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Recent records of swordfish attacks on harpoon vessels in the Sicilian waters (Mediterranean Sea)

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Recent cases of swordfish attacks on harpoon fishing vessels of the Sicilian fleet were examined and the particular behavior adopted by this fish during the approach to fishermen was described.

The information was collected in the period between 1999 and 2014 in Sicilian waters (Mediterranean Sea) through interviews with harpoon fishermen and through direct observations during research activities. Additional cases of the attacks from the previous years are also reported. Overall, 29 cases of swordfish aggressive behavior against fishing boats were documented. Swordfish usually attacked when provoked or when wanted to defend its mate and in several cases, it tried to pierce the boat by the bill. Some attacks culminated with a damage to the target, whereas no injuries to humans were recorded.

Key words: *Xiphias gladius*, behavior, attack, human risk, harpoon fishery, Mediterranean Sea

INTRODUCTION

The swordfish, *Xiphias gladius* (Linnaeus, 1758) is the only species belonging to the Xiphiidae family that inhabits tropical and temperate seas of the world. It is an apex opportunistic predator and a fast swimmer (CANESE *et al.*, 2008; LEE *et al.*, 2009). It can perform rapid depth excursions from 400-500 m to the surface in few minutes (CAREY, 1981; CANESE *et al.*, 2004, 2008). The

greatest swimming depth (900 m) was reported by TAKAHASHI *et al.* (2003) in the Pacific Ocean.

The name originates from the Latin word “*gladius*” which means “sword” and describes a peculiar characteristic of the species: a long rostrum similar to a sword. A prominent bone protruding from the snout is also common to other billfishes as spearfish, sailfish and marlins and it has several functions, such as defense (FIERSTINE, 1997; FIERSTINE *et al.*, 1997), improve-

ment of swimming hydrodynamics (WISNER, 1958; OVCHINNIKOV, 1970; SAGONG *et al.*, 2013) and feeding strategy (SCOTT & TIBBO, 1968; STILLWELL & KOHLER, 1985; FRAZIER *et al.*, 1994; SHIMOSE *et al.*, 2007; DOMENICI *et al.*, 2014). However, rostrum of the swordfish is much longer and wider than the rostrum of other billfish. Studies on swordfish feeding behavior described the usefulness of the elongated rostrum for killing and cutting prey using a lateral splashing (SCOTT & TIBBO 1968). This was proven by the fragments of the prey found in the stomach contents with evident injuries caused by the bill, especially on squids and silver scabbardfish that were split into two or more sections (STILLWELL & KOHLER 1985; ROMEO *et al.*, 2009a). A well-developed visual system and a muscle tissue that warms the blood flowing to the brain and eyes, especially when the fish is in the cold waters, allow swordfish to individuate its prey also from long distances, increasing the success of predation. Moreover, FRITCHES *et al.* (2005) proposed a possibility that swordfish might see in color. All these characteristics and abilities make the swordfish a capable predator.

Nevertheless, the function of the bill is well recognized in feeding strategy and in swordfish attacks on the objects (ships, boats, fishing vessels), but also attacks on large pelagic animals (whales, sharks and turtles) were reported (GOODE, 1882; GUDGER, 1938, 1940; ELLIS, 2013). Attacks on small submersibles or mesoscaphes are also known. A careful description of an attack occurred during an expedition by the Submarine Alvin in Florida was given (ZARUDSK & HAEDRICH, 1974); in this case, a swordfish impaled (without releasing) itself in a joint of the submersible's upper and lower parts and it was caught when the submersible surfaced. ELLIS (2013) described other similar cases.

Cases of swordfish attacks to humans have been reported from the ocean waters and the events have been often examined from a clinic point of view. For instance, some specific swordfish attacks to fishermen were described: Brazil (HADDAD *et al.*, 2009); Spain (GALBIS *et al.*, 2002; MENDONÇA-CARIDAD *et al.*, 2008). Studies reported that this fish behaves dangerously when

provoked or disturbed. In Malaysia, a man was injured while swimming and the attack culminated with his death (GOOI *et al.*, 2006); in Santorini Island (Greece) another case of probably unprovoked swordfish attack to a woman who was swimming was clinically analyzed (GEORGIADOU *et al.*, 2010).

