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SHARKS
OF THE
GENUS **ISURUS** RAFINESQUE, 1810,

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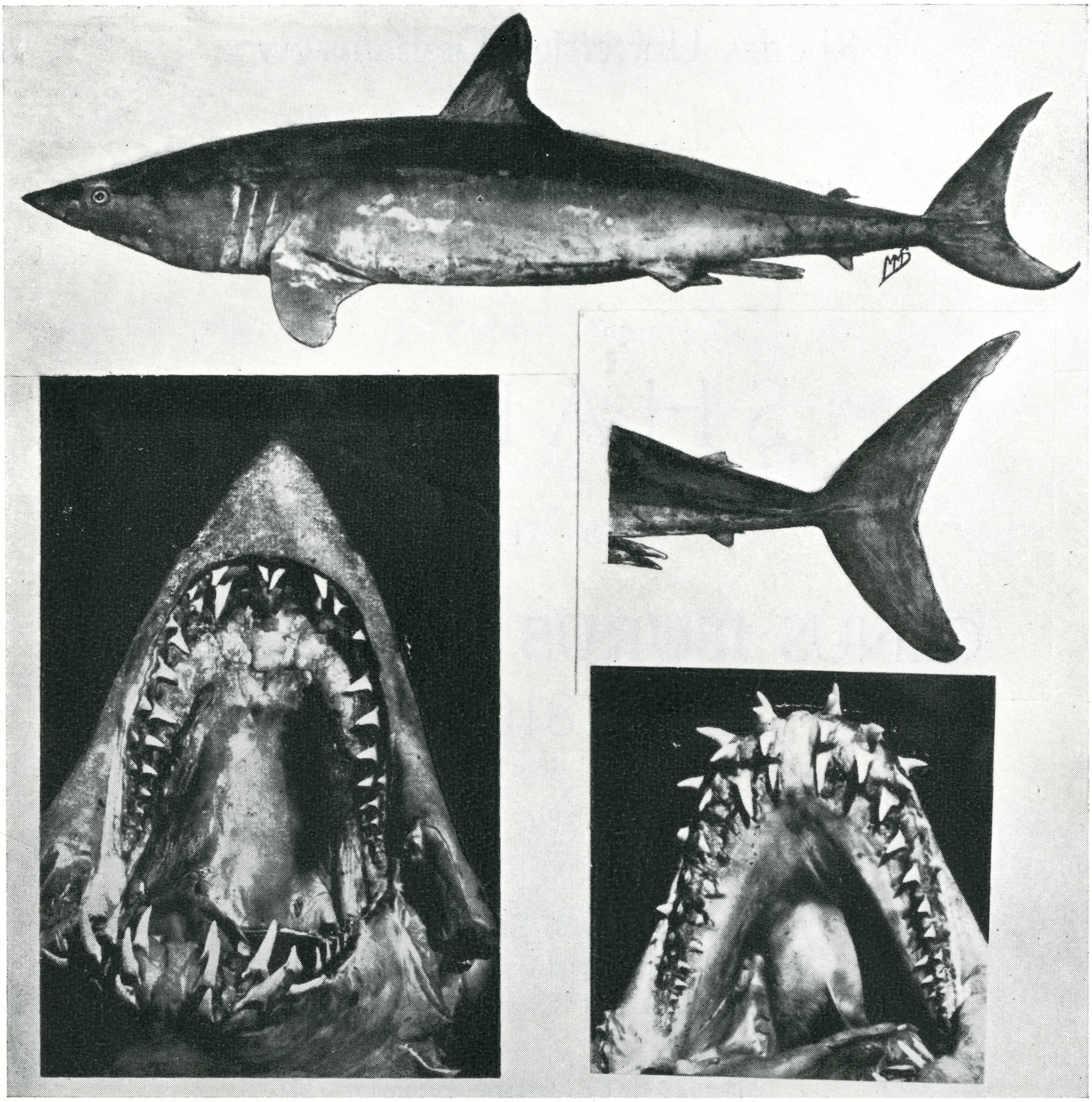

PLATE I.

Above: **Isurus tigris** Atwood, total length 2540 mm., from Algoa Bay. (Dorsal fin shrunken —see Text). Below right: Caudal, enlarged. Left, Upper jaw. Right, Lower jaw.

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SHARKS
of the Genus ISURUS Rafinesque, 1810,

(with Plate I)

By J. L. B. SMITH,

Research Professor and South African Council for Scientific and Industrial Research Fellow in Ichthyology, Rhodes University, Grahamstown.

