

FIRST RECORD OF A BASKING SHARK *Cetorhinus maximus* (Gunnerus, 1765)
IN THE BRAZILIAN ATLANTIC

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SYNOPSIS

The capture on November 19, 1970, of a juvenile female of the Basking Shark *Cetorhinus maximus* (Gunnerus, 1765), 438 cm long, is the first record of this species in the Brazilian Atlantic, at about 24°00' to 24°10' Lat. S, and 45°35' to 45°15' Long. W. The teeth are mostly in three, sometimes two or four, functional series. Vertebral numbers and characteristics: Precaudal - 53; Caudal - 56; Total - 109; Monospondylous - 37; A-values - 167; B-values - 82 (*sensu* Springer & Garrick, 1964). The gill rakers are well developed and brilliant black.

INTRODUCTION

On May 3, 1971 I received a frozen shark for study from the CONFRIO - Companhia Nacional de Frigoríficos, São Sebastião, SP. The specimen had been eviscerated and partly damaged. According to the accompanying information of the fishing company the shark had been caught on November 19, 1970, by the shrimp-trawler "CONFRIO IV" while fishing with a trawl-net, near the Alcatrazes Island (about 24°00' to 24°10' Lat. S; 45°35' to 45°45' Long. W) at ca. 35 to 50 m depth. Table I shows the temperatures recorded for this area. The shark was taken out of the trawl without any resistance.

TABLE I - Temperature data from the region near Alcatrazes Island

Date	Ship	Station (nº)	Position	Temperature (°C)	
				Surface	Bottom
11/10/70	Emília	4	24°10'S 46°20'W	20.65	15.39 (25 m)
		5*	24°18'S 46°15'W	21.17	14.95 (35 m)
		6*	24°26'S 46°11'W	21.21	14.86 (47 m)
11/11/70		7	24°28'S 46°28'W	21.40	15.84 (38 m)
		8	24°36'S 46°42'W	21.10	16.24 (37 m)
		9	24°29'S 46°46'W	21.36	17.90 (27 m)
12/04/70	Prof.W.Besnard	1269	23°34'S 44°57'W	22.08	20.55 (35 m)
		1270	23°54'S 44°54'W	23.09	16.70 (60 m)
		1271	24°13'S 44°51'W	23.49	15.60 (85 m)
12/05/70		1272	24°38'S 44°48'W	22.82	15.70 (130 m)
		1273	25°03'S 44°45'W	23.12	14.88 (235 m)
		1274	25°26'S 45°35'W	22.51	12.40 (120 m)
		1275	24°47'S 45°34'W	23.11	15.51 (75 m)
		1276	24°27'S 45°46'W	23.00	17.97 (60 m)
		1277*	24°07'S 46°51'W	23.45	21.49 (35 m)

* : Stations nearer Alcatrazes Island.

Note: Data kindly supplied by Dr. Luiz Bruner de Miranda and Motonaga Iwai, respectively from the Divisions of Physical Oceanography and Biological Oceanography, Instituto Oceanográfico.

DESCRIPTION

The specimen, a juvenile female 438 cm in total length (*sensu* Sadowsky, 1968), can be defined as a Basking Shark *Cetorhinus maximus* (Gunnerus, 1765), because of its very large gill slits, beginning at dorsal surface and extending nearly to midline of throat, provided with long bristly rakers arranged to form comblike sieves on the arches, its minute and numerous teeth, and its peculiar tip to the snout. The long, horny and flexible rakers (strainers - Garman, 1913, p. 40), important components of the feeding mechanism of Basking Sharks, were fully developed.

Their lengths were 52 to 65 mm in the middle of the branchial arch, and at least 16 mm on the extremities. I counted 17-19 rakers on 10 mm length of an arch. Their colour was brilliant black (Fig. 1).