In the Mediterranean Sea, the swordfish behavior has been studied by a direct visual approach onboard harpoon fishing vessels that operate in the Strait of Messina and the nearby areas (ROMEO *et al.*, 2009a, 2010, 2011b, 2015). Indeed, this fishing activity represents a useful opportunity to study the surface swimming behavior of this fish during its reproductive season, since it is carried out during daylight and based on a visual exploration of the sea surface and sighting of specimens. Studies performed by pop-up archival tags in the Strait of Messina demonstrated that swordfish usually stays in surface layers during night hours, whereas, during daylight, it carries out depth excursions from deep waters to the sea surface, remaining there for about 1 hour (CANESE *et al.*, 2004, 2008). For this reason, the resource becomes available to the harpoon fishing in the area (ROMEO *et al.*, 2015).

Based on this information, the aim of this paper is to report recent records of swordfish attacks to harpoon fishing vessels of the Sicilian fleet and examine the particular behavior adopted by this fish while approaching fishermen and evaluate if this aggressive behavior represents any risk for humans in the study area.

MATERIAL AND METHODS

The information was collected through interviews with harpoon fishermen and direct observations during research activities from 1999 to 2014 in Sicilian waters (Mediterranean Sea). Information on some attacks in previous years was also obtained from older fishermen. The interviews were conducted with Sicilian harpoon fishermen, as they have the opportunity to testify and directly observe living swordfish specimens during their fishing activity. Overall 27 fishermen were interviewed, having a mean

age of 42 ± 20 years (age range: 16 - 70 years), 12 of which were older than 60 years. All data obtained were analyzed and categorized as true if at least 2 of the interviewed harpoon fishermen reported the same event. When the information was obtained by the story of only one fisherman, it was reported as “historical memory”.

RESULTS AND DISCUSSION

All collected records are summarized in Table 1. The table includes true records, historical memories of swordfish attacks collected during the interviews and direct observations obtained by researchers during sampling activities onboard harpoon vessels.

Graphic representation of the observation of an attack is reported in Fig. 1.

Overall, 29 cases of swordfish aggressive behavior towards boats were documented. If we consider the years between 1999 and 2014 (years in which the research was carried out) a mean value of 1.50 attacks for a year resulted. These attacks did not cause any injuries to fishermen, only damages to the boats were recorded in some cases. Descriptions of the events (Table 1) indicate that swordfish attacked mainly when provoked and in several cases, it tried to pierce its ‘enemy’ by the bill. However, several fishermen reported that the attack did not culminate with a real damage to the target, since the fish behavior was based on flipping the boat over by swimming aggressively, only simulating attacks, without piercing the boat by the ‘sword’. The bill, generally used in feeding strategy, in this case is used for defensive purpose. The swordfish visual capability (FRITCHES *et al.*, 2005) allows this species to choose a specific target during its aggressive behavior. In several reported cases the swordfish, when harpooned, retaliates by attacking its assailant. Moreover, several attacks reported in Table 1 are referred to a fish-pair, sighted during the peak of swordfish reproductive period, in June and July (ROMEO *et al.*, 2015). We can suppose that in these cases the attacks reflect the tendency to perceive the fishing vessel as a probable enemy and/or main reason of the mate death, confirming as reported by SISI



Fig. 1. Illustration (G. Ammendolia) showing a harpooned swordfish attacking a supporting boat of an harpoon fishing vessel operating in the Strait of Messina.

(2005) about male’s fidelity to female during the breeding season. The swordfish harpoon fishing (DI NATALE *et al.*, 2005; ROMEO *et al.*, 2015) carried out in Italian waters has the feature of a seasonal activity, being performed between May and August/September, a period that also includes the swordfish breeding season in the study area (ROMEO *et al.* 2015). It is well known among harpoon fishermen that female and male swordfish are usually swimming together near the surface during the reproductive period in order to spawn (ROMEO *et al.*, 2009b) and that males tend to protect its mate, becoming aggressive. As reported by ROMEO *et al.* (2015), this behavior represents an opportunity of increasing catches for harpoon fishermen: when a pair is sighted, the fisherman first harpoons the largest specimen (usually the female) keeping it in the water alongside the vessel and waiting for the male to approach. Indeed, male does not leave its mate and tries to defend it, giving the harpooner a greater chance

Table 1. Information and description of swordfish attacks to harpoon vessels and fishermen. Location and period of each attack is reported, together with the weight and sex of specimens (according to Romeo et al. 2008, 2009b, 2011b, 2015, we define "pair" as a female swimming together with a male during the reproductive period in order to spawn). ID = progressive identification statement; *Direct observation of the researcher; ** Historical memory.