Family Isuridae.

This family embraces probably not more than 6 species of large swift wide-ranging sharks of the open sea, characterised by having a conical head, the snout sharply pointed, 5 wide gill-slits, vestigial spiracle, an anal fin, the caudal lunate, its axis steeply raised, the peduncle depressed and expanded to a lateral keel, the teeth powerful, triangular or lanceolate, the third upper tooth on each side smaller than its neighbours. No nictitating membrane or fin spines.

Despite attempts to extend the number of genera, only three are generally recognised, distinguished as follows:

A. Upper teeth broadly triangular, the edges serrate .... **Carcharodon**
The Man-Eater

B. Upper teeth slender, the edges smooth.

I. A secondary keel on caudal. 1st dorsal origin well in advance of hind angle of pectoral. Teeth with small basal point each side .... **Lamna**
Mackerel Shark

II. No secondary keel on caudal. 1st dorsal starts over or behind hind angle of pectoral. Teeth without basal points .... **Isurus**
Blue Pointers: Mako

Genus **Isurus** Rafinesque, 1810.

Mako or Bonito Sharks; Blue-pointers.

Genotype **Isurus oxyrinchus** Rafinesque, 1810. Characterised by the broad family diagnosis and the key above. Few species, found in all oceans, swift predators, that feed mainly on shoal fishes such as Mackerel, all are famous game fishes much sought after by anglers, usually live in the open sea. As their flesh is of excellent texture and flavour, rather like tender poultry, these sharks are almost everywhere valued as food, being especially sought after by the Japanese. The presence of numbers of any species of this genus in the seas of any country is a great economic asset as large sums are spent by big game anglers in their pursuit.

The systematic problems in these clearly wide ranging pelagic sharks are as difficult as those of the marlins. We as yet know little of any growth changes, which may be considerable in the larger species. The full systematic picture will necessitate examination of series of specimens of global extent, which it will be no easy matter to assemble. The number of species that has been recognised by different workers ranges from 2 — 7, but there are probably only three: **oxyrinchus** Rafinesque, found over most of the temperate and tropical Atlantic and Mediterranean, round the Cape to India: **glaucus** Muller & Henle, probably Indian and Pacific only, while **tigris** Atwood, 1869 seems to occur in all oceans, possibly as three geographical subspecies.

Detailed and accurate descriptions of **Isurus** species are almost as rare as reliable illustrations, most of the latter being copied or compiled. There are, however, some good photographs of Isurid sharks in angling publications, markedly more so than in scientific works.

The presence of the genus **Isurus** Rafinesque in South African seas was based on a 36″ stuffed specimen in the British Museum, described by Gunther (Cat.Fish.B.M. 1870, VIII, 391) as **Lamna glauca** Muller & Henle, from "Cape Seas", which covers a vast area of the S.E. Atlantic and S.W. Indian Oceans. Later workers in South Africa apparently saw no actual specimens of **Isurus,** merely copying Gunther's record. Barnard (Ann.S.A.Mus. 1927, XXI, 33, Pl I, fig. 6) listed the "Porbeagle", named as **Isurus glaucus** (Muller & Henle), from Cape seas, and copied an illustration, stated to be that species, by Waite (Fish.S.Austr. 1923, 39, fig. 27), but Waite's figure is clearly **Lamna nasus** (Bonnaterre), 1788, with the stout body of that species, the first dorsal origin before hind pectoral angle, and the characteristic secondary caudal keel is clearly visible in the original figure (**loc. cit.** above) though this was omitted by Barnard (**loc. cit.** Pl I, fig. 6). Whitley (Rec.Aust.Mus. 1931, XVIII, 140, Pl XX, figs. 1-2) gave a brief account of a 47 inch S. African specimen of **"Isuropsis sp."** which was later named **Isurus bideni** by Phillips (N.Z.Journ.Sci.Tech. 1932, XIII, 226), who considered it distinct from the New Zealand species because of (1) the relative heights of the two dorsal fins and (2) the greater width of the caudal. Phillips distinguished the South African form from **glaucus** M & H, in having the anal base wholly behind the second dorsal, in **glaucus** it is partly behind. Barnard (Ann.S.A. Mus. 1949, XXXVI, 342) later published a note on two specimens in the S.A. Museum, one he identified as **Isurus bideni** Phillips, the other as **glaucus** M & H, based on the relative positions of 2nd dorsal and anal. **bideni** otherwise agrees in every particular with **glaucus** M & H, and can scarcely be maintained on such slender grounds which examination of numbers would doubtless expose as variable.

