been previously recorded in bathers or swimmers (V.H. Jr, unpublished data, 2002). About 4 years ago, injuries caused by piranha bites began to be recorded in the town, reaching their highest numbers in the late summer of 2002.

The human injuries resulting from piranha bites were observed and recorded during 5 consecutive Sundays from early March to early April 2002, which paralleled an increase in water recreation activities by weekend tourists (V.H. Jr, unpublished data, 2002). The injured people were attended to in a small ambulatory clinic run by the Health Division of the town. Epidemiological,

clinical, and therapeutic data were recorded by V.H. Jr, and wounds were photographed for further analyses. An estimate of tourist numbers in the water was conducted throughout the observation period.

Results

Thirty-eight instances of piranha bite were recorded over the 5 weekends. All the injured persons were bathing or swimming near the shoreline in shallow and clear waters, and most of the bites were inflicted on the victims' lower limbs (Table 1). Bites on feet were inflicted mostly in the heel area. The incidence peaked in the third week, which coincided with the highest frequency of bathers in the water. Injury frequency from weeks 1 to 5 was distributed as follows (number of bites in parentheses): week 1(4), 2(8), 3(16), 4(6), and 5(4). Male victims accounted for 61% ($n = 23$) of the accidents, and female victims accounted for 39% ($n = 15$). Age of patients ranged from 1 to 67 years, with 68% between 10 and 29 years ($n = 26$).

As the frequency of piranha bites increased, the public authorities placed several warning signs and distributed pamphlets to the tourists, and a small ambulatory care station was installed close to the bathing area to administer first aid to victims. The frequency of people in the water, however, showed no decrease as a result of these measures (Figure 2). Hourly incidence of piranha bites

Table 1. Distribution of wounds inflicted by speckled piranhas on body parts for 38 bites recorded during an outbreak in southeast Brazil. All bites are single (ie, 1 bite per victim)

Body part	<i>n</i> (%)
Upper extremity	4 (10.5)
Arm	1 (2.6)
Hand	3 (7.9)
Lower extremity	29 (89.5)
Leg	19 (50.0)
Foot	15 (39.5)

Figure 2. Bathers swarm close to a warning sign about piranha danger set in the beach at a recreational site in the town of Santa Cruz of Conceição, southeast Brazil. Photo by VH Jr.

increased after noon (Table 2), which coincided with a higher frequency of people in the water (about 2000 people along a 300-m bank stretch), and decreased throughout the afternoon.

The wounds inflicted by piranhas were single in all the injured people (ie, 1 bite per person). The bites were always lacerated, most of them showing a characteristic rounded and craterlike shape, with fair loss of tissue (Figures 3 and 4) and bleeding. Other local fishes and aquatic animals, or even sharp objects such as shell or glass fragments, would rarely, if ever, cause such wounds.^{1,3,4} A few piranha bites developed severe complications, including amputation of a toe (1 case) and extensive bleeding, which caused the transport of 5 patients (13% of the total) to a larger medical center in the nearby town of Leme. The treatment of most bites, however, was done in the small aid station close to the bath-

ing area. General treatment included intensive cleaning of the wound, a compressive dressing to stanch the bleeding, and an antitetanus shot when appropriate.

Discussion and conclusions

The piranha bites reported here took place in warm weather, when tourism to the study site was high. Initially occurring in small numbers, the bites reached a peak in the third week and gradually decreased in the following 2 weeks. This is similar to the pattern observed for piranha attacks in the previous 4–5 years according to the local public health personnel and the town inhabitants.

The hourly distribution of piranha attacks coincided with the highest frequency of people in the water during the warmest afternoon period. There were about 2000 bathers in the water in the periods of observation, and thus the estimated attack rate was 3.8 bites per 100 person hours (2000 bathers assumed to bathe for about 30 minutes each). Male individuals were attacked in larger proportion, but this was likely because they made up a greater proportion of the tourist groups (a common trend in Brazil and other South American countries). Similarly, the age distribution of the injured people was proportional to the age distribution among the tourists in the water.

