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AN ATLANTIC BLUE MARLIN, *MAKAIRA NIGRICANS*, IMPALED BY TWO SPECIES OF BILLFISHES (TELEOSTEI: ISTIOPHORIDAE)

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Billfishes (Istiophoridae and Xiphiidae) are notorious for driving their rostra into animate and inanimate objects, a behavior usually resulting in transverse fracture of the bill and leaving the distal segment embedded (Gudger, 1940; Frazier et al., 1994). Some billfishes recover from this loss because there are records of apparently healthy fish with missing rostra (Frazier et al., 1994). Generally only one rostral fragment is found in each object, but multiple stabbings have been reported. For example, fragments of three swordfish bills were discovered in a whale during flensing (Jonsgard, 1962), several "marlin" spears were found impaled in bales of rubber that were floating at sea (Smith, 1956), and two istiophorid rostra were identified in the timber of a vessel that was brought in for repair (Gudger, 1940; Fierstine and Crimmen, 1996). The following is a detailed account of a large Atlantic blue marlin with two rostral fragments embedded in its head and is the first record of a fish with multiple wounds. I briefly discuss whether impalement was the result of a predator-prey interaction, if embedded rostra aid in understanding migration patterns in both prey and predator, and the effect of impalement on a predator.

Materials and Methods

Rostral fragments are identified using the methodology and terminology of Fierstine and Voigt (1996) and Fierstine and Crimmen (1996). Because all bills in this study were distal segments, measurements and ratios were compared with values in Table 1 of Fierstine and Voigt (1996) at one-fourth bill length (0.25L, or one-fourth the distance between the tip and the orbital margin of the lateral ethmoid bone). A combination of the scientific and common names of Nakamura (1985) and the American Fisheries Society (1991) are used. Institutional abbreviations are: IGFA is symbolic code for the collections of the International Game Fish Association, Pompano Beach, FL, and LACM for the Natural History Museum of Los Angeles County, Los Angeles, CA.

The IGFA received an all-tackle record application for a 789.7 kg black marlin (*Makaira indica*), later reidentified by C. R. Robins (pers. comm.) as an Atlantic blue marlin (*M. nigricans*), caught July 25, 1993 off Algarve, Portugal. Two rostral fragments accompanied the application, one (Fig. 1A) was found embedded in the nape (IGFA 1) and the other (Fig. 1B) was found impaled in the lower jaw (IGFA 2) of the large marlin. Unable to verify the weight and conditions of capture, the IGFA denied the application. The two bill fragments are housed in IGFA's permanent collection.

Results and Discussion

The distal tip of rostral fragment IGFA 1 (Table 1; Fig. 1A) is worn secondarily into a new point. Denticles cover the entire dorsal, lateral, and ventral surfaces of the fragment and barnacles are attached to the exposed (posterior) end. Measurements and cross section were made 90 mm from the distal tip to approximate the position of 0.25L (Table 1). Fragment IGFA 1 is probably from a white marlin (*Tetrapturus albidus*) or, less likely a striped marlin (*T. audax*) for the following reasons: (1) Ratio D/W of IGFA 1 (Table 1) is