The first detailed account of a species of **Isurus** in South Africa was my own (Smith, Nature, 1953, vol. 171, 977, figs. 1-2), the specimen a young male, 1130 mm. total length, unquestionably **Isurus oxyrinchus** Rafinesque, from Algoa Bay. Since that time several anglers have reported catching similar sharks well out at sea, over the area from Mossel Bay to Durban. Only recently, however, has any further specimen come to hand, again from Algoa Bay. This is a 295 lb. male, 2540 mm. total length, which appears to confirm the views of Australasian workers that the form they know is distinct from either **oxyrinchus** or **glaucus,** normally known as **mako** Whitley, 1929, a name hitherto accepted only by some Australasian workers, the species at present regarded as confined to that region, but which is almost certainly identical with **tigris** Atwood, 1869 from the Northwestern Atlantic. As is shown below, this recent South African fish also agrees closely with that species.

It is noteworthy that most recent workers in the Atlantic accept only **oxyrinchus** Rafinesque as occurring there, a view maintained by Bigelow & Schroeder in their valuable and monumental work on the sharks of the N.W. Atlantic. They have put practically all names for **Isurus** species from the Atlantic in the synonymy of **oxyrinchus.** An excellent photograph and description of a specimen of **Isurus tigris** Atwood from New York, by Murphy (Copeia, 1919, 32, Pl I), was identified by Bigelow and Schroeder (**loc. cit.** 1948, 132) as **oxyrinchus** Rafinesque, which is surprising, as brief examination of the illustration reveals marked divergence from the critical characters used as diagnostic by Bigelow & Schroeder in their Key to the species. Similarly the data of the original description of **tigris** by Atwood (Proc.Bost.Soc.Nat.Hist. 1869, XII, 268) do not accord with **oxyrinchus.** On Atwood's data I have prepared an outline and this agrees closely in all details with Murphy's New York specimen, with my present Algoa Bay specimen and with New Zealand "Mako", all clearly conspecific, whereas most American workers have considered **tigris** identical with **oxyrinchus.**

In Australasia all specimens have been identified as **mako** Whitley, commonly known as "Mako", but descriptions and especially excellent photographs of anglers' catches establish that two species are present, namely **glaucus** M & H, and **tigris** Atwood.

In South African seas all three species, **oxyrinchus** Rafinesque, **glaucus** Muller & Henle, and **tigris** Atwood, appear to be present.

The species **guntheri** Murray, 1884 has been something of a mystery, for by the criteria hitherto used to distinguish species of **Isurus** Rafinesque, it appeared to differ only in having teeth "22/28 on either side." This is so startling a divergence from all known Isurid sharks, that were it to be accepted it might well indicate a different genus at least. Had this quoted number been any but exactly double the normal range, the identity of this shark might be in doubt, but as it is there can be little doubt that the "22/28" teeth was intended to be total count in the jaws. Most workers, suspecting the statement about the teeth to be an error, as it almost certainly is, have hitherto regarded **guntheri** as probably identical with **glaucus** Muller & Henle, chiefly because that species was known to occur in the Indo Pacific, whereas **oxyrinchus** Rafinesque, was regarded as Atlantic only. As shown here **oxyrinchus** Rafinesque, certainly extends to India and possibly beyond, while **glaucus** M & H, ranges the whole Pacific, and reaches the southeast coast of Southern Africa. A valuable clue to the identity of **guntheri** Murray, is the statement that the dorsal is inserted "about its own length behind the base of the pectoral." This does not agree with **oxyrinchus** Rafinesque, or with **glaucus** M & H, but does agree, as also the remaining data, exactly with **tigris** Atwood, both from New Zealand and South Africa. On the available data therefore it seems likely that **guntheri** Murray, is identical with **tigris** Atwood, thereby linking the occurrence in the Atlantic and South Africa with that in the Pacific through the Indian Ocean.

It is possible that **tigris** Atwood, 1869 may have to yield priority to **dekayi** Gill, 1861, but that can be established only by examination of Gill's type.

According to the differentiation here accepted and to the available information the distributional picture is as follows:

oxyrinchus Rafinesque; Atlantic, round the Cape at least to India.
glaucus M & H; whole Indo-Pacific to South Africa.
tigris Atwood; N.W. Atlantic: South Africa: India: Australasia, probably cosmopolitan.

