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SHARK ATTACKS IN PERNAMBUCO, BRAZIL: ANALYSIS OF BATHER'S PERCEPTIONS AND ENVIRONMENTAL FACTORS

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RESUMO

Ataques de tubarões em Pernambuco, Brasil: análise das percepções dos banhistas e dos fatores ambientais

O litoral de Pernambuco, no Nordeste do Brasil, detém o recorde mundial de ataques fatais de tubarões, com 17 mortes em 46 ataques, entre 1992 e 2004. Este estudo visou investigar o nível de conhecimento da população local sobre as causas destes incidentes, bem como das espécies envolvidas; e detectar mudanças comportamentais nos banhistas causadas pelos ataques. Também se propõe a relacionar fatores ambientais locais que possam estar ligados ao aumento no número de incidentes. Para isto, foram entrevistados 355 banhistas na Praia de Piedade, Pernambuco, Brasil, entre julho e agosto de 2004. Foi observado um baixo nível de conhecimento sobre as causas dos ataques e as espécies envolvidas, sendo a televisão (90%) a fonte de informação mais freqüente sobre o tema. A freqüência de entrada dos banhistas no mar foi reduzida em 71% após terem conhecimento dos ataques. Apesar do medo generalizado detectado entre os banhistas, a maioria se posicionou contrária à matança dos tubarões, e defendeu campanhas de

educação ambiental mais agressivas para manter a população informada e diminuir o problema.

Palavras-chave: tubarão tigre, tubarão cabeça-chata, *Carcharhinus leucas, Galeocerdo cuvier,* percepção pública, Praia de Piedade, educação ambiental.

ABSTRACT

Shark attacks in Pernambuco, Brazil: analysis of bather's perceptions and environmental factors

The coast of Pernambuco, in Northeastern Brazil, holds the world record for fatal shark attacks, with 17 deaths from 46 attacks between 1992 and 2004. This study aimed to investigate the level of knowledge of the local population about the causes of such incidents and the shark species involved, and to detect bathers' behavioral changes induced by attacks. An attempt to link local environmental factors with the increase in the incidents is also pursued. To achieve that, we interviewed 355 bathers in Piedade Beach, Pernambuco, Brazil, between July and August 2004. We noticed a low level of knowledge on the causes of attacks and the species involved, and that television (90%) is the most frequent source of information on this subject. 71% of the interviewees admitted having reduced their frequency of entering the sea after the attacks. Despite the overall fear detected among bathers, most people are against killing sharks, and defend more aggressive educational and environmental campaigns to inform the locals and reduce the problem.

Keywords: tiger shark, bull shark, *Carcharhinus leucas, Galeocerdo cuvier,* public perceptions, Piedade Beach, environmental education.

INTRODUCTION

From "villains of the sea" to "perfect killing machines" to "meat seeking missiles", the image of sharks has been associated with death and fear. According to Caldicott *et al.* (2001), few creatures – real or imaginary – solicit more apprehension than sharks, although the worldwide number of shark attacks does not justify the antipathy towards those animals. On a purely biological level, sharks are Chondrichthyes fishes that dwell in both coastal and oceanic waters. They are typically top predators whose many adaptations have allowed them to maintain this ecological position over the ages: the cartilaginous skeleton provides great maneuverability, and the absence of swim bladders allows them to ascend rapidly in pursuit of prey (CARRIER *et al.,* 2004). Their relatively poor eyesight is compensated by an efficient sense of smell and high sensitivity to water vibrations (CALDICOTT *et al.,* 2001). Sharks can locate a sound source with extreme accuracy and have an additional sense of electroreception with which they recognize small electrical fields given off by other living creatures (CALDICOTT, *idem)*

There are approximately 380 shark species described, from which only 32 have been undoubtedly involved in human attacks (STEVENS & LAST,

1995). Because of their scarcity, shark attacks have only been a subject of public curiosity in the latter half of the 20th century. Today, the International Shark Attack File (ISAF), administered by the America Elasmobranch Society and the Florida Museum of Natural History, holds the most comprehensive epidemiological data on shark-related incidents.

