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Sharks of the east coast of southern Africa. III. The families Carcharhinidae (excluding *Mustelus* and *Carcharhinus*) and Sphyrnidae.

by

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Contents

Introduction

This paper, the third of a series on the sharks of the east coast of southern Africa, reviews the Carcharhinidae (excluding the genera *Carcharhinus* and *Mustelus*) and Sphyrnidae as recorded in this region. The first report (Bass, D'Aubrey and Kistnasamy 1973) treated the genus *Carcharhinus* as well as giving a general introduction to the series, a summary of the physical environment of the study area, and a key to the families of sharks. The Scyliorhinidae and Pseudotriakidae were treated in the second report (Bass, D'Aubrey and Kistnasamy 1975).

The east coast of southern Africa is arbitrarily defined here as ranging from Beira in the north-east to Knysna in the south-west (fig. 1). Three of the sharks treated here (*Ctenacis fehlmanni*, *Iago omanensis* and *Hemigaleus* sp.) have not been recorded from the study area but do occur further to the north and may well be added to the list of southern Africa ichthyofauna in time to come. Our knowledge of the genus *Mustelus* in southern African waters is still confused and the present report treats this group only at the generic level. The genus *Hypoprion* has been recorded from East Africa (Günther 1870) and Bass, D'Aubrey and Kistnasamy (1973) included it in a key to the carcharhinid sharks likely to be found off the east coast of southern Africa. *Hypoprion* is not included here, as examination of the only specimen of the genus recorded from the western Indian Ocean, the type of *Hypoprion playfairii* Günther, 1870 (BMNH type, no other number) showed this specimen to be similar to *Carcharhinus melanopterus* in all ascertainable respects. The tooth count given in the original description was $\frac{29}{28}$ and differs markedly from that usually found in *C.melanopterus* ($\frac{12—1 \text{ or } 2—12}{11—1—11}$; see Bass, D'Aubrey and Kistnasamy 1973). Our count of this specimen was $\frac{12—1—13}{12—1—12}$ and we conclude that *Hypoprion playfairii* is a junior synonym of *Carcharhinus melanopterus* (Quoy and Gaimard, 1824).

Generic and familial relationships in galeoid sharks have recently been clarified by the work of Compagno (1970, 1973 a, b, c). The group of sharks so far covered in the present series (Scyliorhinidae, Pseudotriakidae, Carcharhinidae, Sphyrnidae), described as the scyliorhinid line by Bass (1972) and as the order Carcharhiniformes by Compagno (1973c), includes a continuous morphological gradient ranging from sluggish, bottom-living forms (scyliorhinids) through somewhat faster demersal types ("lower" carcharhinids) to fast pelagic forms ("higher" carcharhinids and sphyrnids). Some of the typical characters of these morphological grades are summarised in table 1. The relationship between the classification of the order Carcharhiniformes of Compagno (1973c) and that followed in the present series is as follows (only genera covered in this series are listed here; those marked with an asterisk have not yet been recorded from the east coast of southern Africa):

Genera	*Present classification*	*Classification of Compagno* (1973c)
*Apristurus**, *Cephaloscyllium*, *Halaelurus*, *Haploblepharus*, *Holohalaelurus*, *Poroderma*, *Scyliorhinus*	Family Scyliorhinidae	Family Scyliorhinidae
*Pseudotriakis**	Family Pseudotriakidae	Family Pseudotriakidae
Eridacnis, *Ctenacis**	Family Carcharhinidae	Family Proscyllidae
		Family Triakidae
Scylliogaleus		Tribe Scylliogaleini
Mustelus, *Triakis*		Tribe Triakini
*Iago**		Tribe Iagini
Galeorhinus, *Hypogaleus*		Tribe Galeorhini
		Family Hemigaleidae
*Hemigaleus**		Subfamily Hemigaleinae
Hemipristis		Subfamily Hemipristinae
		Family Carcharhinidae
Galeocerdo		Subfamily Galeocerdinae
Triaenodon, *Negaprion*, *Prionace*, *Loxodon*, *Rhizoprionodon*, *Carcharhinus*		Subfamily Carcharhininae
Sphyrna	Family Sphyrnidae	Family Sphyrnidae

Materials and methods

Collection of material

Present study material has been collected haphazardly where and when available, rather than on the basis of regular sampling at specific localities. The bulk of the specimens have come from anti-shark nets at bathing beaches, commercial trawlers, and line fishermen. Others have been taken by surf anglers and, in a few cases, by skin divers. The collections of the British Museum (Natural History) (BMNH), the South African Museum in Cape Town (SAM) and the J. L. B. Smith Institute of Ichthyology at Rhodes University, Grahamstown (RUSI) have been of particular help.

Methods

Specimens were photographed and weighed before being measured in detail. A skin sample was taken from the side below the first dorsal fin and the jaws were removed for examination and, in many cases, preservation. At least one example of each species (except *Ctenacis fehlmanni*, *Iago omanensis*, *Triakis natalensis*, *Hemipristis elongatus* and *Hemigaleus* sp.) has been preserved in the collection of the Oceanographic Research Institute in Durban. When necessary, vertebral counts of these preserved specimens were made by means of X-ray photographs.

In the more abundant species the number of sharks measured in detail was limited to an adequate sample of each sex over the size range observed. Only the total length, reproductive state and stomach contents were recorded for any further specimens.

Specimens were photographed in as lifelike a position as possible. This was often achieved by freezing a shark until its trunk became stiff and then setting it up for photography. The fins tended to droop or twist but could be held in place by strings attached by small hooks. In addition, detailed notes were made on colour and markings as well as any unusual features such as parasites and injuries.

The majority of specimens were weighed but the results are not reported here as body weights proved to be so variable for sharks of any given size, sex and species as to be of

little practical significance. A summary of this information will be published later for the benefit of sport fishermen, commercial fishing concerns and other interested persons.

Denticles

Dermal denticles are of limited use in the identification of carcharhinid and sphyrnid sharks for, apart from growth changes, their shape varies considerably among specimens of the same size. Descriptions of denticles have therefore been omitted in the present paper. In a few cases note is made of the distribution of denticles and oral papillae on the tongue and on the roof of the mouth and also on the inner surfaces of the gill bars.

Teeth

The terminology used here is adapted from those of Strasburg (1963), Applegate (1965, 1967), S. Springer (1965) and Compagno (1970). A shark tooth is divided into two regions: the enamel-covered crown and the root. The crown consists of a base with one or more cusps varying in size from relatively large to minute. In multicuspid teeth one cusp may be larger than the others in which case it is the primary cusp while the others are secondary cusps. The cusps and bases may have rounded or sharp edges with the latter either smooth or serrated. Secondary serrations may be present on the edges of larger serrations. The difference between a secondary cusp and a large serration is a matter of degree and in some teeth the use of one or the other of these terms is an arbitrary choice. The inner side of a tooth refers to that side closest to the centre of the jaw while the outer side is that closest to the angle of the jaw.

A row of teeth is defined as a line of teeth derived from a single germinal area and including one or more functional teeth plus replacements at various degrees of development. A row is usually, but not always, approximately at right angles to the jaw cartilage. A series is defined as a line of teeth parallel to the jaw axis, all of them in different rows. One or more series may be functional at any one time. In the "higher" carcharhinids and in sphyrnids only one series is functional in the upper jaw. In other genera (e.g. *Mustelus*) the teeth are closely pressed against one another so that several series are functional at any one time and a continuous "pavement" of teeth is present. Intermediate types are graded continuously between these two extremes and all systems yet devised to classify them seem to have more exceptions than examples.

In some sharks (e.g. *Eridacnis sinuans*) several different types of teeth may be found in a jaw. In the "higher" carcharhinids and in sphyrnids the only distinction needed is that between the relatively large lateral teeth along the sides of the jaws and the smaller central teeth over the symphyses. Central teeth are defined as markedly small teeth in the centre of a jaw. They are usually easily separable from the larger lateral teeth on each side and may have erect or oblique cusps. Tooth counts refer to the number of rows and are given in the form:

$$\frac{\text{No. of laterals—No. of centrals—No. of laterals (Upper jaws)}}{\text{No. of laterals—No. of centrals—No. of laterals (Lower jaws)}}$$

Where no central teeth are distinguishable the tooth counts are given in the form:

$$\frac{\text{No. of teeth (Upper jaws)}}{\text{No. of teeth (Lower jaws)}}$$

In summaries of tooth counts the numbers of lateral teeth are given as totals for both sides of the jaws. This enables the variation in numbers of lateral teeth to be summarised neatly and efficiently. In practice, the numbers of lateral teeth on each side of a jaw rarely differ by more than one so that an even total number can be assumed to result from equal numbers on each side. Thus, 27 lateral teeth in a jaw can be assumed to have been distributed as 13—14 or 14—13.

Tooth shapes have been illustrated rather than described. It should be noted that shark teeth may change shape slightly while drying. In particular, oblique cusps may become slightly more so as the teeth dry out.

Vertebral counts

V. G. Springer and Garrick (1964) provided a valuable survey of vertebral numbers in sharks. Unfortunately, many of the counts recorded during the present study were made before their paper was received and there are some differences in methods. Springer and Garrick counted as precaudal all entire vertebrae in front of the upper precaudal pit (where present). In cases where a vertebra occurs directly underneath the upper caudal origin we have taken it as being precaudal if half or more of the vertebra is in front of the origin. Precaudal counts given here will thus average very slightly more than those of Springer and Garrick. Total counts are not affected by this. Numbers of monospondylous and diplospondylous vertebrae have not been recorded, only the numbers of precaudal and total vertebrae.

The data given here include counts from juveniles and adults of both sexes. Differences between the vertebral numbers of males and females are usually so small as to be insignificant for the present purpose (Bass *et al* 1973) but may differ significantly in some species (e.g. *Iago omanensis*).

Reproductive state

The features used to determine maturity in sharks are discussed in detail by S. Springer (1960) and by Clark and von Schmidt (1965). Males are considered to be mature when the claspers are fully grown with the clasper cartilages rigid from calcification. In adolescent males the claspers are partly or fully grown but the clasper cartilages are soft and uncalcified. Immature males have short, very soft claspers. Semen is often present in sharks with immature claspers and should not be used as an index of maturity. The presence of enlarged testes, quantities of semen in the seminal vesicles, and swollen, bleeding claspers can be taken as indications of mating activity in adult males.

Signs of maturity in females are distinct ova in the ovary and expansion of the uteri to form loose sacs rather than thin, tight-walled tubes. In doubtful cases the presence or absence of an intact hymen can be used to show whether an animal is adolescent or in an inactive state between pregnancies. Many species have a form of courtship during which the males may inflict fairly severe bites on the females. Mating scars and bites are usually found in the pelvic region, less often on or near the pectoral fins, and occasionally elsewhere. In most, probably all, carcharhinid and sphyrnid species only the right ovary is functional.

Nictitating lower eyelid

The terminology used to describe this structure (also called the nictitating membrane, nictitating fold, nictitans, subocular fold and movable lower eyelid) follows that of Compagno (1970). The groove outside a nictitating lower eyelid is called the subocular pouch, and the fold outside the pouch is called the secondary lower eyelid. The nictitating lower eyelid is a variable structure forming a continuous morphological gradient in sharks, but for practical purposes this can be divided into four grades ranging from the least specialised or "lowest" to the most advanced. These are as follows:

(i) RUDIMENTARY. Here the nictitating lower eyelid forms the lower edge of the eye aperture, connecting at both front and back with the upper eyelid. The subocular pouch is a shallow groove, usually lined with denticles, below the eye and the secondary lower eyelid is not clearly differentiated.

(ii) EXTERNAL. This is similar to the rudimentary type except that the subocular pouch is strongly marked and the secondary lower eyelid is well defined. The subocular pouch is usually naked.

(iii) TRANSITIONAL. The subocular pouch and secondary lower eyelid are strongly defined. The latter has one end (usually the front) attached to the upper eyelid while the nictitating lower eyelid is attached to the other end of the upper eyelid.

(iv) INTERNAL. The nictitating lower eyelid and subocular pouch are completely within the eye aperture and the secondary lower eyelid is attached to the upper eyelid at both ends.

The type of nictitating lower eyelid may change with growth in a species. For instance, in the genus *Galeorhinus* young specimens have a transitional nictitating lower eyelid which changes to an internal type in the adults (Compagno 1970).

Measurements

Terminology of the external parts is shown in fig. 2 while the measurements used here are illustrated in fig. 3. Distances were measured along straight lines and not "along the curve". Bilateral dimensions were measured on both sides and then averaged. A consistent total length was calculated by the use of the following formula (Bass 1973):

Total length = Standard length + α × Upper caudal length
where α = 0.97 for *Eridacnis*, *Scylliogaleus*, *Mustelus and Triakis*
and α = 0.80 for *Triaenodon*, *Galeorhinus*, *Hypogaleus*, *Negaprion*, *Prionace*, *Galeocerdo*, *Loxodon*, *Rhizoprionodon* and *Sphyrna*.

Proportional dimensions were analysed according to the method described by Bass (1973). The results are described directly in terms of proportional dimensions in a format which indicates the variation and changes (if any) of the dimensions with growth of the animal. The various growth patterns are shown in fig. 4. In the simplest case (C) a proportional dimension stays constant with increase in length and is described by the format:

Anal base $4.2 \pm 0.5\%$

This indicates that the anal base averages 4.2% of the total length and ranges from 3.7 to 4.7% in 95% of cases.

Proportional dimensions showing the growth patterns SU, SD, CU, CD, XU and XD are described in the format:

Anal base $2.7 \quad \alpha \quad 4.2 \pm 0.5\%$

where α = SU, SD, CU, CD, XU or XD. This indicates that the anal base changes from 2.7% of total length in the smallest specimens to 4.2% in the largest. In 95% of cases the proportional dimension will be within 0.5% of the average value at any particular total length:

In the case of the growth patterns MAX and MIN a slightly more complex format is used:

Anal base $3.5 \quad 5.6\ (120) \quad 4.7 \pm 0.5\%$

This example indicates that the anal base averages 3.5% of total length in the smallest animals, rises to a maximum of 5.6% at a total length of 120 cm and then drops to 4.7% in the largest animals. Again, in 95% of cases the proportional dimension will be within 0.5% of the average value at any particular total length.

Where fewer than ten measurements are available the results are expressed merely as a mean and range.

Family Carcharhinidæ

In the sense used here the family Carcharhinidae includes a number of diverse genera ranging from scyliorhinid forms such as *Eridacnis* to the "higher" carcharhinids such as *Rhizoprionodon*. The only difference between the "lower" Carcharhinidae and the Scyliorhinidae is the position of the first dorsal fin (its axil over or behind the pelvic origin in the Scyliorhinidae, in front of it in the Carcharhinidae). At the other end of the morphological gradient, the Sphyrnidae are separable only by their possession of lateral expansions of the head to form the distinctive "hammer". Identification to family level can be made by the following combination of characters: two dorsal fins, without spines; first dorsal axil in front of pelvic origin; first dorsal base much shorter than upper caudal fin; anal fin present; caudal fin not lunate, much less than half of total length; nostrils separate from or connected to the mouth; nasal barbels absent; five gill slits, the fifth over or behind the pectoral origin; head of "normal" shark shape, not greatly expanded laterally to form a "hammer".

The following key will identify the genera of carcharhinid sharks recorded from or considered likely to be found off the east coast of southern Africa. This key is an emended version of that given by Bass, D'Aubrey and Kistnasamy (1973). A key to all carcharhinid genera can be found in Bigelow and Schroeder (1948), parts of which have been brought up to date by V. G. Springer (1964) and Compagno (1970, 1973b). It should be noted that *Loxodon*, *Negaprion* and *Triaenodon* will key out twice because of intrageneric variation in the presence or absence of spiracles.

Key to carcharhinid genera

1A Spiracles present 2
1B Spiracles absent 15

2A A longitudinal dermal ridge on each side of the caudal peduncle . . . *Galeocerdo*
2B Caudal peduncle smooth, without a longitudinal dermal ridge on each side . . 3

3A Internasal distance much greater than distance from snout to mouth . . *Triaenodon*
3B Internasal distance less than or equal to distance from snout to mouth . . . 4

4A Teeth single-cusped; one to three functional series 5
4B Teeth single- or multi-cusped; more than three functional series 9

5A Nostrils connected to mouth by grooves . . . . . *Scylliogaleus*
5B Nostrils not connected to mouth by grooves 6

6A Mouth width more than five times length of the longest lip groove 7
6B Mouth width less than five times length of the longest lip groove 8

7A Body with clear pattern of dorsal saddles and large spots . . . . . *Ctenacis*
7B Body plain, without more than a faint suggestion of dorsal saddles or spots *Eridacnis*

8A Upper lip grooves extending forward almost to the level of or in front of the level of the tip of the lower jaws; tooth series not alternating, the tooth rows perpendicular to the jaw axis; teeth with a prominent pointed central cusp, sometimes with an extra pair of smaller lateral cusps . . . . . *Triakis*
8B Upper lip grooves extending to a level well behind the tip of the lower jaw; tooth series alternating, the tooth rows appearing diagonal rather than perpendicular to the jaw axis; teeth with a single low, rounded, inconspicuous cusp *Mustelus*

9A Inner margins of upper lateral teeth regularly serrate almost to the tips *Hemipristis*

9B Inner margins of upper lateral teeth smooth, not serrated (one or more large basal serrations or secondary cusps may be present) 10

10A No precaudal pits 11

10B Precaudal pits present (lower may be indistinct) 13

11A First dorsal origin in front of pectoral axil . . . . . *Iago*

11B First dorsal origin behind pectoral axil 12

12A Distinct upper and lower lip grooves present 13

12B Lower lip grooves absent, upper lip grooves minute . . . . . *Negaprion*

13A Second dorsal height about $1\frac{1}{2} \times$ anal height . . . . . *Hypogaleus*

13B Second dorsal height about equal to anal height . . . . . *Galeorhinus*

14A Anal origin behind second dorsal origin . . . . . *Hemigaleus*

14B Anal origin well in front of second dorsal origin . . . . . *Loxodon*

15A First dorsal origin not behind inner pectoral corner by a distance greater than or equal to that from the 1st to the 5th gill-slits 16

15B First dorsal origin behind inner pectoral corner by a distance greater than or equal to that from the 1st to the 5th gill-slits 19

16A Second dorsal origin over or behind the centre of the anal base 17

16B Second dorsal origin in front of the centre of the anal base 18

17A A distinct notch on the posterior edge of the orbit . . . . . *Loxodon*

17B Orbit smooth, without any notch on its posterior edge . . . . . *Rhizoprionodon*

18A Second dorsal height less than 0.7 × first dorsal height . . . . . *Carcharhinus*

18B Second dorsal height more than 0.7 × first dorsal height . . . . . *Negaprion*

19A Second dorsal height much less than distance from tip of snout to mouth . *Prionace*

19B Second dorsal height more than distance from tip of snout to mouth . *Triaenodon*

Identification of the carcharhinid genera likely to be found off the east coast of southern Africa will be facilitated by reference to table 2 which summarises the principal features of each genus.

Genus *Ctenacis* Compagno, 1973

Ctenacis Compagno 1973a: 258, fig. 1; type-species *Triakis fehlmanni* S. Springer 1968: 614, figs. 1 to 5 (Somalia)

Ctenacis is a monotypic genus of which only one specimen has yet been recorded. Scyliorhinid is appearance, it is distinguished from that family by the forward position of the first dorsal fin with its axil just in front of the pelvic origin. *Ctenacis* is distinguished from the other carcharhinids of the south-western Indian Ocean (except *Eridacnis*) by the following combination of characters: distinct spiracles; short upper and lower lip grooves; external nictitating lower eyelid; axil of first dorsal fin slightly in front of pelvic axil; first dorsal origin slightly behind inner pectoral corner; no interdorsal ridge; second dorsal fin almost equal to first dorsal in size; no precaudal pits; caudal fin without distinct lower lobe; teeth scyliorhinid in overall appearance, but the lateral teeth of the lower jaws with several nearly equal cusps in contrast to the tricuspid central teeth which have the middle cusp by far the largest. *Ctenacis* is closely allied to *Eridacnis* from which it is distinguished by the clearly marked pattern of dark brown dorsal saddles and spots (*Eridacnis* is plain except for faint traces of dorsal saddles on the caudal fin), by nasal flaps with "scalloped" edges (smooth in *Eridacnis*), and by the presence of springy gill-rakers interdigitating across the internal gill openings (absent or minute in *Eridacnis*). Other differences are noted by S. Springer (1968) and Compagno (1973a).

Ctenacis fehlmanni (Springer, 1968)

Triakis fehlmanni S. Springer 1968: 614, figs. 1-5 (orig. descr.; Somalia)
Ctenacis fehlmanni: Compagno 1973a: 258, fig. 1 (orig. descr. of genus)

No study material. Only one specimen of *C.fehlmanni*, a 46 cm adult female from 70 to 170 m off Somalia, has yet been recorded. This type-specimen is shown in fig. 5 (after fig. 1 of S. Springer 1968). The teeth are similar in general appearance and arrangement to those of *Eridacnis sinuans*. Another similarity between these two species is in the ovoviviparous method of reproduction. The holotype of *C.fehlmanni* has "in each oviduct, one very thin-walled, transparent, 45 by 17 mm egg-case enclosing an amorphous mass of egg-yolk material" (S. Springer 1968, p. 621). The stomach contents of this shark were not recorded but Springer suggests that *C.fehlmanni* feeds on small invertebrates because of the large mouth, small teeth and large branchial chamber with interdigitating gill-rakers.

Genus *Eridacnis* H. M. Smith, 1913

Eridacnis H. M. Smith 1913: 599; type-species *Eridacnis radcliffei* H. M. Smith 1913: 599, pl. 47 (Sulu Archipelago)

Eridacnis is a genus of carcharhinid sharks very close to the scyliorhinids from which it is distinguished only by the forward position of the first dorsal fin with its axil just in front of the pelvic origin. *Eridacnis* is distinguished from all carcharhinids (except *Ctenacis*) by the following combination of characters: distinct spiracles; short upper and lower lip grooves; external, transitional or internal nictitating lower eyelid; axil of first dorsal fin slightly in front of pelvic axil; first dorsal origin slightly behind pectoral inner corner; no interdorsal ridge; second dorsal; fin almost equal to first dorsal in size; no precaudal pits; caudal fin without distinct lower lobe; teeth dissimilar in upper and lower jaws, scyliorhinid in overall appearance, but the lateral teeth of the lower jaws with four or five nearly equal cusps in contrast to the central teeth which usually have one large cusp with perhaps a pair of minute accessory cusps. The closely allied genus *Ctenacis* is distinguished from Eridacnis by its clearly marked pattern of dark brown dorsal saddles and spots (*Eridacnis* is plain except for faint traces of dorsal saddles on the caudal fin), and by the presence of springy gill-rakers interdigitating across the internal gill openings (absent or minute in *Eridacnis*). Other differences are noted by S. Springer (1968) and by Compagno (1973a).

Compagno (1970) notes the existence of four nominal species which can be ascribed to this genus: *E.radcliffei* H. M. Smith, 1913; *E.barbouri* (Bigelow and Schroeder, 1944); *E.alcocki* (Misra, 1950); and *E.sinuans* (J. L. B. Smith, 1957). *E.alcocki* appears to be synonymous with *E.radcliffei*, according to Nair and Mohan (1973). The three remaining species are easily distinguished by differences in proportional dimensions, as shown in the following key (based on the descriptions of Bigelow and Schroeder (1948) for *E.barbouri*, of Nair and Mohan (1973) for *E.radcliffei*, and on present study material for *E.sinuans*). The proportional dimensions of the three species are also compared in table 20. *E.sinuans* is most easily distinguished from the other species of its genus by a relatively short mouth, a longer snout, and by a long fin bases.

1A Distance from tip of snout to mouth more than twice mouth length . . . *sinuans* (south-western Indian Ocean)

1B Distance from tip of snout to mouth equal to or less than twice mouth length . 2

2A Anal base longer than distance from anal axil to lower caudal origin . . *barbouri*
(north-western Atlantic Ocean)

2B Anal base shorter than or equal to distance from anal axil to lower caudal origin *radcliffei*
(northern Indian Ocean)

Eridacnis sinuans (Smith, 1957)

Neotriakis sinuans J. L. B. Smith 1957a: 262, fig. 2 (orig. descr., distrib.; Natal); J. L. B. Smith 1961: 565, pl. 108 (16a) (descr.; Natal); J. L. B. Smith 1964: 284 (further descr.; Durban); Kato 1968: 319 (synonymy)
Eridacnis sinuans: Compagno 1970; 90 (generic synonymy, key)

Study material

A 26 cm male and 22 cm female from 238 to 265 m off southern Mozambique; numerous males (18 to 37 cm) and six females (17 to 37 cm) off the Natal coast; the type of *E.sinuans* (J. L. B. Smith, 1957), a 32 cm male from 329 m off Durban.

Five males of 26 to 37 cm (ORI 2563, 1532, 1485, 1533, 1529) and four females of 17 to 37 cm (ORI 1108, 1107, 2570, 1023) are preserved in the collection of the Oceanographic Research Institute in Durban.

Description

A 28 cm immature male *E.sinuans* from the Natal coast is shown in fig. 6. The overall colour is a pale brownish gray, becoming browner in formalin, and paler below. The markings on the tail and on the dorsal fins are somewhat more distinct in young animals than in the adults. The nictitating lower eyelid is rudimentary in juveniles of less than 20 cm and changes to external in adults. It is always fully lined with denticles. The palate has a few papillae just behind the upper jaws, while the tongue has a few small scattered papillae. The inner surfaces of the gill bars are lined with denticles.

The proportional dimensions of 48 specimens (42 male, 6 female, 17 to 37 cm in length) are summarised in table 20.

TEETH

The overall appearance of the teeth is typically scyliorhinid rather than carcharhinid (fig. 7). Near the centre of the upper jaws the teeth are relatively long and lanceolate with one large central cusp and a pair of much smaller side cusps. At about the tenth row from the centre the teeth become shorter, markedly oblique, and develop a fourth and even a fifth small cusp. In the lower jaws the teeth near the centre are similar to those of the upper, but are longer and virtually single-cusped, especially in adult males. Laterally, the teeth are shorter but of similar form until about the ninth row, after which the teeth become broad and comb-like with four or five approximately equal cusps. These latter teeth (of which there are some 16 rows) are in a distinctive spiral arrangement, two or three series being functional at any one time. The overall adaptation is for grasping in the centre and for cutting towards the sides of the jaws. The dental formula varies greatly but is typically in the region of

$$\frac{22—10—10—22}{16—9—9—16}$$

VERTEBRAL COUNTS

Precaudal counts of 44 *E.sinuans* ranged from 82 to 88 with a mean of 85.4 (s = 1.8). Total vertebrae of 39 of these sharks averaged 139.0 (132 to 144, s = 2.6).

Biology

SIZE

E.sinuans is born at 15 to 17 cm in length. Males are immature at 28 cm, mature at 31 cm and grow to at least 37 cm. Only seven females have yet been recorded, six of them immature ranging from 17 to 22 cm and a single pregnant specimen of 37 cm.

BREEDING DATA

E.sinuans can be described as ovoviviparous. Each uterus of a mature female contained a paper-thin egg-case enclosing a 14 to 15 cm embryo. The embryos were lying in a folded position within the egg-cases which measured approximately 65 by 15 mm. Some external yolk material remained – the exact amount is not known because some had disappeared during preservation. Free-swimming specimens of 17 cm have been taken off Natal and the two embryos described here were probably almost full-term.

DISTRIBUTION

E.sinuans is known only from the Natal and southern Mozambique coasts at depths of about 230 to 480 m. The great majority of specimens taken off Natal are male, mostly adults ranging from about 30 to 37 cm in length plus a few juveniles of 18 to 29 cm. Six females have been taken off Natal — five of them immature and ranging from 17 to 20 cm in length, the sixth mature and measuring 37 cm. As yet, only two *E.sinuans* have been recorded in Mozambique waters, a 26 cm male and a 22 cm female taken at a depth of 238 to 265 m.

FEEDING

The stomach contents of *E.sinuans* examined in the present study comprised teleost fish and crustacean remains plus a few cephalopods and (in one instance) a piece of elasmobranch skin.

Genus *Scylliogaleus* Boulenger, 1902

Scylliogaleus Boulenger 1902: 51; type-species *Scylliogaleus quecketti* Boulenger 1902: 51, pl. 4 (coast of Natal, 40 fathoms)

Scylliogaleus is a monotypic genus endemic to the present study area. It is immediately distinguished from all other carcharhinid sharks by the possession of grooves joining the nostrils to the mouth. Other characteristics are distinct spiracles; a transitional nictitating lower eyelid; long upper and lower lip grooves; an interdorsal ridge; first dorsal origin just behind edge of pectoral; second dorsal fin almost equal to first dorsal in size; caudal peduncle without lateral ridges; no precaudal pits; caudal fin with a definite lower lobe; teeth small and rounded, in a mosaic arrangement with several functional series.

Scylliogaleus quecketti Boulenger, 1902

"Flapnose houndshark"

Scylliogaleus quecketti Boulenger 1902: 52, pl. 4 (orig. descr.; coast of Natal, 40 fathoms); Garman 1913: 179 (descr.; Natal); Fowler 1941: 210 (descr.; Natal); Barnard (1947): 10, pl. 1 (7, 7a) (descr.; Natal); J. L. B. Smith 1950: 878 (Richards Bay); J. L. B. Smith 1957c: 353, fig. 1A, B (descr., distrib.; Natal, eastern Cape); V. G. Springer and Garrick 1964: 86 (vert. counts of holotype)

Scylliogaleus queketti: Boulenger 1903: 63 (correction of type-locality); Gilchrist and Thompson 1916: 283 (Natal); Barnard 1925: 31, pl. 1 (5) (descr.; Natal); Barnard 1927: 1013 (type-locality); von Bonde 1934: 14 (size, distrib.); J. L. B. Smith 1949: 44, fig. 16 (descr.; Natal)

Study material

Two males (± 70 and 89 cm) and fourteen females (70 to 102 cm), all from the Natal coast; the holotype of *Scylliogaleus quecketti* Boulenger, 1902, a 34 cm male (embryo?) from the Natal coast (BMNH 1903.2.6.21).

An 81 cm male (ORI 2096), two females of 75 and 95 cm (ORI 550, 754) and four embryos of 32 to 34 cm (ORI 1121a, 1121b, 2586a, 2587a) are preserved in the collection of the Oceanographic Research Institute in Durban.