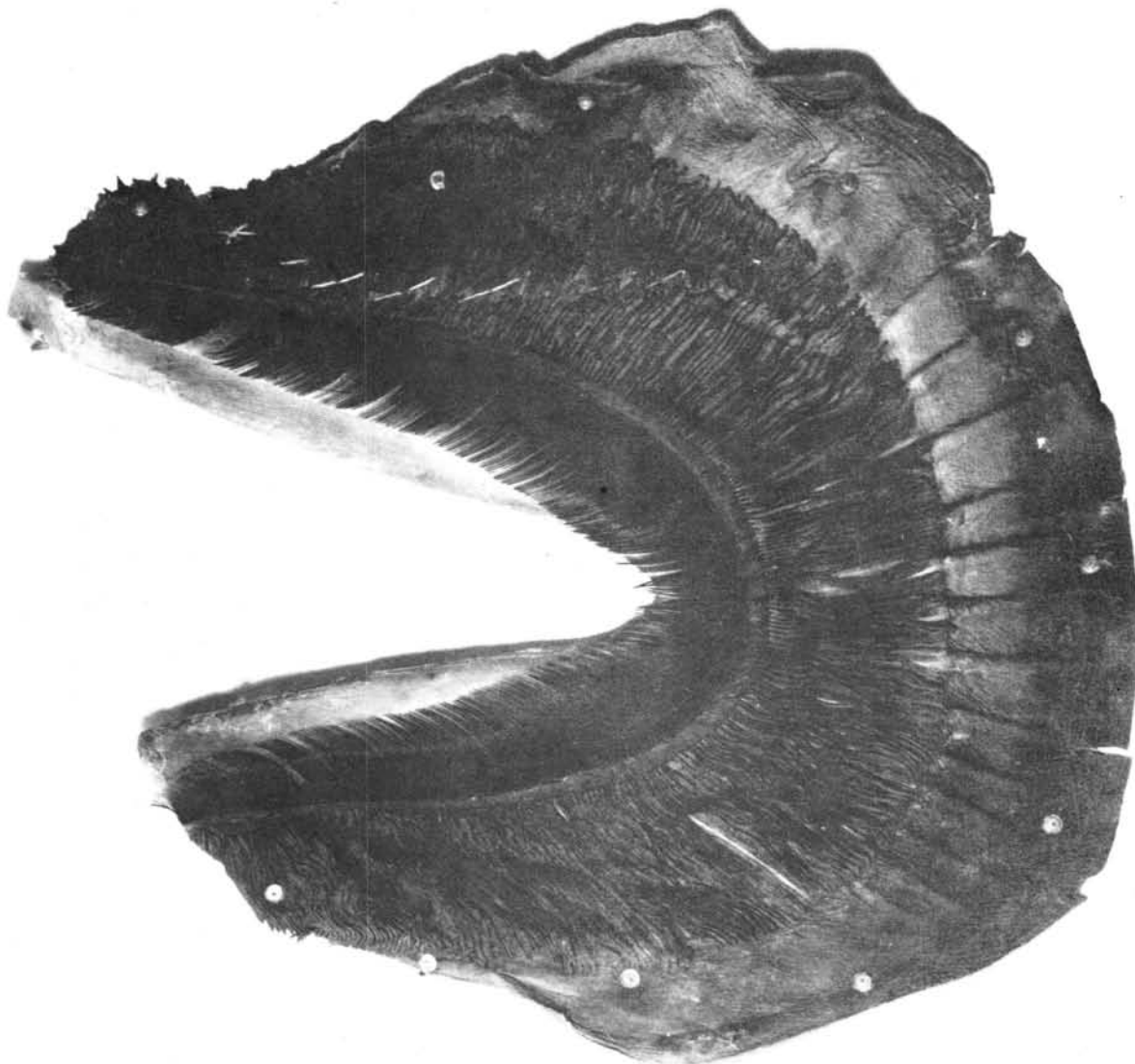


FIG. 1 - Branchial bar of Basking Shark. Upper side: gill rakers (organ of feeding); Lower side: primary lamellae (organ of respiration). (Terminology after Gans & Persons, 1964, p. 31). Photo: Rolando Carneiro.

The subconical teeth are smooth-edged and curved. They are small, generally 2.5 to 3.8 mm high, and distributed in three, sometimes two or four, functional series. One supplementary series is formed of much smaller teeth, about 1 mm high. Towards the end of the jaw the numbers decrease to two series of teeth, only 2.0-1.5 mm high. In the lower jaw there is a parasymphysal space 20 mm wide without teeth. As several teeth had been removed after capture, the dental formula can only be given approximately, and is: Upper jaw - 100-11 = 13-116; Lower jaw - 117-124.

The counts of vertebrae and measurements of their dimensions were taken from the cleaned skeleton of the shark.

Table II compares the few and incomplete data on the characters of the vertebral column of the Basking Sharks with these measured here.