The places with the highest incidence of attacks are the United States of America - USA (especially Florida), Australia and South Africa. Usually, at the encounter between a shark and a diver, mutual fear is followed by flight – each party in the opposite direction (SZPILMAN, 1992). When the attack does occur, the commonest type is the "hit and run", when the victim is usually seized and released before they have any time to react (BURGESS, 1990). According to the ISAF, *ca*. 70 to 100 accidents are registered annually worldwide. It is certainly a small number, considering the millions of people who bathe in the sea everyday worldwide, and the number of sharks killed by men. While there are around 10-20 fatal incidents per year in the world, 770 thousand tons of sharks and rays are captured and killed in fishing and non-related activities in the same period (BURGESS, 1990; STEVENS & LAST, 1995).

Currently, Brazil ranks fourth in the world ranking of shark attacks (ISAF, 2004), especially on the Northeastern State of Pernambuco, which holds the highest concentration of fatal cases in the world. From 1992 to 2004, 46 incidents were registered, of which 17 were fatal (HAZIN, 1995). From the 82 shark species reported in Brazil (LESSA *et al*., 2004), 11 are found in Pernambuco, including *Carcharhinus limbatus* (black tip shark), *C. leucas* (bull shark), *Ginglymostoma cirratum* (nurse shark), *Galeocerdo cuvier* (tiger shark), *Sphyrna lewini* (scalloped hammerhead) and *Prionace glauca* (blue shark) (BRASIL, 2000).

So far, two species, the bull shark and the tiger shark, were identified as responsible for attacks in Pernambuco (HAZIN *et al.*, 1995). The bull shark can reach up to 3.4 m and is regarded as the most dangerous species for humans, since it lives close to the coast in shallow waters (occasionally less than 1 m deep) (SZPILMAN, 1992). The tiger shark is a large coastal species that can reach up to 5.5 m and feeds on practically any type of prey, from small fish and crustaceans to large sea turtles, rays and other sharks (RANDALL, 1999).

The increasing number of attacks in recent years has aroused the population's fear and curiosity towards sharks. However, a profound lack of information - combined with widespread erroneous beliefs - is observed among potential victims. Educational and preventive programs have been hampered by a lack of basic information about what the population knows about such accidents. In this context, this research had the following objectives: a) to investigate the point of view, degree of knowledge and sources of information about shark attacks along the Piedade Beach; b) to detect behavioral changes in beach use caused by the presence of sharks; c) to assemble suggestions from users in order to minimize the problem and reduce the risk, and d) to provide a tentative link between local environmental factors and the escalation of shark incidents in Pernambuco. It is hoped to contribute to the discussion about the real dimension of the accidents, as environmental education and biological conservation projects should take into account the public's actual knowledge and perceptions if the success of this programs is to be achieved.

MATERIAL AND METHODS

Description of the area

The coast of Pernambuco State has a rich marine life and a peculiar topography: close to the shore the depths reach 50 m and then the underwater relief rises sharply forming a belt less than 20 m deep, which favors the formation of sandstone and coral reefs (MEDEIROS, 1996). Recife, the capital, has nearly 3 million inhabitants in its Metropolitan Region. The climate is hot and humid: temperatures are usually above 25°C throughout the year; the average relative humidity is above 70%, and the mean annual rainfall is around 2,000 mm (IBGE, 2005). Several beaches, such as Boa Viagem and Piedade, attract thousands of tourists every year, especially in the summer and holidays. The Metropolitan Region of Recife, particularly Piedade Beach - in the city of Jaboatão dos Guararapes (08°06'46"S; 35°00'53"W) - has the world's highest rate of fatal shark attacks (Fig. 1).