(For possible subspecies see below).

A number of reputed **Isurus** species caught in South African seas have proved to be the young of the Man-eater, **Carcharodon** Agassiz, whose teeth in juvenile stadia are much more slender than in the adult. This confusion has almost certainly occurred elsewhere. In South Africa it has probably led to the name "Blue Pointer" for **Carcharodon** used by Natal anglers.

KEY TO THE SPECIES

1. Top of 1st dorsal broadly rounded, the length of its base never less than the vertical height of the fin, which latter is less than one-third of (3.1 — 3.5 in) distance from snout tip to level of pectoral origin, the latter distance not or little more than distance from hind margin of pectoral base to pelvic origin. Distance between levels of origins of 1st dorsal and pectoral equals postorbital to near 2nd gill slit .... **glaucus**

2. Top of 1st dorsal acute or acutely rounded, its vertical height distinctly greater than length of its base, its height not shorter than ⅓ of distance from snout tip to level of pectoral origin.
   A. Vertical height of 1st dorsal (not as long as entire fin) 2.6 — 3.0 in distance from snout tip to level of pectoral origin, which latter distance is usually distinctly more than distance from hind margin of pectoral base to pelvic origin. Distance between levels of origins of 1st dorsal and pectoral about 2.5 in head to pectoral origin, not longer than postorbital to 1st gill slit ...... **oxyrinchus**
   B. Vertical height of 1st dorsal (often as long as entire fin) 2.2 — 2.4 in distance from snout tip to level of pectoral origin, which latter distance is usually distinctly less than distance from hind margin of pectoral base to pelvic origin. Distance between levels of origins of 1st dorsal and pectoral 1.5 — 2 in head to pectoral origin, about equals postorbital to 2nd or 3rd gill slit .... **tigris**

Dimensional relationships in sharks appear to be more easily reproducible if based on the length from snout tip to the origin of the upper caudal lobe, rather than on "Total length."