Boulenger named this shark after Mr. P. F. Quekett, curator of the Durban Museum but spelt the name as *S.quecketti* in the original description, an error which must remain so. He also gave the type-locality as "off the coast of Natal in about 40 fathoms" (*ibid.*, p. 52) but later (1903) noted that it was actually caught from the rocks at Umkomaas on the southern Natal coast.

Description

A 94 cm adult female *Scylliogaleus quecketti* is shown in fig. 8. The overall colour is gray with the underside a pale cream. Late embryos have white trailing edges on the dorsal, anal and caudal fins. The nictitating lower eyelid is transitional in both adults and late embryos.

The proportional dimensions of eleven specimens (one male, ten female, 75 to 102 cm in length) are summarised in table 20.

TEETH

The teeth (fig. 9A) are low, single-cusped, and set in a mosaic arrangement with several functional series. The teeth of the two adult males examined did not appear to differ significantly from those of adult and immature females.

VERTEBRAL COUNTS

Precaudal counts of 11 *S.quecketti* (including that of the holotype as given by V. G. Springer and Garrick 1964) ranged from 88 to 93 with a mean of 90.0 (s = 1.3). Total vertebrae of ten of these sharks averaged 142.1 (139 to 144, s = 1.5).

Biology

SIZE

Embryos of up to 34 cm and apparently full-term have been recorded (J. L. B. Smith 1950; present study). Boulenger (1902) did not record whether the 34 cm type was an embryo or a free-swimming specimen. Present study material includes immature females of 70 to 74 cm and mature females of 80 to 102 cm. J. L. B. Smith (1950) recorded an embryo taken from a 34 inch (77 cm) female. Two adult males measured about 70 and 89 cm.

BREEDING DATA

S.quecketti gives birth to live young after a gestation period of nine to ten months. Two females taken in the months of October and November had undeveloped eggs in the uteri, and embryos of 7 and 16 cm were recorded in January and March respectively. Another four pregnant females taken from July to September contained advanced embryos of 28 to 34 cm. Litter size in eight females ranged from two to four with an average of 2.6.

DISTRIBUTION

S.quecketti has only been found in shallow water off the Natal and north-eastern Cape

coasts (Boulenger 1902; J. L. B. Smith 1950 and 1957c; present study). Recorded specimens include a majority of adult or adolescent females. For instance, the present study material included two adult males, four immature females not far off maturity and ten adult females, eight of them pregnant. J. L. B. Smith (1957c) recorded eight specimens of 30 to 88 cm in length but did not indicate the individual lengths and sexes or state how many of these were embryos.

FEEDING

Scylliogaleus has low rounded teeth set in an alternate "mosaic" pattern similar to that found in many *Mustelus* species and, like the latter, feeds mainly on crustaceans. The stomach contents of eleven specimens examined during the present study included crustaceans (eight times) and a squid (once only). Six of the sharks containing crustacean remains had been eating rock-lobsters (*Panulirus homarus*).

Genus *Triakis* Müller and Henle, 1838

Triakis and *Mustelus* are distinguished from other carcharhinid sharks by the following combination of characters: distinct spiracles; upper and lower lip grooves present, the uppers being the longer; external or transitional nictitating lower eyelid; first dorsal origin over or slightly behind inner pectoral corner; interdorsal ridge present; second dorsal more than half as high as first dorsal; no precaudal pits; caudal fin with definite lower lobe; teeth in a pavement arrangement with several functional series.

Triakis has previously been combined with *Mustelus* as the two genera are difficult to distinguish by external morphological characters. Compagno (1973b) has recently redefined the family Triakidae and provides a key to triakid genera which differentiates between *Mustelus* and *Triakis* as follows:

> Snout bluntly rounded in dorsoventral view, thick and blunt in lateral view; mouth arcuate in shape, lower jaw with convex edges; teeth of lower jaw hardly overlapping or not extending onto its ventral surface, not enlarged at symphysis or forming a knob . . . . . *Triakis*
>
> Snout bluntly parabolic to subtriangular in dorsoventral view, bluntly to narrowly pointed in lateral view; mouth subtriangular or triangular in shape, lower jaw with straight or nearly straight edges; teeth of lower jaw prominently overlapping onto its ventral surface, more or less enlarged at symphysis to form a knob resembling that of rays of the genus *Rhynchobatus* . . . . . *Mustelus*

The southern African representatives of these genera are more readily distinguished by the shape and arrangement of the teeth as well as the length of the lip grooves, as seen in the following key:

> Upper lip grooves extending forward almost to the level of or in front of the level of the tip of the lower jaw; tooth series not alternating, the tooth rows perpendicular to the jaw axis; teeth with a prominent pointed central cusp, sometimes with an extra pair of lateral cusps . . . . . *Triakis*
>
> Upper lip grooves extending to a level well behind the tip of the lower jaw; tooth series alternating, the tooth rows appearing diagonal rather than perpendicular to the jaw axis; teeth with a single low, rounded, inconspicuous cusp . . *Mustelus*

Two species of *Triakis* may occur in the present study area. *T.megalopterus* is a fairly common shark of the Cape coasts, well known to most fishermen. *T.natalensis* is known only from the original description of a young specimen from "Port Natal" '(Steindachner

1866) and from a further immature shark from the eastern Cape. As known at present, these two species are readily distinguished by differences in tooth shape (fig. 9 C, D):

Teeth with a single prominent, pointed cusp . . . . . *megalopterus*

Teeth tricuspid, the central cusp being the largest . . . . . *natalensis*

Newborn young of *T.megalopterus* have not been recorded and Barnard (1925) and Bass (1972) note the possibility that *T.natalensis* refers to young *T.megalopterus*. Examination of late embryos of *T.megalopterus* would clarify this point. For the present, *T.natalensis* is briefly described here as a distinct species.

Triakis megalopterus (A. Smith, 1849)

"Sharptooth smoothhound"

Mustelus megalopterus A. Smith 1849: pl. 2 (orig. descr.; Cape); Gray 1851: 58 (after A. Smith 1849); Bleeker 1860: 57 (Cape); J. L. B. Smith 1957c: 357, fig. 2L (after A. Smith 1849)

Mustelus laevis (*partim*): Günther 1870: 385 (Cape); Gilchrist 1902: 163 (listed; S. Africa); Thompson 1914: 142 (listed; Cape); Barnard 1925: 29 (descr.; S. Africa)

Mustelus nigropunctatus J. L. B. Smith 1952: 223, pl. 3 (orig. descr.; False Bay to Natal); J. L. B. Smith 1949: 45, fig. 18 (descr.; S. Africa); J. L. B. Smith 1957c: 357, fig. 23, K (descr., distrib.; Cape, Natal); van Bruggen 1965: 190 (kept in captivity; Port Elizabeth); J. L. B. Smith 1966: 115 (edibility; South Africa); Day *et al* 1970: 88 (False Bay)

Study material

Two males (140 and 143 cm) and three females (82 to 147 cm) from Algoa Bay; the type of *Mustelus nigropunctatus* J. L. B. Smith, 1952, a 79 cm immature male (RUSI 424); a 100 cm female from Saldanha Bay.

A 147 cm female (ORI 2857) is preserved in the collection of the Oceanographic Research Institute in Durban.

Description

A 145 cm female *Triakis megalopterus* from Algoa Bay is shown in fig. 10. The basic colour is a dark grey overlaid with black spots. The proportional dimensions of seven specimens (three male, four female, 79 to 147 cm in length) are summarised in table 20.

TEETH

The teeth of a 140 cm male *T.megalopterus* are shown in fig. 9C. No sexual dimorphism was apparent in the few jaws examined.

VERTEBRAL COUNTS

Precaudal counts of three specimens were 104, 106 and 107. Total counts of all of these sharks were 166.

Biology

SIZE

The size at birth is not known. A 79 cm male was immature while males of 140 and 143 cm

were both fully mature. Females of 82 and 100 cm were immature, another of 140 cm was apparently mature but still virgin, while a 147 cm female was pregnant. Maximum size of this species is probably in the region of 150 to 170 cm.

BREEDING DATA

T.megalopterus is probably live-bearing, as shown by the presence of long fragile, soft-walled egg cases in the uteri of a 147 cm female. The egg-cases, five in each uterus, were about 35 cm long and contained yolks measuring approximately 55 mm in diameter and carrying young embryos of 40 to 45 mm in length. This specimen was caught during the month of March.

DISTRIBUTION

The range of *T.megalopterus* extends from the western Cape to East London (present study). We have not seen specimens from East London but this shark is well-known to local anglers and the East London Museum has a plaster cast of a specimen presumably taken from the area. *T.megalopterus* may be caught occasionally on the southern Natal coast but we have no definite records from this area. A shallow water shark, most specimens have been caught by shore anglers.

FEEDING

Of five sharks examined two had fed on crabs (*Plagusia chabrus*), two on teleost fishes, and one on a *Scyliorhinus capensis*.

Triakis natalensis (Steindachner, 1866)

"Roughtooth smoothhound"

Mustelus natalensis Steindachner 1866: 482, pl. 1 (orig. descr.; "Port Natal", = ? Durban); Thompson 1914: 143 (listed; Cape); J. L. B. Smith 1957c: 357, fig. 26G, H, I (after Steindachner 1866)

Mustelus laevis (*partim*): Günther 1870: 385 (Cape); Gilchrist 1902: 163 (listed; S. Africa); Barnard 1925: 29 (descr.; S. Africa)

Study material

A 41 cm immature male (RUSI 2418) from the Alexandria area of the eastern Cape.

Description

A 41 cm immature male *Triakis natalensis* from the eastern Cape is illustrated in fig. 11. The colour (in alcohol) is a pale brown, cream below. The proportional dimensions of this shark are given in table 20.

TEETH

The teeth are tricuspid with the central cusp being the largest (fig. 9D).

Biology

Nothing is known of the biology of *T.natalensis*. Only two specimens have been recorded, a 41 cm immature male from the eastern Cape and the type, a specimen of about the same size and with the locality given as Port Natal (an old name for Durban).

Genus *Mustelus* Link, 1790

Mustelus Link 1790: 31, type-species *Squalus mustelus* Linnaeus, 1758 (after Bigelow and Schroeder 1948: 240)

The genus *Mustelus* is a complex group containing many species, several of which may occur in the present study area. Our present knowledge of this genus is so confused that we can do no more than illustrate a typical *Mustelus* (figs. 9B and 12) to indicate the general appearance of these sharks. In combination with Dr. P. C. Heemstra, who is engaged on a worldwide revision of the genus, we shall continue work on *Mustelus* and hope to revise the southern African representatives in the near future. Identification of *Mustelus* to generic level is covered under the section on *Triakis*.

Genus *Iago* Compagno and Springer, 1971

Iago Compagno and S. Springer 1971: 616; type-species *Eugaleus omanensis* Norman 1939: 11, fig. 3, Gulf of Oman

Iago omanensis was first described by Norman (1939) from a 28 cm female taken in 210 m of water in the Gulf of Oman. He tentatively placed it in the genus *Eugaleus* (synonymous with *Galeorhinus*). Compagno (1970) noted that it should be in a new genus and he and S. Springer (1971) described the monotypic genus *Iago* on the basis of sixteen specimens from the Arabian Sea. *Iago* has not been recorded from the south-west Indian Ocean and the following brief account is based on those of Norman (1939), Compagno and S. Springer (1971) and Nair and Mohan (1973).

Iago is characterized by the following combination of characters: distinct spiracles; upper and lower lip grooves present, the uppers being the longer; transitional nictitating lower eyelid; first dorsal origin in front of pectoral axil; interdorsal ridge present; second dorsal more than half as high as first dorsal; no precaudal pits; caudal fin without definite lower lobe; teeth with single cusps, markedly oblique, not serrated, in two or three functional rows. The most characteristic features are the forward position of the first dorsal with its origin in front of the pectoral axil, and the lack of a definite lower lobe to the caudal fin. The latter distinguishes *Iago* from all the carcharhinid genera of the south-west Indian Ocean except *Eridacnis*, *Ctenacis* and possibly *Scylliogaleus*. The latter genera all have a first dorsal origin well behind the pectoral axil. The forward position of the first dorsal differentiates *Iago* from all the other carcharhinids of this region except some species of *Carcharhinus*. These are identified by, among other characters, distinct precaudal pits (absent in *Iago*) and the absence of spiracles (present in *Iago*).

Iago omanensis (Norman, 1939)

Eugaleus omanensis Norman 1939: 11, fig. 3 (orig. descr., Gulf of Oman): Nair and Mohan 1973: 76, fig. 3 (descr.; Gulf of Mannar)

Iago omanensis: Compagno and S. Springer 1971: 619, figs. 1 to 6 (good descr., distrib., biology; Gulf of Oman, Northern Arabian Sea)

No study material. The information presented here is taken from Compagno and S. Springer (1971) and Nair and Mohan (1973).

Description

A 57 cm female from the northern Arabian Sea is outlined in fig. 13 (after figs. 1 and 2 of Compagno and S. Springer 1971). The colour is described as brownish or greyish above and lighter below, with no conspicuous markings or abrupt colour changes from dorsal to ventral. The tips and leading edges of the dorsal and caudal fins, the gill slit margins and the pectoral axil may have a darker pigmentation. Nair and Mohan (1973) note the presence of irregular white patches (possibly albinism) on the body.

TEETH

The teeth (fig. 13B) are small, similar in upper and lower jaws, not serrated, and in two or three functional rows. The dental formula is given as $\frac{46 \text{ to } 55}{37 \text{ to } 45}$ (Compagno and S. Springer 1971) and as $\frac{18—2—18}{18—2—18}$ (Nair and Mohan 1973). Slight sexual dimorphism is shown by the slightly more erect cusp tips on the teeth of adult males (Compagno and S. Springer 1971).

VERTEBRAL COUNTS

Iago omanensis is notable among sharks in having a clear indication of sexual dimorphism in vertebral numbers. According to the data presented in table 3 of Compagno and S. Springer (1971) there is a significant difference between males and females in regard to numbers of monospondylous precaudal, diplospondylous precaudal, caudal, and total vertebrae (table 3). Only in the case of precaudal numbers is the difference not significant, but this may result from the small sample size.

Biology

SIZE

Recorded examples (one by Norman 1939, 16 by Compagno and S. Springer 1971, 18 by Nair and Mohan 1973) range from 22 to 58 cm in length. A 22 cm male was immature and others of 30 to 36 cm were mature, as were females of 40 to 58 cm.

BREEDING DATA

Iago omanensis probably bears live young in litters ranging from about two to ten in number (Compagno and S. Springer 1971).

DISTRIBUTION

Locality records range from the Gulf of Oman and the northern Arabian Sea in depths of 110 to 368 m (Norman 1939, Compagno and S. Springer 1971) to the Gulf of Mannar at the southern tip of India in depths of 366 to 494 m (Nair and Mohan 1973).

Genus *Galeorhinus* Blainville, 1816

Galeorhinus Blainville 1816: 212; type-species *Squalus galeus* Linnaeus 1758 (*fide* Garrick and Schultz 1963: 27)

Compagno (1970) discussed *Galeorhinus* and allied genera in some detail and provided a key to their identification. The genera likely to be found in the present study area include *Galeorhinus*, *Hypogaleus* and *Iago* and are easily distinguished by the characters used in the

present generic key. No adequate review of the taxonomy of the genus *Galeorhinus* (*sensu stricto*) is available. Compagno (1970) lists five nominal species used by recent authors of which *G.galeus* (Linnaeus, 1758) is the southern African representative. J. L. B. Smith (1957b) recognized only three species in the genus *Galeorhinus* (*sensu lato*) — *galeus*, *japanicus* and *zanzibarensis*. He placed the latter two species in a new subgenus *Hypogaleus*, subsequently raised to generic rank by Compagno (1970), with two nominal species — *zanzibarensis* Smith, 1957 and *hyugaensis* Miyosi, 1939. "*Galeorhinus*" *japanicus* is properly placed in the genus *Hemitriakis* which does not occur in the present study area.

Only one species of *Galeorhinus* (*G.galeus*) is found in the seas about southern Africa. It can be distinguished from the other carcharhinid sharks of the area by the combination of spiracles, single-cusped smooth-edged teeth in two or three functional series, no precaudal pits, a long terminal sector to the caudal fin (distance from caudal notch to tip equal to about half the length of the upper caudal trailing edge), and an anal fin about equal in height to the second dorsal fin. Other features include a nictitating lower eyelid varying from transitional to internal, distinct upper and lower lip grooves, no interdorsal ridge, a first dorsal origin approximately over the inner pectoral corner and a second dorsal fin less than half the height of the first dorsal.

Galeorhinus galeus (Linnæus, 1758)

"Soupfin shark"

Squalus galeus Linnaeus 1758: 234 ("European Ocean")

Galeus canis: Gilchrist 1902: 163 (recorded; South Africa); von Bonde 1933: 40 (recorded; Cape); von Bonde 1934: 14 (distrib.; South Africa)

Galeorhinus canis: Thompson 1914: 140 (synonymy; Cape); Barnard 1925: 28, pl. 1 (3) (descr., distrib.; Cape seas.); Barnard (1947): 10, pl. 1 (5, 5a) (descr., distrib.; South Africa)

Galeorhinus galeus: J. L. B. Smith 1949: 44, fig. 15 (descr., distrib.; South Africa); D'Aubrey 1964: 21, pl. 7 (descr., distrib.; Cape); Davies 1964: 48, 50, 88 (exploited; South Africa); Morgans 1964: 86 (listed; North Kenya); Day *et al* 1970: 88 (distrib.; False Bay); J. L. B. Smith 1971: 237, fig. 2 (descr.; Cape)

Study material

20 males (82 to 152 cm) and 14 females (67 to 143 cm) plus a 21 cm embryo, all from the eastern to south-western Cape coast; a 143 cm male from South West Africa.

A 138 cm male (ORI 2444) is preserved in the collection of the Oceanographic Research Institute, in Durban.

Description

A 134 cm mature male *Galeorhinus galeus* from the eastern Cape is shown in fig. 14. The colour is dark gray above, paler below. Seen from below the snout has a translucent, slightly milky appearance. The nictitating lower eyelid was transitional in a 21 cm embryo, internal in specimens of 67 cm and longer.

The proportional dimensions of 18 specimens (13 male, 5 female, 67 to 139 cm in length) are summarised in table 21.

TEETH

The teeth of a 140 cm mature female from Algoa Bay are shown in pl. 1. Tooth counts of fifteen jaws ranged from $\frac{34}{31}$ to $\frac{40}{36}$ as summarised in table 4. No significant sexual dimorphism was apparent in the jaws examined.

VERTEBRAL COUNTS

Precaudal counts of 40 *G.galeus* ranged from 81 to 87 with a mean of 83.5 (s = 1.4). Total vertebrae of these sharks averaged 132.9 (129 to 139, s = 2.5).

Biology

Virtually nothing is known about the biology of *G.galeus* in southern African waters although it is one of the most abundant sharks of the southern and western Cape, known to every fisherman and taken on a commercial basis at times. As recently as five years ago Day *et al* (1970), in a survey of the benthic fauna of False Bay in the south-western Cape, summarised the range of *G.galeus* as from Beira to Walvis Bay. In fact this shark rarely, if ever, occurs as far north as Natal along the east coast. Confusion over the distribution of the species has probably arisen from misidentification of the similar species *Hypogaleus hyugaensis*, a tropical shark occasionally found in Mozambique and Natal waters. The reason for the lack of information about the biology of the species in Cape waters is not so clear — *G.galeus* seems to be one of those animals that is so common that nobody considers the species worthy of attention. *Galeorhinus* populations from other parts of the world have been studied extensively (e.g. in Australia — Olsen 1953, 1954, 1959; in southern California — Ripley 1946). The following brief account of the present state of knowledge of the southern African species does little more than show up the need for research on one of the few sharks of the area that occurs in sufficient numbers to be fished commercially.

SIZE

We have only one record of an embryo of *G.galeus* — a 21 cm specimen from Port Elizabeth. J. L. B. Smith (1957b) noted 30 cm specimens and illustrated a 29 cm male but did not state whether or not these were embryos. The smallest free-swimming specimen in the present study material is a 67 cm female. Females of up to 133 cm were immature and another of 143 cm was mature. Males of 105 to 113 cm were adolescent and the smallest mature male (of six) measured 123 cm. The largest specimens seen in the present study were a 143 cm female and a 152 cm male. Barnard (1925) and J. L. B. Smith (1949) gave the maximum size as about 180 cm but Smith later (1957b) noted that he examined specimens ranging up to only 135 cm in length.

BREEDING DATA

No information is available on the breeding habits of southern African *G.galeus* save that it is live-bearing. A lone embryo, 21 cm in length, is included among the present study material.

DISTRIBUTION

G.galeus is an abundant shark of the western and southern Cape coasts, ranging up the east coast at least as far as East London. It has not been recorded from Natal during the present study. J. L. B. Smith (1957b, p. 589) does not give any definite records of *G.galeus* from Natal or southern Mozambique but states that "we found no evidence of its presence anywhere north of Delagoa Bay". This shark is caught from the shore and is also taken by trawlers at depths down to at least 100 fathoms (183 m) (J. L. B. Smith 1957b).

FEEDING

The stomach contents of *G.galeus* examined during the present study consisted mainly of bottom-living teleost fish such as soles (Soleidae) and hake (*Merluccius capensis*). Several specimens had eaten small cephalopods.

Genus *Hypogaleus* Smith, 1957

Hypogaleus J. L. B. Smith 1957b: 589; type-species *Galeorhinus* (*Hypogaleus*) *zanzibarensis* J. L. B. Smith 1957b: 589, fig. 2, pl. 19 (Zanzibar)

The genus *Hypogaleus* includes two nominal species — *hyugaensis* (Miyosi, 1939) and *zanzibarensis* J. L. B. Smith, 1957. As Compagno (1970) points out, Smith did not mention the Japanese shark *H.hyugaensis* in his description of *H.zanzibarensis* as taken from Zanzibar and the Kenya coast and the two species may be synonymous. We can find no significant differences between specimens from the Natal coast and *H.hyugaensis* as illustrated and described by Miyosi (1939). For the present, we regard *H.hyugaensis* and *H.zanzibarensis* as synonyms.

Hypogaleus can be distinguished from the other carcharhinid sharks of south-west Indian Ocean by the combination of distinct spiracles, single-cusped teeth in two or three functional series, no precaudal pits, a first dorsal origin over or slightly behind the inner pectoral corner, and an anal fin about two-thirds as high as the second dorsal. Other features include an internal nictitating lower eyelid, no interdorsal ridge or lateral ridges on the caudal peduncle, and a distinct lower lobe on the caudal fin which has a short terminal sector (distance from caudal notch to tip less than half the length of the upper caudal trailing edge).

Hypogaleus hyugænsis (Miyosi, 1939)

"Lesser soupfin shark"

Eugalensis hyugaensis Miyosi 1939: 91, fig. 1 (orig. descr.; Japan)
Galeorhinus (*Hypogaleus*) *zanzibarensis* J. L. B. Smith 1957b: 589, fig. 2, pl. 19 (orig. descr.; Zanzibar)
Galeorhinus hyugaensis: Chen 1963: 82 (descr.; Taiwan)
Galeorhinus zanzibarensis: D'Aubrey 1964: 22, pl. 8 (descr.; Natal)

Study material

Four males (112 to 127 cm) and four females (115 to 122 cm), two of these pregnant, plus two embryos of 27 and 28 cm, all from the Natal coast.

A 118 cm male (ORI 2922), a 115 cm female (ORI 2928), and a 26 cm female embryo (ORI 2927b) are preserved in the collection of the Oceanographic Research Institute in Durban.

Description

A 127 cm mature male *Hypogaleus hyugaensis* from Natal is shown in fig. 15. The basic colour is a dull grey, paler underneath except for the front part of the snout which is slightly pigmented. In late embryos the dorsal and caudal fins are clearly marked with black tips and transparent trailing edges, while the anal fin is completely colourless. The angle of the trailing edge of the caudal fin also has a clear black mark, while the underside of the snout in front of the nostrils is dark with three distinct linès and an outermost pair of thinner, blurred lines (fig. 15B).

The proportional dimensions of seven specimens (four male, three female, 110 to 122 cm in length) are summarised in table 21.

TEETH

The teeth of a 115 cm male *H.hyugaensis* from the Natal coast are shown in pl. 2. The dental formulae of three jaws were $\frac{48}{43}$ and $\frac{50}{44}$ (twice). No sexual dimorphism was apparent in the few jaws examined.

VERTEBRAL COUNTS

Precaudal counts of three specimens ranged from 93 to 97 with a mean of 95.3. Total counts of these sharks averaged 157.7 (154 to 160).

Biology

SIZE

A litter of embryos averaging 34.1 cm and ranging from 33 to 35 cm in length appeared to be close to full-term. Five males of 112 to 127 cm from the African coast (J. L. B. Smith 1957b; present study) were all mature, as were four females of 114 to 112 cm. The only specimens recorded from elsewhere are two females of 90 and 87 cm from Japan and Taiwan respectively (Miyosi 1939; Teng 1962 *in* Chen 1963). The state of maturity of these two females was not recorded. The largest *H.hyugaensis* yet recorded are a 122 cm female and a 127 cm male, both from Natal. J. L. B. Smith (1957b, p. 592) took occasional specimens at Zanzibar and also on the Kenya coast, "the largest not exceeding 2 000 mm in length". As a female of 114 cm was fully mature, we doubt whether the species does in fact attain even 150 cm in length.

BREEDING DATA

H.hyugaensis is live-bearing, the embryos being nourished by a yolk-sac placenta. Despite the paucity of data on this species there is a clear indication of seasonal breeding with a gestation period of perhaps 15 months ending in about December (table 5). The two complete litters obtained each had eleven embryos, while another female had empty uteri but eleven ripe ova.

DISTRIBUTION

Two females measuring 87 and 90 cm in length have been recorded from Japan (Miyosi 1939) and Taiwan (Chen 1963) but further work is needed to determine whether these are in fact synonymous with specimens taken from the south-west Indian Ocean. In the latter area specimens have been taken from Zanzibar and the Kenya coast (J. L. B. Smith 1957b) and from the Natal coast (present study). *H.hyugaensis* taken in the latter area has been caught in water ranging from 65 to 230 m in depth and includes four mature males and four mature females, plus two embryos taken from another female.

FEEDING

Only two of the sharks examined had any food remains in their stomachs. Both of these had fed on teleost fish.

Genus *Triænodon* Müller and Henle, 1837

Triaenodon Müller and Henle 1837: 117; type-species *Carcharias obesus* Rüppell 1835: 64, pl. 18, fig. 2 (Red Sea)

Triaenodon is a genus of carcharhinid sharks characterized by the following combination of

characters: spiracles present (sometimes absent?); an internal nictitating lower eyelid; minute lip-grooves barely extending around the mouth corners; the snout very short and blunt; no interdorsal ridge; first dorsal origin about midway between pectoral axil and pelvic origin; second dorsal and anal fins about equal in size, each about half the size of the first dorsal; caudal peduncle without lateral ridges; precaudal pits present (lower is indistinct); caudal fin with a definite lower lobe; teeth in rows rather than a mosaic arrangement, in two or three functional series, each with one or more smaller cusps on each side of the main cusp, not serrated.

Three nominal species can be ascribed to the genus *Triaenodon: T.apicalis* Whitley, 1939; *T.obesus* (Rüppell, 1835); and *T.obtusus* Day, 1878. *Triaenodon smithii* Müller and Henle, 1841 belongs in the West African genus *Leptocharias*, while *Triaenodon nigricans* Philippi is a teleost fish. *T.apicalis* is almost certainly a synonym of *T.obesus* while *T.obtusus* is of doubtful status (Day illustrates it with the first dorsal origin over the inner pectoral edge, apart from other differences). Most modern authors regard *Triaenodon* as a monotypic genus.

Triænodon obesus (Rüppell, 1835)

"Blunthead shark"

Carcharhinus obesus Rüppell 1835: 64, pl. 18, fig. 2 (orig. description; Djetta, Red Sea)

Triaenodon obesus: Müller and Henle 1841: 55, pl. (descr., good illustration; Indian Ocean, Red Sea); Playfair 1867: 870 (descr.; Seychelles); Bleeker 1874: 67 (Seychelles); Sauvage 1891: 510 (Madagascar); Garman 1913: 163 (descr., distrib.; Red Sea, Indian Ocean); Fowler 1941: 194 (good synonymy, descr., distrib.; Philippines); J. L. B. Smith 1952: 225 (Inhaca Island); J. L. B. Smith 1953: 511, fig. 13a (descr.; South Africa); Wheeler 1953: 37, pl. V(3) (Mauritius-Seychelles area); Klausewitz 1960: 291, fig. 4, pl. 42 (1) (illustrations of type in Senckenberg Museum, SMF 3149); Wheeler 1960: 202, fig. 1 (descr., distrib.; Tanganyika, Chagos Archipelago); Fourmanoir 1961: 48, fig. 39, pl. XVI (descr., biology; Madagascar; fig. 39 illustrates the teeth of a small *Negaprion*, stated in author's corrections); Fourmanoir 1963: 90, fig. 6 (A) (descr., distrib.; Madagascar); J. L. B. Smith and M. M. Smith 1963: 5, pl. 1 (5) (Seychelles); V. G. Springer and Garrick 1964: 87 (vertebral counts); Talbot 1965: 463 (Tanganyika); Compagno 1970: 80 (discussion of relation of *Triaenodon* to other genera)

Triaenodon apicalis: Fourmanoir 1954: 203 (Comores)

Study material

A 139 cm male from northern Natal; the jaws of two specimens taken in southern Mozambique; a damaged specimen measuring about 70 cm from Mauritius, now in the collection of the museum at Port Louis.

A 139 cm male (ORI 2696) is preserved in the collection of the Oceanographic Research Institute in Durban.

Description

A 139 cm mature male *Triaenodon obesus* is illustrated in fig. 16. This shark had a small but definite spiracle on each side and an internal nictitating lower eyelid. The overall colour was a grayish brown, darker on the head region, and cream underneath. The first dorsal and upper caudal fins were tipped with white, while the leading and trailing edges of all the fins were slightly darkened, although the latter was only apparent on close examination. The proportional dimensions of this specimen are summarised in table 21.

TEETH

The teeth of a 139 cm male from Natal are shown in pl. 3. Dental formulae of three

jaws (including that shown in pl. 3) were $\frac{47}{45}$, $\frac{48}{44}$ and $\frac{50}{46}$ including smaller central teeth of $\frac{5}{4}$, $\frac{4}{4}$ $\frac{4}{5}$ respectively.