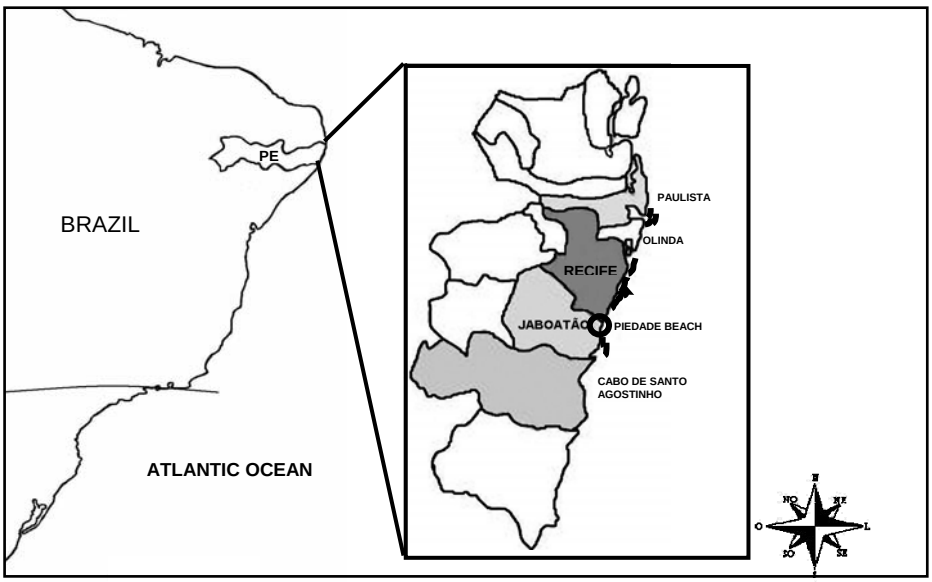

Figure 1 – Location of the Metropolitan Region of Recife, highlighting the areas where shark attacks occurred. Notice the line along the coast, depicting the reef formation.

Piedade Beach is approximately 3,700 m long, with two distinct zones: one with reef formations emerging at low tide and another one without reefs. The open-sea area suffers the effects of marine erosion and is subject to seasonal changes in hydrodynamic conditions (MEDEIROS, 1996). The whole coastline is a fragile zone, further compromised by intense and disordered human occupation, which resulted in a marked alteration in the natural landscape. Like other beaches in Brazil, people of various ages, ethnic, religious and socio-economic groups mingle in Piedade. The reef formation

allows for the creation of tepid, pleasant “swimming pools”, and the water quality is satisfactory throughout the year.

Data collection

The survey was carried out on a 1 km shoreline around a small church (the *Igreja de Nossa Senhora da Piedade*) in Piedade Beach, an area with the highest risk of shark attacks. In a random manner, we interviewed 355 local people (16 years old and above) who were using the beach in several situations, sunbathing, running, playing sports, and coming out of the water. We performed the interviews on Saturdays and Sundays from 9 am to 3 pm in the months of July and August 2004.

The interviews were based on a questionnaire with open-ended and multiple-choice questions involving the following topics: the knowledge about the causes of shark attacks and on the species involved; the bathers’ sources of information on the topic and the changes of beach use caused by the incidents. We also gathered bathers’ suggestions on how the local authorities and responsible institutions should tackle the problem in order to reduce the incidence of human-shark encounters. We encouraged the interviewees to talk freely and with no time restraints, with minimal interference on their answers.

RESULTS AND DISCUSSION

Overall perception on shark attacks

The profile of the interviewed people was as follows: 42.3% men and 57.7% women, at the following age groups: 21.0% between 15 and 20 years old, 42.6% from 21 to 30, 24.1% from 31 to 40, and 12.3% over 40 years old. When questioned about the causes for the increasing number of attacks, several reasons were brought up, the two most frequent being “the construction of the Port of Suape” (45.4% of the answers), and “the reduction of food resources for sharks” (16.8%). Almost one third (31.4%) of the interviewed people admitted not knowing any reason for the attacks. Less frequent answers included “increase in sea pollution”, “tide alterations”, “changes on rain, moon cycle and other abiotic factors”, “modifications on the coast topography”, and “behavioral changes of sharks”. Perhaps claims by the media and some scientists blaming the construction of the Port of the Suape for the attacks have influenced the bathers’ perception of the incidents. However, the vast majority could not cite any direct reason how the Port may have contributed to the attacks.

Information on shark incidents came mainly from television (90%), a major habit among Brazilians of all ages and socio-economic groups. The local newspapers (25%) were the second most used source of information and it is important to mention the erroneous dealing of the subject by some sensationalist local vehicles, which contributed to a state of panic among the locals. Despite that, most bathers (83.8%) regarded media reports as realistic while only 11.5% of the interviewees found them sensationalist. Magazines, Internet and radio were also mentioned as sources of information on shark

attacks (Fig. 2), while the number of people who cited schools or universities was negligible.