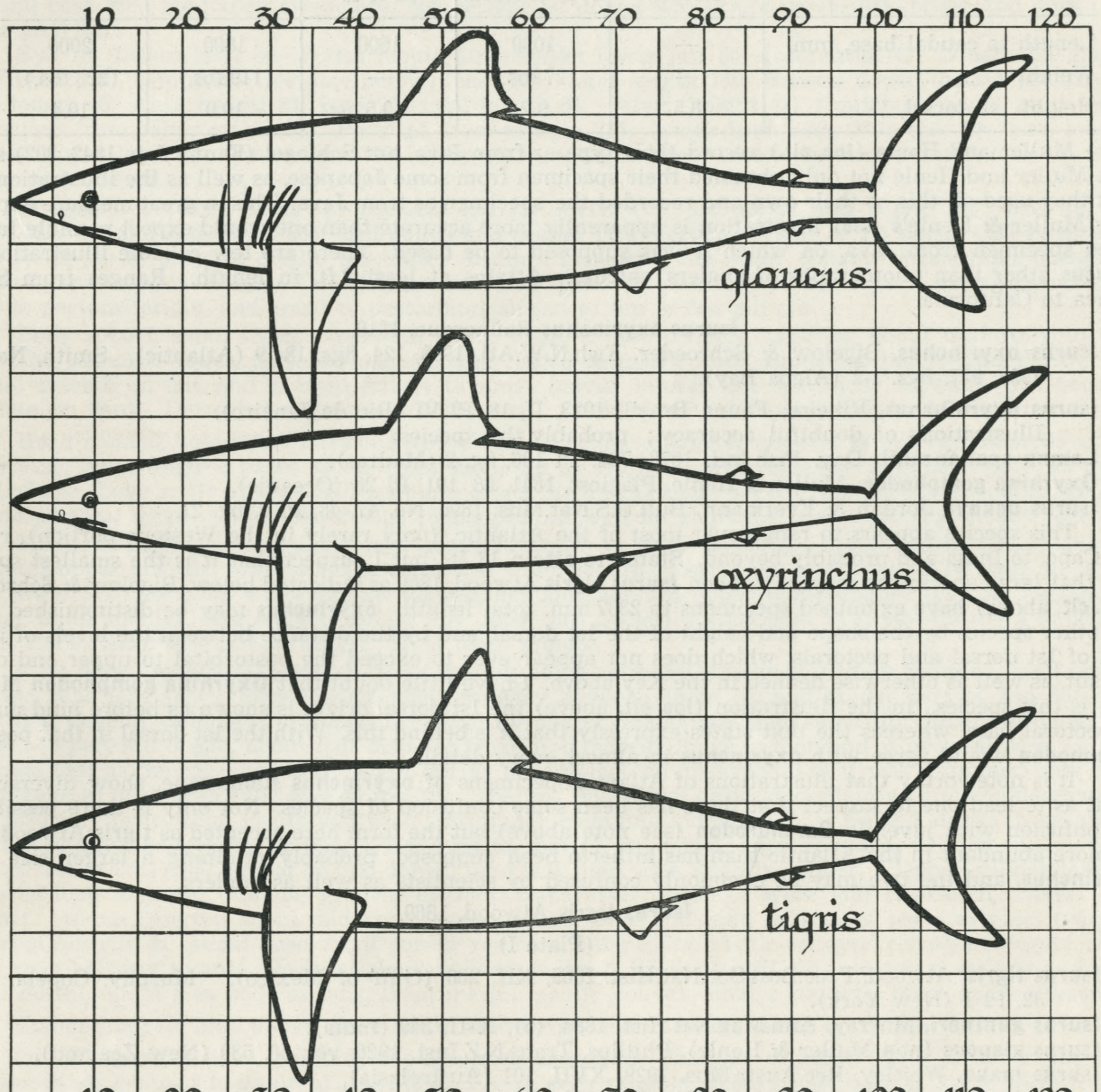

Fig. 1. To show typical forms of adult sharks of the genus **Isurus** Rafinesque.

Isurus glaucus (Muller & Henle), 1841.

Isurus glaucus, Muller & Henle, Plagiost. 1841, 69, Pl 29 (Japan!). Roedel, Cal.Fish.Game. 1953, Bull. 91, 15, fig. 8 (California).

Isuropsis mako (non Whitley 1929), Whitley, Mem.Queensl.Mus. 1934, X, 194 (Port Jackson, Australia).

Isuropsis sp., Whitley, 1931, XVIII, 140, Pl XX, figs. 1-2 (S. Africa).

Isurus bideni, Phillips, N.Z.Journ.Sci.Tech. 1932, XIII, 227, fig. 2 (S. Africa).

"Mako", Hanlon, Bay Islands Swdf. and Mako Shark Club, Brochure, N.Z. 1955, pp. 2, 18. (Photographs, New Zealand).

The first dorsal fin low, with curved front margin and broadly rounded top, vertical height 8.5 — 10.5 percent of length to caudal base, and never more than the length of the base. Distance between levels of insertion of pectoral and 1st dorsal about 2 in head to pectoral origin, slightly more than postorbital to 1st gill slit. Front margin of 1st dorsal at lower angle to line of back than in **tigris** or **oxyrinchus.** In this species the relative height of the dorsal appears to increase with age.

Locality	California (Roedel)	S. A. Type of **bideni**	Java? M & H	N. Z.	N. Z.
Length to caudal base, mm.	—	1050	1500	1800	2000
Weight	—	(27 lbs.)	—	(119 lbs.)	(228 lbs.)
Height 1st dorsal, %	8.5	9.2	9.5	10.0	10.4

Muller and Henle (**loc. cit.**) record their type as from Java, but Schlegel (Fauna Jap. 1842, 302) states that Muller and Henle not only obtained their specimen from some Japanese, as well as the illustration, but that they used all this as their own and recorded the specimen as from Java. This in great measure explains why Muller & Henle's (**sic**) illustration is apparently more accurate than one would expect possible from a dried specimen from Java, on which it was supposed to be based. There are few reliable illustrations of **glaucus** other than photographs of anglers' catches. Attains at least 8 ft. in length. Ranges from South Africa to California.

Isurus oxyrinchus Rafinesque, 1810.

Isurus oxyrinchus, Bigelow & Schroeder, Fish.N.W.Atl. 1948, 124, figs. 18-19 (Atlantic). Smith, Nature, 1953, 977, figs. 1-2 (Algoa Bay).

Isurus oxyrhinchus, Ribeiro, Fauna Brazil, 1923, II, 18, Pl VI (Rio de Janeiro).

Illustrations of doubtful accuracy ; probably this species;

Lamna spallanzanii, Day, Fish.Ind. 1878, 722, Pl 186, fig. 2 (Madras).