TABLE II

Author	Date	Vertebrae					
		P.	C.	T.	M.	A	B
1. Pavesi	1874 Mediterranean	-	-	100	-	-	-
2. Pavesi	1878 Mediterranean	53	32	85	-	-	-
3. Siccardi	1960 Argentina	51	56	107	-	-	-
4. Springer & Garrick	1964 Brit. Columbia	50	60	110	-	-	-
5. Springer & Garrick	1964 California	-	-	110	-	-	-
6. Sadowsky	1971 Brazil	53	56	109	37	167	82

Definition of the terms and measurements used in the sense of Springer & Garrick (1964, p. 75-79):

Vertebral characters:

- P. - precaudal vertebrae;
- C. - caudal vertebrae;
- T. - total of vertebrae;
- M. - monospondylous vertebrae;
- A-values - length of penultimate monospondylous centrum divided by length of 1st diplospondylous centrum, multiplied by 100;
- B-values - length of penultimate monospondylous centrum divided by its width, multiplied by 100.

The vertebrae of the Basking Shark are of a modified asterospondylic type after White (1937, pl. 39, E).

The measurements were taken immediately after the dissection of the shark; this is important to state, as after 30 days of drying in the open air the skeleton had suffered a strong shrinkage and the length of each vertebra diminished by an average of 3-4 mm. The vertebral column was very poorly calcified; the intervertebral ligaments were 3 to 17 mm in width. The largest spaces were found between the trunk vertebrae 13 to 25.

DISCUSSION

Basking Sharks are usually considered to belong to a single species (Garman, 1913, and many others), but possibly more than one species exists, as the specific relationship between the Pacific, South Atlantic and North Atlantic forms of this shark is not clear. A definitive decision must be based upon the critical comparison of specimens from the different geographical areas (Bigelow & Schroeder, 1948, p. 147).

In her publication Siccardi (1960) distinguished four subspecies (p. 84) or species (p. 95): *Cetorhinus maximus* (Gunnerus) from the North Atlantic, *C. rostratus* (Macri) from the Mediterranean, *C. maccoyi* Barrat, from Australia, and *C. normani* Siccardi, from the Southwestern Atlantic.

As her suggestion has not as yet been considered in the newer ichthyological publications (Garrick & Schultz, 1963; Stead, 1963; Smith, 1965; Kate et al., 1968; Blache et al., 1970; Lineaweaver & Backus, 1970; Maximov, 1970; Budker, 1971; Parin, 1971; Collignon & Aloncle, 1972), and as the specific characters of the specimen examined here do not correspond exclusively to one of Siccardi's proposed species, I consider it as belonging to *Cetorhinus maximus*.

The distribution of the Basking Sharks is antitropical and bipolar (Bigelow & Schroeder, 1953, p. 36; Berg, 1953, p. 24), limited to the temperate waters of the northern and southern hemispheres in the areas enclosed between the average yearly isotherms 6 and 20°C (Siccardi, 1960, p. 1) or 0 to 20°C (Engelhardt, 1913, p. 37).

However, two cases of capture of Basking Sharks were reported from the coast of Senegal, near Dakar, about 14° N, which corresponds to the inter-tropical zone of the Eastern Atlantic. These two animals were juveniles of 425 and 337 cm length (Cadenat, 1950, p. 87; 1962, p. 310) and the surface temperature was 20°C on the day of capture of the second specimen. The occurrence of the species in this area may be explained in view of the abundance of Basking Sharks on the coasts of Morocco (Furnestin et al., 1958, p. 387-388) and the existence of the cold Canary current flowing south along the coast of Africa, which periodically reaches the region of Dakar producing a decrease of the temperature to a level tolerated by the species. At the same time this current permits a rapid development of the planktonic organisms as food for these sharks. In the Southeastern Atlantic, in the area of the penetration of the

cold Benguella current in the subtropical zone, in spite of the existence of dense concentrations of plankton (Hart & Currie, 1960) the occurrence of the Basking Shark has not been indicated. This might as well be due to the absence of the species, or perhaps, which is even more probable, to the absence of the respective records.

In the Western South Atlantic Basking Sharks have been reported only between the Latitudes about 52 and 34°, near the Falkland Islands (Norman, 1937, p. 7), in Argentinean waters (Lahille, 1928, p. 325; Siccardi, 1960, p. 65-73), and in Uruguay (De Buen, 1950, p. 58). The specimen caught in Brazil, at 24°, probably came from this region, and its northward migration might have been favoured by the cold Falkland's current.