VERTEBRAL COUNTS

The adult male taken in northern Natal had 128 precaudal in a total of 208 vertebrae. The only data available for comparison are 129 precaudal and 214 total in an embryo from the western Pacific Ocean (V. G. Springer and Garrick 1964).

Biology

T.obesus appears to be a fairly common shark of the northern Natal and Mozambique coasts but only one intact specimen and a few jaws and photographs have been obtained during the present study. The following brief account of *T.obesus* in the south-west Indian ocean consists primarily of information extracted from the literature.

SIZE

According to Fourmanoir (1961) *T.obesus* is born at 52 to 60 cm in length and matures at 100 cm. He noted a 52 cm embryo while the smallest free-swimming specimen yet recorded appears to be a 68 cm female from Zanzibar (Wheeler 1959).

Pregnant females have ranged from 105 to 145 cm in length (Wheeler 1960, Fourmanoir 1961) and Wheeler (1953) noted that a 110 cm male from the Mauritius/Seychelles area was mature. The largest specimen recorded in the south-west Indian Ocean measured 160 cm (Fourmanoir 1954). J. L. B. Smith and M. M. Smith (1963) state that *T.obesus* attains seven feet (213 cm) but illustrate a 122 cm specimen.

BREEDING DATA

Three litters recorded by Wheeler (1959) and Fourmanoir (1961) contained two, two and three embryos. Insufficient information is available to determine any seasonality in the breeding habits.

DISTRIBUTION

T.obesus is a common species of shallow tropical waters in the Indian and Pacific Oceans. In the eastern Pacific it is insular in habit, being plentiful at the Galapagos Islands but rare on the mainland coast (Kato *et al* 1967). In the south-west Indian Ocean the situation is different, for *T.obesus* is apparently fairly common on the northern Natal and southern Mozambique coasts where it is regularly seen by skin-divers. It has been recorded from Tanganyika (Wheeler 1959), Mozambique (J. L. B. Smith 1952; present study) and northern Natal (present study). *T.obesus* also occurs near most of the islands of the south-west Indian Ocean. It has been recorded at Zanzibar (Wheeler 1959), Madagascar (Fourmanoir 1961), the Comores (Fourmanoir 1954), Tromelin Island (G. R. Batchelor, *pers. comm.* and photograph) and the Mauritius/Seychelles area (present study, among others).

T.obesus appears to be restricted to clear, shallow waters in coral-reef areas. Fourmanoir (1961) notes that it usually swims at depths of 8 to 40 m but is occasionally caught in deeper water down to 110 m.

FEEDING

Fourmanoir (1961) observed that *T.obesus* from Madagascar feeds mainly on crustaceans. The most comprehensive study of the feeding habits of this species comes from work by Hobson (1963) in the Marshall Islands of the South Pacific. He noted that *T.obesus* frequented the shallow lagoons, the centre of activity being among the coral heads and ledges bordering the seaward passages. It was commonly seen resting motionless on the bottom, often under ledges and in caves. Hobson (1963, p. 177) noted that it was "clumsy and ineffective in attempts at taking baits which were suspended in mid-water. However, this same shark was remarkably effective in tracking down and capturing prey which had taken shelter deep in one of the many holes or crevices typical of a coral reef".

Genus *Negaprion* Whitley, 1940

Negaprion Whitley 1940: 111; type-species *Aprionodon acutidens queenslandicus* Whitley 1939: 233, fig. 6 (Queensland)

The genus *Negaprion* is distinguished from all other carcharhinid sharks by a combination of erect, smooth-edged, single-cusped teeth and a second dorsal fin almost as large as the first. Other characters include an internal nictitating lower eyelid; minute upper lip groove but no lower lip groove; first dorsal origin slightly behind inner pectoral corner; no interdorsal ridge; anal fin almost as large as second dorsal fin; caudal peduncle without lateral ridges; definite precaudal pits; and a distinct lower lobe to the caudal fin. Spiracles are usually considered to be absent in *Negaprion* but do occur in our study material, among others (see Fourmanoir 1961). The characteristic pale brown colour gives rise to the common name of "lemon shark".

There are several nominal species (see Bigelow and Schroeder 1948, p. 309) which should probably be referred to two species: *N.brevirostris* (Poey, 1868) of the western (and eastern?) Atlantic, and *N.acutidens* (Rüppell, 1835) of the Indian and western Pacific Oceans. Further study might show the genus to be monotypic, but further descriptions of specimens from various localities are necessary before a valid comparison is possible. The present description fills in one of these gaps in our knowledge of *Negaprion*.

Negaprion acutidens (Rüppell, 1835) is the name usually applied to Indian Ocean and Pacific members of this genus. This species was originally described from a 68 cm specimen taken in the Red Sea and is distinguished from *N.brevirostris* by a wider snout and by differences in the teeth (bases of some of the teeth with one strong denticle on the outer side in *N.acutidens*, without any strong denticles in *N.brevirostris* — see Bigelow and Schroeder 1948, p. 309). An adult female *Negaprion* from Iran (in the present study material) refers to *N.brevirostris* in snout shape and in the denticulation of the teeth. However, a 52 cm embryo taken from this same shark has some of the teeth with a marked denticle on the outer side of the base. Both the embryo and the adult have a snout shape corresponding to *N.brevirostris* rather than *N.acutidens* and it seems likely that R ppell's illustration (1835, pl. 18, fig. 3) is inaccurate in this regard. Examination of the type-specimen (now in the Senckenberg Museum — Klausewitz 1960) would resolve this point. Specimens from Madagascar (described under the name *Odontaspis madagascariensis* Fourmanoir, 1961) and from the Seychelles and Natal (present study material) appear to be identical with that from Iran. An 84 cm specimen from the Seychelles has upper teeth with at least one corrugation, often appearing as a definite cusp, on the outer side of the base. The teeth of the lower jaw all have smooth bases. Larger specimens (from Natal) lack these denticulations and have smooth bases to all their teeth (pl. 4).

Negaprion acutidens (Rüppell, 1835)

"Lemon shark"

Carcharias acutidens Rüppell 1835: 65, pl. 18, fig. 3 (orig. descr.; Red Sea); Günther 1870: 361 (descr.; Seychelles); Sauvage 1891: 510 (Madagascar)

Negaprion acutidens: J. L. B. Smith 1959: 16, pl. (descr.; Kosi Bay); Klausewitz 1960: 292, fig. 5 (holotype); J. L. B. Smith 1961b: 565, pl. 108 (10b) (descr.; Seychelles); D'Aubrey 1964: 23, pl. 9 (descr., distrib.: northern Natal)

Odontaspis madagascariensis Fourmanoir 1961: 15, figs. 8, 39, pl. 3 (orig. descr., biology; Madagascar)

Negaprion madagascariensis: Fourmanoir 1963: 95 (habitat; Madagascar)

Study material

A 243 cm male from northern Natal; the jaws of three specimens from northern Natal and southern Mozambique; the teeth of a 234 cm specimen from Mauritius; an 84 cm female from the Seychelles (BMNH ?.5.14.58); a 232 cm female from Iran, containing six embryos of 24 to 51 cm.

A 243 cm male (ORI 2934) from Natal and a 232 cm female plus four embryos of 24 to 51 cm (ORI 1158, 1158c, d, e, f) from Iran are preserved in the collection of the Oceanographic Research Institute in Durban.

Description

A 243 cm mature male *Negaprion acutidens* from Northern Natal is shown in fig. 17A, The overall colour is a yellowish brown, paler below. Also shown in fig. 17B for comparative purposes is an outline of a 232 cm female *N.acutidens* from Iran. The nictitating lower eyelid is internal. *Negaprion* is usually described as lacking spiracles (see, e.g., Bigelow and Schroeder 1948:308) but the mature male described here has no spiracle on one side but a definite spiracle some one and a half millimetres in length on the other side. Fourmanoir (1961) describes specimens from Madagascar as having spiracles.

The proportional dimensions of a 243 cm male *N.acutidens* from Natal are summarised in table 21.

TEETH

The teeth of a female of approximately 280 cm from southern Mozambique are shown in pl. 4. The teeth are smooth-edged, without serrations. As noted above, the teeth of young specimens may have denticulated bases, particularly in the upper jaws.

The dental formulae of three jaws were $\frac{14—1—14}{13—2—13}$, $\frac{14—2—14}{14—1—14}$, and $\frac{14—2—14}{14—2—14}$.

Fourmanoir (1961) gives the dental formula of specimens from Madagascar as $\frac{32}{30}$.

VERTEBRAL COUNTS

A specimen from Natal had 139 precaudal in a total of 225 vertebrae, while an embryo from Iran had 140 precaudal in a total of 227. These counts differ markedly from that of 117 precaudal and 201 total in a Florida *Negaprion* (V. G. Springer and Garrick 1964).

Biology

The following brief account of the biology of *N.acutidens* in the south-west Indian Ocean is largely based on data provided by Fourmanoir (1961).

SIZE

Fourmanoir (1961) records embryos of 62 cm in length and notes that the newborn young measure 70 to 80 cm. He gives the length at maturity as about 214 cm and the maximum length as 310 cm. Specimens caught off the northern Natal and southern Mozambique coasts appear to range from about two to three metres in length. A 243 cm male from northern Natal was fully mature.

According to Fourmanoir (1961), the young are born in October and November. A female caught in January had ripe ova ("avec des ouefs en formation") and another taken in August contained thirteen embryos averaging 62 cm in length.

DISTRIBUTION

Sharks of the genus *Negaprion* have been recorded from warm, shallow waters of all major oceans. The southernmost record of this species along the east coast of Africa consists of two specimens taken in northern Natal at a latitude of 28°25′S. Elsewhere in the south-western Indian Ocean it has been recorded from Madagascar (Fourmanoir 1961), Maritius and the Seychelles (present study). This rather sluggish shark is usually found in shallow water where it swims near the bottom. Fourmanoir (1961) notes that in Madagascar it prefers sandy plateaus with little coral structure and is caught most readily in depths of 8 to 15 m.

FEEDING

The only records of stomach contents of *N.acutidens* taken in the south-west Indian Ocean include a *Diodon hystrix* and spines from a sting-ray (*Dasyatis* sp.). Garrick and Schultz (1963) regard *Negaprion* as dangerous and list one uprovoked and five provoked attacks by *N.brevirostris* in the Florida/South Carolina area.

Genus *Hemipristis* Agassiz, 1833

Hemipristis Agassiz 1833: 8; type-species *Hemipristis serra* Agassiz, 1833 (*fide* Garrick and Schultz 1963: 28)

The genus *Hemipristis* was first described on the basis of fossil teeth. Leriche (1938) realised that the Red Sea shark named *Dirrhizodon elongatus* Klunzinger, 1871 was closely allied to *Hemipristis*, and published good illustrations of the teeth of the type-specimen. Despite this, Gohar and Mazhar (1964) described a further two specimens from the Red Sea under the name *Heterogaleus ghardaquensis*. We follow the majority of modern workers in regarding *Hemipristis* and *Dirrhizodon* as congeneric, but note that Compagno (1973c) separates the two genera on the basis of histological differences in the tooth structure. Specimens have now been recorded from the seas around India and south-east Asia as well as the south-west Indian Ocean. The first record from the East African coast was made by J. L. B. Smith (1957d) on the basis of specimens from Zanzibar and northern Mozambique while Fourmanoir (1961) took three sharks of this species on the west coast of Madagascar. At present there appears to be only one extant species but a lack of comparative material prevents a thorough investigation into the differences, if any, between specimens from the different parts of the Indian Ocean and the Red Sea. Considerable variation is present in the descriptions available at present, probably because of growth changes in the proportional dimensions.

The characteristic teeth allow sharks of this genus to be readily identified (pl. 5). Other features include distinct spiracles; definite upper and lower lip grooves; internal nictitating lower eyelids; first dorsal origin approximately over the inner pectoral corner; second

dorsal fin about half the height of first dorsal, its origin in front of anal origin; anal fin slightly shorter than second dorsal; caudal peduncle without lateral ridges; precaudal pits present although the lower may not be distinct; caudal fin with a distinct lower lobe and subterminal notch, the length from the subterminal notch to the tip about a fifth of the upper caudal length; and notably long falcate pelvic fins with acute tips to the lateral lobes. An interdorsal ridge has been reported as present (Fourmanoir 1961) and as absent (J. L. B. Smith 1957d).

Hemipristis elongatus (Klunzinger, 1871)

"Fossil shark"

Dirrhizodon elongatus Klunzinger 1871: 665 (orig. descr.; Red Sea)

Hemipristis elongatus: Leriche 1938: 12, figs. 3, 4 (generic synonymy, figs. of jaw of type specimen); J. L. B. Smith 1957d: 556, fig. 1, pl. 16 (synonymy, descr., distrib.; Zanzibar, northern Mozambique); Fourmanoir 1961: 46, figs. 37, 38, pl. 15 (descr.; Madagascar); V. G. Springer and Garrick 1964: 88 (vertebral counts; Gulf of Thailand)

Heterogaleus ghardaquensis Gohar and Mazhar 1964: 29, figs. 13-16, pl. 2 (orig. descr.; Red Sea)

Study material

Part of the jaw of a 137 cm female from Zanzibar, now in the collection of the J. L. B. Smith Institute of Ichthyology in Grahamstown; the jaws from a specimen of about 150 to 200 cm, sex not recorded, from Margate (latitude 30°52′S on the Natal coast), now in the collection of the Natal Anti-Shark Measures Board.

Description

Descriptions of specimens from the south-west Indian Ocean are given by J. L. B. Smith (1957d) and Fourmanoir (1961), the former including good illustrations and detailed measurements of a 137 cm female from Zanzibar. An outline of this shark is shown in fig. 18 (after pl. 17 of J. L. B. Smith 1957d). Fourmanoir (1961) and Setna and Sarangdhar (1949) note that small specimens have a much longer snout than adults. The body is an almost uniform light grey, hardly lighter below, the fins plain (J. L. B. Smith 1957d). Gohar and Mazhar (1964) give a similar description of a specimen from the Red Sea while Setna and Sarangdhar (1949) note that Indian specimens are a light ashy-brown above and dull white on the sides and below.

TEETH

The teeth of the 137 cm female from Zanzibar described by J. L. B. Smith (1957d) are illustrated in pl. 5. Smith gives the dental formula of this shark as $\frac{13—13}{16—16}$ but a recount of the left side of the same jaw gives a count of $\frac{14}{18}$. The shark taken on the Natal coast had a tooth count of $\frac{14—14}{18—18}$. Fourmanoir (1961) notes a count of $\frac{14—14}{17—17}$ in specimens from Madagascar and Setna and Sarangdhar (1949) recorded counts of $\frac{13 \text{ or } 14—13 \text{ or } 14}{18—18}$ in sharks from India.

VERTEBRAL COUNTS

The only data available are three counts of specimens from the Gulf of Thailand (V. G. Springer and Garrick 1964). Precaudal vertebrae of these sharks ranged from 103 to 104 (mean = 103.7) while total counts varied from 190 to 194 (mean = 192.0).

Biology

SIZE

A 60 cm male from Madagascar had a visible umbilical scar (Fourmanoir 1961) and Setna and Sarangdhar (1949) gave the size at birth as about 45 cm and recorded a free-swimming specimen of 68 cm from India. Their largest specimen was 218 cm in length. Garrick and Schultz (1963) noted that *H.elongatus* is common up to about 240 cm in the Gulf of Thailand and the type-specimen, from the Red Sea, measured 230 cm (Klunzinger 1871).

BREEDING DATA

Setna and Sarangdhar (1949) state that *H.elongatus* is viviparous and record a range of six to eight embryos per litter.

DISTRIBUTION

H.elongatus is a common inhabitant of the shallow waters about India and in the Gulf of Thailand (Setna and Sarangdhar 1949, Garrick and Schultz 1963). It has been recorded from Vietnam (Fourmanoir 1965) west to the Red Sea (Gohar and Mazhar 1964) and south to Madagascar (Fourmanoir 1961) and the East African coast (J. L. B. Smith 1957d). Smith noted a 137 cm female from Zanzibar and a mutilated specimen of about 1,5 m from 14°10′S on the Mozambique coast. The specimen taken at Margate (30°52′S) extends the range of this species into South African waters where it appears to be a rare visitor. All *H.elongatus* recorded from the south-west Indian Ocean have been taken close to the shore.

FEEDING

Setna and Sarangdhar (1949) note a wide range of prey items including smaller sharks (*Carcharhinus* sp.), rays (*Pteroplatea poecilura*) and mackerel (*Scomber* sp.). *H.elongatus* is thus an active predator on relatively large prey which, when combined with the shallow-water habitat, may make it potentially dangerous to man-as noted by Garrick and Schultz (1963).

Genus *Hemigaleus* Bleeker, 1852

Hemigaleus Bleeker 1852: 46; type-species *Hemigaleus macrostoma* Bleeker 1852: 46, fig. 10, Batavia (*fide* Norman 1966: 18)

In the absence of study material we follow Compagno (1970) in considering *Hemigaleus* Bleeker, 1852, *Chaenogaleus* Gill, 1862, *Negogaleus* Whitley, 1931 and *Paragaleus* Budker, 1935 to be congeneric. Several different species have been described, mainly from the northern Indian Ocean and the western Pacific. In the Atlantic Ocean, *H.pectoralis* was described by Garman (1906) from a specimen apparently taken in the north-west Atlantic. No further specimens have been taken in this region but *H.gruveli* (Budker 1935) from tropical West Africa appears to be a junior synonym of *H.pectoralis* (Krefft 1968). Six nominal species have been recorded from Indian and western Pacific seas but the only record of the genus *Hemigaleus* from the south-west Indian Ocean is of two sharks described as *Paragaleus pectoralis* by Fourmanoir (1961), both taken off the west coast of

Madagascar. These sharks appear to correspond with the type-specimen of *H.pectoralis* as illustrated in Garman (1913) except for the teeth in the lower jaws. Fourmanoir (1961, fig. 41) shows the eighth, ninth and tenth lower teeth as being erect and only slightly denticulated on the outer side of the bases whereas the corresponding teeth in *H.pectoralis* are markedly oblique and heavily denticulated on the outer side of the bases. Fourmanoir gives the number of teeth in the lower jaw as about twenty as compared to a range of 27 to 33 in *H.pectoralis*, or 24 to 30 if the central teeth are not counted (see Krefft 1968). Apart from this discrepancy the Malagasy sharks are indistinguishable from *H.pectoralis*. A certain identification will have to await the collection of further specimens from the south-west Indian Ocean.

The genus *Hemigaleus* can be characterized by the following combination of characters: distinct spiracles; well-marked precaudal pits; caudal peduncle without lateral ridges; caudal fin with a distinct lower lobe and subterminal notch; lip-grooves present, the uppers at least half as long as the mouth length, the lowers somewhat shorter; teeth with single, non-serrated cusps, the uppers oblique with strongly denticulated bases on the outer edge, the lowers erect towards the centre and erect or oblique towards the sides; from one to four rows of functional teeth, the teeth not in a mosaic arrangement.

The combination of distinct spiracles and precaudal pits, a definite lower caudal lobe, and the arrangement of the teeth in rows rather than a mosaic distinguishes *Hemigaleus* from all the carcharhinid sharks of the south-west Indian ocean except *Galeocerdo*, *Triaenodon*, *Hemipristis* and *Loxodon*. *Galeocerdo* and *Hemipristis* can be separated by the heavily serrated cusps to their upper and (*in Galeocerdo*) lower teeth. *Hemigaleus* has smooth, non-serrated cusps to the teeth in both jaws, although the upper teeth may have strongly denticulated bases on the outer side. *Triaenodon* is distinguished by, among other characters, multicuspid teeth and a short, blunt snout (internasal distance more than snout length in *Triaenodon*, less than snout length in Hemigaleus). *Loxodon* is easily differentiated by its minute or indiscernible spiracle and by the relative positions of the anal and second dorsal fins (anal origin over or behind the second dorsal origin in *Hemigaleus*, well in front of it in *Loxodon*).

Hemigaleus sp. (incertæ sedis)

Paragaleus pectoralis: Fourmanoir 1961: 49, figs. 7 (c), 40, 41, 42 (descr.; Madagascar)

No study material. Specific identification is dependent on the collection of further specimens. Descriptions of the various nominal species can be found in Chen 1963 (*H.balfouri*, *H.pingi*, *H.microstoma*, *H.macrostoma*, *H.tengi*), Garman 1913 (*H.pectoralis*), Budker 1935 (*H.gruveli*) and Fowler 1941 (*H.machlani*).

DESCRIPTION

Fourmanoir (1961) gives good illustrations of a 102 cm female from the west coast of Madagascar, plus a few measurements of the body dimensions. An outline of this specimen is shown in fig. 19 (after fig. 42 of Fourmanoir 1961). The colour is described as gray with the trailing edges of the fins a paler colour. The tooth count is given as about thirty in the upper jaws and twenty in the lowers.

VERTEBRAL COUNTS

The only counts available for any shark of this genus range from 72 to 82 (precaudal) and from 142 to 150 (total) in *H.pectoralis* from the Atlantic Ocean (V. G. Springer and Garrick 1964, Krefft 1968).

Biology

Fourmanoir (1961) records a 102 cm female and another of which the size and sex was not recorded. He does not indicate whether the female was mature or immature. Most species of *Hemigaleus* grow to a maximum length of not much than a metre. Mature males of *H.balfouri*, *H.microstoma* and *H.tengi* measured 97, 91 and from 77 to 81 cm respectively (Chen 1963). Krefft (1968) described a 57 cm male *H.pectoralis* from West Africa as "semiadult" and another two males of 78 and 93 cm as adult while a gravid female from the same region measured 138 cm and contained embryos ranging from 44 to 47 cm in length (Budker 1935). No further details of the method of reproduction are known.

DISTRIBUTION

Hemigaleus appears to be confined to fairly shallow tropical seas in the western Pacific, Indian and eastern Atlantic oceans. The single record from the western Atlantic was of uncertain origin (Garman 1913) and the genus is at the most a rare visitor to American coasts.

Genus *Prionace* Cantor, 1849

Prionace Cantor 1849: 1381; type-species *Squalus glaucus* Linnaeus 1758: 235 (*fide* Bigelow and Schroeder 1948: 280)

The monotypic genus *Prionace* is readily identified among carcharhinid sharks by the combination of no spiracles, distinct precaudal pits, a first dorsal fin set far back with its origin well behind the inner pectoral corner (by a distance equal to or greater than that from the 1st to 5th gill-slits), and teeth with single, markedly serrated cusps. Other characters include an internal nictitating lower eyelid, minute upper lip groove, no lower lip groove, a long pointed snout, no inter-dorsal ridge, a caudal peduncle without lateral ridges, and a distinct lower lobe to the caudal fin. When alive or newly dead *Prionace* is characterized by a brilliant dark blue colour on its dorsal surface.

Prionace glauca (Linnæus, 1758)

"Blue shark"

Squalus glaucus Linnaeus 1758: 235 ("European Ocean")

Carcharhinus glaucus: Barnard 1925: 26 (descr.; Agulhus Bank); Barnard (1947): 9 (Agulhas Bank)

Eulamia glaucus: von Bonde 1934: 14 (distrib.; South Africa)

Glyphis glaucus: J. L. B. Smith 1949: 42, fig. 10 (descr.; South Africa)

Prionace glauca: Crosnier and Fourmanoir 1961: 881, fig. (Madagascar); Fourmanoir 1961: 20, 81, fig. 10 (descr.; Comores); D'Aubrey 1964: 24, pl. 10 (descr., distrib.; South Africa); V. G. Springer and Garrick 1964: 88 (vertebral counts); Merrett 1965: 19 (south-west Indian Ocean); Merrett 1966: 18 (East Africa); Day *et al* 1970: 88 (False Bay)

Study material

Six males (248 to 300 cm) and eight females (97 and 222 to 320 cm), from various offshore localities in the south-west Indian Ocean.

Four sibling embryos of 29 to 34 cm (ORI 1722 d, f, h, l) are preserved in the collection of the Oceanographic Research Institute in Durban.

Description

A 279 cm mature male *Prionace glauca* from 29°49′S, 32°24′E is shown in fig. 20. The overall colour is a brilliant dark blue which fades to a dull grey soon after death. The underparts are white.

The proportional dimensions of nine specimens (five male, four female, 218 to 295 cm in length) are summarised in table 21.

TEETH

The teeth of a 279 cm adult male from 29°49′S, 32°24′E are shown in pl. 6. No marked sexual dimorphism was apparent in the jaws examined.

The usual tooth count in 13 jaws was $\frac{14—1—14}{13 \text{ or } 14—2—13 \text{ or } 14}$

Central teeth varied between none and one in the upper jaws and between one and two in the lower jaws. Variation in the numbers of lateral teeth is summarised in table 6.

VERTEBRAL COUNTS

Precaudal counts of 12 *P.glauca* ranged from 146 to 150 with a mean of 147.9 (s = 1.6). Total vertebrae of these sharks averaged 245.1 (241 to 250, s = 2.4). These counts do not differ markedly from those recorded for *P.glauca* by V. G. Springer and Garrick (1964). The latter note a specimen from Cape Town with 143 precaudal vertebrae, slightly below the range shown by the present study material.

Biology

Present study material includes only a few records of this pelagic shark and the following brief account of its biology is amplified by information extracted from the literature, in particular from the detailed study of Strasburg (1958) on the pelagic sharks of the central Pacific Ocean. It should be noted that populations of *P.glauca* from different regions may differ in regard to features such as size and breeding habits and the present account is no more than a guide to the general biology of the species.

SIZE

P.glauca is usually born at about 50 cm in length. Fourmanoir (1961) recorded embryos ranging from 48 to 50 cm in females taken near Madagascar and Backus (1957) noted that western Atlantic *P.glauca* is born at about this length. Free-swimming specimens of slightly over 50 cm have been recorded (Bigelow and Schroeder 1948). The size at maturity is not known in males. Nine adults of this sex taken during the present study ranged from 248 to 300 cm, but as no smaller males were caught the size at maturity cannot be determined. The smallest mature female on record is a pregnant specimen measuring 208 cm from the Pacific Ocean (Strasburg 1958). Ten mature females taken in the south-western Indian Ocean have ranged from 222 to 320 cm (Fourmanoir 1961 and present study). The largest specimen for which Bigelow and Schroeder (1948) could find positive record measured 383 cm while the largest which they themselves saw was only 11 feet (335 cm) which is probably closer to the usual maximum size for *P.glauca*.

BREEDING DATA

Litters of *P.glauca* contain highly variable numbers of embryos and there may be a correlation between the size of the mother and the number of young. Three pregnant females taken during the present study contained 6, 17 and 58 embryos, while Fourmanoir (1961) recorded two litters from Madagascar, each of which contained 39 embryos.

Elsewhere, litters ranging from only 4 (Strasburg 1958) to 63 have been recorded (see list of European and western Atlantic records in Tucker and Newnham 1957). Backus (1957) notes that the reproductive season is apparently not restricted in *P.glauca* of the northern Atlantic. However, the data of Strasburg (1958) for central Pacific specimens suggest that more young may be born during summer than at other times.

DISTRIBUTION

P.glauca is a pelagic species usually found away from continental shelf areas. In the south-west Indian Ocean it has been recorded from about 35°S latitude (present study) northwards to at least the Comores (13°S — Fourmanoir 1961). J. L. B. Smith (1949) notes that off the west coast of southern Africa it is abundant and commonly attacks the nets of trawlers working in the area. It will occasionally come into very shallow inshore waters (Randall 1963), but definitely increases in abundance with increased distance from land (Strasburg 1958).

Strasburg (1958) discusses temperature preferences in *P.glauca* of the central Pacific. This shark is usually found in water of temperatures ranging from 7 to 15°C, less often in warmer water up to 21°C, and occasionally in even warmer waters. This explains why *P.glauca* is found in temperate and tropical seas, for in the latter regions it normally occurs in deeper and thus cooler water than that found at the surface. Strasburg found that, in the north-central Pacific, the greatest concentrations of this shark are to the north of 20°N latitude. In the tropical regions (between latitudes 20°N and 23°S) no seasonal fluctuations in the abundance of *P.glauca* were apparent. In the region from 20° to 50°N marked seasonal migrations (northwards in summer, southwards in summer) were observed, often in relation of the shifting transition zone between the relatively cold Aleutian Current and the relatively warm North Pacific Current. Strasburg also noted a marked degree of sexual segregation, females being concentrated at higher latitudes (possibly in relation to nursery areas) and males at lower latitudes.

FEEDING

The stomach contents of a few specimens examined during the present study included a number of teleost fish, two elasmobranchs (including a *Scapanorhynchus owstoni* and some squid. Like most pelagic sharks, *P.glauca* appears to feed on virtually anything that comes within range. Limbaugh (1963, p. 76) notes that specimens are "often seen biting at tin cans and wooden boxes floating on the surface". He considers it to be aggressive and Garrick and Schultz (1963) list several unauthoritative identifications of *P.glauca* as being responsible for shark attacks in various parts of the world.

Genus *Galeocerdo* Müller and Henle, 1837

Galeocerdo Müller and Henle 1837: 397; type-species *Squalus arcticus* Faber, 1829 (= *Squalus cuvier* Lesueur, 1822 — *fide* Bigelow and Schroeder 1948: 265)

The genus *Galeocerdo* has only one modern representative, easily distinguished from all other carcharhinid sharks by the single-cusped, heavily-serrated, cockscomb-shaped teeth and the lateral keels on the caudal peduncle. Other characters include the presence of spiracles, long upper and lower lip grooves, an internal nictitating lower eyelid, first dorsal origin over the pectoral axil or inner edge, second dorsal much smaller than the first, an interdorsal ridge, definite upper and lower precaudal pits, and a long thin tapering tip to the upper caudal. The common name of "tiger shark" comes from the striped markings visible on juveniles but fading in adults. *G.cuvieri* (Lesueur, 1822) is a common species of shallow

tropical waters in all three major oceans and a great deal has been written about the biology of this shark, in particular their feeding habits. An excellent summary of the biology of the species in the western Atlantic is given by Clark and von Schmidt (1965). Unless otherwise indicated the following account of *G.cuvieri* refers only to the populations found in the south-western Indian Ocean where, unfortunately, few original observations have been made. A good synonymy of the species can be found in Bigelow and Schroeder (1948).