Oxyrhina gomphodon, Muller & Henle, Plagiost. 1841, 68, 191, Pl 28 (Oceanic).

Isurus dekayi, Jordan & Evermann, Bull.U.S.Nat.Mus. 1896, No. 47, 48, Pl 6, fig. 21.

This species appears to range over most of the Atlantic, (only rarely in the Western portion), round the Cape, to India and probably beyond. Stated to attain 13 ft., but I suspect that it is the smallest species and that large specimens may have been **Isurus tigris** Atwood, 1869 as indicated below. Bigelow & Schroeder (**loc. cit.** above) have examined specimens to 2337 mm. total length. **oxyrinchus** may be distinguished from the other species by the shape and height of the 1st dorsal, and by the distance between the levels of insertion of 1st dorsal and pectorals, which does not appear ever to exceed the postorbital to upper end of 1st gill slit, as well as otherwise defined in the Key above. I have little doubt that **Oxyrhina gomphodon** M & H, 1841 is this species. In the illustration (**loc. cit.** above) the 1st dorsal origin is shown as before hind margin of pectoral base, whereas the text states expressly that it is behind this. With the 1st dorsal in that position **gomphodon** would agree with **oxyrinchus** in almost every detail.

It is noteworthy that illustrations of Atlantic specimens of **oxyrinchus** Rafinesque, show diversity so great as to lead one to suspect that there has been some confusion of species. Not only is there possibility of confusion with juvenile **Carcharodon** (see note above) but the form here accepted as **tigris** Atwood may be more abundant in the Atlantic than has hitherto been supposed, probably attaining a larger size than **oxyrinchus,** and the two may be commonly confused by scientists as well as anglers.

Isurus tigris Atwood, 1869.

(Plate I)

Isurus tigris, Atwood, Proc.Bost.Soc.Nat.Hist. 1869, XII, 268 (Gulf of Mexico). Murphy, Copeia, 1919, 32, Pl I (New York).

Isurus guntheri, Murray, Ann.Mag.Nat.Hist. 1884, (5), XIII, 349 (India).

Isurus glaucus (non Muller & Henle), Phillips, Trans.N.Z.Inst. 1926, vol. 56, 530 (New Zealand).

Isurus mako, Whitley, Rec.Austr.Mus. 1929, XVII, 101 (Australasia).

Isuropsis mako, Whitley, Fish.Aust., Sharks, 1930, 122, fig. 129, (not Fig. 130 = **Lamna nasus**) (whole southern Australia).

"Mako", Hanlon, Bay Isl. Swdfish. Mako Club Brochure, 1955, Photos, pp 4, 17, 20, (N. Zealand).

This species probably occurs in all the major oceans, throughout the Atlantic and Indian Oceans, and at least to Australasia. It may be distinguished at once from **glaucus** by the higher and more acute 1st dorsal and by the more posterior insertion of that fin, as defined in the Key above. The dorsal fin appears to become relatively higher and its apex more acute with age:

Locality	New York (Murphy)	S. A.	N. Z.	Mexico (Atwood)	N. Z.
Length mm. to caudal base	1270	2160	2300	2350	2400
Weight, lbs.	—	295	520	—	590
Height 1st dorsal, %	12.3	12.5	13.5	14.3	14.4

A full description and illustrations are given here of a male, 2540 mm. total length, from Algoa Bay, weight 295 lbs. Dimensions are given in thousandths of length from snout tip to origin of upper caudal lobe (2160 mm.): Total length 1175. Snout tip to level of: nostrils 53; front of mouth 71; front of eye 88; hind margin of jaw 160; spiracle 155; top 1st gill slit 235; top 5th gill slit 325; pectoral origin 295; hindmargin pectoral base 350; hind apex of pectoral 400; origin 1st dorsal 475; origin pelvic 700; origin 2nd dorsal 900; origin anal 920.

Eye 18. Interorbital 80. Width mouth 100; height lower jaw 85. Internarial 47. Length 1st gill slit 90. First dorsal, height 125 (see note below): base 118; total length 140. Second dorsal, height 23; base 15; total length 46. Anal, height 23; base 20; total length 54. Pelvic, height 42; front margin 55; total length of claspers from pelvic origin 185. Pectoral, front margin 235; length from body 230; base 65; hind lobe 40. Caudal, upper lobe 230; lower lobe 190; distance from origin lower lobe to anterior point in fork 85; width across peduncle 95.