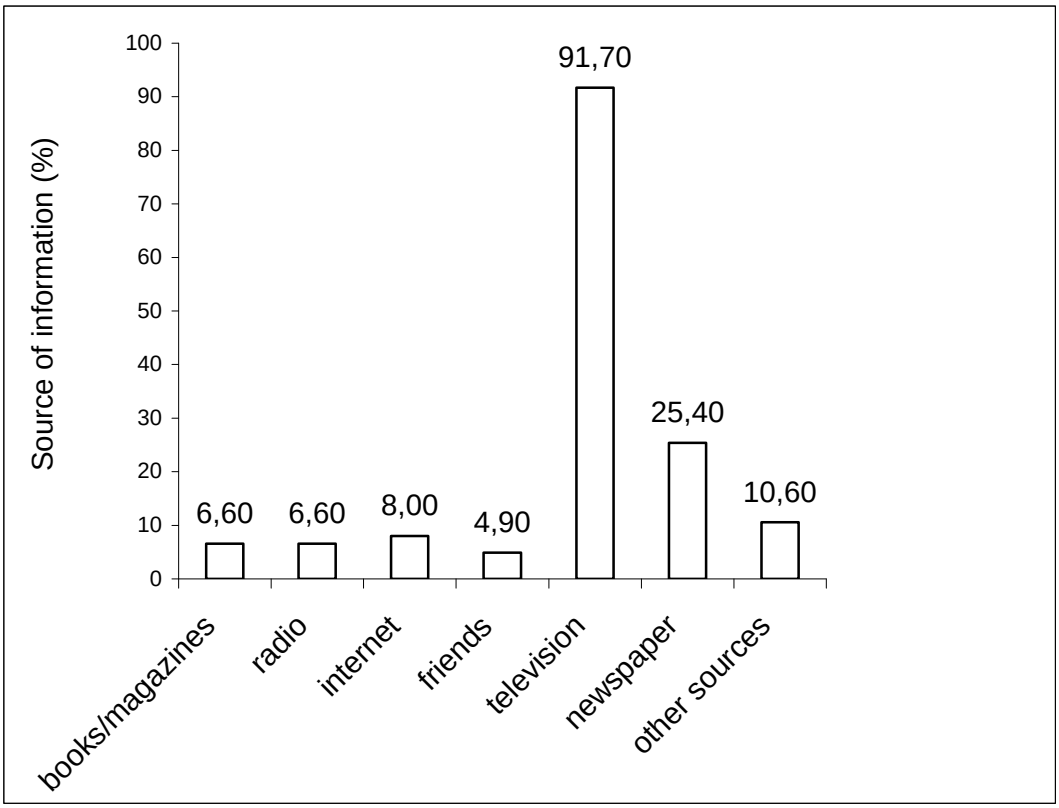

Figure 2 – Sources of information of bathers at Piedade Beach about shark-related accidents, according to interviews performed between July-August, 2004 (more than one answer possible, N = 355).

When questioned about the shark species involved in the accidents, most bathers (43.1%) believed that the bull shark was responsible, followed by 13.5% who thought that the tiger shark was involved (Fig. 3). A few shark species with no record of accidents involving humans along the coast of Pernambuco were cited, such as the nurse shark, perhaps for being a more "harmless" species and more easily caught, and the scalloped hammerhead, probably remembered for its peculiar morphology. Curiously, the white shark (*Carcharodon carcharias*) was cited by 4.2% of the interviewees, despite the absence of this species in Pernambuco. The popularity of the latter may have arisen from the mystification generated by fictional accounts in literature and USA movies. Almost 25% of the bathers could not cite the common name of any of the sharks involved in accidents.