In the tropical zone of the Pacific Ocean the occurrence of Basking Sharks was recorded from the Galapagos Islands and from Ecuador waters (Gudger, 1934; Fowler, 1929; Stevenson, 1902, cited from Orces, 1952, p. 89). In these cases an influx of the cold water of the Peru current into the low latitudes of the hemisphere favoured the penetration of this shark into the equatorial zone.

Another indication of the occurrence of *C. maximus* in the same zone (05°02' Lat. S; 154°06' Long. W) was inferred from the finding of a non-fossilized tooth of this species on the floor of an abyssal basin (Belyaev & Glikman, 1970, p. 265). The origin of this specimen could be from either the northern hemisphere, via the southerly California current running down the west coast of North America, or from the southern hemisphere, even though the place at which the tooth was found (Malden Island region) is located very far from the cold current running northwards along the coast of Peru.

The records from the Atlantic, as well as from the Pacific, in my opinion make it rather doubtful that the bipolar distribution of the Basking Sharks corresponds to a complete isolation of the populations of both hemispheres. Moreover I do not think it probable that the tropical belt, which is narrowed by the entrance of water from cold currents, represents an insurmountable obstacle for a shark of the size of *Cetorhinus maximus* which could have transgressed the tropics by deep water isothermal route (Hubbs, 1952).

As the Basking Sharks are generally caught in the upper water layers where the plankton is most concentrated (Tempelman, 1963, p. 11; Backus, 1960, p. 244), the capture of our specimen in a shrimp-trawl at a depth of 35-50 m is exceptional. Possibly this is due to the conditions of the water at the place and time of fishing. For the water temperatures of the area see Table I.

Due to the damaged state in which the animal was received for study it was impossible to take the morphometrical measurements for comparative considerations. However, the caudal fin was sufficiently preserved to allow for the statement that its shape is not like that figured by Siccardi (1960, p. 85) referring to *C. maximus normani* (fig. 12, b) but like *C. maximus maximus* (fig. 12, a) from the Northern Atlantic with the difference that the breadth of the inferior lobe relative to that of the tail is dissimilar. In this respect the

Brazilian specimen is more similar to the figure of the South African Basking Shark given by Smith (1965, p. 47). The gill rakers of the present specimen were well developed. This fact should, according to the suggestion of Parker & Boeseman (1954, p. 192), indicate that the shark at the time of capture was in an active feeding stage.

In the North Atlantic area Basking Sharks have been found which had no gill rakers developed (Deinse & Adriani, 1953; Schnakenbeck, 1955; and others). These cases were difficult to interpret, since these organs had been considered as an essential component of the feeding mechanism of the species. The explanation found was either that the animals were juvenile; the largest given length of gill raker-less Basking Sharks is 390 cm (Schnakenbeck, 1955, p. 101), or that the gill rakers are periodically shed and replaced (Parker & Boeseman, op. cit., p. 192). The latter authors ponder that the phenomenon is due to seasonal changes in the medium. When in the beginning of the winter the planktonic food concentration in the sea diminishes, the Basking Sharks lose their rakers and undergo a resting, non-feeding, demersal stage during which a new set of rakers is developed, till the feeding conditions turn better at the end of the winter.

Differing from Siccardi's report (1960, p. 72) is the colour of the gill rakers, described as brown, while in our specimen they are a brilliant black. Whereas Siccardi counted an average of 15 gill rakers to one centimeter of gill arch, in ours there are 17-19.

The number of three (sometimes two or four) series of functional teeth comes closer to the populations reported for the Southern Atlantic (2-5) or Western North Pacific (3-4) according to Chen (1963, p. 38), than that for the Northern Atlantic (4-7), according to Bigelow & Schroeder (1948, p. 150), and 4-9, according to Tortonese (1956, p. 116). This detail may be explained by Siccardi's observations (op. cit., p. 86) according to which the number of series of teeth increases proportionally to the age of the individual. Thus one can suppose that the supplementary series of small teeth found in the studied shark was still in a growing phase, so that later four functional series might be developed, which number is also recorded for Basking Sharks from the Northern Atlantic.

The shape of the teeth shows certain variations depending upon the place they occupy in the jaw (Müller & Henle, 1841, p. 72). It is remarkable that the upper surface of the crowns is more like that of the teeth of the young specimen caught in Argentina (Siccardi, op. cit., p. 69, fig. 2), as they are generally less flattened than those of the adult shark from the Northern Atlantic (Bigelow & Schroeder, op. cit., p. 148, fig. 26). In the present specimen I did not find teeth with bases widened as triangles, as in those illustrated by Barnard (1937, pl. 7) referring to an adult shark from South African waters. This fact allows us to suppose that not only the number but also the shape of the teeth might be subject to variations related to the age of the Basking Sharks.