ID	Year	Month	Location	Weight (kg)	Sex	Description of the event	Damages to vessel	Injury to fisherman
1**	1969	Jul	Strait of Messina (Grotte)	60	-	The harpooned fish swam fast towards the supporting boat (a small vessel which in same case is used to recover the harpooned fish while the main vessel restarts fishing) suddenly emerging from the deep waters and pierced the boat hull. It remained blocked and unsuccessfully tried to escape. It was necessary to land and cut the sword, to recover the catch.	X	-
2**	1973	Jun	Southern Tyrrhenian Sea	~ 70	-	The boat was sailing, when the hull was hit by a mysterious object. When the boat landed fishermen checked the vessel and found a sword stuck into the hull. The bill was broken and belonged to a swordfish of about 70 kg.	X	-
3**	1990	Jun	Strait of Messina (Cannitello)	65	-	The harpooned fish swam fast towards the supporting boat suddenly emerging from the deep waters and pierced the boat hull. Fishermen understood the intention of swordfish and immediately jumped on the boat seats, so avoiding to be hit. The bill was broken down and fish was caught.	X	-
4**	1992	Sep	Strait of Messina (S. Agata)	91	Female	The harpooned fish swam fast towards the boat suddenly emerging from the deep waters and pierced the boat hull. It remained blocked and unsuccessfully tried to escape.	X	-
5**	1994	Jun	Strait of Messina (Scilla)	125	Female	The harpooned fish turned around the supporting boat and then repeatedly beat the bill against the boat. Finally the specimen broke its bill.	-	-
6*	1999	Jun	Southern Tyrrhenian Sea (Aeolian Islands - Vulcano)	91	Pair	The harpooned fish (female) attacked the boat and its bill remained pierced into the vessel. The male fish have been already harpooned by another vessel.	X	-
7*	1999	Jun	Southern Tyrrhenian Sea (Cape Rasocolmo)	~ 45	Male	The fish turned around the boat with rapid and forcible movements. It simulated to attack the boat, but when it arrived near the hull, it turned back. The fish repeated this behavior for about an hour and fisherman could not harpoon it for its fast swimming. After, fish disappeared from the sea surface.	-	-
8	2000	Jun	Southern Tyrrhenian Sea (Aeolian Islands - Panarea)	35	Pair	The male fish turned around the boat with forcible movements. It simulated to attack the boat. After three jumps the fish was harpooned. The male was nervous because another vessel had already killed the female of the pair.	-	-
9	2001	Jul	Southern Tyrrhenian Sea (Aeolian Islands)	~ 60	-	The fish turned around the boat with aggressive movements. The fish repeated this behavior for two times and then disappeared from the sea surface towards deeper waters.	-	-
10**	2002	Jul	Southern Tyrrhenian Sea (Aeolian Islands)	~ 30	-	The fish aggressively swam fast towards the boat. When it approached the boat under the bow, it turned back. Fish disappeared from the surface after three simulated attacks.	-	-
11	2003	Jun	Southern Tyrrhenian Sea (Cape Rasocolmo)	32	Pair	The female fish was harpooned and the male began to swim around the boat, jumping and simulating attacks against this vessel. Fishermen, taking advantage from this situation, harpooned the male.	-	-
12	2004	Jul	Strait of Messina	42	Male	The harpooned fish turned around the supporting boat and then repeatedly hit this vessel by bill. Finally the specimen pierced the boat and broke down its bill.	X	-