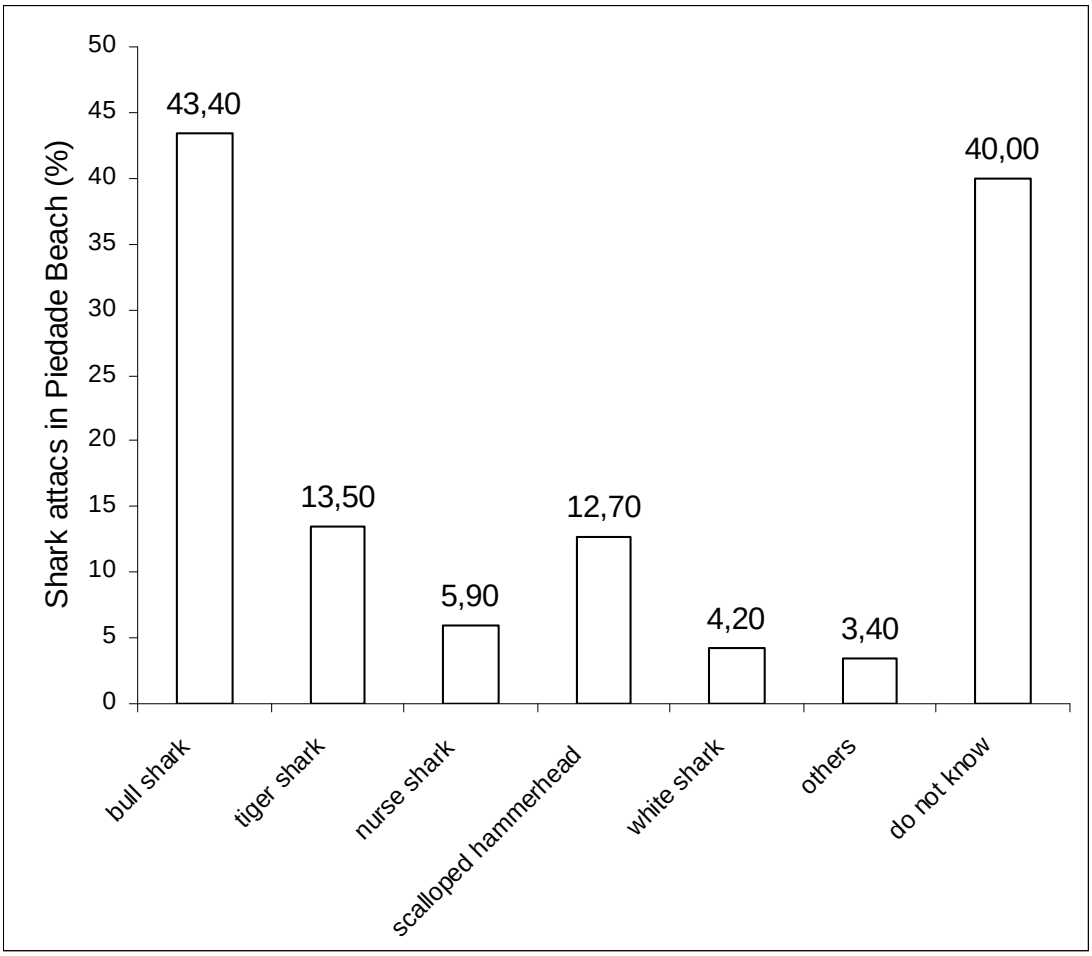

Figure 3 – Shark species cited by bathers as responsible for attacks in Piedade Beach (more than one answer possible, N = 355).

The repercussion from the attacks altered the habits of 71% of bathers, who claimed to have reduced the frequency of swimming/bathing. Twenty nine percent of the bathers stated that they have not changed their habits – that means that they either continue to enter the sea or did not use to do it before the incidents (for not knowing how to swim, disliking swimming in the sea, or finding the sea polluted). Even among the people who said to have continued bathing/swimming, cautionary behavioral changes were reported: 30% only go until shallow depth (a highly variable concept between the users but generally around the waist level), preferably before the reef line that goes along the coast. Other interviewees (4%) claimed to take other sort of precautions such as not entering the sea when the tide was high, avoiding areas considered dangerous, such as those without reefs, not swimming when injured, bleeding or menstruated. Around 30% of the bathers claimed to have quitted entering the sea for the meantime until the incidents diminish.

Among the suggestions to overcome the problem, the bathers suggested that protection nets should be installed associated with repellents and sensors, probably influenced by the local media. Interestingly, only a small part of the interviewees believed that killing the animals was the best method to reduce the incidents (Fig. 4). The population also perceives the need for educational campaigns, as they suggested that local government should produce leaflets and promote a more aggressive signalization about the danger of shark attack along the beach. This is supported by the local Fire Brigade/Life Guard Corporation, which defends a stronger investment on the public's awareness to prevent accidents.