Galeocerdo cuvieri (Lesueur, 1822)

"Tiger shark"

Squalus cuvier Lesueur 1822: 351 ("New Holland")

Galeocerdo cuvier: Bigelow and Schroeder 1948: 266, fig. 44 (good descr., distrib., synonymy; north-west Atlantic); J. L. B. Smith 1949: 44, pl. 1 (14) (descr.; South Africa); Fourmanoir 1961: 21, figs. 12, 13 (descr.; Madagascar); J. L. B. Smith and M. M. Smith 1963: 5, pl. 2F, F (Seychelles); D'Aubrey 1964: 19, pl. 6 (descr., distrib.; South Africa).

Study material

An embryo of about 63 cm from a female taken off Cape St. Francis in the eastern Cape, now in the Natal Museum, Pietermaritzburg; 23 males and 24 females (130 to 410 cm) from Natal; a 104 cm female from southern Mozambique; a record of a 205 cm female from Tromelin Island; three females (283 to 367 cm) and the jaws of a pregnant female from St. Brandon; an adult male (not measured) from Mauritius.

A 168 cm male (ORI 1166) and a 104 cm female (ORI 2591) are preserved in the collection of the Oceanographic Research Institute in Durban.

Description

A 107 cm immature female *Galeocerdo cuvieri* from southern Mozambique is shown in fig. 21. Larger specimens lose the dark striping although remnants of this can still be seen in some specimens of three metres or longer.

The proportional dimensions of 30 specimens (10 male, 20 female, 104 to 410 cm in length) are summarised in table 22.

TEETH

The teeth of a 239 cm immature female from Natal are shown in pl. 7. The usual tooth count among 34 specimens from Natal was $\frac{10 \text{ or } 11—1—10 \text{ or } 11}{11—1—11}$. Central teeth always numbered one in both jaws with one exception where the upper jaws contained two central teeth. Variation in the numbers of lateral teeth is summarised in table 7. Tooth counts of four specimens from St. Brandon appear to be slightly lower than those of Natal *G.cuvieri*, usually being $\frac{10—1—10}{10—1—10}$ (table 7). The possibility of isolation and differentiation between populations to the east and west of Madagascar should not be ignored.

VERTEBRAL COUNTS

Precaudal counts of 28 specimens from Natal ranged from 100 to 112 with a mean of 106.5

(s = 2.2). Total counts of 25 of these sharks averaged 225.6 (216 to 233, s = 4.1). A specimen from St. Brandon had 102 precaudal vertebrae while V. G. Springer and Garrick (1964) recorded precaudal counts of 106 and 108 in two embryos from Florida and 105 precaudal in a total of 231 in a specimen from the Gulf of Thailand.

Biology

SIZE

An embryo from a specimen caught in the eastern Cape measured 63 cm while a litter of well-developed embryos taken at St. Brandon averaged 63 cm, ranging from 59 to 67 cm. Fourmanoir (1961) notes a litter of *G.cuvieri* embryos averaging 68 cm. The smallest free-swimming specimen yet recorded in the south-west Indian Ocean is the 104 cm female illustrated here.

Males are immature at 259 cm, adolescent at 275 cm and mature at lengths of 290 cm and more. Females from about 250 to 300 cm are adolescent and Fourmanoir (1961), presumably referring to female *G.cuvieri* from Madagascar, notes that maturity is at about 340 cm. He records three pregnant females of 345 to 377 cm while present study material includes four mature females of 363 to 410 cm.

The largest specimens recorded in the south-west Indian Ocean are a 410 cm female and a 370 cm male (present study). The longest of which Bigelow and Schroeder (1948) found positive record was a Cuban specimen of about 18 feet (5.5 m). Fourmanoir (1961) notes that he has seen a photograph of a 7.4 m female from Indo-China.

BREEDING DATA

In the south-west Indian Ocean five pregnant female *G.cuvieri* have been recorded (table 8). Numbers of embryos averaged 35.4 and ranged from 23 to 46 per litter.

DISTRIBUTION

G.cuvieri is widespread throughout the tropical parts of the south-west Indian Ocean. It has been recorded from the Seychelles (J. L. B. Smith and M. M. Smith 1963), St. Brandon, Mauritius and Tromelin (present study), Madagascar and Europa Island (Fourmanoir 1961), southern Mozambique, Natal and the eastern Cape (present study). The principal adult population and the nursery areas seem to be restricted to tropical regions for *G.cuvieri* taken in Natal has consisted almost entirely of immature and adolescent animals. Only two of 24 females were fully mature and only six of 23 males. The smallest specimen taken in Natal was a 127 cm male. In the eastern Cape *G.cuvieri* is rare, the only definite record being a pregnant female caught in 1929.

The seasonal distribution of specimens taken in Natal is summarised in table 9. Contrary to what might be expected of a tropical species, *G.cuvieri* appears to be rare during the warm months of January to April. Females were most abundant from October to December while males showed a more diffuse seasonality with a slight concentration from May to September. In an analysis of the catches of *G.cuvieri* in shark nets off bathing beaches along the Natal coast, Wallett (1973) noted a similar size distribution to that recorded here. He noted that this shark is caught in small numbers throughout the year and that, contrary to what one might expect for a tropical species, it appears to be more common in southern Natal than in the northern regions.

FEEDING

The indiscriminate feeding habits of *G.cuvieri* have brought it a great deal of attention. It is best described as a scavenger (see, e.g., Bigelow and Schroeder 1948, J. L. B. Smith 1949, Clark and von Schmidt 1965). The stomach contents of specimens caught during the present study confirm this definition (table 10).

The large size, shallow-water habitat and all-embracing appetite make *G.cuvieri* one of the most dangerous species of sharks as far as man is concerned. None of the numerous southern African shark attacks have been proved to be due to *G.cuvieri* but the species has been blamed for several attacks in other parts of the world (see, e.g. Garrick and Schultz 1963).

Genus *Loxodon* Müller and Henle, 1838

Loxodon Müller and Henle 1838: 36; type-species *Loxodon macrorhinus* Müller and Henle 1841: 61, pl. (no type locality)

The three closely related carcharhinid genera *Loxodon*, *Rhizoprionodon* and *Scoliodon* have been reviewed by V. G. Springer (1964). *Scoliodon* does not occur in the present study area but *Loxodon* and *Rhizoprionodon* each have one representative in the south-west Indian Ocean. A key to all three genera and the several species can be found in V. G. Springer (1964) and will not be repeated here. It will suffice to note that *Loxodon* and *Rhizoprionodon* can be distinguished from the other carcharhinids of the south-west Indian Ocean by the following combination of characters: origin of second dorsal fin never in advance of the centre of the anal base, often over or behind the anal axil; smooth, single-cusped oblique teeth in two or three functional series; an internal nictitating lower eyelid; first dorsal origin over or slightly behind inner pectoral corner; no lateral ridges on caudal peduncle; distinct precaudal pits; and a caudal fin with a definite lower lobe.

The two species of this group found in the south-west Indian Ocean, *Loxodon macrorhinus* Müller and Henle, 1841 and *Rhizoprionodon acutus* (Rüppell, 1837), are similar at first sight but are easily separated by the following characters:

	L.macrorhinus	*R.acutus*
Combined length of upper and lower lip grooves	Less than nostril length	Equal to or more than nostril length
Position of second dorsal origin	Over or behind anal axil	In front of anal axil
Shape of eye	Orbit with a distinct notch in hind rim	Orbit smooth, without notch in hind rim
Fin markings	First dorsal and caudal with thin dark trailing edges; pectorals and pelvics with pale trailing edges	Fins plain, tips and trailing edges at most slightly darkened
Precaudal vertebrae	70 or less	More than 70

Loxodon macrorhinus Müller and Henle, 1841

"Sliteye shark"

Loxodon macrorhinus Müller and Henle 1841: 61 (orig. descr.; no type-locality); Bleeker 1874: 67 (listed; Madagascar); Poller 1874: 62 (listed; Madagascar); Sauvage 1891: 510 (listed; Madagascar); Gudger 1929: 511 (painting by Nicolas Pike; Mauritius); Wheeler 1959: 106, figs. 1, 2, 3 (descr.; Zanzibar); J. L. B. Smith

1961b: 565, pl. 108 (15a) (distrib.; Inhaca island); J. L. B. Smith 1961: 19, fig. (Delagoa Bay); J. L. B. Smith and M. M. Smith 1963: 5, pl. 1 (H) (Seychelles); V. G. Springer 1964: 588, fig. 4, pl. 1 (A) (revision of genus) *Scoliodon palasorrah:* Fourmanoir 1961: 44, figs. 34, 35 (descr.; Madagascar); J. L. B. Smith and M. M. Smith 1963: 5, pl. 2 (6) (Seychelles)

Study material

Five males (73 to 85 cm) and nine females (74 to 90 cm), from northern Natal, southern Mozambique, and St. Brandon (one). Most of these specimens were obtained in poor condition, many of them gutted.

Two males of 78 and 79 cm (ORI 2657, 1244) and a 74 cm female (ORI 1244) are preserved in the collection of the Oceanographic Research Institute in Durban.

Description

A 75 cm adolescent male *Loxodon macrorhinus* from southern Mozambique is shown in fig. 22. The overall colour is grey with the trailing edges of the fins transparent, overlain by a thin black edging in the case of the first dorsal and caudal fins. A very thin dark edging is apparent on the trailing edge of the second dorsal but is only visible on close examination. A minute spiracle is usually present but visible only to an experienced worker. The characteristic notching of the hind rim of the orbit is always noticeable. The second dorsal origin is usually over, sometimes slightly behind, the anal axil. None of our specimens had any trace of an interdorsal ridge but V. G. Springer (1964) reports that a low, short ridge is sometimes present in this species.

The proportional dimensions of eight specimens (four male, four female, 73 to 86 cm in total length) are summarised in table 22.

TEETH

The teeth of a 78 cm male from St. Brandon are shown in pl. 8. The cusps are smooth in all cases. V. G. Springer (1964, p. 588) notes that "the teeth of adult males may be slightly more erect than those of females, but the difference is not striking". No sexual dimorphism was apparent in our limited study material.

The usual tooth count among eight jaws was $\frac{12—1—12}{12—1 \text{ or } 2—12}$. Central teeth were always single in the upper jaws, in one or two rows in the lower jaws. Variation in the numbers of lateral teeth is summarised in table 11.

VERTEBRAL COUNTS

Precaudal counts of seven *L.macrorhinus* ranged from 83 to 85 with a mean of 84.0 ($s = 1.0$). Total vertebrae of these sharks averaged 161.7 (160 to 163, $s = 0.9$). As shown by V. G. Springer (1964), vertebral counts of *L.macrorhinus* from different localities vary greatly.

Biology

SIZE

Two apparently full-term embryos from a female taken off southern Mozambique measured 39 and 40 cm. V. G. Springer (1964) recorded a 42 cm embryo from Mauritius and noted a free-swimming specimen measuring only 43 cm (from Formosa). Males are immature at 66 cm (Philippines — V. G. Springer 1964) and mature at about 73 to 75 cm (present study). Females of 85 cm taken in the south-west Indian Ocean were pregnant (Wheeler 1959; present study). The longest specimen seen at Zanzibar by Wheeler (1959) measured 91 cm. Present study material includes an 85 cm male and a 90 cm female.

BREEDING DATA

Two pregnant females taken in the south-west Indian Ocean each contained two embryos. Nothing is known about seasonality of reproduction in *L.macrorhinus*.

DISTRIBUTION

L.macrorhinus ranges from northern Natal and southern Mozambique (present study) northwards to the Red Sea and eastwards to Madagascar (Fourmanoir 1961, as *Scoliodon palasorrah*), the Mauritius/Seychelles area (V. G. Springer; present study), India, the Philippines, Dutch East Indies and Australia (V. G. Springer 1964). Judging by the distribution along the Natal coast *L.macrorhinus* appears to be restricted to warm clear water in which it is fairly common. We have only one doubtful record of the species from the more turbid waters of central Natal where *Rhizoprionodon acutus* is abundant. Depth records for *L.macrorhinus* range from 7 m (Zanzibar — Wheeler 1959) to about 80 m (northern Natal — present study).

Genus *Rhizoprionodon* Whitley, 1929

Rhizoprionodon Whitley 1929: 354; type-species *Carcharias (Scoliodon) crenidens* Klunzinger, 1880 (= *Carcharias acutus* Rüppell, 1835) (*fide* V. G. Springer 1964)

Of seven species recognized by V. G. Springer (1964) in a review of this genus, only *R.acutus* (Rüppell, 1837) occurs in the present study area. A full key to all the species of *Rhizoprionodon* can be found in V. G. Springer (1964) and will not be repeated here. Identification of *R.acutus* is discussed under *Loxodon* (p. 27).

Rhizoprionodon acutus (Rüppell, 1835)

"Milk shark"

Carcharias acutus Rüppell 1835: 65, pl. 18 (4) (orig. descr.; Red Sea)

Scoliodon vagatus Garman 1913: 116 (orig. descr.; Zanzibar); J. L. B. Smith 1949: 43 (listed; East Africa);

Scoliodon walbeehmi: J. L. B. Smith 1949: 43, fig. 12 (descr.; Natal)

Scoliodon palasorrah: J. L. B. Smith 1949: 43 (descr.; Natal)

Rhizoprionodon acutus: D'Aubrey 1964: 25, pl. 11 (descr., distrib.; south-east Africa); Davies and Joubert 1966: 11, 15, 21 (tagged; Natal; Davies and Joubert 1967: 118, 121, 126 (tagged; Durban); Johnson *et al* 1968: 661 (bacteria in gut; Mozambique channel)

Rhizoprionodon (Rhizoprionodon) acutus: V. G. Springer 1964: 594, figs. 5, 6 (revision of genus)

Study material

Numerous specimens ranging from 30 to 89 cm (male) and from 29 to 102 cm (female), all from Natal and southern Mozambique.

A 66 cm male (ORI 1207) and three females of 34 to 99 cm (ORI 1927, 928, 2590) are preserved in the collection of the Oceanographic Research Institute in Durban.

Description

A 99 cm mature female *Rhizoprionodon acutus* from Natal is shown in fig. 23. The overall colour is grey, paler below, with the fins only slightly if at all darker than the back. There is

no spiracle, nor is there an interdorsal ridge. The second dorsal origin is over or slightly behind the centre of the anal base. The orbit is smooth, without any trace of the notching characteristic of *Loxodon*.

The proportional dimensions of 111 specimens (40 male, 71 female, 32 to 101 cm in length) are summarised in table 22.

TEETH

The teeth of a 95 cm mature female from Natal are shown in pl. 9. The teeth are smooth edged except in specimens over 90 cm where slight traces of serrations can be seen under magnification. No sexual dimorphism is apparent in our study material, but V. G. Springer (1964) notes that the cusps of mature males may be slightly more erect than those of females.

The commonest tooth count among 100 jaws was a remarkably constant $\frac{12—1—12}{11—2—11}$

The central teeth numbered one above and two below in each case. Variation in the numbers of lateral teeth is summarised in table 12.

VERTEBRAL COUNTS

Precaudal counts of 107 *R.acutus* ranged from 64 to 70 with a mean of 67.0 (s = 1.6). Total vertebrae of 104 of these sharks averaged 136.3 (128 to 148, s = 3.2). V. G. Springer (1964, table 9) summarises the precaudal vertebral counts of *R.acutus* from a number of localities with a wide range of variation in numbers.

Biology

SIZE

R.acutus from the east coast of southern Africa is born at a length of about 30 to 35 cm. Full-term embryos have ranged up to 34 cm in length and free-swimming specimens of 29 to 35 cm, all with open umbilical slits, have been recorded. Males mature between 68 and 72 cm, females at 70 to 80 cm. The smallest pregnant female measured 71 cm but another was still virgin at 81 cm although otherwise fully mature. The largest specimens were an 89 cm male and a 102 cm female. V. G. Springer (1964) notes that different populations of *R.acutus* may differ with regard to size.

BREEDING DATA

The number of embryos in 27 litters ranged from two to eight, usually from three to six, with an average of 4.7. A fairly clear breeding season is apparent with mating in November, December and, to a lesser extent, January. The young are born about a year later (table 13).

DISTRIBUTION

According to V. G. Springer (1964), *R.acutus* ranges from Madeira in the eastern Atlantic to the east African coast, Madagascar, the Red Sea, Australia and Japan. Off the east coast of southern Africa, the distribution ranges as far south as Natal where the bulk of the specimens taken are adolescent or mature males and females. A few newborn young have been recorded, mostly from northern Natal. *R.acutus* is usually taken from inshore waters and is often caught in the surf in Natal where it occurs throughout the year but is more abundant during the warmer months. Two newborn young were caught in Richards Bay in salinities of 30 and 33‰, showing that this shark may enter brackish water on occasion.

FEEDING

R.acutus usually feeds on small teleost fish but has also been recorded as preying on crustaceans and cephalopods. It does not reach a large enough size to be dangerous to man.

Genus *Carcharhinus* Blainville, 1816

Carcharhinus Blainville 1816: 121; type-species (by designation) *Carcharias melanopterus* Quoy and Gaimard 1824: 194, figs. 1, 2, pl. 24 (Waigu Island)

The genus *Carcharhinus* as represented in the south-western Indian Ocean is treated by Bass, D'Aubrey and Kistnasamy (1973). We note here only that sharks of this genus can be distinguished from the other carcharhinid sharks of the area by the combination of the following features: no spiracles; internal nictitating lower eyelid; lip grooves very short; teeth blade-like with single cusps; cusps of the upper teeth always (sometimes minutely) serrated, the lowers with smooth or serrated cusps; one series of teeth functional in the upper jaws, one to three in the lower jaws; first dorsal origin closer to the pectoral axil than to the pelvic origin; second dorsal fin not more than half the height of the first dorsal; second dorsal origin in front of centre of anal base; anal base less than twice as long as second dorsal base; upper and lower precaudal pits present; caudal fin with a definite lower lobe; caudal peduncle without lateral keels.

Family Sphyrnidæ

Sharks of the family Sphyrnidae are easily distinguished from all other sharks by the possession of lateral expansions of the head to form the well-known "hammer". Apart from this feature they are virtually indistinguishable from the "higher" carcharhinids. Recent revisions of this family have been made by Fraser-Brunner (1950), Tortonese (1950) and Gilbert (1967). We follow Gilbert (1967) as being not only the latest but also the most complete work on this group.

Several different genera have been proposed of which Gilbert (1967) recognises only *Sphyrna* with three subgenera: *Sphyrna*, *Eusphyra* and *Platysqualus*. Three species, all belonging to the subgenus *Sphyrna*, have been recorded from the south-west Indian Ocean.

Genus *Sphyrna* Rafinesque, 1810

Sphyrna Rafinesque 1810: 46, 60; type-species *Squalus zygaena* Linnaeus 1758: 234 (*fide* Bigelow and Schroeder 1948: 408)

This genus is distinguished primarily by the shape of the head which is expanded laterally so as to carry the eyes out to the tips of dorso-ventrally flattened stalks. The nostrils are situated along the leading edge of this "hammer". Other features include an internal nictitating lower eyelid, no spiracles, second dorsal fin much smaller than the first, no interdorsal ridge and a definite upper precaudal pit. The lower precaudal pit is less well marked and, in a few cases, absent. A key to all species of *Sphyrna* can be found in Gilbert (1967). The following key serves only to distinguish those species found off the south-east African coast:

1A Front margin of head without a median indentation or "scallop" . . . . *zygaena*

1B Front margin of head with a median indentation or "scallop" 2

2A Hind margins of pelvic fins markedly concave; teeth with definite serrations easily visible to the naked eye; second dorsal height greater than length of third gill-slit . . . . . *mokarran*

2B Hind margins of pelvic fins almost straight, at most only slightly concave; teeth with smooth-edged or at most weakly serrated cusps; second dorsal height less than or equal to length of third gill-slit . . . . . *lewini*

Good synonymies for each species are given by Gilbert (1967). The great majority of references to *Sphyrna* in the south-west Indian Ocean are not referable to any particular species with certainty and have been ignored in the present account. Similarly, many incidents involving skin-divers and sharks of this genus have been reported from localities on the southern African coast. Most of these have involved sharks interested in fish which had been speared, and unprovoked attacks by hammerhead sharks on swimmers are rare. Garrick and Schultz (1963) list two cases of authoritative identifications of unprovoked attacks by these sharks, as well as several less definite cases.

Sphyrna lewini (Griffith and Smith, 1834)

"Scalloped hammerhead"

Zygaena lewini Griffith and Smith *in* Cuvier, Griffith and Smith 1834: 640, pl. 50 ("New Holland") (*fide* Gilbert 1967: 37)

Sphyrna diplana: Fourmanoir 1961: 42, pl. 16 (descr., biology; Madagascar)

Sphyrna lewini: D'Aubrey 1964: 46, pl. 27 (descr., distrib.; South Africa), Gilbert 1967: 37, figs. 10, 21d, pls. 3, 6B, 9B, 10B (revision of family)

Study material

Numerous specimens ranging from 73 to 295 cm (male) and from 45 to 307 cm (female), from the Natal and southern Mozambique coasts.

Two females of 45 and 47 cm (ORI 1544, 1545) are preserved in the collection of the Oceanographic Research Institute in Durban.

Description

A 47 cm immature female *Sphyrna lewini* from Natal is shown in fig. 24. The colour is grey above, paler below. Larger specimens are darker in colour and lose the fin markings.

The proportional dimensions of 91 specimens (49 male, 42 female, 45 to 307 cm in length) are summarised in table 23.

TEETH

The teeth of a 307 cm female from Durban are shown in pl. 10. In contrast to *S.mokarran* and *S.zygaena* the cusps are not serrated. No sexual dimorphism was apparent in the few adult jaws examined. The usual tooth count among 78 specimens was $\frac{15—2—15}{15 \text{ or } 16—1—15 \text{ or } 16}$.

Central teeth were usually two above and one below, very occasionally one or none above and two below. Variation in the numbers of lateral teeth is summarised in table 14.

VERTEBRAL COUNTS

Precaudal counts of 66 *S.lewini* ranged from 91 to 96 with a mean of 93.6 (s = 1.3). Total counts of these sharks averaged 196.4 (191 to 203, s = 2.4). These agree with counts of 92 to 96 precaudal and 192 to 204 total for three specimens from Java, China and Jamaica, but are substantially higher than the count of 89 precaudal and 174 total for a shark from

Carolina (V. G. Springer and Garrick 1964). Gilbert (1967) gives a range of 86 to 100 precaudal and 174 to 204 total vertebrae in nine specimens, the localities not given but probably including the four specimens of Springer and Garrick.

SIZE

The smallest *S.lewini* taken during the present study measured 45 cm in length. Slightly larger specimens have also had fresh umbilical scars and some may be born at lengths of up to 50 cm. Males mature between 140 and 165 cm and reach a maximum length of at least 295 cm. Information on the size at maturity in females is lacking as only one adult of this sex, 307 cm in length, was recorded during the present study. A 212 cm female was adolescent, possibly mature, but still virgin. Clarke (1971) took a 309 cm female at Hawaii and Gilbert (1967) notes that the maximum length of the species is probably between 12 and 13 feet (3.7 and 4.0 metres).

BREEDING DATA

A pregnant female taken at Durban in July 1971 contained 30 embryos and four undeveloped eggs in her uteri. The embryos averaged 22.8 cm in length, ranging from 19 to 25 cm. The distribution of the sexes in each uterus was remarkably asymmetrical. The right uterus contained 11 females and 4 males, the left contained 3 females and 12 males. The probability of such a distribution (if a 50:50 sex ratio is expected in each uterus) is less than 0.005 ($x^2 = 8.57$ with one degree of freedom). This could be just a rare occurrence, but litters taken from other shark species during this study have shown similar phenomena on occasion, and the genetic basis of sex determination in sharks deserves further investigation. No other data are available on the breeding of *S.lewini* in the south-west Indian Ocean. Clarke (1971) noted that *S.lewini* at Hawaii dropped their young throughout the year with an increased birth rate during the summer months.

DISTRIBUTION

Gilbert (1967) notes that *S.lewini* has a circumtropical distribution and has been recorded from the Pacific, Atlantic, Mediterranean and Indian Oceans. Off the east coast of southern Africa *S.lewini* is common as far south as Natal where juvenile and adolescent specimens are taken throughout the year but in greater numbers during the warmer months. A few newborn specimens have been taken by trawlers in northern Natal but the primary nursery areas appear to be concentrated further to the north. Numbers of young *Sphyrna* spp., possibly *S.lewini*, are caught by commercial fishermen in northern Mozambique (G. R. Hughes, *pers. comm.*). Adult females are rare in Natal seas — the only one seen during the present study was found dead in Durban Bay — while adult males are caught only during December. This is a regular feature occurring every year and presumably reflects a migration of some sort. Wallett (1973) reports that large numbers of *S.lewini*, estimated as being from about 80 to 120 cm in length, have been seen swimming in packs along the Natal south coast during the months from September to January. This seems to be analagous to the situation in *S.zygaena* where large aggregations of young occur in the eastern Cape during the summer months. The size and seasonal distribution of *S.lewini* in Natal is summarised in table 15.

Near Madagascar *S.lewini* is apparently fairly common but neither adults nor newborn young have been recorded. The smallest specimen taken measured 71 cm (Fourmanoir 1961).

FEEDING

99 of 186 *S.lewini* had food remains in their stomachs, as summarised in table 16. Teleost fish proved to be the principal diet component with cephalopods a poor second. Clarke (1971) found a high proportion of squid remains in the stomach contents of Hawaiian

specimens. This probably reflects the availability of fish and squid in each area rather than a difference in food preferences.

Sphyrna mokarran (Rüppell, 1835)

"Great hammerhead"

Zygaena mokarran Rüppell 1835: 66, pl. 17 (orig. descr.; Red Sea)
Sphyrna tudes: Fourmanoir 1961: 41, figs. 31, 32 (descr., biology; Madagascar)
Sphyrna mokarran: D'Aubrey 1964: 47, pl. 28 (descr., distrib.; Natal); Gilbert 1967: 25, figs. 6, 7, 21b, 22b, pls. 2, 6A (revision of family)

Study material

Five males (175 to 310 cm) and seven females (165 to 338 cm) from the Natal coast; a 300 cm female from the Mozambique channel; a 341 cm male from the Nazareth Bank to the north of St. Brandon.

Description

A 187 cm immature male *Sphyrna mokarran* from Natal is shown in fig. 25. Field identification of this species is often made by reference to the relatively straight leading edge of the hammer. It should be noted that young specimens have the leading edge of the hammer angling back on each side and may therefore be confused with *S.lewini*. The overall colour is a dark gray or gray-brown, paler below.

The proportional dimensions of ten specimens (four male, six female, 162 to 332 cm in length) are summarised in table 23.

TEETH

The teeth of a 338 cm female from Natal are shown in pl. 11. A slight sexual dimorphism is apparent, with the teeth of adult males slightly thinner and more erect than those of females. However, these differences are not marked and it is impossible to determine the sex of a jaw without comparative material. The usual tooth count among seven specimens was $\frac{17—2 \text{ or } 3—17}{17—1—17}$. Central teeth varied between two and three in the upper jaws, between one and two in the lower. Variation in the numbers of lateral teeth is summarised in table 17.

VERTEBRAL COUNTS

Precaudal counts of five *S.mokarran* ranged from 94 to 96 with a mean of 95.2. Total counts of four of these sharks averaged 205.8 (203 to 208). These compare with counts of 97 and 98 precaudal and 205 and 206 total for two specimens from Australia and Mexico respectively (V. G. Springer and Garrick 1964). Gilbert (1967) gives what are apparently the vertebral counts of the same two sharks but does not mention locality and also gives one precaudal count as 95. Calculating back from his figures of total and of "tail minus body" vertebrae this figure is obviously a misprint and should be read as 97.

Biology

SIZE

According to Fourmanoir (1961) the size at birth in *S.mokarran* should not exceed 50 cm.

He recorded embryos of up to 32 cm in length and did not indicate the length of his smallest free-swimming specimens. A 187 cm male taken off southern Natal was immature. Fourmanoir (1961) noted that maturity is reached at about 250 cm and that the maximum size is about 5.5 m. The largest specimens taken during the present study were a 341 cm male and a 338 cm female. *S.mokarran* is reputed to grow to about 20 feet (six metres) (Gilbert 1967), but specimens over four metres are probably rare.

BREEDING DATA

Fourmanoir (1961) recorded three litters of 18, 18 and 21 embryos from the west coast of Madagascar. The average lengths of each litter were about 25 cm (June), 32 cm (July) and 37 cm (July). No pregnant females have been recorded from the African coast but probably do occur there in the tropical regions.

DISTRIBUTION

S.mokarran is found in warm tropical waters throughout the world (Gilbert 1967). In the south-west Indian Ocean it has been recorded from the Mauritius-Seychelles area (present study), Madagascar (Fourmanoir 1961), the Mozambique channel and the Natal coast (present study; Wallett 1973). Breeding adults appear to be restricted to tropical regions and the nursery areas in the Indian Ocean have yet to be delimited.

S.mokarran taken from the coast of Natal have included adults (three males and four females) and immatures (two males and three females) but juveniles of less than 165 cm are absent. Most of these sharks have been caught during the warmer months (table 18). A similar distribution is shown by catches in shark nets off Natal (Wallett 1973).

Specimens taken during the present study have been caught in depths ranging from 6 to 30 m. Several were trapped in the shark nets placed just outside the surf zone of many Natal beaches. Fourmanoir (1961) notes that *S.mokarran* is found in a wide range of depths near Madagascar. He records catching specimens on drifting lines in the deep sea and notes large *S.mokarran* of three metres and more in water of 70 cm depth and also swimming between emerging coral heads while chasing fish.

FEEDING

Of eight *S.mokarran* stomachs examined in the present study one was empty; seaweed, a rock lobster (*Panulirus homarus*) and a squid beak were recorded once each; teleost fishes twice; and elasmobranch fishes five times. Identifiable prey fishes included *Sparodon durbanensis*, *Dasyatis jenkensii*, *Rhinobatus* sp. and *Halaelurus lineatus*.

Sphyrna zygæna (Linnæus, 1758)

"Smooth hammerhead"

Squalus zygaena Linnaeus 1758: 234 ("Europe and America")

Sphyrna zygaena: D'Aubrey 1964: 45, pl. 26 (desc., distrib.; South Africa); Gilbert 1967: 31, figs. 8, 9, 21c, 22c, pl. 6C (revision of family)

Study material

Three embryos of 43 to 49 cm from the market in Lourenco Marques; 13 males and 15 females (59 to 305 cm) from Natal; 14 males and 12 females (73 to 302 cm) from the eastern and southern Cape.

A 43 cm male embryo (ORI 824) and a 71 cm female (ORI 805) are preserved in the collection of the Oceanographic Research Institute in Durban.