13	2007	Jul	Strait of Messina	~ 40	-	The fish turned around the boat with aggressive and nervous movements and then attacked for two times, hitting the boat by bill. Finally the fish disappeared from the sea surface towards deeper waters.	-	-
14	2007	Jul	Strait of Messina	~ 30	Pair	The female fish was harpooned and the male began to swim around the boat, jumping and attacking this vessel. It beat the boat by bill and then disappeared from the sea surface towards deeper waters.	-	-
15**	2008	Jun	Strait of Messina (Reggio Calabria)	-	Pair	The female fish was harpooned and the male attacked the boat, beating it by bill. Then the male disappeared from the sea surface towards deeper waters.	-	-
16	2009	Jul	Southern Tyrrhenian Sea (Cape Milazzo)	-	Pair	The female fish was harpooned and the male attacked the boat. Fishermen, taking advantage from this situation, harpooned the male.	-	-
17	2010	Jun	Strait of Messina (Scilla)	80	Female	The fish turned around the boat with aggressive and nervous movements and then pierced the boat, but broking down its bill.	X	-
18	2010	Jul	Strait of Messina	30	Male	The fish survived and released after harpooning. It turned around the boat with aggressive swimming, simulating some attacks, and finally disappeared.	-	-
19	2011	Jun	Southern Tyrrhenian Sea (Cape Rasocolmo)	70 - 30	Pair	The female fish attacked the boat, but it was harpooned. The male tried to defend the female, remaining near to the boat and trying to attack it, but it was harpooned too.	-	-
20	2012	Jul	Strait of Messina	98	Female	The fish attacked and pierced the supporting boat after the harpooning, broking its bill into the target.	X	-
21	2013	Jun	Southern Tyrrhenian Sea (Aeolian Islands)	~ 120	Pair	The female continued to swim near the harpooned male during the catch phase. The pair decided to attack simultaneously the boat. When the male was caught, the female disappeared from the sea surface towards deeper waters.	-	-
22	2014	Jul	Strait of Messina	35	Pair	The female fish was harpooned and the male attacked the boat. Fishermen, taking advantage from this situation, harpooned the male.	-	-
23	2014	Jul	Strait of Messina	32	Pair	The female fish was harpooned and the male attacked the boat. Fishermen, taking advantage from this situation, harpooned the male.	-	-
24	2014	Jul	Strait of Messina	40	Female	When the fisherman sighted the swordfish the specimen with a rapid swimming movement attack the boat	-	-
25	2014	Jul	Strait of Messina	45	Pair	The female fish was harpooned and the male attacked the boat. Fishermen, taking advantage from this situation, harpooned the male.	-	-
26	2014	Jul	Strait of Messina	38	Female	When the fisherman sighted the fish, the specimen attacked the boat with rapid and aggressive swimming movements. Then it was harpooned.	-	-
27	2014	Jul	Strait of Messina	37	Male	When the fisherman sighted the fish, the specimen attacked the boat with rapid and aggressive swimming movements. Then it was harpooned.	-	-
28	2014	Jul	Strait of Messina	35	Male	When the fisherman sighted the fish, the specimen attacked the boat with rapid and aggressive swimming movements. Then it was harpooned.	-	-
29	2014	Jul	Strait of Messina	30	Male	The harpooned fish has turned around the boat and repeatedly (three times) has tried to attack this vessel, before death.	-	-

to catch additional specimens. In reversed situation, females usually do not defend males but escape.

Only the attack occurred in June 1973 remained unexplained. Differently from the others, which regarded harpooned specimens or cases in which a fish defended its mate, in this event, a mysterious object hit the boat hull while sailing, but no fish were noticed on the sea surface. When the boat landed, fishermen found a broken bill stuck into the hull, presumably belonging to a swordfish of about 70 kg. Is it possible that the swordfish had already lost its mate in a harpooning and attacked the boat similar to its first enemy? We cannot prove this hypothesis, but it is probable. Furthermore, what is the destiny of the specimens that escape the catch but break down their bill in an attack? Considering the high importance of the bill for swordfish, playing a significant role in feeding strategy and defense (SCOTT & TIBBO, 1968; STILLWELL & KOHLER, 1985; HABEGGER *et al.*, 2015), we can hypothesize that the loss of the bill can lead to premature death.

Several records of swordfish attacks were reported during 2014. Even if the historical memory may be lost during the years, this phenomenon can be partly explained by a recovery of the swordfish resources in the fishing area rather than a change in the fish behavior. Indeed, during the previous years, especially from 1999 to 2005, few pieces of attacks' evidence may be driven by the decrease of the swordfish resources in the study area related to the high fish pressure mainly due to driftnet fishing in all Mediterranean waters (ICCAT SCRS, 2013). The harpoon catches in the study area during 1999-2005 decreased too, and only after this period they showed a positive trend (DI NATALE *et al.*, 2005; ROMEO *et al.*, 2015). The implementation of the EC Regulation (n. 849/97, 1239/98 and n. 809/2007; ICCAT Rec. 03-04; GFCM Rec. 2005/3), which imposes limits on the swordfish fishing, probably has been showing its effect on the harpoon fishing activity since 2006, with an increase in both the mean fish size and the number of fish-pairs (ROMEO *et al.*, 2008, 2015).