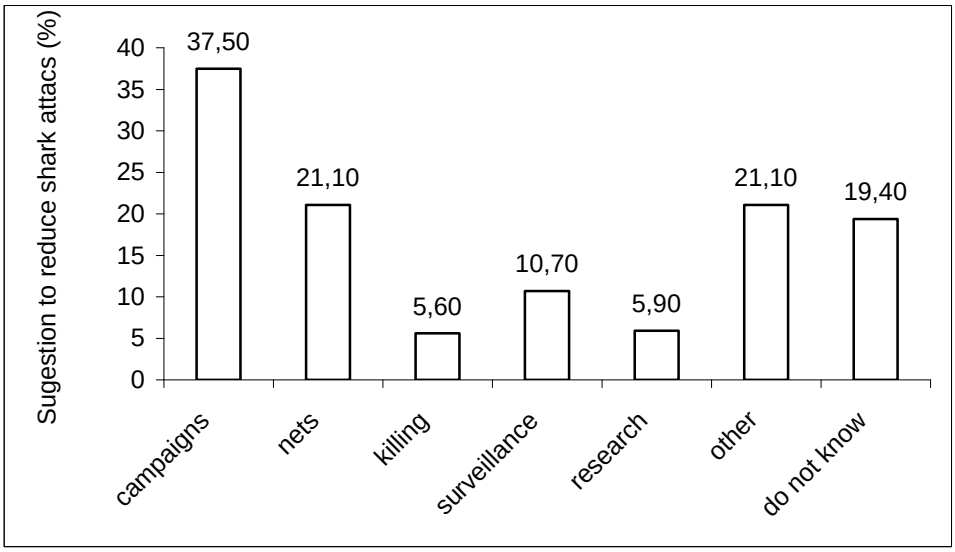

Figure 4 –Bathers at Piedade Beach to reduce shark attacks along Pernambuco coast (more than one answer possible, N = 355).

An attempt to understand shark attacks in Pernambuco

Although human impact has been acknowledged as a major contributor to shark attacks, the global increase in the accidents may also be a direct consequence of the escalation of world population itself. This is aggravated by the fact that littoral zones harbor almost 40% of the world population, and that such areas are among the most dramatically modified regions on the planet (CPRH, 2004). According to the ISAF (2004), the rate of human-shark interactions is directly proportional to the amount of people who use the sea for leisure or work and – realistically - it is unlikely that the number of attacks will drop considerably in the next decades.

The coast of Pernambuco seems prone to continue suffering the attacks, partly due to the rise in the number of bathers and surfers in the last decades

as consequence of the increase in the population and tourism. Adding to the fact that the Metropolitan Region of Recife comprises 55% of the population of Pernambuco (IBGE, 2005), several other factors are involved. The non-selective fishing nets used along the coastline catch a wide variety of non-target fish that are discarded back into the sea close to urban beaches. These fishes constitute an additional source of food for sharks, which are attracted by their smell and blood diluted in the water.

The construction of the Port of Suape, initiated in the late 70s by the Brazilian government, induced a major modification on both maritime traffic and coastal topography on the Southern coast of Pernambuco (HAZIN *et al.*, 1996). It has been argued that the intense traffic of commercial fleet caused irreversible disruptions on the local ecological processes that have set off changes in the sharks' natural behavior (HAZIN *et al.*, 2000). Additionally, human-shark encounters result from natural factors, such as local topography of the coast, characterized by a deep canal that runs along the beaches of Boa Viagem and Piedade. This canal is covered with mud rich in organic matter that provides food for a variety of marine organisms – which in turn attracts sharks (ROLLNIC, 2002) Also, the dejects of fishing vessels have increased the amount of food available to scavenging and predatory fish species, including sharks. It has been demonstrated in Australia that tiger sharks can learn how to exploit anthropogenic sources of food, and move to different areas whenever man-produced food is available (SIMPFENDORFER *et al.*, 2001). Tiger sharks in Pernambuco may display similar tendencies, which explain their regular occurrence close to shore and their attacks on humans (GADIG & SAZIMA, 2003).

It is believed that the drainage and destruction of estuarine habitats (e.g. mangrove where sharks used to feed and breed, to make room for the Port of Suape, further enhanced behavioral adaptations, triggering sharks' move towards urban beaches (GADIG & SAZIMA, 2003). According to local biologists and oceanographers, the presence of jetties built at the entrance of the Port to facilitate ship debarkation could have caused the waters from the local river (Jaboatão) to be diverted to the urban beaches of Boa Viagem and Piedade. Following this hypothesis, nutrients from the Jaboatão River that used to flow directly into the open sea have been diverted to the beaches around Recife, attracting fish and their predators, sharks among them.

