STRANDINGS OF THE SHORTFIN MAKO AND THE PELAGIC STINGRAY ON THE COAST OF SÃO PAULO STATE, SOUTHEASTERN BRAZIL: REPORT OF CASES

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ABSTRACT

Strandings of oceanic-pelagic elasmobranchs in the southeastern Brazil are reported. Data comes from animals observed in the coast of São Paulo state, between 1999 and 2012. Nine individuals of two species were recorded: *Pteroplatytrygon violacea* (n = 5; mostly during the winter) and *Isurus oxyrinchus* (n = 4; two in the winter and two in the summer). For *P. violacea* the strandings restricted to the austral winter suggest that the species follows the intrusion of high temperatures water masses recorded in southeastern Brazil during this season, bringing some individuals to shallow waters. For *I. oxyrinchus* is possible that individuals escaped from hooks of the commercial pelagic longline fishery and suffered injuries in the esophagus and in the gastric wall, stranding due to difficulties in locomotion and feeding. As these stranded sharks were not necropsied and only two animals were observed during the austral summer, we cannot exclude other causes of beaching such diseases or the intrusion of cold water masses in the continental shelf during this season.

Keywords: Stranded animals; mortality; *Pteroplatytrygon violacea; Isurus oxyrinchus*; Atlantic Ocean.

ENCALHES DE TUBARÕES ANEQUINS E DE RAIAS-PRETAS NO LITORAL DO ESTADO DE SÃO PAULO, SUDESTE DO BRASIL: RELATO DE CASOS

RESUMO

Encalhes de elasmobrânquios oceânico-pelágicos no sudeste do Brasil são apresentados. Os dados provêm de animais observados no litoral do estado de São Paulo, entre 1999 e 2012. Nove indivíduos de duas espécies foram registrados: *Pteroplatytrygon violacea* (n = 5; principalmente durante o inverno) e *Isurus oxyrinchus* (n = 4; dois no inverno e dois no verão). Para *P. violacea* os encalhes restritos ao inverno austral sugerem que a espécie segue a intrusão de massas de água quente registradas no sudeste do Brasil durante esta época do ano, trazendo alguns indivíduos para águas rasas. Para *I. oxyrinchus* é possível que os indivíduos tenham se soltado de anzóis da pesca comercial de espinhel pelágico e sofrido injúrias no esôfago e na parede gástrica, encalhando devido a dificuldades de locomoção e alimentação. Como estes tubarões encalhados não foram necropsiados e apenas dois animais foram observados durante o verão austral, não podemos excluir outras causas de encalhe, como doenças ou a intrusão de massas de águas frias na plataforma continental durante essa temporada.

Palavras chave: Animais encalhados; mortalidade; *Pteroplatytrygon violacea; Isurus oxyrinchus*; Oceano Atlântico.

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INTRODUCTION

Strandings of marine animals are reported worldwide, especially regarding to cetacean species. However, the reasons of this behavior still remain poorly understood and numerous theories were proposed (EVANS *et al.*, 2005; BRADSHAW *et al.*, 2005; SPEED *et al.*, 2009). Some explanations available in the literature include the interference in the magnetic navigation system of these animals (*e.g.* undersea power cables), the climate and oceanographic variation (*e.g.* abrupt changes in the sea water temperature), and the bacterial infections as the main causes of beach strandings (BECKLEY *et al.*, 1997; EVANS *et al.*, 2005; NORMANDEAU *et al.*, 2011; SCHAFFER *et al.*, 2013).

In contrast, the lack of data on elasmobranchs strandings around the world, suggest that are uncommon. Some of the existing summaries list records only for six species of stranded sharks – *Carcharodon carcharias*, *Cetorhinus maximus*, *Lamna ditropis*, *Megachasma pelagios*, *Rhincodon typus* and *Triakis semifasciata* (SPEED *et al.*, 2009; TINKER, 2011), not mentioning batoids and neither cases occurred in South America. However, elasmobranchs strandings perhaps occurs more frequently and are not well documented. In this paper, we reported the occurrence of strandings of two oceanic-pelagic elasmobranchs species, the shortfin mako (*Isurus oxyrinchus)* and the pelagic stingray (*Pteroplatytrygon violacea*), observed on the coast of São Paulo state. The shortfin mako exhibit a widespread distribution in temperate and tropical waters of all oceans, occurring from the surface to at least 600 m depth (COMPAGNO, 2001). It is a frequently species taken by commercial fisheries around the world, mainly as bycatch of tuna and swordfish longlining (CASEY and KOHLER, 1992). The pelagic stingray is an epipelagic species, with a circumglobal distribution in both temperate and tropical seas and is usually found in shallower waters than 100m (MOLLET, 2002; LAST and STEVENS, 2009). Likewise, this species is a common component of the longline fishery that captures tunas, billfishes and sharks (NEER, 2008).