Description

A 71 cm immature female *Sphyrna zygaena* from Durban is shown in fig. 26. The colour is grey above, paler below. The lack of a median indentation on the leading edge of the hammer readily distinguishes this species from *S.lewini* and *S.mokarran*.

The proportional dimensions of 46 specimens (26 male, 20 female, 58 to 305 cm in length) as summarised in table 23.

TEETH

The teeth of a 305 cm female from Durban are shown in pl. 12. The cusps of all the teeth have finely serrated edges. The usual tooth count among 39 specimens was $\frac{14-12-14}{14\quad 1\quad 14}$.

Central teeth numbered two in the upper jaws and one, very rarely two, in the lower jaws. Variation in the numbers of lateral teeth is summarised in table 19.

VERTEBRAL COUNTS

Precaudal counts of 39 *S.zygaena* ranged from 94 to 102 with a mean of 99.7 (s 1.8). Total counts of 37 of these sharks averaged 199.5 (193 to 206, s 3.2). These compare with counts of 99, 102 and 101 precaudal and 202, 206 and 196 total for specimens from Japan, Virginia and an unrecorded locality respectively (first two counts from V. G. Springer and Garrick 1964, third count from Gilbert 1967).

Biology

SIZE

S.zygaena is born at about 60 cm in length. The smallest free-swimming specimen taken during the present study measured 59 cm while the largest embryo was 61 cm long. The size at maturity is not known. The only adults recorded during the present study were two females measuring 302 and 304 cm. Bigelow and Schroeder (1948) note that *S.zygaena* in the north-west Atlantic seemingly does not mature at less than 7 to 8 feet (2.1 to 2.4 m). Gilbert (1967) gives the maximum length as probably between 12 and 13 feet (3.7 and 4.0 m).

BREEDING DATA

A 305 cm female taken near Durban in February had one egg-case in each uterus as well as one 38 mm egg in the left uterus. The ovary contained 52 large (35 to 40 mm) eggs. This shark had fresh courtship bites and was apparently being accompanied by a somewhat smaller shark when it was caught, possibly a courting male. A pregnant female taken near Port Elizabeth in November contained at least 34 full-term embryos averaging 60 cm in length with a range of 57 to 61 cm.

DISTRIBUTION

S.zygaena is found in relatively cool waters in both hemispheres but is apparently rare or absent in the tropics (Gilbert 1967). Off the east coast of southern Africa, young specimens up to about 150 cm are common off the Cape coast and present but less abundant off Natal where they occur throughout the year. Only two adults have been recorded during the present study, both of them females. Embryos of 43 to 49 cm in length and of uncertain locality have been bought in the Lourenco Marques market. These probably come from the Delagoa Bay area and indicate that *S.zygaena* may range further into tropical areas than previously thought. Wallett (1973) noted that *S.zygaena* is seldom caught in shark nets off Natal. The few that are taken are usually in the more southerly areas where they occur chiefly during the cooler months.

Large aggregations of young *S.zygaena* of one to one and a half metres in length have been seen at times along the coast in the vicinity of Port Elizabeth. One such occasion was reported by Mr. G. J. B. Ross in January 1973 when thousands of these sharks were seen along a 26 km stretch of coast between the van Staden's and the Gamtoos rivers. In November 1974 a similar aggregation was observed by one of us (A.J.B.) off the Port Elizabeth beaches at the western end of Algoa Bay. Most of these sharks were swimming idly near the surface, and there was certainly no concerted movement in any one direction. A third aggregation was reported by a member of the Algoa Flying Club who saw hundreds of small hammerheads in January or February 1972 along the coast to the west of Port Elizabeth.

FEEDING

The few stomach contents examined during the present study consisted chiefly of teleost fish with a lesser number of cephalopods and crustaceans.

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Tables
Pages 52 to 65

Table 1. Summary of characters typical of the different grades of carcharhiniform sharks.

General mode of life	Fast-swimming, pelagic	Slow-swimming, usually near the bottom	Very slow-swimming, usually rest on the bottom
General body shape	Relatively short	Long, fusiform	Long, slightly flattened
Position of first dorsal fin	Over pectoral region	Between pectoral and pelvic regions	Over the pelvic region
First dorsal relative to second dorsal fin	Much larger	Slightly larger or about equal	About equal, may be slightly smaller or larger
Angle of upper caudal	Markedly raised	Moderately raised	Almost horizontal
Lower caudal fin	Distinct	Distinct to rather reduced	Virtually non-existent
Precaudal pits	Distinct	Absent	Absent
Nictitating lower eyelid	Internal	Rudimentary, external or transitional	Rudimentary or external
Spiracles	Absent or minute	Present, usually fairly small	Present, usually fairly large
Teeth	Single cusps, only one functional series	One or more cusps, several functional series	Multicuspid, several functional series
Reproduction	Live-bearing with yolk-sac placentae	Live-bearing, with or without yolk-sac placentae	Usually oviparous

Table 2A. Summary of some of the characters of the various carcharhinid genera likely to be found off the east coast of southern Africa.

Genus	Spiracles	Nictitating lower eyelid	Precaudal pits		Usual position of first dorsal origin
			Upper	Lower	
Carcharhinus	Absent	Internal	Present	Present	From slightly behind inner pectoral corner to slightly in front of pectoral axil.
Rhizoprionodon	Absent	Internal	Present	Present	Over inner pectoral edge or corner.
Loxodon	Absent or minute	Internal	Present	Present	Behind inner pectoral corner.
Galeocerdo	Present	Internal	Present	Present	About over pectoral axil.
Prionace	Absent	Internal	Present	Present	Well behind inner pectoral corner.
Hemigaleus	Present	Internal	Present	Present	About over inner pectoral corner.
Hemipristis	Present	Internal	Present	Faint	Over or slightly behind inner pectoral corner.
Negaprion	Absent or minute	Internal	Present	Present	Slightly behind inner pectoral corner.
Hypogaleus	Present	Internal	Absent	Absent	Behind inner pectoral corner.
Galeorhinus	Present	Transitional to internal	Absent	Absent	Behind inner pectoral corner.
Triaenodon	Absent or small	Internal	Present	Faint	Well behind inner pectoral corner.
Iago	Present	Internal	Absent	Absent	In front of pectoral axil.
Mustelus	Present	External or transitional	Absent	Absent	Over inner pectoral edge or corner.
Triakis	Present	External or transitional	Absent	Absent	Over inner pectoral edge or corner.
Scylliogaleus	Present	Transitional	Absent	Absent	Over or slightly behind inner pectoral corner.
Eridacnis	Present	Rudimentary to external	Absent	Absent	Over or slightly in front of inner pectoral corner.
Ctenacis	Present	External	Absent	Absent	Slightly behind inner pectoral corner.

Table 2B. Summary of some of the characters of the various carcharhinid genera likely to be found off the east coast of southern Africa.

Genus	Lip grooves	Interdorsal ridge	Second dorsal height relative to that of first dorsal	Other distinctive features
Carcharhinus	Very short, virtually absent	Present or absent	Never more than half	—
Rhizoprionodon	Fairly short, present on both jaws	Present or absent	Less than half	Second dorsal origin over or behind middle of anal base.
Loxodon	Fairly short, longer on lower jaws	Present or absent	Less than half	Second dorsal origin over anal axil; orbit with distinct notch.
Galeocerdo	Long, particularly on upper jaws	Present	Less than half	Lateral ridges on caudal peduncle; elongated tip to upper caudal.
Prionace	Very short, virtually absent	Absent	Less than half	Very long, pointed snout; long, falcate pectoral fins.
Hemigaleus	Medium length, present on both jaws	Absent	About half or more	—
Hemipristis	Medium length, present on both jaws	Present or absent	About half	Long, falcate pelvic fins with acute tips to lateral lobes.
Negaprion	Very short, virtually absent	Absent	Slightly less	Lemon colour; short blunt snout.
Hypogaleus	Medium length, present on both jaws	Absent	Slightly more than half	First dorsal height over $\frac{1}{2}$ × distance from caudal notch to tip.
Galeorhinus	Medium length, present on both jaws	Absent	About half	First dorsal height less than $\frac{1}{2}$ × distance from caudal notch to tip.
Triaenodon	Short above, longer on lower jaws	Absent	Slightly more than half	Extremely short, blunt snout.
Iago	Medium length, present on both jaws	Absent	About three-quarter	—
Mustelus	Medium length, present on both jaws	Present	About half or more	—
Triakis	Medium to long, present on both jaws	Present	About half or more	—
Scyliogaleus	Long, present on both jaws	Absent	Very slightly less	Prominent grooves joining nostrils to mouth.
Eridacnis	Very short, present on both jaws	Absent	Slightly less	—
Crenacis	Short, present on both jaws	Absent	Slightly less	Long, springy, interdigitating gill-rakers.

Table 2C. Summary of the tooth characters of the various carcharhinid genera likely to be found off the east coast of southern Africa.

Carcharhinus	One or two series functional along sides of jaws; upper teeth single-cusped, edges serrated; lower teeth single-cusped, edges smooth or serrated.
Rhizoprionodon	One or two series functional along sides of jaws; teeth of both jaws single-cusped, cusps and bases smooth or serrated.
Loxodon	As for *Rhizoprionodon* except that the teeth always have smooth-edged cusps, the bases not denticulated.
Galeocerdo	One or two series functional along sides of jaws; teeth similar in both jaws and of distinctive cockscomb shape with heavy serrations.
Prionace	One or two series functional along sides of jaws; teeth of both jaws with single, serrated cusps.
Hemigaleus	Two or three series functional along sides of jaws; teeth of the upper jaws single-cusped, smooth-edged, the bases strongly denticulated on the outer side; lower teeth similar except that only the teeth towards the outer sides of the jaws have the bases strongly denticulated.
Hemipristis	One or two series functional along sides of jaws; teeth near centre of upper jaws lancet-shaped with smooth, single cusps and definite basal denticles, graduating to triangular teeth serrated on both sides of the cusp; lower teeth similar except that the teeth near the sides of the jaws are serrated on the outer side only.
Negaprion	One to three series functional along sides of jaws; teeth of both jaws single-cusped, smooth-edged with the central cusp larger than the outer cusps.
Hypogaleus	One to three series functional along sides of jaws; teeth of both jaws single-cusped, smooth-edged with the bases strongly denticulated on the outer side.
Galeorhinus	As for *Hypogaleus*.
Triaenodon	Two to five series functional along sides of jaws; teeth of both jaws tricuspid, smooth-edged with the central cusp larger than the outer cusps.
Iago	Two or three series functional along sides of jaws; teeth similar in both jaws; central teeth tricuspid, lateral teeth single-cusped, smooth-edged, oblique.
Mustelus	Several functional series with low, rounded, single-cusped teeth in a mosaic arrangement, alternating so the tooth rows appear to be diagonal to the jaw axis.
Triakis	Several functional series with pointed, single- or tri-cuspid teeth in a pavement arrangement, the tooth rows perpendicular to the jaw axis.
Scyliogaleus	Arrangement as for *Mustelus*; teeth with single low, rounded cusps.
Eridacnis	Several series of teeth functional along sides of jaws; central teeth of both jaws tricuspid, smooth-edged with the middle cusp the largest; lateral teeth of upper jaws similar to those in centre in shape and in arrangement; lateral teeth of lower jaws with several equal cusps, arranged in a spiral manner reminiscent of that shown by *Pseudotriakis microdon*.
Crenacis	As for *Eridacnis*.

Table 3. Vertebral counts of *Iago omanensis*. Original data from table 3 of Compagno and S. Springer (1971).

	Sex	Range	Mean	Std. dev.	N	t-value	Significance of difference (%)
Monospondylous precaudals	Male	34-37	35.9	1.35	7	2.71	98
	female	37-42	38.0	1.66	9		
Diplospondylous precaudals	Male	45-51	48.0	1.92	7	2.00	98
	Female	47-52	50.4	1.51	9		
Precaudal	Male	44-58	50.3	4.35	6	1.11	90
	Female	50-58	52.3	2.87	9		
Caudal	Male	129-143	134.1	4.71	7	2.99	99
	Female	134-147	140.8	4.18	9		
Total	Male	81-88	83.9	2.55	7	3.90	99
	Female	84-91	88.4	2.07	9		

Table 4. *Galeorhinus galeus*. Variation in numbers of teeth in 15 specimens.

		Upper jaws							
		33	34	35	36	37	38	39	40
Lower jaws	31	–	1	–	–	–	–	–	–
	32	1	–	–	–	1	–	–	–
	33	1	–	–	1	–	–	–	–
	34	–	–	–	1	–	1	–	–
	35	–	1	–	–	2	3	–	–
	36	–	–	–	–	–	–	1	1

Table 5. *Hypogaleus hyugaensis*. Breeding data.

August	122 cm female – empty uteri, 11 ripe ova (29 to 42 mm diameter)
August	114 cm female – 11 embryos (2 male, 9 female), 22 to 25 cm, mean 23.4 cm
November	? cm female – 2+ embryos (1 male, 1 female), 27 and 28 cm, mean 27.5 cm
December	119 cm female – 11 embryos (6 male, 5 female), 33 to 35 cm, mean 34.1 cm.

Table 6. *Prionace glauca*. Variation in numbers of lateral teeth in 13 specimens.

		Upper jaws					
		24	25	26	27	28	29
Lower jaws	24	–	–	–	1	–	–
	25	–	–	–	–	–	–
	26	1	–	–	–	–	1
	27	–	–	–	–	4	–
	28	–	–	–	–	4	1
	29	–	–	–	–	–	1

Table 7. *Galeocerdo cuvieri*. Variation in numbers of lateral teeth in 34 specimens from Natal and four specimens from St. Brandon (in brackets).

		Upper jaws					
		19	20	21	22	23	24
Lower jaws	20	–	1+(3)	1	–	–	–
	21	–	1	(1)	–	–	–
	2	1	7	2	12	1	–
	23	–	–	1	1	–	–
	24	–	–	–	2	–	2
	25	–	–	–	2	–	–

Table 8. *Galeocerdo cuvieri*. Records of pregnant females in the south-west Indian Ocean.

Locality	Date	Length of mother (cm)	Length of embryos (cm) Mean	Range	Number of embryos	Source of data
Eastern Cape	1926	±375	63	(only one measured)	35	Present study
Madagascar	4/9/59	345	57	(not recorded)	23	Fourmanoir 1961
Madagascar	19/8/59	353	68	(not recorded)	46	Fourmanoir 1961
Madagascar	3/11/58	377	64	(not recorded)	30	Fourmanoir 1961
St. Brandon	14/11/70	363	63	59-67	43	Present study

Table 9. *Galeocerdo cuvieri*. Seasonal distribution of 47 specimens taken in Natal.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Male	1	–	–	2	6	3	2	2	3	1	2	1
Female	1	1	–	2	1	1	2	2	1	5	4	4
Total	2	1	–	4	7	4	4	4	4	6	6	5

Table 10. *Galeocerdo cuvieri*. Summary of the stomach contents of 39 sharks.

Type of food	No.	%	
Elasmobranch	11	28	Including remains of *Odontaspis taurus*, *Squalus* sp., *Carcharhinus* sp., *Echinothinus brucus*, *Squatina africana* (twice), *Gymnura natalensis*, *Piliotrema warreni*.
Teleost	10	26	Including remains of *Lactoria cornutus*, *Platycephalus* sp., *Diodon hystrix*, *Johnius hololepidotus*, a surmullet (Mullidae), a toby (*Lagocephalidae*).
Bird	9	23	Including the remains of a domestic chicken and a Cape Hen (*Procellaria aequinoctialis*).
Reptile	5	13	Including *Chelonia mydas* (twice) and *Eretmochelys imbricata*.
Marine mammals	5	13	Including *Arctocephalus pusillus* and pieces of small cetaceans (three times).
Crustacean	3	8	Including *Palinurus delagoae*, *Scylla serrata* and an unidentified crab.
Cephalopod	6	15	Including *Sepia* sp.
Other	13	33	Mainly scavenged material including pumpkin seeds, a matchstick, a tin can, a plastic bag, a rat, the leg of a monkey, bones and bracelets from a human forearm, and bones of domestic animals (cow, sheep, pig; nine times)

Table 11. *Loxodon macrorhinus*. Variation in numbers of lateral teeth in eight specimens.

		Upper jaws			
		23	24	25	26
Lower jaws	22	1	–	–	–
	23	–	–	–	–
	24	–	3	2	–
	25	–	–	–	–
	26	–	–	1	–
	27	–	–	–	–
	28	–	–	–	1

Table 12. *Rhizoprionodon acutus*. Variation in numbers of lateral teeth in 100 specimens.

		Upper jaws		
		24	25	26
Lower jaws	20	3	–	–
	21	–	–	–
	22	85	2	5
	23	2	1	1
	24	1	–	–

Table 13 *Rhizoprionodon acutus*. Breeding data from females caught in Natal.

	Mean total length per litter (mm)						
	Under 50	50-99	100-149	150-199	200-249	250-299	300 and over
December	1	–	–	–	–	–	–
January	3	1	–	–	–	–	–
February	–	3	2	–	–	–	–
March	–	–	1	–	–	–	–
April	–	1	3	–	–	–	–
May	–	–	–	–	–	–	–
June	–	–	–	1	–	–	–
July	–	–	–	–	1	–	–
August	–	–	–	–	–	–	–
September	–	–	–	–	1	1	–
October	–	–	–	–	–	–	–
November	1	–	–	–	–	–	6

Table 14 *Sphyrna lewini*. Variation in numbers of lateral teeth in 78 specimens.

		Upper jaws				
		30	31	32	33	34
Lower jaws	29	2	–	1	–	–
	30	24	5	4	–	1
	31	9	4	6	–	–
	32	16	3	1	–	–
	33	1	–	1	–	–

Table 13. *Sphyrna lewini*. Size and seasonal distribution of 186 specimens from Natal. Numbers of males above in normal type, numbers of females below in heavy type.

Total	Total length (cm)													
	50-69	70-89	90-109	110-129	130-149	150-169	170-189	190-209	210-299	230-249	250-269	270-289	290-309	
20			3	6	7	4								Jan.
11			**3**	**2**	**3**	**3**	**1**							
5			2	1	2									Feb.
4				**2**	**1**	**1**								
12			2	6	4									Mar.
1			**1**											
5			2	1	1		1							Apr.
4			**2**		**2**									
5			1	4										May
0														
4			2		1	1								Jun.
0														
5			2	1		2								Jul.
6			**3**	**1**	**1**								**1**	
10			3	3	3	1								Aug.
5				**2**	**3**									
7		1	3	2				1						Sep.
5	**1**	**2**	**1**	**1**										
8		1	2	1	1	2			1					Oct.
10	**1**	**1**	**4**	**2**	**1**	**1**								
17		2	6	4	1	4								Nov.
12		**2**	**1**	**6**	**2**		**1**							
20			3	3	2	1	2				4	4	1	Dec.
10			**4**	**2**	**2**	**2**								

Table 16. *Sphyrna lewini*. Summary of the stomach contents of 99 sharks.

Type of food	No. of stomachs	%	
Teleost	79	80	Including *Sardinops ocellata*, *Trachurus trachurus*, *Pomatomus saltatrix*, *Elops saurus* and mullet (Mugilidae).
Mollusc	24	24	Mainly squid but including *Voluta* sp. (once).
Crustacean	9	9	Including *Palinurus* sp. and *Penaeus* sp.
Elasmobranch	1	1	*Squatina africana*.

Table 17. *Sphyrna mokarran*. Variation in numbers of lateral teeth in seven specimens.

		Upper jaws		
		34	35	36
Lower jaws	33	1	–	–
	34	2	1	1
	35	1	–	–
	36	–	1	–

Table 18. *Sphyrna mokarran*. Seasonal distribution of specimens caught along the Natal coast.

	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Males	2	2	–	–	–	–	–	–	–	–	1	–
Females	3	–	–	–	–	2	–	–	–	1	–	2
Both sexes	5	2	–	–	–	2	–	–	–	1	1	2

Table 19. *Sphyrna zygaena*. Variation in numbers of lateral teeth in 39 specimens.

		Upper jaws		
		27	28	29
Lower jaws	24	–	1	–
	25	–	–	–
	26	1	3	–
	27	–	5	–
	28	–	27	1
	29	–	–	–
	30	–	1	–

Table 20. Summary of the proportional dimensions of *Eridacnis sinuans*, *E. barbouri*, *E. radcliffei*, *Scyliogaleus quecketti*, *Triakis natalensis* and *T. megalopterus*. The data for *E. barbouri* are taken from Bigelow and Schroeder (1948), those for *E. radcliffei* from Nair and Mohan (1973).

	E. sinuans 42 males, 6 females 17 to 37 cm		*E. barbouri* 1 male, 1 female 28 and 30 cm	*E. radcliffei* Mean of several specimens (?) 8 to 21 cm		*S. quecketti* 1 male, 10 females 75 to 102 cm		*T. natalensis* 41 cm male	*T. megalopterus* 3 males, 4 females 79 to 147 cm
Snout to nostrils	5.5 SD	4.6 ± 0.5	—	—			—	4.9	3.7 (3.4— 4.0)
mouth	7.4 CD	6.1 ± 0.5	5.5	5.5		4.1 SD	3.6 ± 0.2	6.8	5.2 (4.8— 5.8)
eye		5.5 ± 0.6	—	5.5			5.1 ± 0.8	6.8	6.6 (5.2— 8.1)
spiracle		10.3 ± 0.7	—	—			7.4 ± 0.9	10.7	8.2 (7.4— 8.8)
1st gill-slit		14.4 ± 1.0	—	—			13.4 ± 1.0	17.8	16.6 (14.7—16.6)
pectoral		17.1 ± 1.4	19.9	20.4		18.2 CD	16.8 ± 1.4	20.0	17.8 (16.7—18.8)
1st dorsal		28.4 ± 1.7	31.3	31.8			28.6 ± 2.1	29.7	29.3 (28.0—30.4)
pelvic	38.9 SU	40.4 ± 1.6	40.9	41.8			45.8 ± 3.4	45.5	47.9 (45.9—50.1)
upper caudal	72.1 SU	76.2 ± 1.9	72.6	74.5		78.9 SU	81.1 ± 0.7	78.6	78.7 (77.8—79.6)
Eye diameter	5.3 SD	4.3 ± 0.7	4.1	5.1		2.5 SD	2.2 ± 0.4	3.2	2.0 (1.8— 2.5)
Spiracle length		1.4 ± 0.4	—	—			0.7 ± 0.2	1.0	0.7 (0.6— 0.9)
1st to 5th gill-slits		4.1 ± 0.7	—	—			3.2 ± 0.7	4.4	4.5 (4.1— 4.9)
1st to 2nd dorsal origins	26.2 SU	28.7 ± 1.7	25.2	26.1		31.2 SU	32.9 ± 1.5	28.7	30.4 (28.2—32.2)
Between dorsal bases	16.5 CU	19.5 ± 1.6	17.0	18.5			20.1 ± 1.5	17.8	18.9 (18.4—19.6)
Pectoral to pelvic	21.8 SU	23.5 ± 1.7	23.3	21.7			28.5 ± 3.3	26.0	30.5 (28.7—32.7)
Pelvic to anal	16.4 SU	18.1 ± 1.5	15.8	16.7	18.1	20.4(96)	20.2 ± 2.5	17.8	18.1 (16.4—19.6)
2nd dorsal to upper caudal		18.1 ± 1.4	16.1	16.9			20.3 ± 1.7	20.7	19.6 (18.9—20.2)
Anal to lower caudal	17.1 SD	16.2 ± 1.8	13.5	18.5			13.2 ± 2.0	13.9	12.2 (11.2—12.9)
Nostril length	3.2 SD	2.9 ± 0.5	—	—		2.5 SD	2.2 ± 0.3	2.4	1.8 (1.6— 2.0)
Internasal distance	3.5 SD	2.8 ± 0.4	2.9	2.7			—	3.2	3.0 (2.9— 3.2)
Mouth width	7.1 SD	6.2 ± 1.1	7.2	8.2			5.5 ± 0.9	6.6	7.3 (6.8— 7.8)
Mouth length		2.3 ± 0.5	3.4	5.6			1.7 ± 0.2	2.4	2.5 (2.3— 2.6)
Upper lip groove		0.9 ± 0.3	0.6	—			2.3 ± 0.4	2.9	2.8 (2.6— 3.0)
Lower lip groove		1.0 ± 0.4	0.6	—			2.2 ± 0.6	2.2	2.2 (2.0— 2.4)
1st gill-slit		1.7 ± 0.5	1.8	2.6	3.2	2.9(85)	3.6 ± 0.7	2.0	2.6 (2.1— 2.9)
3rd gill-slit		1.7 ± 0.5	1.8	3.2	3.3	3.1(82)	3.9 ± 0.8	2.2	2.8 (2.3— 3.4)
5th gill-slit	1.5 SD	1.2 ± 0.5	1.3	2.4	2.2	2.8(97)	2.6 ± 0.6	1.8	2.3 (2.0— 2.7)
1st dorsal base	9.1 8.4(25)	9.0 ± 0.9	7.2	7.8			11.7 ± 1.5	10.7	11.8 (10.7—12.1)
height		5.4 ± 0.8	5.2	5.6			9.7 ± 1.5	9.2	11.0 (10.6—11.5)
lobe	3.5 4.2(27)	3.9 ± 0.7	—	—		6.3 SD	4.6 ± 0.9	5.1	5.1 (4.2— 6.0)
2nd dorsal base		10.2 ± 1.0	8.8	8.0			11.6 ± 1.1	10.9	11.0 (10.3—11.5)
height	5.1 SU	5.8 ± 1.0	4.7	5.8			8.8 ± 1.1	8.0	9.2 (8.6—10.1)
lobe	3.1 3.8(25)	3.1 ± 0.6	—	—			3.7 ± 0.5	3.9	3.8 (3.4— 4.3)
Anal base	8.6 SD	8.0 ± 1.0	8.6	7.9			6.3 ± 1.1	7.8	6.8 (6.2— 7.3)
height	2.0 2.5(27)	2.2 ± 0.5	3.2	2.2			3.7 ± 0.7	3.6	4.7 (4.4— 4.9)
lobe	2.8 SD	2.6 ± 0.5	—	—			2.8 ± 0.5	3.2	3.2 (2.9— 3.8)
Pectoral base	4.9 SD	4.6 ± 0.6	—	—		4.5 CU	5.3 ± 0.9	4.9	5.9 (5.5— 6.5)
inner edge		6.6 ± 1.0	—	—			7.2 ± 0.8	7.8	8.5 (8.0— 9.1)
length	11.2 12.1(27)	11.7 ± 1.0	13.4	11.9		16.5 SD	15.1 ± 1.3	14.1	17.4 (16.6—18.8)
Pelvic — lateral lobe	6.2 6.5(25)	6.1 ± 0.7	—	—			9.3 ± 0.9	8.2	10.6 (9.8—11.1)
median lip	10.3 10.9(32)	10.8 ± 1.2	—	—			10.1 ± 0.8	10.9	11.5 (10.9—11.9)
Caudal upper lobe	29.0 SD	25.7 ± 1.9	27.4	23.2		21.8 SD	19.5 ± 0.7	22.1	22.0 (21.1—22.9)
base of notch to lip		5.8 ± 0.7	—	—		7.8 SD	6.7 ± 0.4	7.5	8.5 (8.2— 8.8)
lower lobe	6.9 SU	7.7 ± 1.3	9.2	20.1		9.3 SD	8.8 ± 0.6	9.5	10.1 (9.6—10.9)

Table 21. Summary of the proportional dimensions of *Galeorhinus galeus*, *Hypogaleus hyugaensis*, *Triaenodon obesus*, *Negaprion acutidens* and *Prionace glauca*.