According to Table II the comparison of the characters of the vertebral columns of the Basking Sharks coming from different geographic areas allows for the statement that in all four cases where the number of precaudal vertebrae was registered, it is uniform, that is, 50 for British Columbia, 51 for Argentina, and 53 for the Mediterranean and Brazil. For the caudal vertebrae the variations is greater: 60 for British Columbia, 56 for Brazil and Argentina, and only 32 for the Mediterranean. This last number appears too small to be characteristic for the population of an area. The total number, given in 6 cases, is 85 to 100 for the Mediterranean, 107 for Argentina, 109 for Brazil, and 110-110 for British Columbia and California (USA).

There are no comparative data for the number of monospondylous vertebrae and for the values of the relations of *A* and *B*, which Springer & Garrick (1964) have introduced for the modern taxometry of sharks.

The above comparisons are weakened by the scarceness of the available data. However, their results do not indicate clear diversities of the skeletal characters of the Basking Sharks.

Only the Mediterranean specimens are separable by the number of their caudal vertebrae. But, as these data are very old, there exists the possibility that they were obtained by different methods of counting.

The studied skeleton is kept in the collection of the Research Base of the Oceanographic Institute of the University of São Paulo, at Cananéia.

RESUMO

A captura, em 19 de novembro de 1970, entre aproximadamente 24°00' e 24°10' Lat. S, e 45°35' e 45°45' Long. W, de uma fêmea jovem de "Basking Shark" *Cetorhinus maximus* (Gunnerus, 1765), com 438 cm de comprimento, é o primeiro registro dessa espécie no Atlântico brasileiro.

Os dentes apresentam-se, na maioria, dispostos em 3 e, às vezes, também em 2 ou 4 séries funcionais. Características e números das vértebras: Pré-caudais - 53; Caudais - 56; Total - 109; Monospondilas - 37; Valores *A* - 167; Valores *B* - 82 (*sensu* Springer & Garrick, 1964). Os rastros branquiais acham-se bem desenvolvidos e são de um colorido negro brilhante.

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REFERENCES

- BACKUS, R. 1960. Notes on western North Atlantic sharks, N^o 2. *Copeia*, (3):243-245.
- BARNARD, K. 1937. Further notes on South African marine fishes. *Ann. S. Afr. Mus.*, 32:41-67.
- BELYAEV, G.M. & GLIKMAN, L.S. 1970. The teeth of sharks on the floor of the Pacific Ocean. *Trans. P. Shirshov Inst. Oceanology Akad. Nauk., SSSR*, 88:252-276. (In Russian).
- BERG, L. 1953. Bipolar distribution of the organisms and the glacial epoch. *Otsherki po obshtshim voprosam Ichtiologii. Akad. Nauk Leningrad*, 318 p.
- BIGELOW, H.B. & SCHROEDER, W.C. 1948. *Sharks. Fishes of the western North Atlantic.* New Haven, Sears Foundation, I, 576 p.
- 1953. *Fishes of the Gulf of Maine.* *Fishery Bull. Fish. Wildl. Serv. U.S.*, 74(53), 577 p.
- BLACHE, J., CADENAT, J. & STAUCH, A. 1970. Clés de détermination des poissons de mer signalés dans l'Atlantique orientale. *Faune Tropicale*, 8. Paris, ORSTOM, 479 p.
- BUDKER, P. 1971. *The life of sharks.* London, Weidenfeld & Nicholson, 222 p.
- BUEN, F. de 1950. El mar de Solis y su fauna de peces. 2^a parte. La fauna de peces del Uruguay. *Publnes cient. Serv. oceanogr. Pesca, Montev.*, (2):47-144.
- CADENAT, J. 1950. *Poissons de mer du Sénégal.* Dakar, IFAN, 345 p.
- 1962. Notes d'ichtyologie ouest-africaine, 37. Sur quelques espèces nouvelles ou peu communes de la côte occidentale d'Afrique. *Bull. Inst. fr. Afr. noire., sér. A*, 24(1):305-312.
- CHEN, J. 1963. A review of the sharks of Taiwan. *Biol. Bull., Thungai Univ.*, 19:1-102.
- DEINSE, A. van & ADRIANI, M. 1953. On the absence of gill rakers in specimens of the Basking sharks, *Cetorhinus maximus* (Gunner). *Zool. Meded., Leiden*, 31(27):307-310.
- ENGELHARDT, R. 1913. *Monographie der Selachier der Münchener Staatssammlung: Teil I: Tiergeographie der Selachier.* *Abh. bayer Akad. Wiss. München (m.-n. Kl.)*, Suppl. 4(3), 110 p.
- GANS, C. & PARSENS, Th. 1964. *A photographic atlas of shark anatomy.* New York, Academic Press, 161 p.
- GARMAN, S. 1913. *Plagiostomia (Sharks, skates and rays).* *Mem. Mus. comp. Zool. Harv.*, 36, 315 p.
- GARRICK, J. & SCHULTZ, L. 1963. A guide to the kinds of potentially dangerous sharks. *In: Gilbert, P.W., ed. Sharks and survival.* Boston, D.C. Heath, p. 3-60.
- HART, T. & CURRIE, R. 1960. The Benguela Current. *Discovery Rep.*, 31: 123-298.
- HUBBS, C. 1952. Antitropical distribution of fishes and other organisms. *Proc. 7th Pacif. Sci. Congr.*, 3:1-6.