Several documented records of swordfish attacks to humans, ships, submersibles and fishing boats mainly in ocean waters, were collected and described in a revision chapter by ELLIS (2013). In the Mediterranean Sea, swordfish aggressive behavior against fishing vessels was known from ancient times, as reported in a revision of Oppiano Cilice's epic (LAMPREDI, 1838). Moreover, SPALLANZANI (1776) described the harpoon fishing activity in the Strait of Messina, underlining the risk of swordfish aggressiveness during some harpoon catch procedures. A Sicilian newspaper published information on swordfish attack on a fishing boat, after harpooning (ILLUSTRAZIONE DEL POPOLO 1947). In the southern Tyrrhenian Sea (Milazzo), a swordfish attack to a human was reported in 1952 by a national newspaper (LA DOMENICA DEL CORRIERE, 1957). The published photo showed a swordfish injuring a fisherman's abdomen. The national newspaper "La Domenica del Corriere" illustrated two records of swordfish attacks on 21 September 1952 and 27 October 1957. Both attacks occurred in the Tyrrhenian Sea (Gulf of Milazzo and Gulf of Naples). In the first case, a swordfish injured a fisherman's abdomen, during fishing activity, whereas in the last case a large specimen (larger than 300 kg) impaled a fishing boat listing it on a side, lost its broken bill and then escaped. No other published data on swordfish attacks to humans or vessels seem to be collected in the Mediterranean Sea.

Differently from other areas where swordfish wreaked injuries to humans (GALBIS *et al.*, 2002; GOOI *et al.*, 2006; MENDONÇA-CARIDAD *et al.*, 2008; HADDAD *et al.*, 2009; GEORGIADOU *et al.*, 2010), results of the present paper highlighted no direct damages to fishermen. In most cases, studies regarded medical aspects of injuries to humans, without reporting additional information on the context of these accidents, even if in some case fishermen were involved (HADDAD *et al.*, 2009; GALBIS *et al.*, 2002; MENDONÇA-CARIDAD *et al.*, 2008). The testimony of harpoon fishermen highlighted in all attacks a clear choice of target, aggressive use of bill toward the vessel, since the fish seems to recognize the boat as the main cause of disturb and/or mate death (in a case of

a pair). Although the attacks described in this paper were always caused by a defensive behavior, it is still unclear if the fish actually perceives people or a boat as a threat. The reasons for several attacks to boats or humans, reported in the literature, are still unexplained and swordfish was apparently unprovoked (ELLIS, 2013).

CONCLUSIONS

The present paper underlines the capacity of the swordfish in defending its mate and generally, it does not represent a serious danger to humans, however, we cannot exclude a potential risk to fishermen targeting swordfish. It is also true that the experience of harpoon fishermen of the study area plays an important role in avoiding any injuries or damages to humans. Fishermen greatly respect their prey and fear its sword. In particular, when fishermen operate on a supporting boat (a small vessel which in some cases is used to recover the harpooned fish while the main vessel continues fishing), they carefully monitor swimming and behavior

of the harpooned fish and when they suspect of an attack, they jump on the boat seats avoiding to be hit by the sword pierced into the hull.

An improved understanding of the behavior, distribution and ecological role of the Mediterranean swordfish is important, not only to preserve the stock but also to mitigate potential risk for public safety, as also reported in a recent study on conservation and public safety regarding other large marine predators (FERRETTI *et al.*, 2015).

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Nedavni zapisi napada igluna na ribarske brodice u vodama oko Sicilije (Sredozemno more)

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SAŽETAK

Razmatrani su nedavni napadi igluna na ribarske brodice iz sicilijanske flote te je opisan poseban obrazac ponašanja koji su ove ribe imale kada su se približavale ribarima.

Informacije su prikupljane u razdoblju između 1999. i 2014. u vodama oko Sicilije (Sredozemno more) kroz razgovore s ribarima koji love harpunima i kroz izravna promatranja tijekom istraživanja. Također smo izvijestili i o drugim slučajevima napada koji su se dogodili prijašnjih godina. Sveukupno je zabilježeno 29 slučajeva agresivnog ponašanja igluna naspram ribarskih plovila. Igluni su uglavnom napadali kada bi ih se izazvalo ili kad bi htjeli obraniti svog para, te su, u nekoliko slučajeva pokušali probosti brod sabljom. Neki su napadi završili materijalnom štetom na meti dok ozljeđivanja ljudi nisu zabilježena.

Ključne riječi: *Xiphias gladius*, ponašanje, napad, rizik za ljude, lov harpunima, Sredozemno more