	G.galeus 13 males, 5 females 87 to 139 cm			H.hyugaensis 4 males, 3 females 110 to 122 cm	T.obesus 139 cm male	N.acutidens 243 cm male	P.glauca 5 males, 4 females 218 to 295 cm
Snout to nostrils		6.8 SD	6.1 ± 0.6	4.7 (4.4— 5.1)	2.2	3.1	4.8 (4.2— 5.1)
mouth			8.2 ± 1.4	6.6 (6.2— 7.3)	3.2	4.6	8.6 (8.3— 9.2)
eye	8.1	8.2(80)	7.6 ± 0.9	5.8 (5.4— 6.8)	4.0	4.4	6.6 (2.7— 7.5)
spiracle			11.8 (11.6—12.2)	10.2 (9.5—11.0)	6.7	6.7	—
1st gill-slit			18.4 ± 1.2	15.1 (14.2—16.7)	15.1	16.8	18.6 (17.6—19.1)
pectoral			21.9 ± 1.5	17.8 (16.2—19.2)	18.8	20.8	22.2 (21.2—24.1)
1st dorsal			32.8 ± 2.1	26.6 (24.7—28.3)	36.9	34.7	38.7 (37.7—39.8)
pelvic	63.8	51.8(97)	53.7 ± 2.1	46.1 (44.6—48.5)	49.8	50.8	53.6 (52.0—55.6)
upper caudal		80.8 SU	82.3 ± 1.4	81.4 (80.7—82.3)	81.5	78.6	79.4 (78.8—79.9)
Eye diameter		3.1 SD	2.5 ± 0.4	3.0 (2.7— 3.1)	1.6	0.9	1.5 (1.3— 2.0)
Spiracle length			0.4 (0.4— 0.5)	0.5 (0.4— 0.6)	0.2	0.1	—
1st to 5th gill-slits			4.6 ± 0.6	4.1 (3.8— 4.6)	5.0	18.1	4.9 (4.2— 5.8)
1st to 2nd dorsal origins		34.3 SU	36.0 ± 1.4	37.5 (36.8—38.7)	29.1	30.0	29.2 (28.4—30.0)
Between dorsal bases		25.1 SU	26.8 ± 1.4	28.0 (26.1—29.7)	16.2	19.3	21.5 (20.6—22.2)
Pectoral to pelvic	33.0	30.3(94)	33.6 ± 2.4	28.8 (27.3—31.4)	32.1	30.4	31.9 (30.2—33.6)
Pelvic to anal			16.4 ± 2.0	19.8 (17.8—21.1)	16.6	14.6	13.8 (12.0—16.1)
2nd dorsal to upper caudal			14.0 ± 2.3	17.7 (16.6—19.3)	15.9	15.7	1.6 (11.0—13.3)
Anal to lower caudal			12.0 ± 1.1	15.3 (14.7—16.1)	15.2	13.0	11.2 (10.3—11.9)
Nostril length	2.0	1.5(109)	1.6 ± 0.4	1.4 (1.3— 1.6)	1.5	1.5	1.4 (1.3— 1.5)
Internasal distance			4.0 ± 0.4	3.8 (3.5— 4.0)	4.3	4.5	3.5 (3.2— 4.0)
Mouth width	9.7	7.6(113)	7.9 ± 1.4	6.5 (5.8— 7.3)	9.6	9.7	6.8 (5.9— 7.9)
Mouth length	3.3	3.9(114)	3.8 ± 0.6	3.0 (2.7— 3.6)	4.7	4.6	3.8 (3.2— 4.4)
Upper lip groove			2.2 (1.8— 2.4)	2.1 (1.9— 2.2)	—	0.7	—
Lower lip groove			1.3 (1.2— 1.6)	1.1 (1.0— 1.1)	—	0.6	—
1st gill-slit			2.7 ± 0.5	2.0 (1.8— 2.5)	2.6	4.4	2.6 (2.1— 3.1)
3rd gill-slit			3.1 ± 0.4	2.4 (2.0— 2.8)	3.4	5.0	3.1 (2.6— 3.4)
5th gill-slit			2.5 ± 0.5	2.2 (1.9— 2.5)	2.9	4.2	2.1 (1.9— 2.3)
1st dorsal base			9.1 ± 1.4	9.6 (8.6—10.8)	8.4	10.7	8.0 (7.5— 8.4)
height	7.9	7.4(94)	8.0 ± 1.0	8.6 (8.2— 8.9)	8.7	10.9	7.7 (7.3— 8.6)
lobe			3.9 ± 0.7	3.6 (3.5— 3.7)	4.3	5.4	4.0 (3.4— 4.9)
2nd dorsal base			4.8 ± 0.8	6.5 (5.9— 7.0)	6.6	8.4	4.2 (3.7— 4.5)
height	3.0	2.8(90)	3.2 ± 0.5	5.0 (4.5— 5.4)	6.1	8.4	2.9 (2.6— 3.1)
lobe			3.0 ± 0.5	3.0 (2.4— 3.4)	3.7	4.0	3.8 (3.2— 4.3)
Anal base			4.6 ± 0.9	11.0 (4.5—48.2)	6.6	7.0	4.0 (3.6— 4.6)
height		2.5 CU	2.8 ± 0.6	3.3 (3.1— 3.5)	5.9	6.5	3.1 (2.8— 3.5)
lobe	3.0	2.4(114)	2.5 ± 0.3	2.6 (2.3— 2.8)	3.2	3.4	3.4 (2.9— 3.9)
Pectoral base			5.6 ± 0.9	4.0 (3.6— 4.4)	5.3	7.2	5.3 (4.5— 6.7)
inner edge			5.7 ± 0.9	4.8 (4.3— 5.2)	4.8	7.4	4.3 (3.7— 4.9)
length	15.8	17.5(109)	17.1 ± 1.6	11.7 (11.2—12.1)	16.6	20.9	23.0 (22.1—25.0)
Pelvic — lateral lobe			5.7 ± 1.2	6.1 (5.8— 6.4)	8.7	11.5	6.9 (6.3— 7.6)
median tip			8.6 ± 1.8	8.5 (8.0— 8.8)	11.1	10.5	8.1 (7.6— 8.9)
Caudal upper lobe		24.1 SD	22.2 ± 1.7	23.3 (22.1—24.1)	23.1	26.7	25.8 (25.1—26.4)
base of notch to tip			11.5 ± 1.0	9.4 (9.0— 9.7)	5.9	7.1	8.6 (7.9— 9.2)
lower lobe			11.8 ± 1.2	10.5 (10.2—11.0)	12.8	13.2	13.7 (13.1—14.6)

Table 22. Summary of the proportional dimensions of *Galeocerdo cuvieri*, *Loxodon macrorhinus* and *Rhizoprionodon acutus*

	G. cuvieri 10 males, 20 females 104 to 410 cm			L. macrorhinus 4 males, 4 females 73 to 86 cm		R. acutus 40 males, 71 females 37 to 101 cm		
Snout to nostrils			2.5 ± 0.3	5.6 (4.9— 6.1)				6.8 ± 1.1
mouth		4.7 SD	4.3 ± 0.5	8.8 (8.1— 9.3)		10.2 SD		9.3 ± 1.2
eye	5.0	4.8(208)	5.0 ± 0.6	7.5 (7.0— 8.0)	9.3	8.6(79)		8.7 ± 1.1
spiracle	8.5	7.2(329)	7.3 ± 1.3	—				—
1st gill-slit			16.6 ± 1.4	17.2 (16.2—18.0)		20.5 SD		19.3 ± 1.3
pectoral			19.8 ± 1.8	20.3 (18.6—21.9)	23.3	23.6(44)		21.9 ± 1.6
1st dorsal		27.0 SU	30.4 ± 2.0	32.5 (30.8—33.8)	32.6	31.6(72)		31.7 ± 1.6
pelvic		48.5 SU	57.6 ± 2.9	47.0 (44.7—48.9)	50.1	47.5(53)		51.8 ± 2.0
upper caudal		73.1 SU	81.6 ± 1.7	78.2 (76.0—79.6)	77.2	76.9(41)		81.5 ± 1.1
Eye diameter		2.2 CD	1.0 ± 0.2	2.6 (2.3— 2.9)		2.9 SD		1.9 ± 0.3
Spiracle length			0.4 ± 0.2	—				—
1st to 5th gill-slits	5.9	5.4(211)	5.8 ± 0.9	4.5 (3.9— 5.1)	4.3	4.0(54)		4.5 ± 0.7
1st to 2nd dorsal origins		32.3 SU	36.7 ± 1.3	35.0 (33.3—37.3)		32.8 SU		38.8 ± 1.7
Between dorsal bases		24.0 SU	28.1 ± 1.2	27.3 (25.3—30.0)		23.9 SU		28.9 ± 1.5
Pectoral to pelvic		29.0 SU	37.9 ± 2.4	26.9 (24.6—30.3)	26.2	24.3(48)		30.4 ± 1.9
Pelvic to anal			12.5 ± 1.4	16.7 (14.7—18.8)		12.7 CU		15.3 ± 1.2
2nd dorsal to upper caudal		14.1 SD	13.3 ± 0.9	10.8 (9.4—12.0)	11.3	11.2(50)		11.6 ± 0.9
Anal to lower caudal		12.4 SD	10.9 ± 1.0	14.3 (13.0—15.5)	14.7	14.1(68)		14.3 ± 1.2
Nostril length			1.6 ± 0.2	1.6 (1.3— 1.8)		2.3 SD		1.6 ± 0.2
Internasal distance		4.6 SU	5.1 ± 0.5	5.5 (5.3— 5.8)		5.5 SD		4.7 ± 0.4
Mouth width		9.0 SU	11.7 ± 1.7	6.5 (5.5— 7.5)	7.8	7.1(74)		7.2 ± 0.7
Mouth length		4.5 CU	5.2 ± 1.0	3.6 (3.1— 4.3)	4.6	4.8(49)		4.1 ± 0.5
Upper lip groove			3.2 ± 2.2	—		1.8 SD		1.6 ± 0.3
Lower lip groove			1.5 ± 0.5	—	1.2	1.6(61)		1.4 ± 0.4
1st gill-slit			2.7 ± 0.8	2.0 (1.8— 2.2)	2.1	1.7(57)		2.0 ± 0.4
3rd gill-slit	3.0	2.9(151)	3.4 ± 0.7	2.3 (2.0— 2.5)	2.6	2.4(55)		2.6 ± 0.6
5th gill-slit		2.0 SU	2.3 ± 0.5	1.6 (1.4— 1.9)	2.0	1.8(59)		1.9 ± 0.4
1st dorsal base		8.6 SU	10.8 ± 0.8	7.9 (6.9— 8.7)	10.0	9.3(52)		10.5 ± 0.9
height	7.4	8.8(253)	8.4 ± 0.9	7.8 (6.8— 8.7)	8.6	9.3(54)		8.3 ± 0.9
lobe	5.2	6.1(213)	5.4 ± 1.0	4.1 (3.7— 4.6)		5.5 SD		4.8 ± 0.6
2nd dorsal			4.8 ± 0.6	2.8 (1.8— 3.6)	3.6	3.3(56)		3.6 ± 0.6
height		2.8 SU	3.4 ± 0.4	1.5 (1.3— 1.7)				2.1 ± 0.4
lobe	4.0	5.0(230)	4.5 ± 0.7	5.0 (4.5— 5.5)		5.4 SD		5.0 ± 0.5
Anal base			4.4 ± 0.8	4.9 (3.8— 6.1)	6.2	5.3(61)		5.8 ± 0.9
height		2.6 SU	3.7 ± 0.4	2.2 (1.9— 2.5)		3.0 SD		2.8 ± 0.4
lobe	3.3	4.3(267)	4.1 ± 0.7	4.2 (2.8— 4.6)		4.9 SD		4.4 ± 0.5
Pectoral base		5.2 SU	6.1 ± 0.6	4.7 (4.2— 5.1)	4.9	5.2(66)		5.1 ± 0.5
inner edge		5.0 SU	5.5 ± 0.6	4.8 (4.4— 5.2)		5.4 SD		4.6 ± 0.5
length	13.5	16.3(275)	15.9 ± 1.0	12.8 (12.0—13.9)	13.7	14.7(56)		13.5 ± 1.1
Pelvic — lateral lobe		5.9 SU	8.9 ± 1.0	5.0 (4.3— 5.8)		5.4 SD		4.5 ± 0.5
median lip		7.6 SU	9.1 ± 0.9	7.4 (6.4— 8.6)				7.6 ± 0.5
Caudal upper lobe		33.7 SD	23.0 ± 2.2	27.3 (25.5—30.0)	28.7	29.0(40)		23.1 ± 1.4
base of notch to tip		6.4 SD	3.5 ± 0.9	9.2 (8.6—10.2)	7.9	8.5(47)		6.2 ± 0.8
lower lobe	11.5	13.7(248)	13.0 ± 1.3	10.8 (10.0—11.9)	10.7	11.1(49)		10.0 ± 0.9

Table 22 Summary of the proportional dimensions of *Sphyrna lewini*, *S mokarran* and *S zygaena*

	S lewini 40 males, 42 females 45 to 307 cm			*S mokarran* 4 males, 6 females 182 to 332 cm			*S zygaena* 26 males, 20 females 58 to 305 cm		
Snout to nostrils		5.7 CD	3.0 ± 0.7			1.9 ± 0.6			5.0 ± 3.0
mouth		8.7 CD	5.2 ± 0.6			5.7 ± 0.7		7.0 CD	4.6 ± 0.6
eye		7.8 CD	4.1 ± 0.8	2.9	2.3(266)	2.4 ± 0.6			5.5 ± 3.2
1st gill-slit		19.9 CD	16.1 ± 1.0			16.8 (15.4—18.7)	18.0	15.5(193)	15.8 ± 0.8
pectoral		23.4 CD	20.1 ± 1.5			20.4 ± 2.5		22.2 CD	18.6 ± 1.3
1st dorsal	30.1	27.2(172)	27.7 ± 1.4			27.2 ± 1.9	28.8	26.3(187)	26.7 ± 1.6
pelvic	48.9	46.2(147)	47.2 ± 2.1			46.2 ± 4.2	49.3	48.0(127)	49.5 ± 2.1
upper caudal		73.1 SU	75.2 ± 1.2			73.7 ± 2.2		75.5 SU	77.2 ± 1.2
Eye diameter		2.6 SD	1.0 ± 0.3	1.4	SD	0.9 ± 0.2		2.4 SD	1.0 ± 0.5
1st to 5th gill-slits		5.9 SU	6.3 ± 0.7			5.4 (4.9— 6.1)	5.2	5.8(141)	5.4 ± 1.0
1st to 2nd dorsal origins		32.5 CU	37.1 ± 1.7			32.9 (31.7—34.8)		36.9 SU	40.7 ± 1.5
Between dorsal bases		21.8 CU	25.9 ± 1.8			22.4 (21.1—23.4)		27.3 SU	29.7 ± 1.3
Pectoral to pelvic	25.9	24.8(99)	27.3 ± 2.4			25.0 ± 3.0		27.1 SU	30.5 ± 2.0
Pelvic to anal		11.2 CU	14.3 ± 1.5			13.3 ± 1.8	12.5	14.0(189)	13.7 ± 1.4
2nd dorsal to upper caudal	12.2	11.3(137)	11.7 ± 1.1			14.2 ± 2.5	11.3	11.8(120)	11.0 ± 1.1
Anal to lower caudal		13.3 SD	12.3 ± 1.1			14.1 ± 1.8			13.1 ± 1.4
Nostril length		3.0 CD	1.9 ± 0.3	1.8	CD	1.4 ± 0.1		2.4 SD	1.7 ± 0.4
Internasal distance		22.5 CD	19.2 ± 1.4	17.4	CU	19.5 ± 2.6	19.9	21.4(153)	20.7 ± 1.5
Mouth width	7.6	6.6(160)	6.9 ± 1.0			7.5 ± 1.3	7.6	6.9(135)	7.4 ± 0.6
Mouth length		4.0 SD	3.0 ± 0.5	2.9	3.7(282)	3.6 ± 0.9		4.0 SD	3.5 ± 0.5
1st gill-slit		3.0 SU	3.9 ± 0.7			3.3 (2.6— 3.9)		2.6 CU	3.0 ± 0.5
3rd gill-slit		3.6 SU	4.3 ± 0.6			4.0 (3.4— 4.6)		3.1 CU	3.6 ± 0.6
5th gill-slit	3.0	2.7(117)	3.0 ± 0.5			2.7 (2.3— 3.0)			2.3 ± 0.6
1st dorsal base			11.0 ± 0.9			10.6 ± 1.6		9.7 SU	11.6 ± 1.5
height		14.9 SD	13.2 ± 1.3			16.6 ± 3.1		10.6 CU	13.7 ± 1.7
lobe		5.1 CD	3.5 ± 0.6	4.6	3.3(239)	4.1 ± 0.5			3.4 ± 0.5
2nd dorsal base	5.0	3.8(163)	4.1 ± 0.7			5.9 ± 1.4			3.4 ± 0.7
height	2.8	2.8(177)	2.8 ± 0.4			5.6 ± 0.9			2.1 ± 0.5
lobe		6.3 SD	5.1 ± 0.7	6.1	SD	5.2 ± 0.9		4.8 SU	5.6 ± 0.7
Anal base		6.6 CD	5.6 ± 0.9			7.1 (6.1— 7.7)			4.9 ± 1.1
height	3.8	3.3(214)	3.3 ± 0.6			4.6 (4.0— 5.1)			2.9 ± 0.4
lobe		4.8 SD	3.8 ± 0.7	4.4	SD	3.5 ± 0.7			4.2 ± 0.8
Pectoral base	5.5	5.3(95)	5.9 ± 0.6			5.8 ± 1.0		5.1 SU	6.6 ± 0.7
inner edge		5.4 CD	3.9 ± 0.6			4.5 ± 0.8		3.8 SD	3.3 ± 0.4
length		14.9 SD	13.9 ± 1.3			15.9 ± 2.5		12.2 SU	16.7 ± 1.3
Pelvic— lateral lobe	6.4	6.5(95)	6.1 ± 0.8			9.5 ± 1.7		4.4 SU	6.0 ± 0.6
median bp		9.2 SD	8.5 ± 0.8			9.8 (9.1—10.7)		7.3 SU	8.2 ± 0.6
Caudal upper lobe		33.7 SD	30.9 ± 1.5			32.8 ± 2.8		30.7 SD	28.5 ± 1.5
base of notch to tip		7.6 SD	5.1 ± 1.1	6.2	5.0(242)	5.7 ± 0.7		6.4 SD	4.8 ± 1.3
lower lobe		13.6 SD	12.9 ± 1.2			13.6 ± 1.9		12.2 SU	14.5 ± 1.2

Figures
Pages 66 to 87

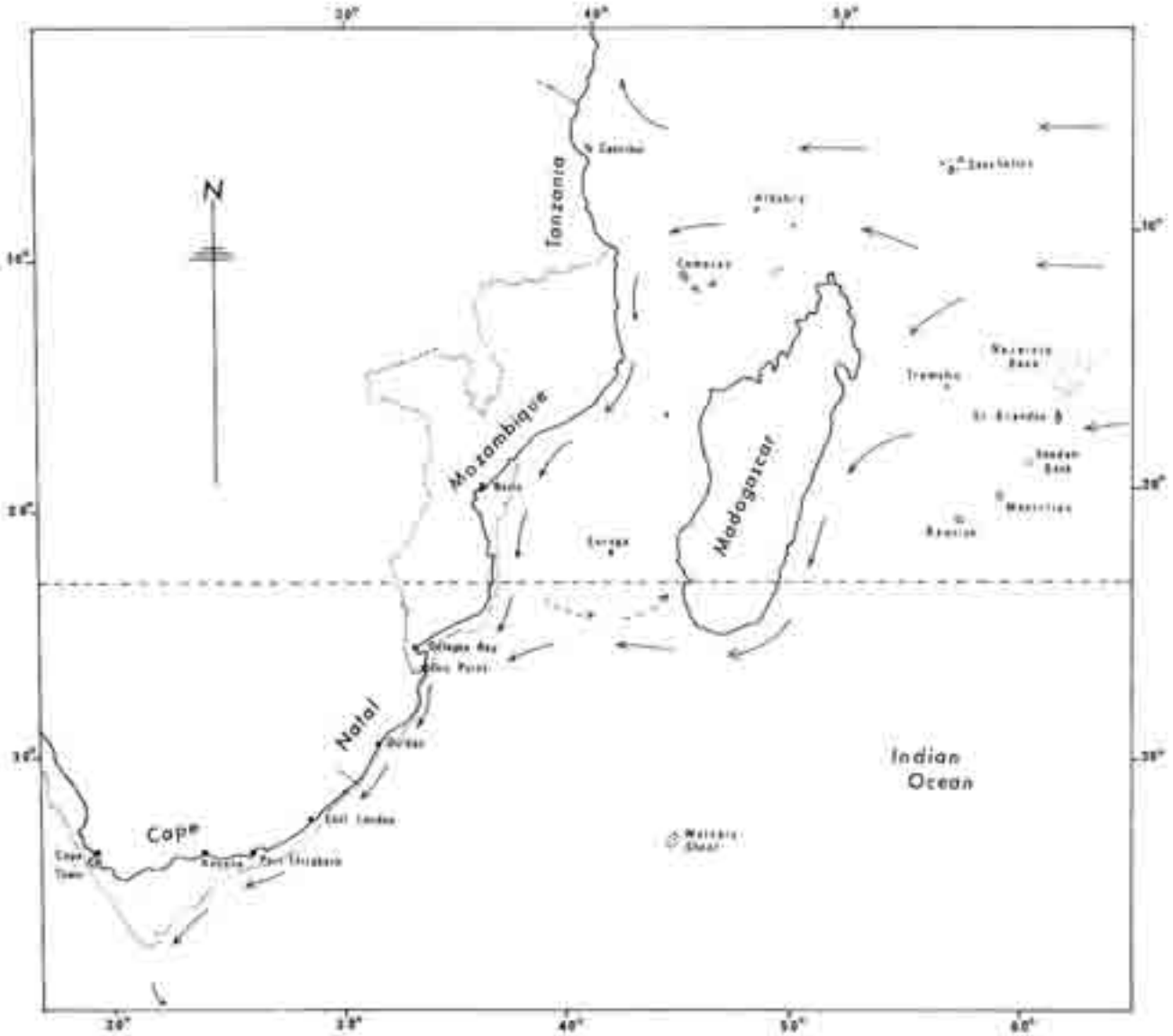

Fig. 1. The south-west Indian Ocean with an indication of the major current systems. The 100-fathom depth contour is shown as a dotted line from Beira southwards along the African coast.

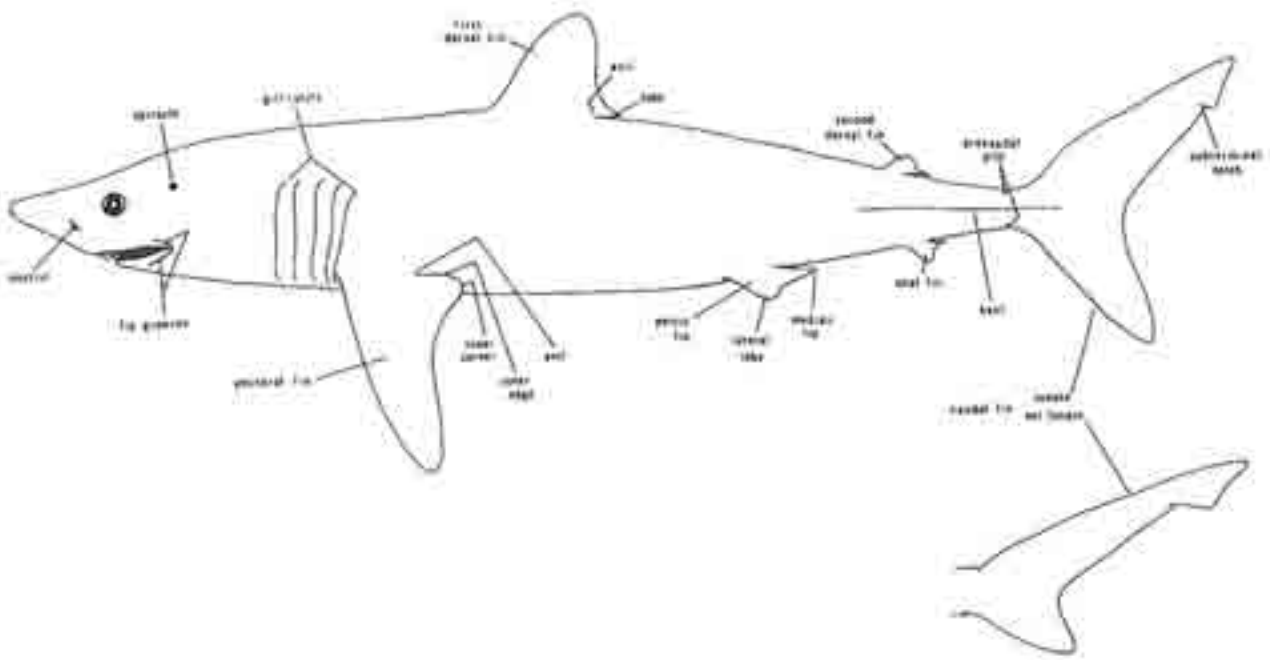

Fig. 2. Terminology of the various parts of the external anatomy of sharks, as used in the present study.

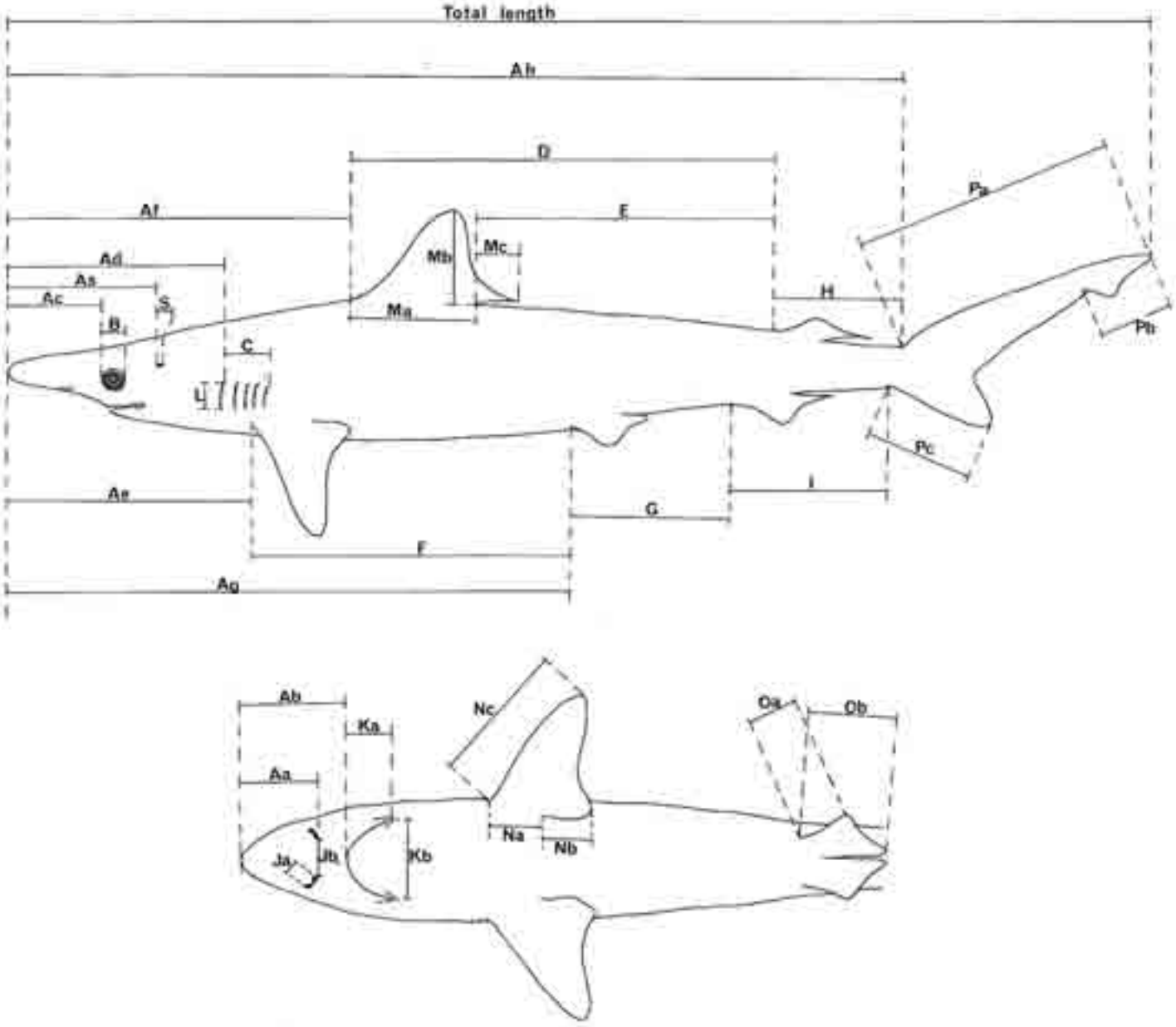

Fig. 3. Measurements taken in the present study. Aa—snout to nostrils; Ab—snout to mouth; Ac—snout to eye; Ad—snout to first gill-slit; Ae—snout to pectoral; Af—snout to first dorsal; Ag—snout to pelvic; Ah—standard length (snout to upper caudal); As—snout to spiracle; B—eye diameter; C—first to fifth gill-slits; D—1st to 2nd dorsal; E—between dorsal bases; F—pectoral to pelvic; G—pelvic to anal; H—2nd dorsal to upper caudal; I—anal to lower caudal; Ja—nostril length; Jb—internasal distance; Ka—mouth length; Kb—mouth width; Ma—fin base; Mb—fin height; Mc—fin lobe; Na—pectoral base; Nb—pectoral inner edge; Nc—pectoral length; Oa—pelvic to lateral lobe; Ob—pelvic to median tip; Pa—upper caudal; Pb—base of notch to tip; Pc—lower caudal; S—spiracle length.

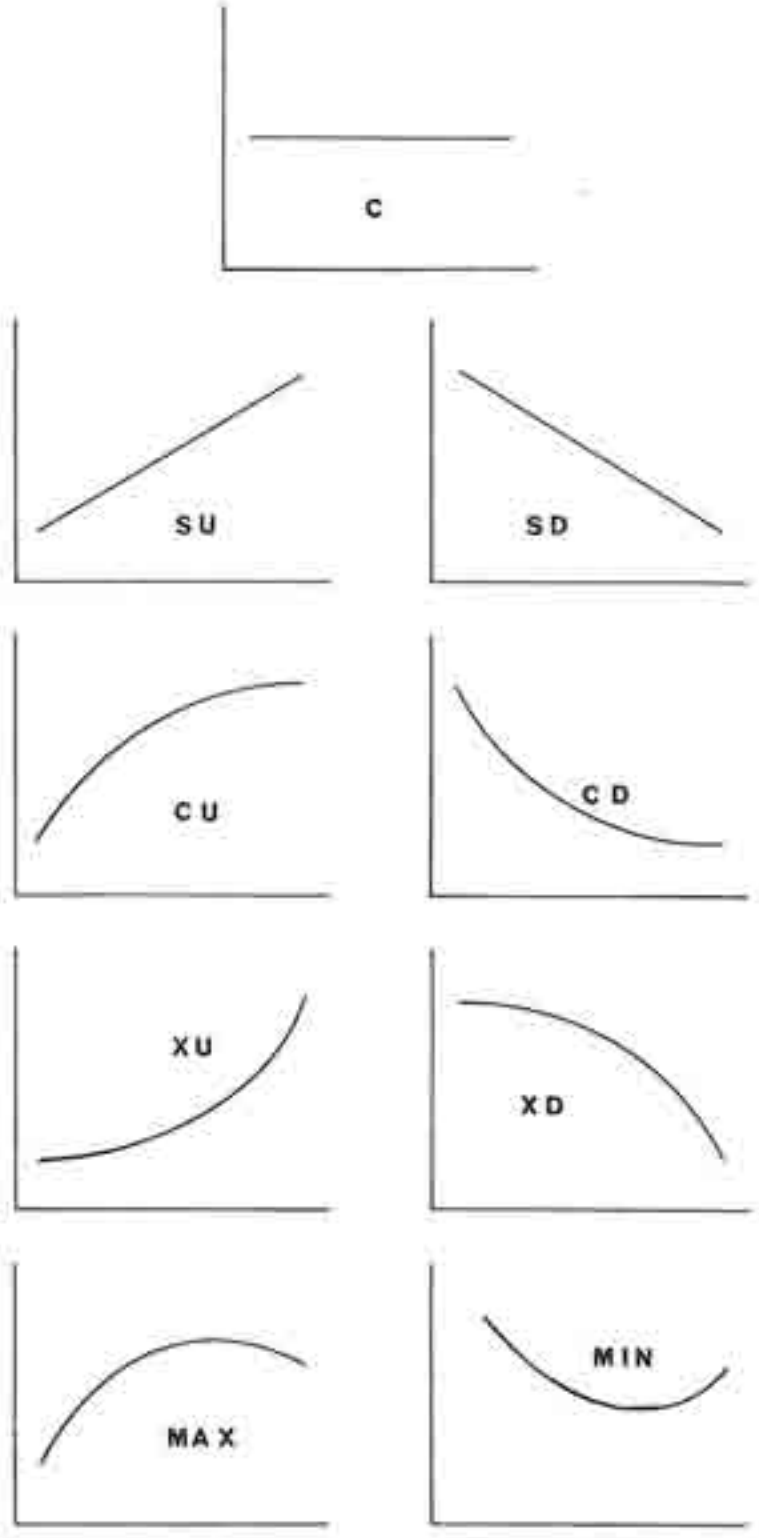

Fig. 4. Different types of growth patterns in the proportional dimensions of sharks. In each case the *x*-axis represents total length (or another standard dimension) and the *y*-axis represents a proportional dimension. C—constant; SU—linear, increasing; SD—linear, decreasing; CU—curvilinear, increasing, the rate of increase dropping off with increase in total length; CD—curvilinear, decreasing, the rate of decrease dropping off with increase in total length; XU—curvilinear, increasing, the rate of increase rising with increase in total length; XD—curvilinear, decreasing, the rate of decrease rising with increase in total length; MAX—curvilinear, rising to a maximum followed by a decrease; MIN—curvilinear, dropping to a minimum followed by an increase.