Although there are data on the distribution, capture and other important biological characteristics of these species we have to considering that there are few documented data on the elasmobranchs strandings in the literature and none for these species. This case report aims to expand the strandings records in the literature and contribute with future studies to a better understanding of these events.

MATERIAL and METHODS

The data used in this study comes from animals observed directly in the field by the authors and/or information provided by third parties, between 1999 and 2012, in different sites on the coast of São Paulo state, in southeastern Brazil. Some information found at the newspaper clipping of the time and other media sources ("gray literature") were used to complement the cases.

For the purposes of this study, stranded elasmobranchs were defined as those specimens found alive along the shoreline as well as in other coastal formations (rocky shores or inside artificial channels) and that were unable to return to the sea by their your own. Specimens found newly dead or in a decomposing state as well as with injuries resulting by attacks of predators, collisions with vessels or entanglement in fishing gear and other artifacts were not included in our casuistry. Each individual was measured or had estimated the size (in centimeters – cm), sexed and checked their general condition and photographed. A stranded *Pteroplatytrygon violacea* (case 8) was deposited in the Elasmobranch Collection of the Universidade Estadual Paulista as a voucher-specimen (UNESP-CLP 0004). The others individuals were carried to the scientific collection of the Museu do Instituto de Pesca de Santos or to local rehabilitation units (Aquário do Guarujá and Aquário de Santos) for the first aid procedures.

RESULTS

In total, strandings of nine individuals belonging to two species of oceanic-pelagic elasmobranchs were recorded: the shortfin mako, *Isurus oxyrinchus* Rafinesque, 1810 and the pelagic stingray, *Pteroplatytrygon violacea* (Bonaparte, 1832) (Table 1). Of these, two occurred

on the north coast of São Paulo state, in the municipality of Ubatuba. The remaining records corresponded to strandings occurred on the central coast of São Paulo state, in the municipalities of Guarujá (n = 1), Itanhaém (n = 1), Praia Grande (1) and Santos (n = 4) (Figure 1).

Table 1. Strandings of oceanic-pelagic elasmobranchs on the coast of São Paulo state, southeastern Brazil (1999 - 2012). TL - Total Length; DW - Disc Width.

CASE	DATE	SPECIES	LOCATION	SIZE (cm)	SEX
1	Jan 01, 1999	*I. oxyrinchus*	Santos, Aparecida Beach (23°58'57.30"S, 46°18'43.65"W)	275 (TL)	Female
2	Aug 12, 1999	*I. oxyrinchus*	Ubatuba, Itaguá Beach (23°27'26.34"S, 45°03'30.76"W)	230 (TL)	Female
3	Nov 11, 2001	*I. oxyrinchus*	Praia Grande, Maracanã Balneary (24°02'24.40"S, 46°29'30.04"W)	254 (TL)	Female
4	Jul 18, 2003	*I. oxyrinchus*	Ubatuba, Itamambuca Beach (23°24'06.46"S, 45°00'08.88"W)	210 (TL)	Unknown
5	Jul 12, 2009	*P. violacea*	Santos, Channel 6 (23°58'53.86"S, 46°18'22.83"W)	40 (DW)	Male
6	Jun 26, 2010	*P. violacea*	Guarujá, Enseada Beach (23°59'17.37"S, 46°13'53.62"W)	45 (DW)	Male
7	Jul 15, 2011	*P. violacea*	Itanhaém, Sonho Beach (24°11'38.45"S, 46°47'51.47"W)	40 (DW)	Female
8	Jun 20, 2012	*P. violacea*	Santos, Ponta da Praia (23°59'12.68"S, 46°18'33.49"W)	48 (DW)	Male
9	Aug 07, 2012	*P. violacea*	Santos, Channel 2 (23°58'11.15"S, 46°20'21.58"W)	40 (DW)	Male