According to Hazin *et al*. (1996), most attacks took place during full or new moon, when the tide amplitude is higher, which facilitates the inshore approach of large sharks. Additionally, in those lunar phases, the high tide occurs at dusk and dawn, when sharks are more active. Most attacks happened around the middle of the year (especially late July-August), when the end of school holidays coincides with periods of stronger South-Southeast wind and high water turbidity.

Gadig and Sazima (2003) state that the depletion of natural prey (sea turtles, manatees, large fishes) and the changes in shore currents due to the construction of Suape contributed to the increase in attacks. In their view, it is no coincidence that the accidents became a problem in the early 90's, when the Port started its full operation. Recently, it has been speculated that slaughterhouses built at the margins of local rivers that flow into the south

coast of Pernambuco released large amounts of organic matter (animal debris) and bovine blood into the sea close to Recife. Given the acute sensitivity of sharks to detect minimum traces of blood dissolved in the sea, it would not be surprising if this could attract them to urban beaches, although definite proof of this phenomenon is yet to be provided.

The situation in Pernambuco is further aggravated by the change on the profile of the victims. Although the vast majority of victims, in concordance with worldwide figures, are young male surfers, recent attacks in Pernambuco involved bathers who were at very shallow waters, including a tragic accident involving a young woman in 2004 who was bathing in waist-deep water. This implies that sharks are coming closer, increasing the risk of contact with humans – including children.

Shark attacks in Pernambuco: actions needed

In Pernambuco, shark attacks have reached the status of a local health problem, and apart from the obvious consequences for the injured people, there are also economical loss, such as the impact on the local tourism. One of the first actions taken by local authorities, in 1995, was to prohibit the practice of surfing/windsurfing between the ports of Suape and Recife. Despite the potential benefits, prohibiting water sports could have the contrary effect. Since most surfers are teenagers, the lure of the forbidden might even increase the practice of water sports or promote ways to avoid inspection such as surfing when lifeguards were not present. Pernambuco is nowadays the birthplace of successful surfers in international championships, so that surfing is a popular sport among teenagers, most of which males.

The situation became so extreme that Recife was chosen to hold the International Workshop on Shark Attacks, in 2004 and 2005, when world experts met to discuss the current status of shark attacks and the strategies to overcome them. As one of the emergency steps taken to understand and prevent the accidents, the Government of Pernambuco created the State Committee for Monitoring of Shark Incidents (*Comitê Estadual de Monitoramento de Incidentes com Tubarões* - CEMIT). It is composed of representatives from over 20 official institutions, non-governmental organizations and from the society, including the Brazilian Institute for Environment and Renewable Natural Resources (IBAMA), Port Authorities, public universities, the State Agency for Support of Scientific Research (FACEPE), State Legislature, State Government (Secretariats of Health, Science and Technology, Public Defense, Industry and Commerce), Tourism and Hotel Trade Association, and neighborhood and fishing communities.

This committee is involved in surveying the local diversity of sharks, monitoring risky areas, following shark incidents and the victims' treatment, and developing basic and applied research on shark biology, ecology and behavior. As an immediate step, the CEMIT promoted educational campaigns to inform locals and tourists about risky behavior, and the delimitation of areas unsuitable for swimming and surfing. One of the first measures to alert about the danger of attacks was the installation of signposts with warnings "Danger: Swimmers in this area exposed to a high risk of shark attack" in Portuguese and English, with an image of a menacing shark, to reach illiterate people. Initially installed in 1999,

new signposts were distributed for 16 km along beaches on the Metropolitan Region of Recife in 2004. However, the warning signposts have not fully raised awareness among locals. On several visits to Piedade Beach during this study - despite being rainy months - we witnessed numerous surfers in sign-posted areas, raising the question why people persist in such dangerous habit.