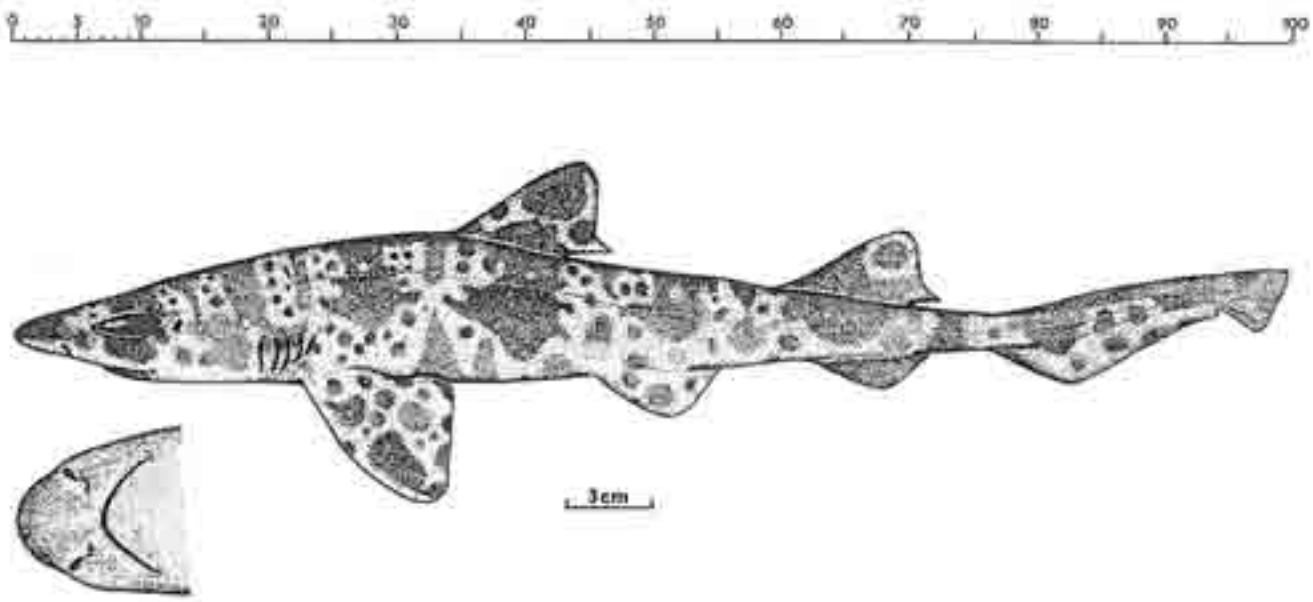

Fig. 5. *Ctenacis fehlmanni*. A 46 cm adult female from Somalia (after fig. 1 of S. Springer 1968). This drawing is reversed left to right from the original to correspond with the other illustrations in this report, and is therefore actually of the right-hand side of this shark.

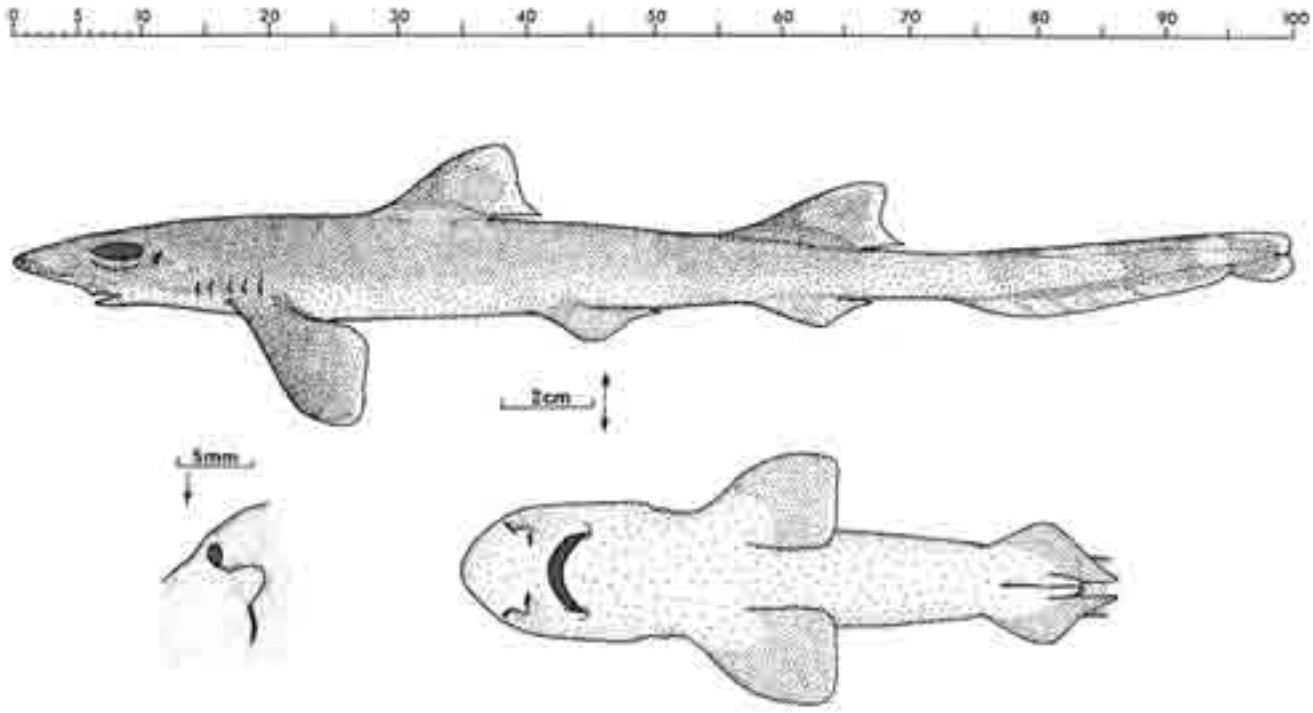

Fig. 6. *Eridacnis sinuans*. A 28 cm immature male from Natal.

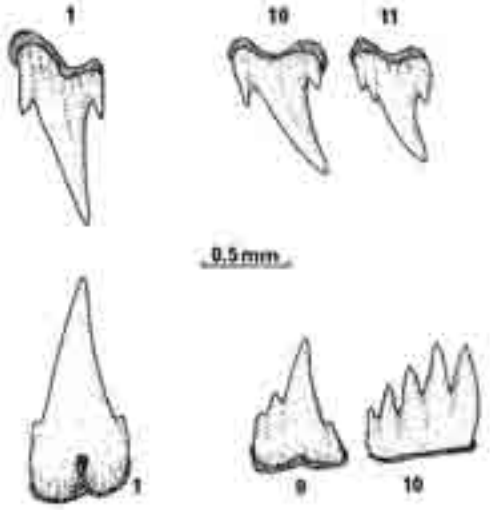

Fig. 7. *Eridacnis sinuans*. Teeth of a 35 cm mature male from Natal. The numbers represent the positions of the teeth from the symphysis towards the side of the jaw.

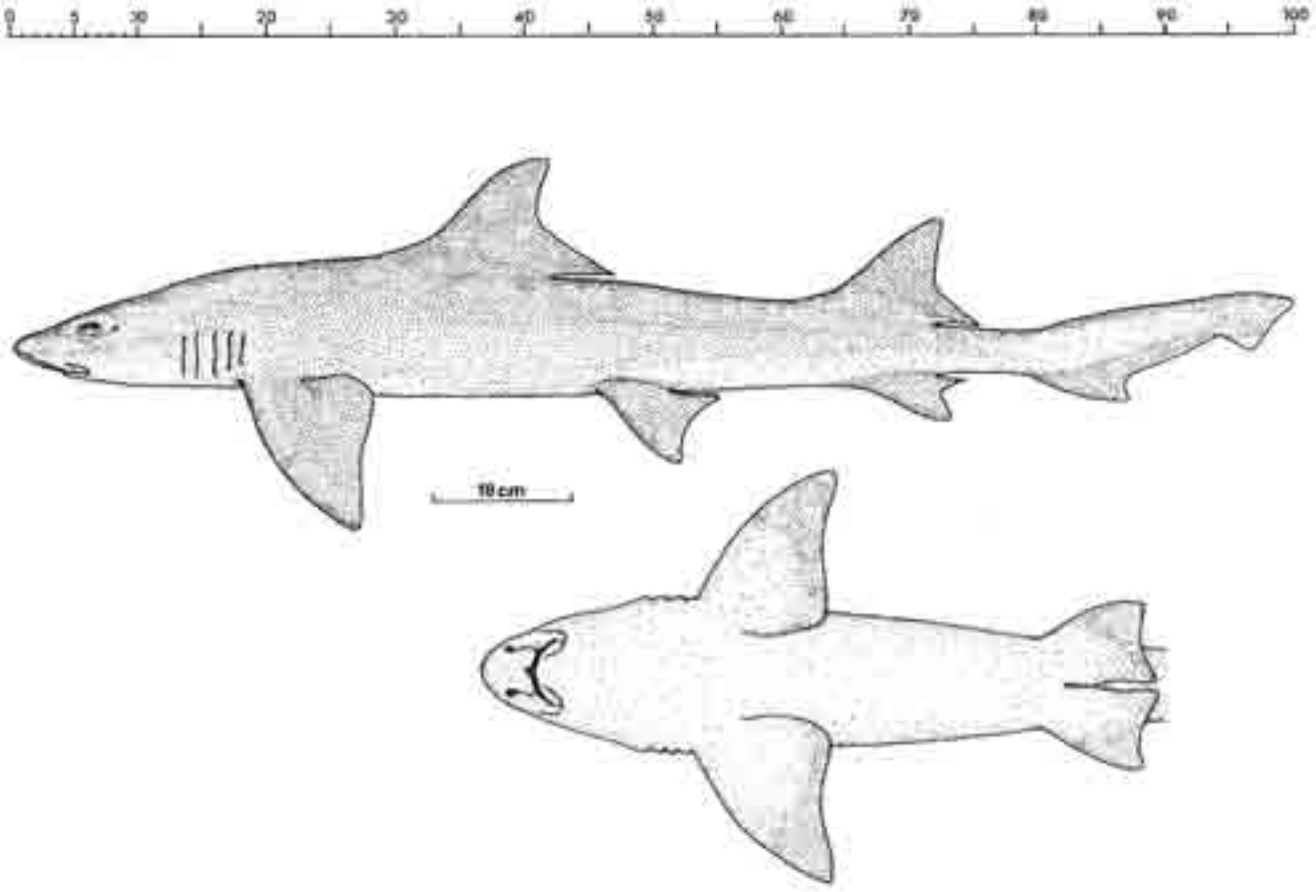

Fig. 8. *Scylliogaleus queckertti*. A 94 cm mature female from Natal.

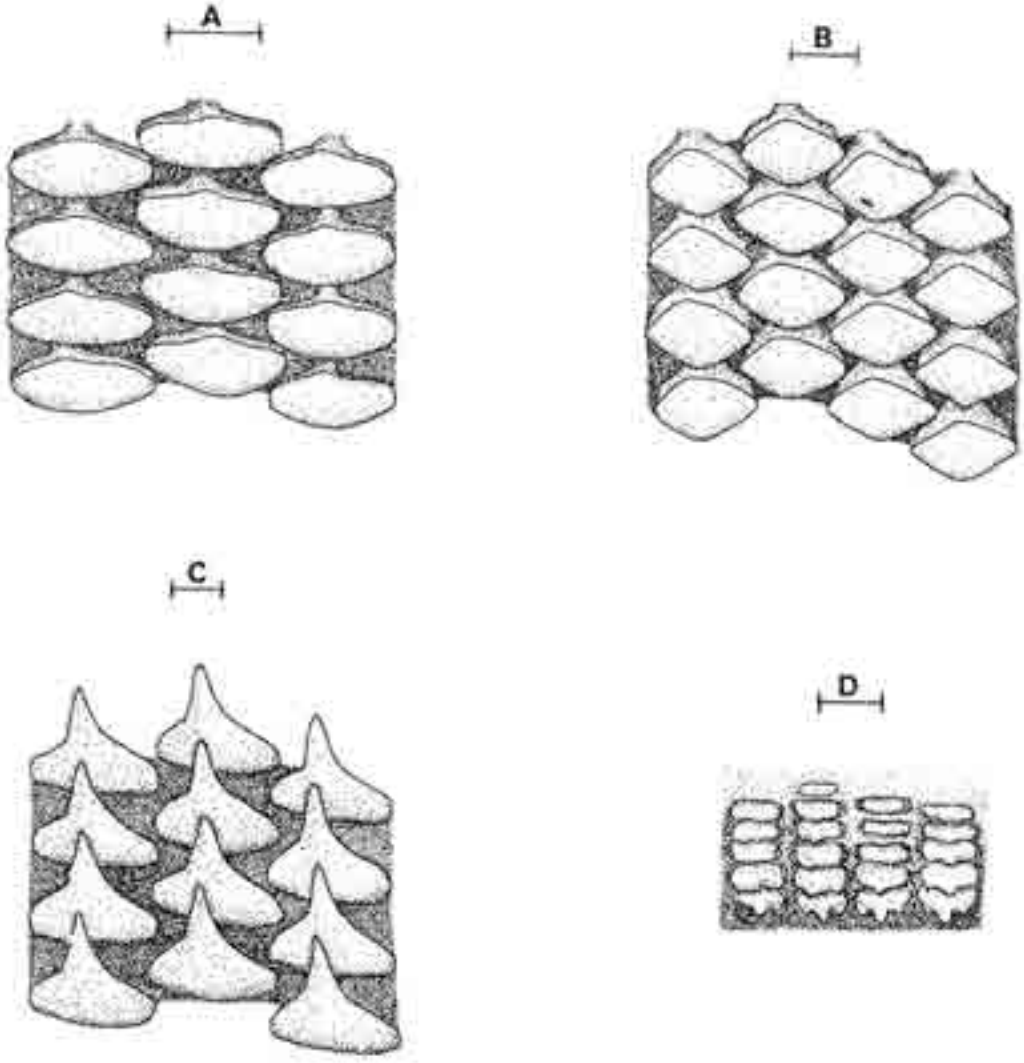

Fig. 9. Teeth of various triakiform species. (A) *Scyliogaleus queckett*i — a 91 cm mature female from Natal. (B) *Mustelus* sp. — a 93 cm immature female from Natal. (C) *Triakis megalopterus* — a 140 cm mature male from Algoa Bay. (D) *Triakis natalensis* — a 41 cm immature male from the eastern Cape. In each case the scale represents one millimetre. In A, B and C the teeth shown are from near the centre of the lower jaws; in D they are from near the centre of the upper jaws.

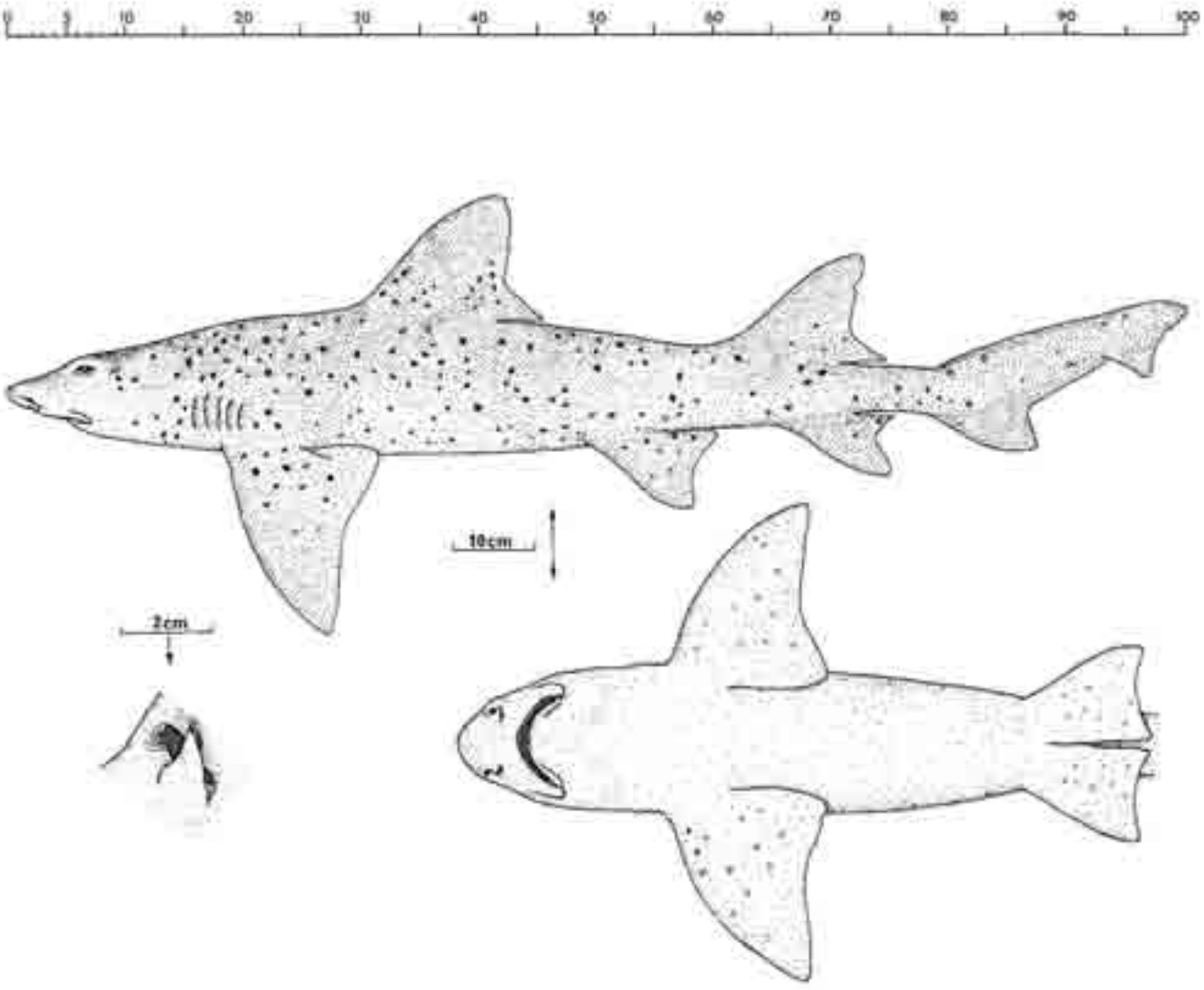

Fig. 10. *Triakis megalopterus*. A 145 cm adult female from Algoa Bay.

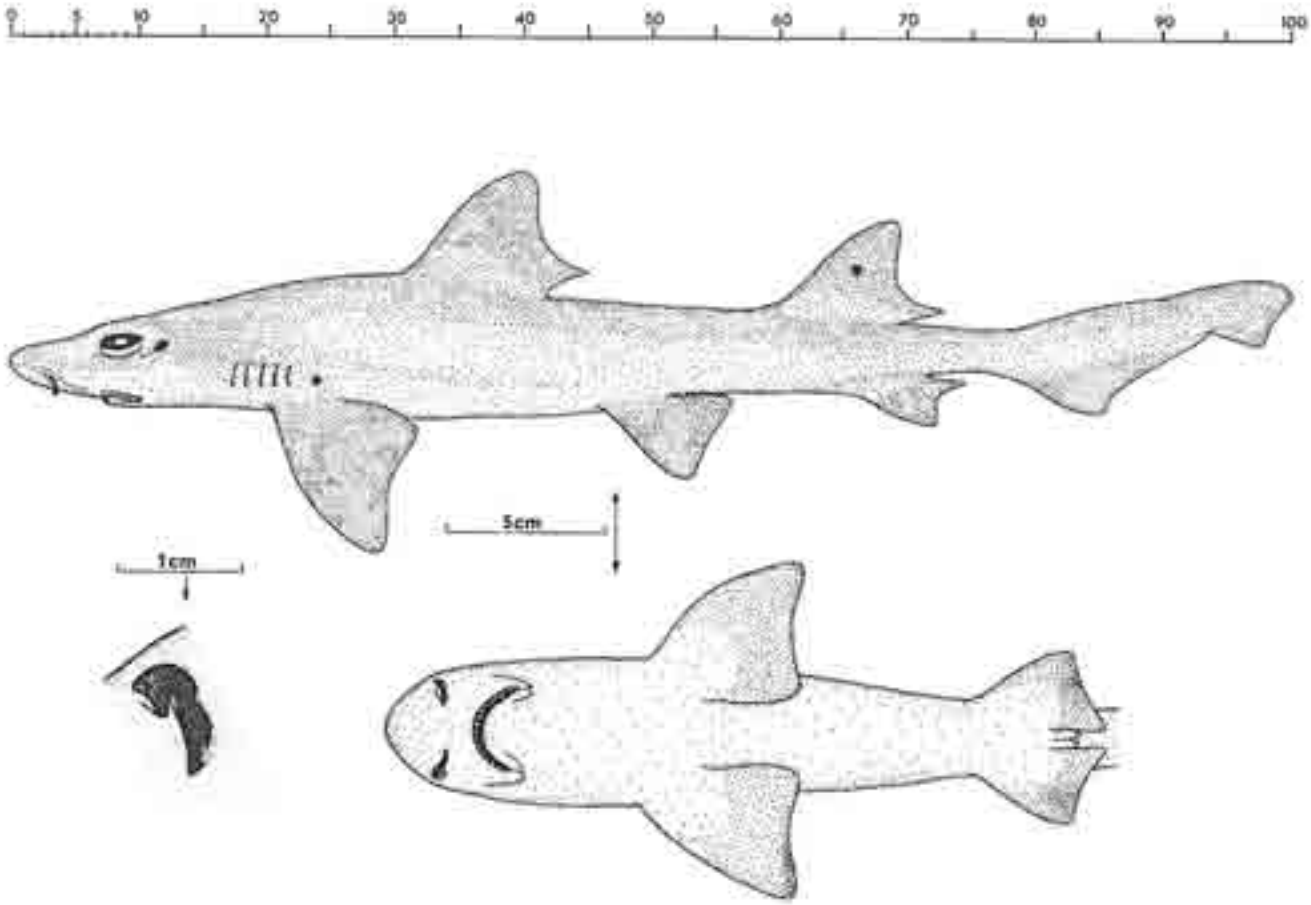

Fig. 11. *Triakis natatensis*. A 41 cm immature male from the eastern Cape.

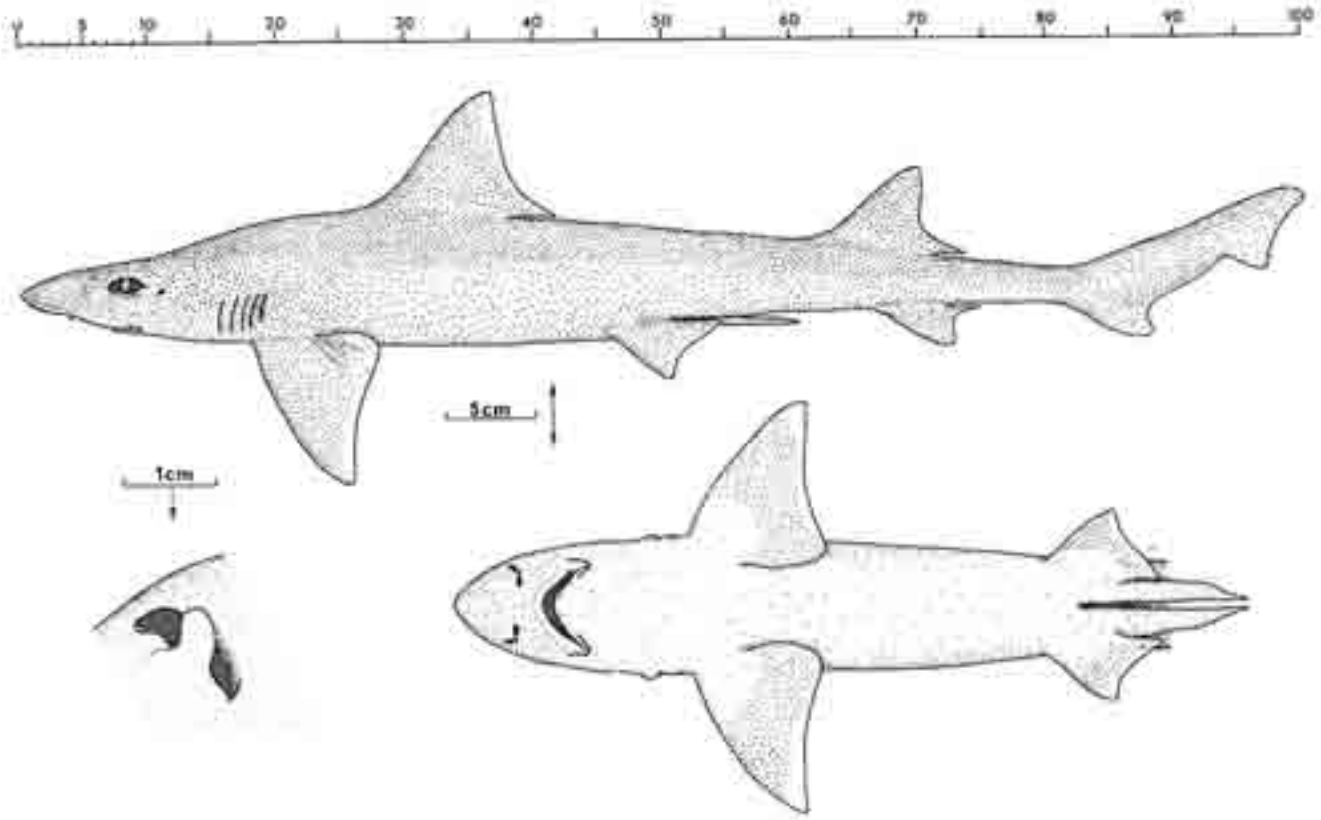

Fig. 12. *Mustelus* sp. A 73 cm mature male from Natal.

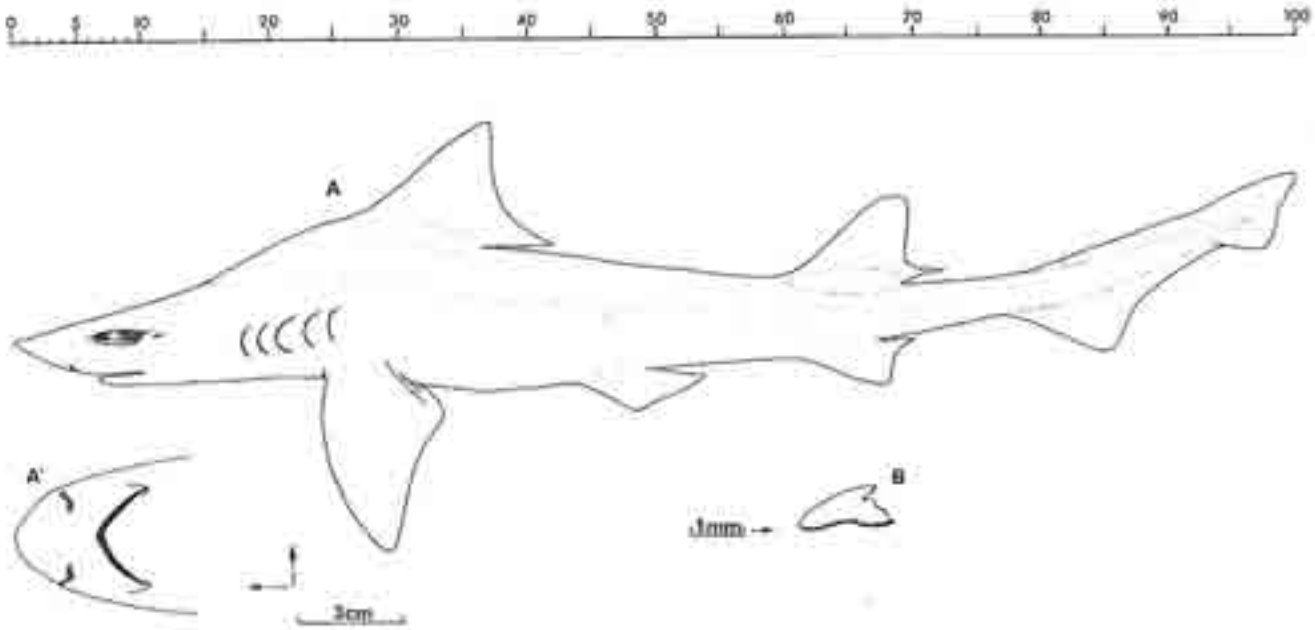

Fig. 13. *Iago omanensis*. (A,A') A 57 cm mature female from the northern Arabian Sea. (B) A typical tooth of the same animal. (After figs. 1, 2A, 3A of Compagno and S. Springer 1971).