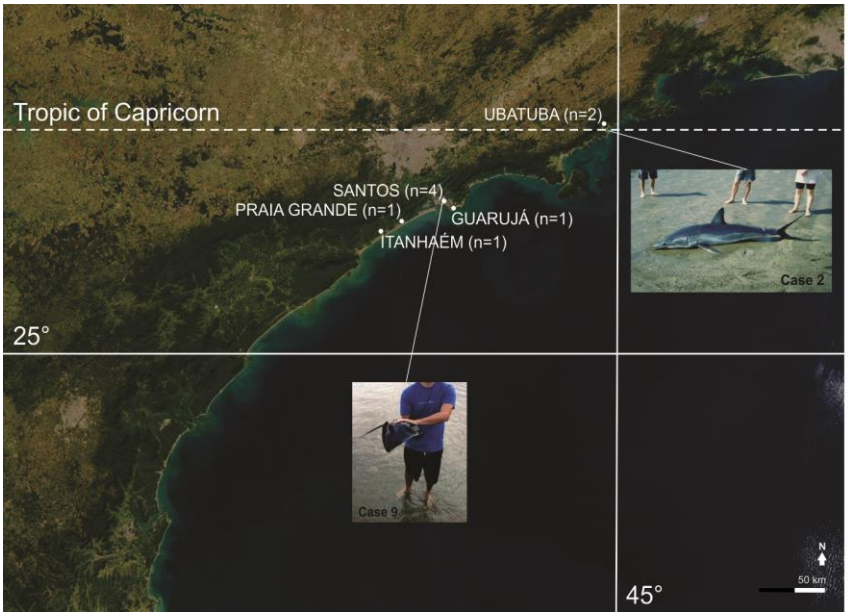

Figure 1. General view of the coast of São Paulo state, southeastern Brazil. Strandings are pointed according to the municipality of occurrence (Modified satellite image from Aqua MODIS database; shark image: Roberto William von Seckendorff; ray image: Alan Reina de Souza).

Strandings of the shortfin mako (*I. oxyrinchus*) occurred on the central and north coastal of São Paulo state, in Santos (n = 2) and Ubatuba (n = 2). Specimens measured between 210 and 275 cm TL. Most were females (n = 3) and were considered subadults, since that these have a size at maturity from 301-312 cm of TL (FRANCIS and DUFFY, 2005). All specimens were observed almost motionless near shore in very shallow waters (less than 1.5 m). Furthermore were found in the stomach of the sharks (cases 1, 3 and 4) a Japanese-made hook used in the pelagic longline fishery (Figure 2).

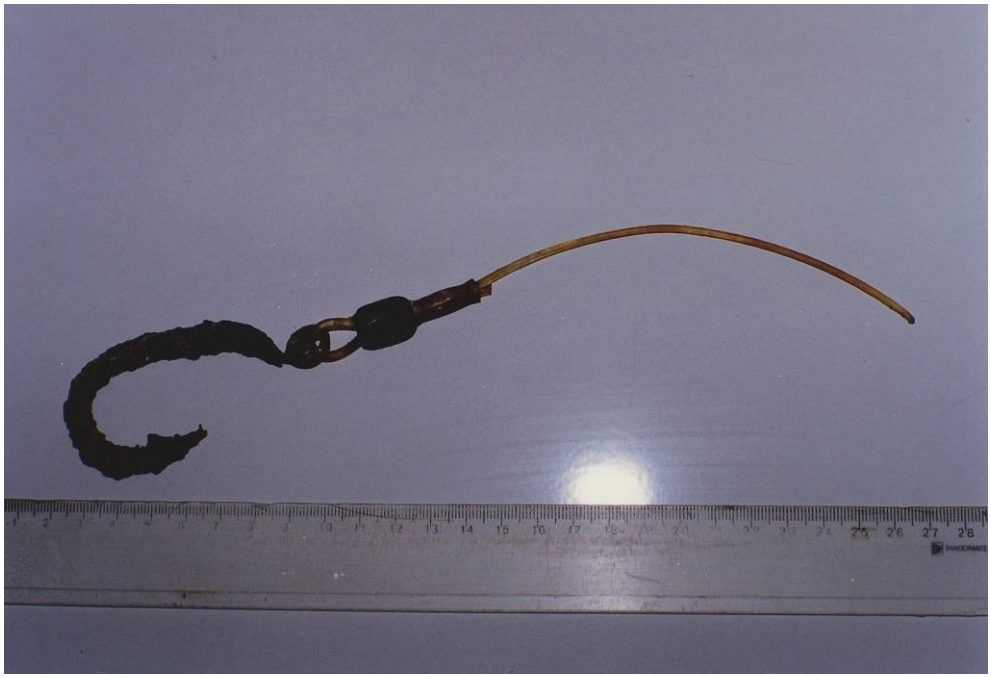

Figure 2. A Japanese-made hook used in the pelagic longline fishery removed from the stomach of a *Isurus oxyrinchus* (275 cm TL female) stranded in the Aparecida Beach, Santos, central coast of São Paulo state (Photo: Otto Bismarck Fazzano Gadig).