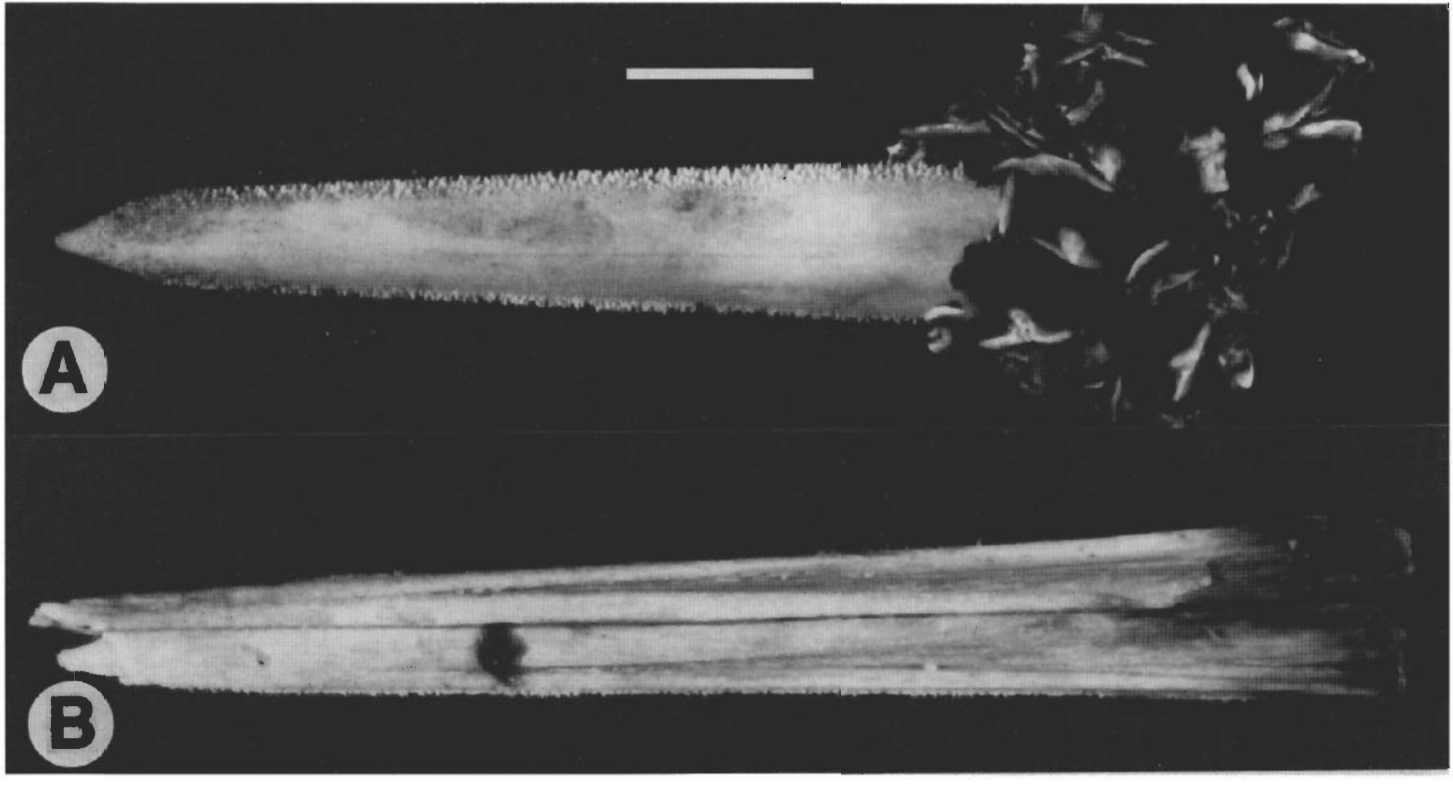

Figure 1. Rostral fragments found impaled in the head of a female *Makaira nigricans*, 789.7 kg, caught off Algarve, Portugal. A. Rostrum (IGFA 1), dorsal view, removed from nape. Note barnacles attached to its proximal end. B. Rostrum (IGFA 2), dorsal view, removed from right lower jaw. Scale = 2 cm for both rostra.

Table 1. Measurements and ratios of two rostra (IGFA 1 and 2) found impaled in a specimen of *Makaira nigricans*.

Catalog number of rostrum	Measurements (mm)					Ratios		
	Length	Width (W)	Depth (D)	Height of nutrient canals (H)	Distance of nutrient canals from dorsum (DD)	D/W	H/D	DD/D
IGFA 1	125	18.3	9.3	1.0	4.1	0.51	0.11	0.44
IGFA 2	142	12.5	8.0	0.9	4.0	0.64	0.11	0.50

only within the range of values of *T. albidus*, but just outside the range of values of *T. audax*. (2) Ratio DD/D (Table 1) is within the range of values of *T. audax* and some other istiophorids, but just outside the range of values of *T. albidus*. (3) Only *Istiophorus platypterus* (sailfish), *T. albidus* and *T. audax* have an extensive covering of denticles on the dorsal surface of the rostrum. (4) The geographic ranges of *T. albidus* and *M. nigricans* have extensive overlap in the Atlantic Ocean, whereas the geographic ranges of *T. audax* and *M. nigricans* have a small area of overlap (see discussion below).