Interspace between bases of: pectoral and 1st dorsal 110; 1st dorsal and pelvic 125; pectoral and pelvic 335; 1st and 2nd dorsal 305; 2nd dorsal and caudal 110. Vertical height of 1st dorsal 2.35 in distance from snout tip to pectoral origin, this latter distance markedly less than distance from hind margin of pectoral base to pelvic origin. The distance between levels of insertion of 1st dorsal and pectoral 1.6 in head to pectoral origin, and equal to postorbital almost to top of 3rd gill slit.

Body robust, snout sharply pointed, trunk fusiform and shapely, tapering about uniformly to each end. The peduncle much flattened and sharply ridged laterally from somewhat before 2nd dorsal, keel behind extends on tail, and in front faintly to above pelvic, lateral line continues forward, but becomes obsolete on flank. Dermal denticles imbricate, small, rounded, with 3 blunt points on hind margin.

Head conical, somewhat flattened above. Eye circular, diameter about 4 in preoral. Nostrils almost transverse, inner angle 3 times as far from snout tip as front of jaw. Spiracle a minute pore at upper level of eye above angle of jaw. Gill openings large, the first $1\frac{1}{3}$ times preoral, the 5th barely longer, extends behind pectoral origin above, below laps round pectoral axil for short distance, 4-5th slits closest together.

Mouth broadly rounded anteriorly, about 1.2 times as wide as long. Upper labial groove about $\frac{1}{3}$ length of upper jaw, the lower shorter, concealed when mouth closed. On each side, 13-14 teeth in upper, 13 in lower jaw, the front 4 in each jaw longest, flexuous, the 3rd upper tooth smaller than its neighbours. Hinder teeth smaller, relatively broader. In upper jaw 2-3 series functional, in front of lower 3 functional series, the anterior few almost exsert. Hind teeth minute.

First dorsal moderate, elevated, front margin almost straight, the apex acutely rounded, hind margin concave, hind lobe short. Dorsal origin about midway between snout tip and hinder part of 2nd dorsal or somewhat beyond. Midpoint of dorsal base slightly nearer caudal base than snout tip. Height of dorsal 2.35 in head to pectoral origin, about half distance from hind margin of eye to hind end of pectoral base. (It may be noted that as the specimen was caught during my absence on an expedition it was examined only after it had been in deep freeze for several months. The first dorsal was desiccated, plainly shrunken downwards, thus probably lower than in life and with subangular emargination behind). Second dorsal base almost entirely in advance of anal, its base 1/7 as long as that of 1st dorsal, apex rounded, pointed hind lobe as long as rest of fin. Anal similar to 2nd dorsal, base and hind lobe slightly longer. Upper caudal lobe 1.2 times as long as lower. Caudal grooves distinct, transverse, peduncle wide and depressed, lateral keel distinct. Pelvics inserted about midway between caudal base and hind margin of pectoral base, twice as far from nostrils as caudal base, front corner rounded, outer margin little concave, claspers elongate, reach more than halfway to anal. Pectoral about as long as snout tip to 1st gill slit, not twice as long as height of 1st dorsal, about $\frac{1}{2}$ as wide as long, front margin gently convex, hinder concave, inner angle subacute.

Colour: cobalt blue above, pure white below, the colours intergrading on flanks.

Of this species I have seen only the specimen described. The type of **tigris** was 8′ 10″ in length, New Zealand fishes are said to attain at least 13 ft. I have seen reliable illustrations only of large (520-590 lbs.) Australasian specimens. In these the first dorsal is apically more acute and slightly higher than in the South African fish described above and than in Murphy's New York specimen. While there is very close correspondence between the latter two, one cannot altogether dismiss the possibility that there may be two or three geographical subspecies, as follows:

(a) **tigris tigris** Atwood. Atlantic.

(b) **tigris africanus nov.** South Africa, type the above specimen described.

(c) **tigris mako** Whitley. Australasia.

I suspect that both Whitley and Phillips have confused species present in their seas, e.g. the illustration and description of **"Isurus glaucus"** (Phillips, 1926, above,) are not in agreement, while in Fishes of Australia (1940, 123, figs. 129-130), as **Isuropsis mako,** Whitley reproduces Waite's 1923 illustration of **Lamna** (Fig. 130) as well as impressionistic sketches of true **mako** (Fig. 129).

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Names accepted as valid are in capitals.