Five specimens of the pelagic stingray (*P. violacea*) measuring between 40 and 48 cm DW were recorded in this study (Figure 3). Three were washed ashore in the beach and two within the drainage urban channels (case 5 and 9) that cross the beaches on Santos city. These channels, numbered from 1 to 7 along the beaches, were constructed aiming to minimize the problems of poor sanitary conditions in Santos during the 19th century, draining freshwater runoff from the city (AZEVEDO, 1965). All stranded *P. violacea* were from central coast of São Paulo State, in Guarujá (n = 1), Santos (n = 3), and Itanhaém (n = 1). Most were adult males (n = 4) and the only female was considered an immature specimen, since that for these species the sexual maturity is observed in individuals with more than 40 cm of DW (WILSON and BECKETT, 1970).

The specimens had no injuries, but the ray of the case 5 had the presence of isopods ectoparasites in the posterior portion of the disc (two in the ventral region and two in the dorsum). Almost all *P. violacea* (n = 4) were directed to local rehabilitation units for the first aid procedures, however, all of these individuals died.

Figure 3. *Pteroplatytrygon violacea* (48 cm DW adult male) stranded in the Aparecida Beach, Santos, central coast of São Paulo state (UNESP-CLP 0004); note the intact tail sting (Photo: Domingos Garrone Neto).

DISCUSSION

Although there are few publications available in the literature about strandings of elasmobranchs, a variety of factors could induce this process, including sudden changes in the water temperature and salinity, unusually low tides, poor water quality, human actions such changes in electromagnetic fields due the installation of undersea power cables and pollution, and more recently, bacterial infections (BECKLEY *et al.*, 1997; SPEED *et al.*, 2009; NORMANDEAU *et al.*, 2011; TINKER, 2011; SCHAFFER *et al.*, 2013).

SCHAFFER *et al.* (2013), studying juvenile salmon shark (*Lamna ditropis*) stranded in the coast of California, United States, documented the first brain infection by bacteria of the *Carnobacterium* genus in elasmobranch species. The authors suggested that the sharks stranded due to meningoencephalitis – a disease caused by this group of bacteria, which leads the young animals to disorientation and death. In the north and central coast of São Paulo state, southeastern Brazil, where the strandings of subadults *I. oxyrinchus* were recorded, there are no available data concerning to bacterial infections or other diseases in sharks. Likewise, TINKER (2011) also proposed that juveniles of leopard shark (*Triakis semifasciata*) were beached due to bacterial infections or by the increased of pollution in the San Francisco Bay, United States. Nevertheless, the author rejected both hypotheses when observed a large variation in the salinity in the South San Francisco Bay in January and March, assigning the strandings to this variation.

Amongst these evidences, the most probable hypothesis for the strandings of *I. oxyrinchus* in the coast of São Paulo state would be that the sharks were captured by the pelagic longline fisheries carried off the coast of southern Brazil and were able to release the hook. This hypothesis was supported by 3 of the 4 stranded sharks (75%) in whose stomachs were found a Japanese-made hook (model 9/0) commonly used in the pelagic longline fishery. Depending on the hook type we can associate with the hooking location (gut-hooked or mouth-hooked) and establish the changes of escape rates during haul-back (YOKOTA *et al.*, 2006). VASKE JR. and RINCÓN FILHO (1998) describing the gastric contents of the blue shark (*Prionace glauca*) and the shortfin mako (*I. oxyrinchus*) from oceanic waters of south

Brazil, estimated that about 5% of these oceanic-pelagic animals caught in Brazilian waters have at least one longline hook in their stomachs.