The distal tip of rostral fragment IGFA 2 (Table 1; Fig. 1B) is missing and may have broken on impact. Denticles cover the lateral and all of the ventral, except midventral, surfaces and are absent on the dorsal surface of the fragment. Measurements and cross section were made 44 mm from the distal tip to approximate 0.25L (Table 1). Fragment IGFA 2 is probably from a longbill spearfish (*T. pfluegeri*), but the Mediterranean spearfish (*T. belone*) was not excluded as a possible candidate. The rare roundscale spearfish (*T. georgei*) was not compared with the bill fragment because its morphology is unknown. The rationale for identification is as follows: (1) Only *T. angustirostris* (shortbill spearfish), *T. pfluegeri* and *T. belone* lack denticles on the dorsal and mid-ventral surfaces of the rostrum. (2) The distance from the anterior extension of the prenasal bone to the distal tip of the rostrum (P) in specimens of *T. angustirostris* studied by Fierstine and Voigt (1996) ranges from 19.8-30.6 mm, values that are considerably less than 87 mm, the estimated length of P in IGFA 2. Therefore, IGFA 2 does not belong to *T. angustirostris*. (3) *Tetrapturus belone* and *M. nigricans* do not have overlapping geographic ranges; the former is restricted to the Mediterranean Sea and the latter is not known to enter the Mediterranean Sea (Nakamura, 1985).

If rostral fragment IGFA 1 was from *T. albidus*, it would be similar in size and weight to LACM 25503 (174.0 cm body length and 27 kg). However, if it was from *T. audax*, it would be similar in size and weight to LACM 25498 (212.1 cm body length and 66.8 kg). Both *T. albidus* and *T. audax* of these sizes would be mature fish (Mather et al., 1975; Strasburg, 1969). Assuming fragment IGFA 2 is from *T. pfluegeri*, then it is similar in size to LACM 25461 (169.0 cm body length, weight unknown). According to Robins (1975), longbill spearfish of this length probably would be 2-yr old adult, and weigh approximately 18 kg.

Major (1981) suggested that rostra found in whales could act as natural tags for recording their migration patterns. Unfortunately, the uncertain identification of the rostra, especially IGFA 1, weakens any attempt to use the rostra to determine the migration pattern of the blue marlin. If IGFA 1 is from a white marlin, spearing only could have occurred in the Atlantic Ocean where the geographic distribution of both blue marlin and

white marlin overlap (Nakamura, 1985). If IGFA 1 is from a striped marlin, impalement could have occurred in the eastern South Atlantic, Indian or Pacific oceans where blue marlin and striped marlin have overlapping ranges. However, striped marlin are only occasional visitors into the Atlantic Ocean (Nakamura, 1985) and only one blue marlin is known to have made a migration from the Atlantic into the Indian Ocean (Nettles et al., 1994). IGFA 2 impaled the blue marlin in the Atlantic Ocean because longbill spearfish only occur in the Atlantic Ocean (Nakamura, 1985).

Blue marlin are opportunistic predators feeding often on scombrids and sometimes on istiophorids (Brock, 1984). Large blue marlin are known to consume prey as large as 50 kg (Rivas, 1975). Since IGFA 1 and IGFA 2 were probably within the size range of prey consumed by large blue marlin, then both spearings probably occurred as the result of a defensive response during a predatory act.

We know little about the effect of impalement on predators. Poisonous spines do not seem to deter the great hammerhead (*Sphyrna mokarran*) from feeding on catfish and stingrays (Compagno, 1984), and there is no evidence in the case presented here or in the literature that predators learn to avoid billfish after being speared. Therefore, if predators continue to feed on billfish in spite of the danger of injury, why aren't more of them found with stab wounds? Perhaps impalements are underrecorded. If a billfish withdraws it rostrum after stabbing or slashing a predator and the act was not directly observed, the resulting wound might be erroneously explained by some other behavior. If impaled bill fragments are not visible externally, then they could be easily overlooked. For example, a shortfin mako (*Isurus oxyrinchus*) was filleted and found to have an istiophorid rostrum embedded in its vertebral column, yet there was no visible wound on the skin (Fierstine, Cailliet and Neer, unpubl.). If a pelagic predator has a vital organ pierced by a rostrum and dies or becomes severely injured, it might be consumed by other predators or sink before it was discovered. However, not all injuries are life threatening. Cliff et al. (1990) captured a shortfin mako with a sailfish rostrum embedded in its left orbit. Since the shark was underweight for its length, they believed that the eye injury affected the shark's ability to capture food. In this study the Atlantic blue marlin apparently remained healthy in spite of two wounds and grew to its enormous size because no vital organ was pierced.

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