The installation of nets along the beach, for protection and/or exclusion, similar to those used in Australia and South Africa, have not yet been performed. Conventional nets are considered to be counterproductive, for being extremely expensive to install and maintain, and ecologically damaging because they capture indiscriminately sharks, dolphins, turtles and big fish in general. Nevertheless, an adaptation of repellent devices attached to non-destructive and malleable nets is to be tested soon in Pernambuco, with state-provided funds recently approved. The selective fishing for scientific purposes of monitoring and research is being carried out, despite some initial negative reaction from the public who are opposed to killing sharks.

In this study, we noticed that local universities have yet not achieved their potential as sources of updated, reliable information for the general public. This could be a consequence of the chronic lack of funds and personnel, or the fact that this complex problem calls for a more integrated approach. For example, even the records of the accidents and the species involved are divergent among some of the institutions involved. It is vital that quantitative and qualitative data are constantly updated and validated in order to avoid duplication of efforts and to maximize their usefulness. It is also important to fully equip the local rescue and medical teams. The number of lifeguards assigned to cover risky areas, and the jet skies and boats available are insufficient. The high mortality observed in Pernambuco could be reduced had local teams access to modern equipment (boats, medical facilities, even helicopters) to inspect the area and save victims. When compared to countries such as Australia and United States, the quality of life-saving devices available to lifeguards and paramedics is inadequate.

On one topic, scientists, the Fire Brigade (responsible for life-saving in Brazil), the governmental agencies and the population agree: the problem cannot be solved without full emphasis on environmental education. The level of information of bathers at Piedade Beach about the attacks, their perpetrators and the strategies for overcoming them is limited and the population has little knowledge on how to reduce the danger of a shark attack. Some recommendations should be made public: not wearing shiny jewelry or high contrast bathing costumes, not urinating in the water, refraining from excessive splashing, avoiding waters with commercial fishing or active seabird feeding, not swimming with pets, among others (CALDICOTT *et al*, 2001). Such cautionary actions were not spontaneously mentioned by the interviewees nor was the work of CEMIT, although a few bathers cited research projects carried out by the local universities.

For the last two years awareness-raising campaigns have been developed among bathers at Boa Viagem and Piedade. Such campaigns involved mainly researchers and students from the courses of Biological Sciences and Fisheries Engineering at one of the local public universities (*Universidade Federal Rural de Pernambuco*). The volunteers distribute leaflets in the beaches and explain

to locals and tourists the risks of accidents and how to prevent them. Despite the bathers' initial ignorance, the university is helping to demystify the image of sharks as evil creatures and reinforcing the idea that the attacks are a response to profound and disastrous human-caused alterations in natural landscape.

It is important to put the shark accidents into a realistic context in order to guarantee safety without panic. Despite the fact that human-shark encounters happen daily around the globe, the risk of an attack is extremely small – just for comparison, accidents caused by shark-related fishes, such as rays, whose poisonous stings cause painful lacerations, are far more frequent than shark attacks (HADDAD Jr., 2000, ISAF, 2004).

Partly due to the attacks around the globe, magnified by the myths created by literature, cinema and television, sharks have acquired the popular reputation of villains of the sea. According to Lessa *et al*. (2004), when sharks receive distorted attention from the media a strong negative reaction of humans is established, which jeopardizes their appeal as research subjects on biodiversity, conservation and environmental education. As a consequence, the importance of these animals to the ecosystem, that is, providing ecological balance and biological control of other species, remains largely ignored. It should be made clear to the public that sharks are vulnerable to overfishing because they are long-lived, take many years to mature and produce few young at a time. Recently, the Brazilian Society of Elasmobranchii Research has alerted the Brazilian Ministry of Environmental Protection about the endangered status of several species along the Northeastern coast.

The correlation between the activities of the Port of Suape and the attacks should serve as a reminder for rethinking the modification of natural resources in highly fragile environments. Instead, we observe quite the opposite in Brazil. Not only have the public authorities resistance in accepting scientific facts but they have also just approved, by presidential decree, the installation of an oil refinery complex with adjacent industries, ironically, in the Suape complex. The plan is to boost the maritime traffic in the region. It is not difficult to foresee the consequences of this decision to the local ichthyofauna – and to bathers.

As stressed by Gadig and Sazima (2003), shark attacks in Pernambuco are expected to continue and even increase, unless common sense prevails among beach users, local authorities and other parties. Environmental education and conservation programs can only succeed if based on complementary information on shark biology and behavior and public perceptions in order to promote awareness and respect about these animals.

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