Therefore, we believe that the stranded individuals of *I. oxyrinchus* escaped the hook of the commercial pelagic longline fishery. Healthy sharks which would be alive at the moment of the haul-back the longline should have more chance to sever the nylon and escape than injured or weaker sharks (AFONSO *et al.*, 2012). However, depending on the hooking location as in the gut-hooked, some injuries due to damage to the esophagus and gastric wall could become the shark weakened (BORUCINSKA *et al.*, 2002). So, we supposed that *I. oxyrinchus* individuals could succumb due to difficulties in locomotion and feeding, stranding as a result. Additionally, no external injuries were observed in the sharks. The stranded sharks were not necropsied and only two animals were observed during the austral summer. Thereby, we cannot exclude other causes for the strandings such some kind of infection or disease.

For *P. violacea,* most records from the Brazilian coast are from around oceanic insular shelf and banks (DOMINGO *et al.*, 2005; VÉRAS *et al.*, 2009), and a few reports from shallower waters of the continental shelf (SIQUEIRA and SANT'ANNA, 2007; VASKE JR. and ROTUNDO, 2012). Although extensively caught by the pelagic longline fishery around the world, there are few records of *P. violacea* over continental shelves, and it movements patterns are poorly documented (NEER, 2008).

MOLLET (2002) suggested that *P. violacea* is pupping in January (during the austral summer) in warmer water almost in the southern mid Atlantic, which would partially agree with his findings for the eastern Pacific. However, little is known about the movement patterns of this species (NEER, 2008) and despite of *P. violacea* usually be regarded as an oceanic-pelagic elasmobranch species (WILSON and BECKETT, 1970; FIGUEIREDO, 1977; MENNI *et al.*, 1995; AMORIM *et al.*, 1998; MENNI and STEHMANN, 2000; MOLLET, 2002), there are few data on specimens in coastal areas over the continental shelf.

SIQUEIRA and SANT'ANNA (2007) reported catches of this species by the hand line fisheries that occurs in the Rio de Janeiro state, southeastern Brazil, in coastal cold waters (below 18 ºC) and depths shallower than 45 m. VASKE JR. and ROTUNDO (2012) reported a similar situation in the north coast of the São Paulo state, where adults of *P. violacea* not rarely has been caught by the pair-trawling fishery in shallow waters (about 30 m of depth). In these both cases, where the catches were associated to the austral summer and late spring (September to March), the possible explanation for the occurrence of an oceanic-pelagic elasmobranch species in shallow waters is the influence of cold water masses deriving from the intrusion of the South Atlantic Central Water (SACW) over the continental shelf of southeastern Brazil during these seasons (MATSUURA, 1986). SIQUEIRA and SANT'ANNA (2007) and VASKE JR. and ROTUNDO (2012) suggested that this phenomenon might be responsible for the occasional occurrence of *P. violacea* in coastal waters, that probably were deviated from oceanic waters by changes in the water masses.

In contrast, at the present study none of the stranded *P. violacea* individuals were observed during the austral summer, when the SACW presents a greatest influence in southeastern Brazil (MATSUURA, 1986). All the stranded rays were observed in the austral winter (June to September), when the SACW recoils offshore and only occasionally penetrates into the continental shelf. At this season, the Brazilian Current (BC) presents a more important effect than the SACW, bring warm waters that flows above the continental shelf during the austral winter (SIGNORINI, 1976). Thus, we can suppose that the strandings restricted to the winter suggest that the species follows the intrusion of high temperatures water masses recorded in southeastern Brazil during this season, bringing some individuals to shallow waters. Previous studies indicate higher correlation between abundance and higher sea temperatures for *P. violacea* (MOLLET, 2002). A more comprehensive study on the distribution and movement patterns of this species is necessary to understanding the occasional occurrence of *P. violacea* on inner

continental shelf of southeastern Brazil and the probable causes of strandings events.

Additionally, we suggest that the hypothesis of possible strandings of weakened rays, incidentally caught by the trawling fishery conducted in shallow waters of the coast of São Paulo state, are discarded due to the absence of wounds or marks from fishing gear in the individuals analyzed. All the stranded *P. violacea* were with intact stings in their tails, which probably would not occur if these individuals had been "dragged" by trawl nets or captured by local fishermen, that usually provokes serious damage in the rays removing the hooks of their jaws and/or amputating their tails before release the specimens, since this oceanic-pelagic species have no commercial value in Brazil (DOMINGO *et al.*, 2005; VASKE JR. and ROTUNDO, 2012).

As a general concluding remark, the occurrence of unusual reports of *I. oxyrinchus* and *P. violacea* stranded on the coast of São Paulo state suggests that these events require a combination of factors.

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