- KATE, S., SPRINGER, S. & WAGNER, M. 1968. Field guide to eastern Pacific and Hawaiian sharks. Fish. Wildl. Serv. U.S. Circ. 271, 47 p.
- LAHILLE, F. 1928. Notas sobre unos peces elasmobranquios. An. Mus. argent. Cienc. nat., 34:299-239.
- LINEAWEAVER III, T.H. & BACKUS, R.H. 1970. The natural history of sharks. London, André Deutsch, 256 p.
- MAXIMOV, W. 1970. Field guide to Atlantic Ocean sharks. Atl. Res. Inst. mar. Fisher. Oceanography (Atlant-Niro) Kaliningrad, 146 p. (In Russian).
- NORMAN, J. 1937. Coast fishes. Part II. The Patagonian region. Discovery Rep., 16, 150 p.
- ORCES, G. 1952. Observaciones sobre los elasmobranquios del Ecuador. Revta Biol. mar., 5(1/3):85-110.
- PARIN, J. 1971. Chriashtshovyye ryby (Class Chondrichthyes). In: Shyzn Shyvotnych, 4(1):27-655. Moscow, Prosve-shtshenie. (In Russian).
- PARKER, H. & BOESEMAN, M. 1954. The Basking shark, *Cetorhinus maximus*, in winter. Proc. zool. Soc. London, 124(1):185-195.
- PAVESI, P. 1874. Contribuizione alla storia naturale del genere Selachi. Annali Mus. civ. Stor. nat. Giacomo Doria, 6:5-72.
- 1878. Seconda contribuzione alla morfologia e sistematica dei Selachi. Annali Mus. civ. Stor. nat. Giacomo Doria, 12:348-418.
- SADOWSKY, V. 1968. On the measurement of the total length of sharks. Zool. Anz., 181(343):197-199.
- SCHNAKENBECK, W. 1955. Der Kiemenreusenapparat von Riesenhai (*Cetorhinus maximus*). Zool. Anz., 154(5/6):99-108.
- SICCARDI, E.M. 1960. "Cetorhinus" en el Atlantico sur (Elasmobranchii: Cetorhinidae). Revta Mus. argent. Cienc. nat. Bernardino Rivadavia. Inst. nac. Invest. Cienc. nat. Cienc. zool., 6(2):61-101.
- SMITH, J.L.B. 1965. The sea fishes of Southern Africa. Rev. ed. Capetown, Central News Agency, 580 p.
- SPRINGER, V. & GARRICK, J. 1964. A survey of vertebral numbers in sharks. Proc. U.S. natn Mus., 116(3496):73-96.
- STEAD, D. 1963. Sharks and rays of Australian seas. Sydney, Angus & Ribertson, 211 p.
- TEMPELMAN, W. 1963. Distribution of sharks in the Canadian Atlantic. Bull. Fish. Res. Bd Can., (140), 77 p.
- TORTONESE, E. 1956. Leptocardia, Ciclostomata, Selachii. Fauna Ital., 2, 332 p.
- WHITE, E.G. 1937. Interrelationships of the elasmobranchs with a key to the Order Galea. Bull. Amer. Mus. nat. Hist., 74:25-118.