Of the 38 accidents, only 5 needed special attention, and the most severe one resulted in amputation. Thus, from a public health viewpoint, piranha bites may be

Table 2. Hourly distribution of piranha bites during an outbreak in southeast Brazil (data gathered over 5 consecutive Sundays). No bites were recorded during other hours of the day

Hours	n (%)
1200–1259	4 (10.4)
1300–1359	13 (33.8)
1400–1459	9 (23.4)
1500–1559	6 (15.6)
1600–1659	6 (15.6)

Figure 3. Frontal view of a speckled piranha's head showing the set of triangular and sharp teeth (left) and a typical, rounded, and craterlike wound on a bather's heel recorded during the bite outbreak (right). Photos by VH Jr.

Figure 4. Speckled piranha bite on a bather's hallux (compare with bite inflicted on the heel's tougher tissue in Figure 3). Photo by VH Jr.

less important than, for instance, accidents provoked by puncture wounds caused by improper handling of catfish by fishermen in southeast Brazil, as these wounds are much more common and may readily develop local infection.⁴ However, piranha bites are potentially mutilating and require prompt medical assistance because of tissue loss and extensive bleeding.⁴ In agreement with the clinical experience of V.H. Jr, piranha bites are treated as typical laceration wounds with no antibiotic administration or prescription.⁴ This issue is controversial, however, as cultures of samples swabbed from the mouth of the speckled piranha showed no microorganisms pathogenic to humans in one study,⁹ whereas another report described a severe infection by *Aeromonas hydrophyla* after a piranha bite in a patient with leukopenia.¹⁰

Limbs were the bitten body parts in all accidents. Bites on lower limbs, especially on feet, are clearly related to the speckled piranha's parental care (see below), as this latter body part is the one most available to the brood-guarding fish when a bather wades or swims through the shallow water and approaches the egg-clutch site.

Several features of piranha biology help clarify its attacks on humans and occasional bite outbreaks. Piranhas are predators that bite off portions of their prey (mostly fishes) with a formidable set of sharp teeth.^{1,3,4} The

spawning season coincides with the warm and wet period throughout their range in southeast Brazil,⁵ but growing evidence suggests that piranhas are able to breed year-round in reservoirs (probably because of the more predictable environmental conditions at dammed sites⁷). The egg clutch may be placed on floating vegetation at shallow sites or on a previously cleaned spot on the ground.⁵⁻⁷ The brood is attended by 1 or both of the parents,⁷ and guarding behavior of the speckled piranha includes biting attacks against larger animals (I.S., unpublished data, 1985–1986). Larvae and juveniles dwell within floating waterweeds (mostly water hyacinths), which also provide them with a potentially efficient rafting dispersal,⁵ thereby allowing colonization of places previously uninhabited and recruitment for smaller populations.

Because of these biological and environmental factors, it is understandable that most bites to humans by the speckled piranha (other than those bites resulting from careless handling of the fish by fishermen) would occur during the fish breeding season, mostly at shallow dammed sites, and at a time when large numbers of people are in the water. Bite outbreaks are thus not unexpected when a sizable piranha breeding population coincides with a concentration of people engaged in recreational activities during warm weekends at the same place. Lack of food as a possible cause for piranha bites to humans is highly unlikely, because dammed river portions in southeast Brazil provide plenty of prey fish for these predators.^{11,12}

Thus, the natural history of speckled piranha bite outbreaks seems to follow a predictable pattern composed of 5 main phases: 1) dammed rivers create a suitable habitat for piranhas, as well as for human recreational activities in the water; 2) piranhas colonize, or establish large populations, at places where they were previously absent or rare; 3) part of the piranha spawning cycle coincides with recreational activities of people in shallow water during warm weather; 4) piranhas show parental care, and their guarding of the brood includes attacks on perceived predators; and 5) people who are unaware that they are wading, bathing, or swimming close to a guarded brood are bitten on limbs, especially the feet.

Speckled piranha bite outbreaks may increase because dams are increasing in Brazil, especially in the heavily populated Southeast. Bite outbreaks similar to that described herein were recently recorded by V.H. Jr at the towns of Itapuí and Iacanga close to the dams of the Rio Tietê, the main river of the São Paulo State. An excess of 50 human injuries related to bites of the speckled piranha was recorded in each of these outbreaks over 2 weeks by V.H. Jr.

Prevention measures to lessen piranha bite outbreaks may include clearance of waterweeds⁶ at bathing sites or setting of net enclosures around bathing areas. Ideas such as introduction of piranha predators seem unrealistic, as there are no data available on such predators to support these actions. Additionally, any such introduction may lead to unpredictable environmental consequences.

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