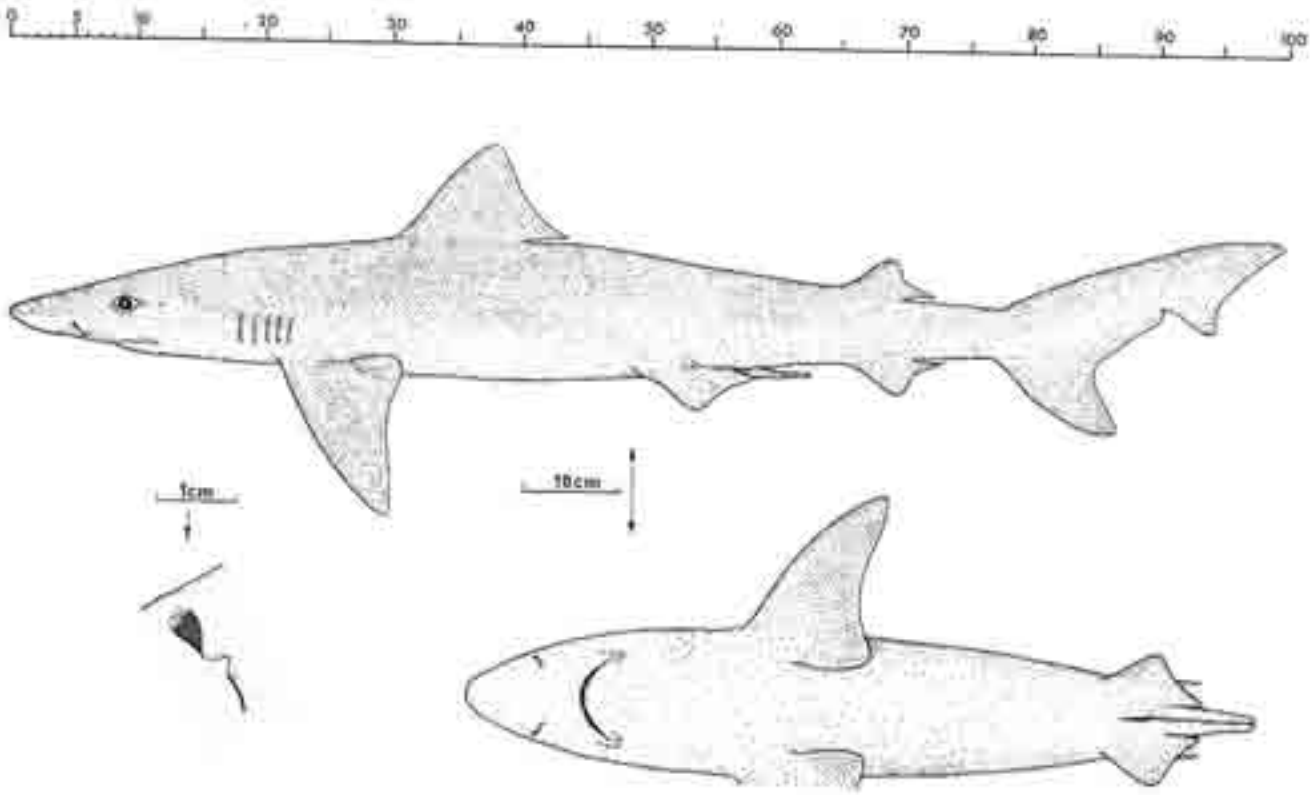

Fig. 14. *Galeorhinus galeus* A 134 cm mature male from the eastern Cape.

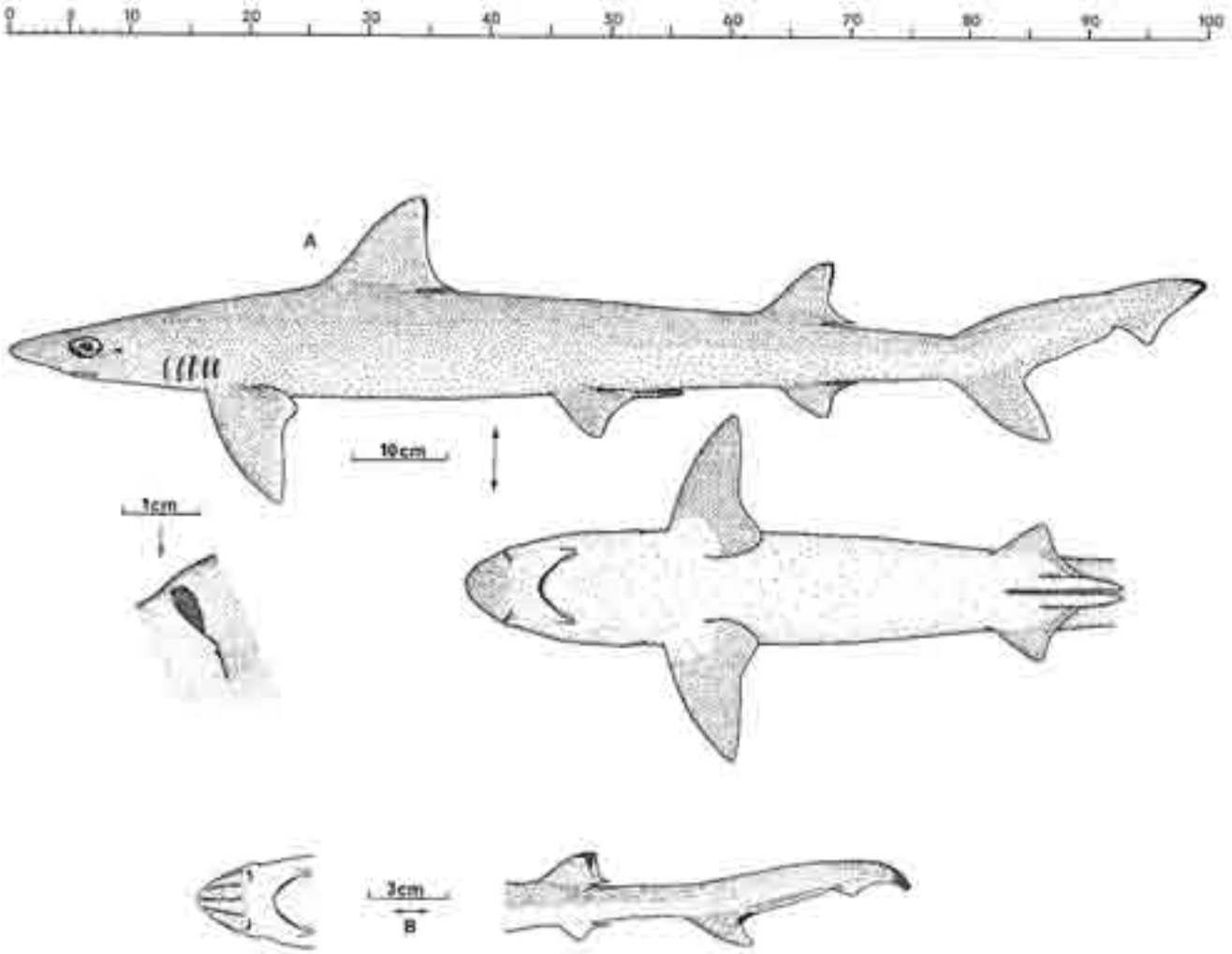

Fig. 15. *Hypogaleus hyugaensis*. (A) A 127 cm mature male from Natal. (B) Snout and caudal region of 34 cm late embryo.

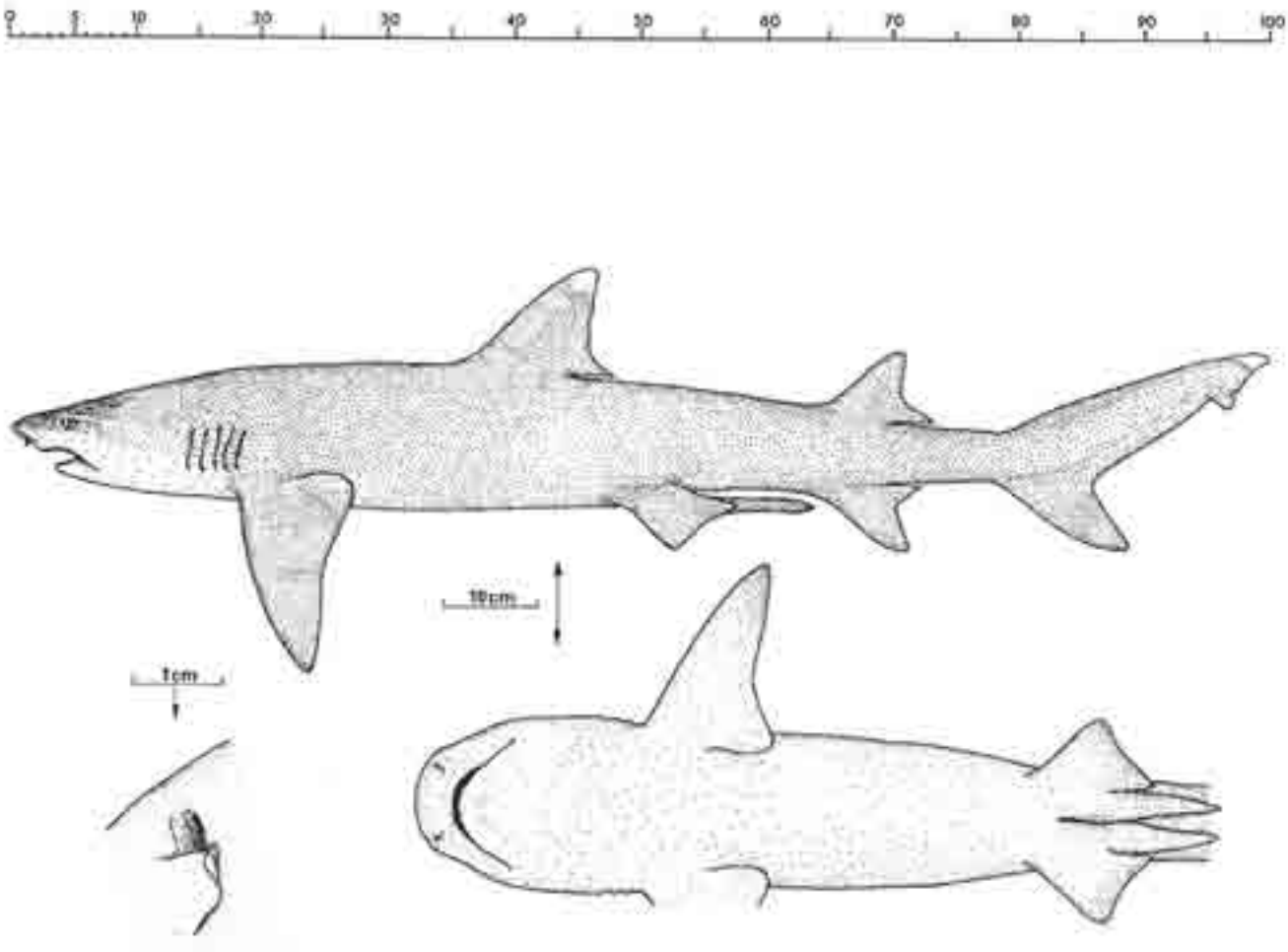

Fig. 16. *Triaenodon obesus*. A 139 cm mature male from northern Natal.

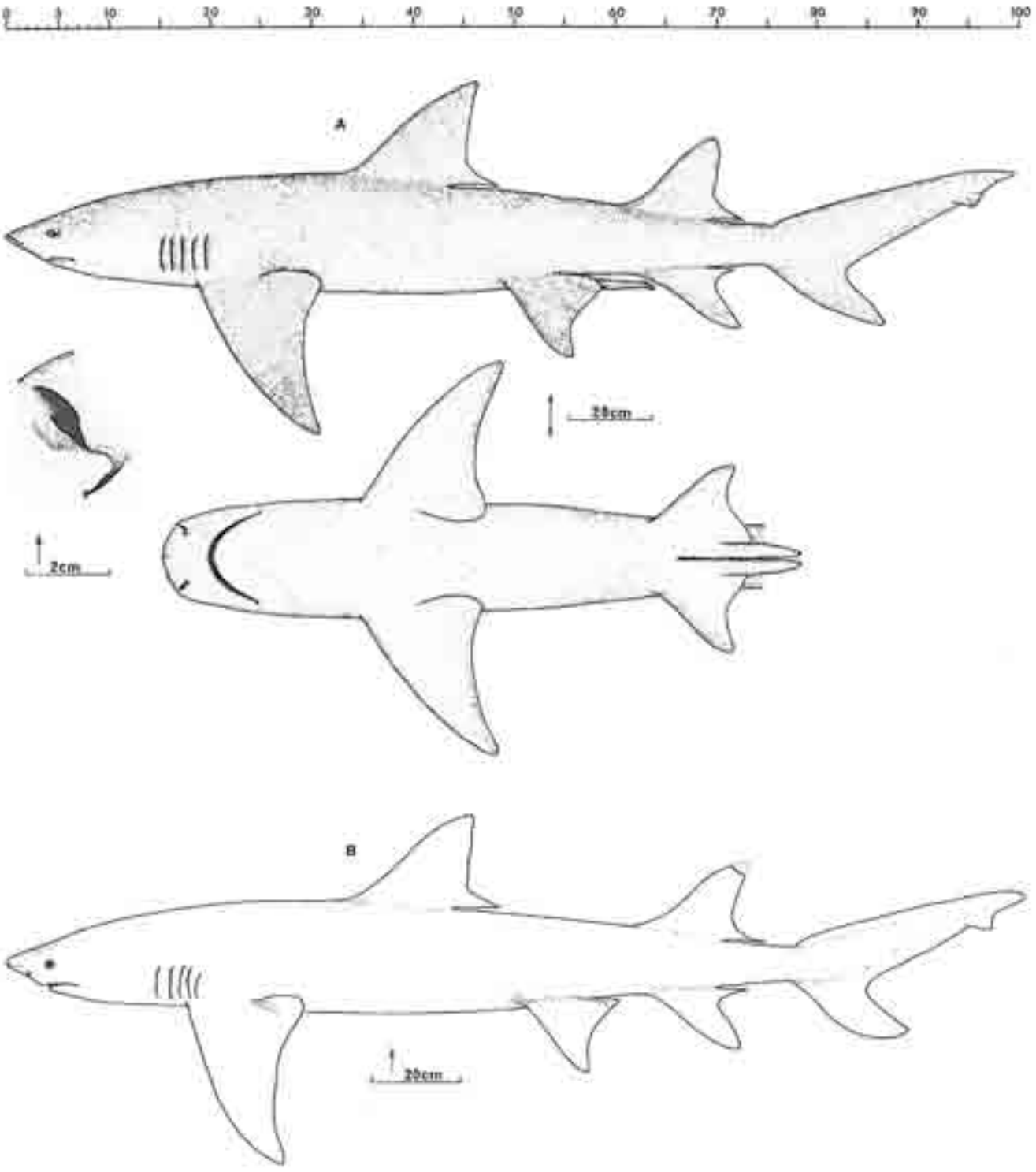

Fig. 17. *Negaprion acutidens*. (A) A 243 cm mature male from northern Natal. (B) A 232 cm mature female from Iran.

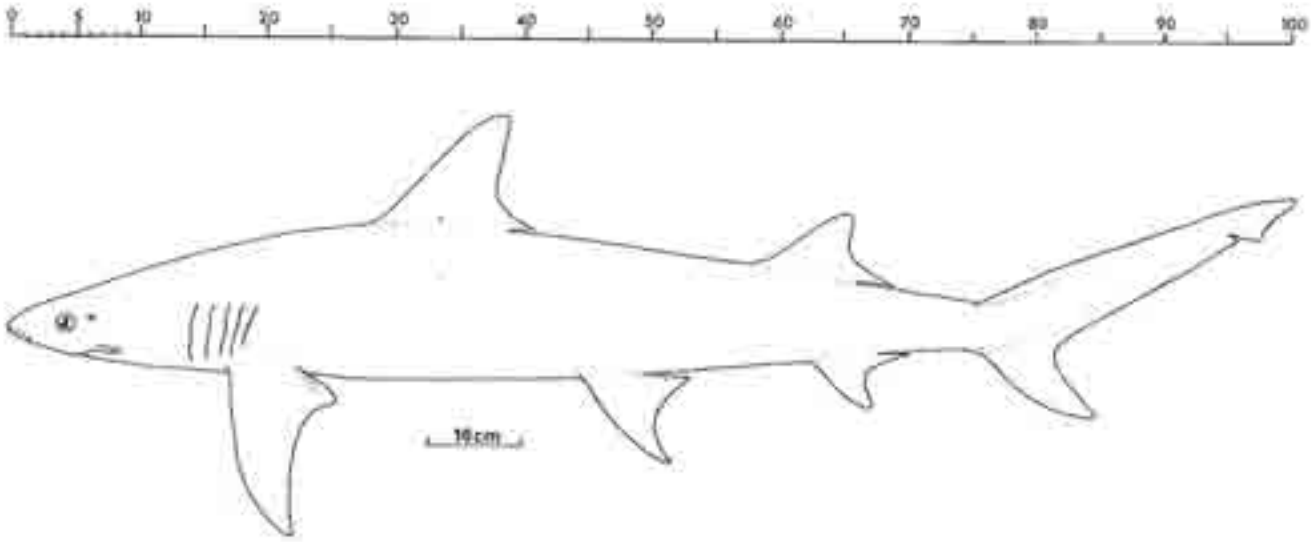

Fig. 18. *Hemipristis elongatus*. A 137 cm immature female from Zanzibar (after pl. 17 of J. L. B. Smith 1957d).

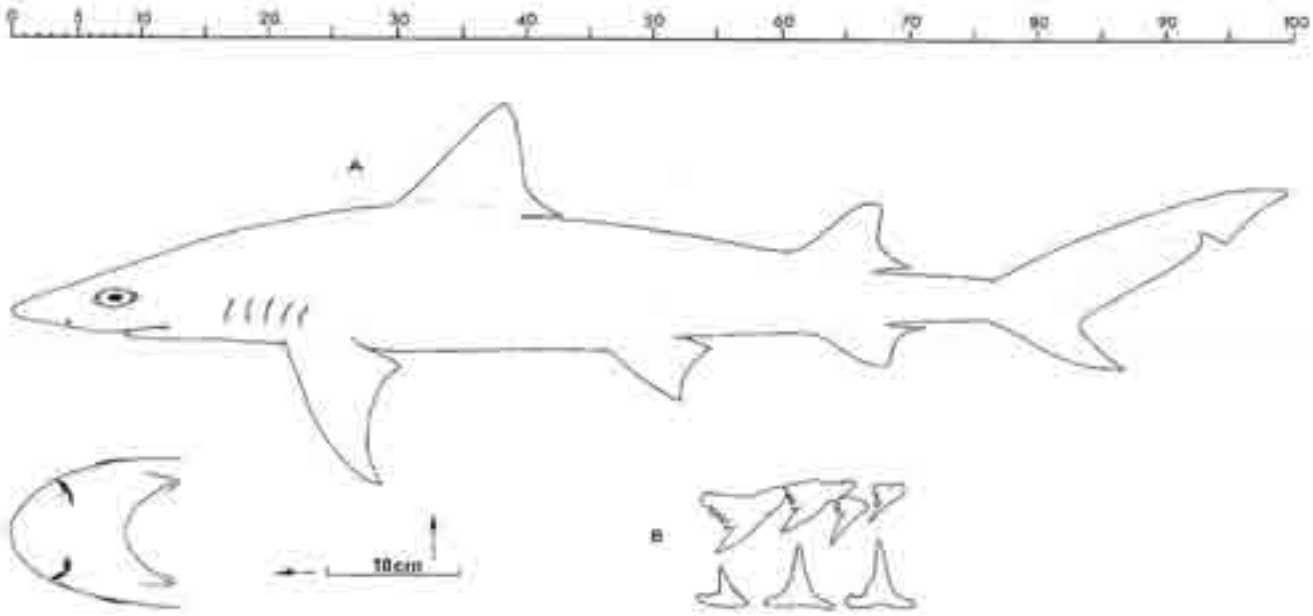

Fig. 19. *Hemigaleus* sp. (A) A 102 cm mature female from the west coast of Madagascar. (B) Upper four median teeth and 8th, 9th and 10th lower teeth from the same animal. (After figs. 40, 41 and 42 of Fourmanoir 1961).

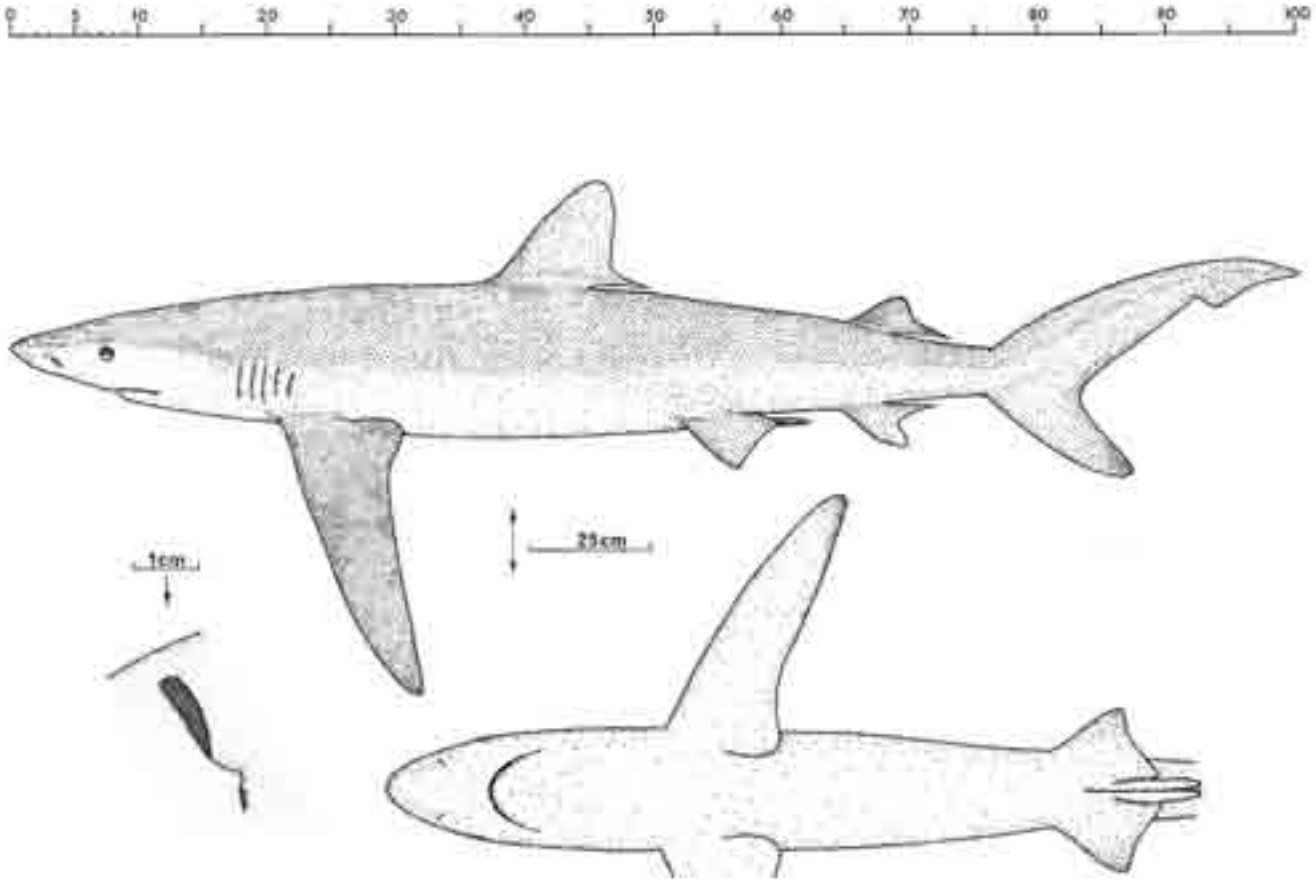

Fig. 20. *Prionace glauca*. A 279 cm mature male from Natal.

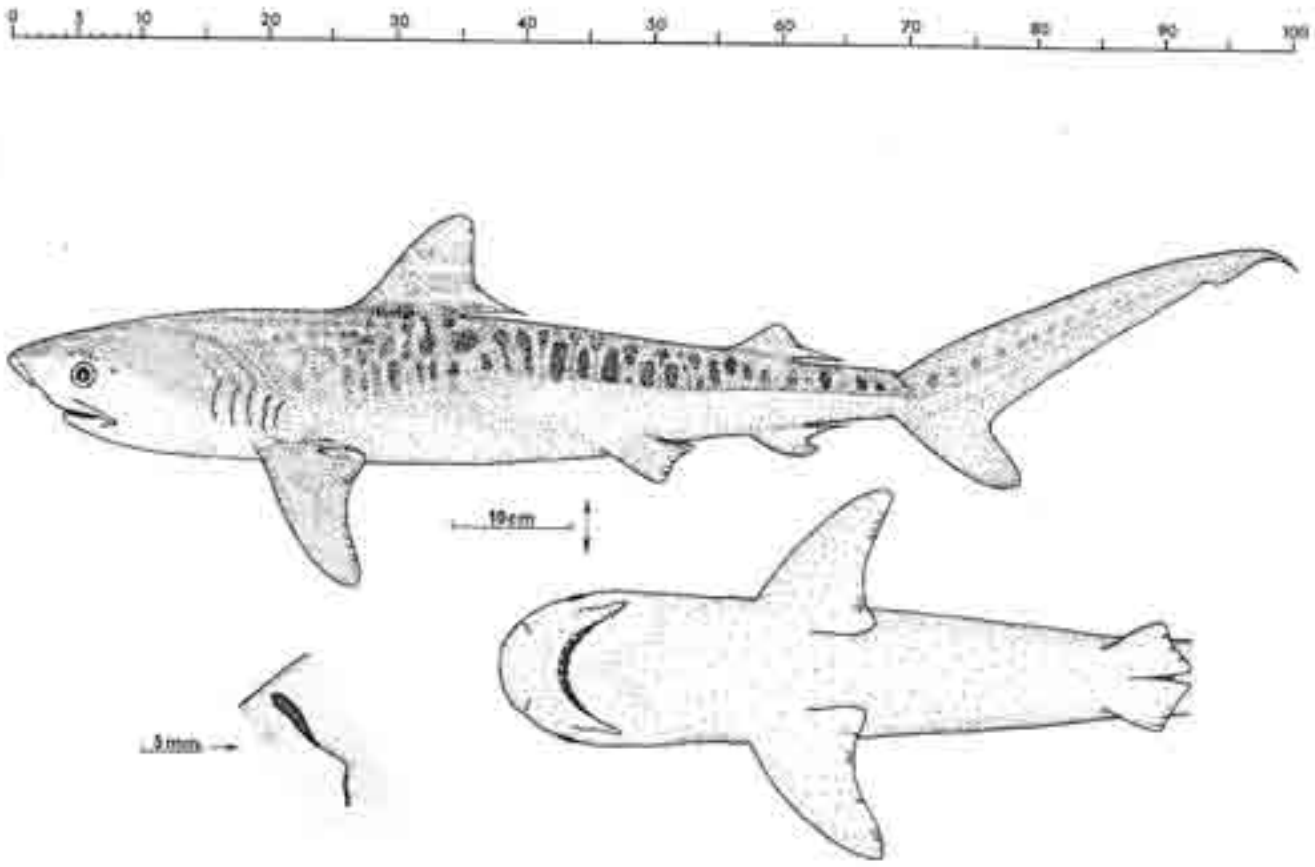

Fig. 21. *Galeocerdo cuvieri*. A 107 cm immature female from southern Mozambique.

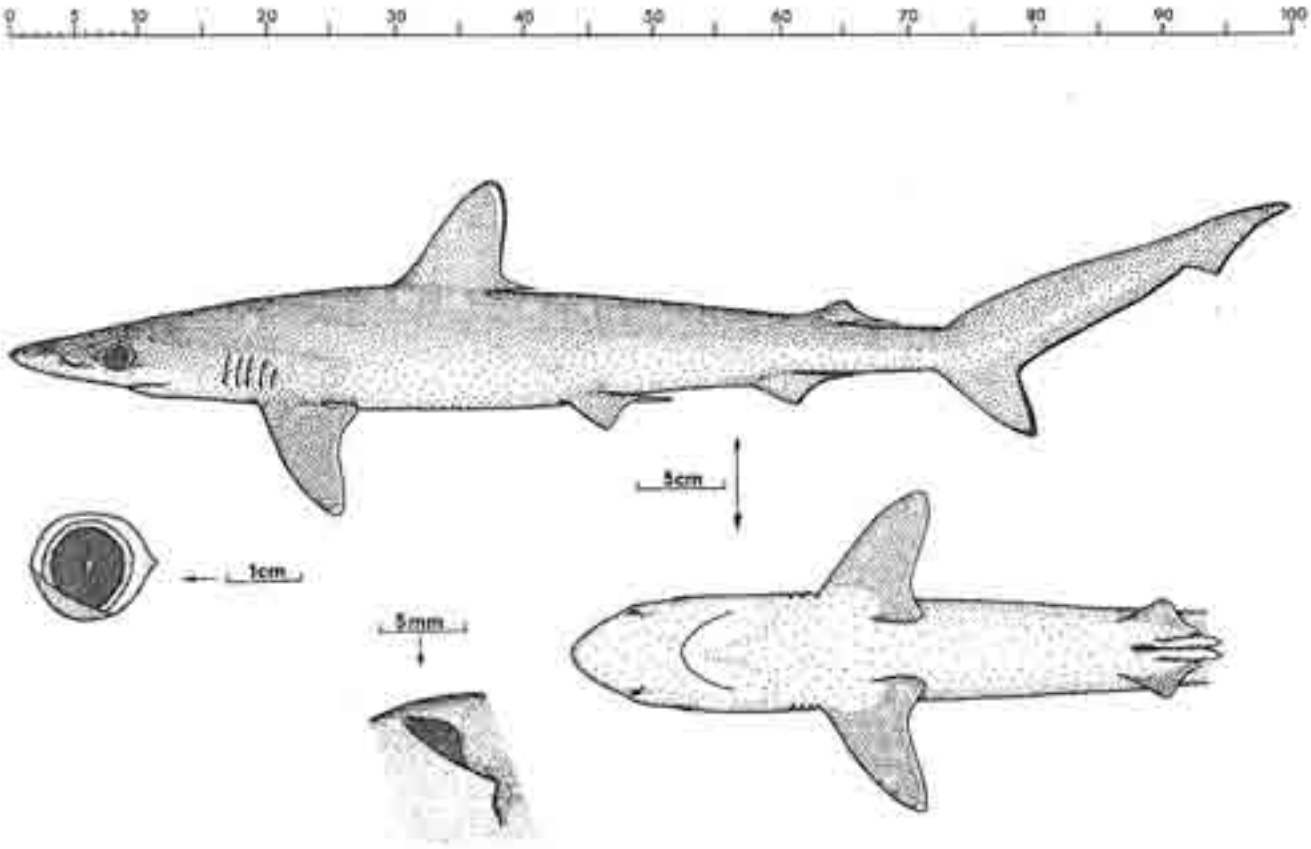

Fig. 22. *Loxodon macrorhinus*. A 75 cm adolescent male from southern Mozambique.

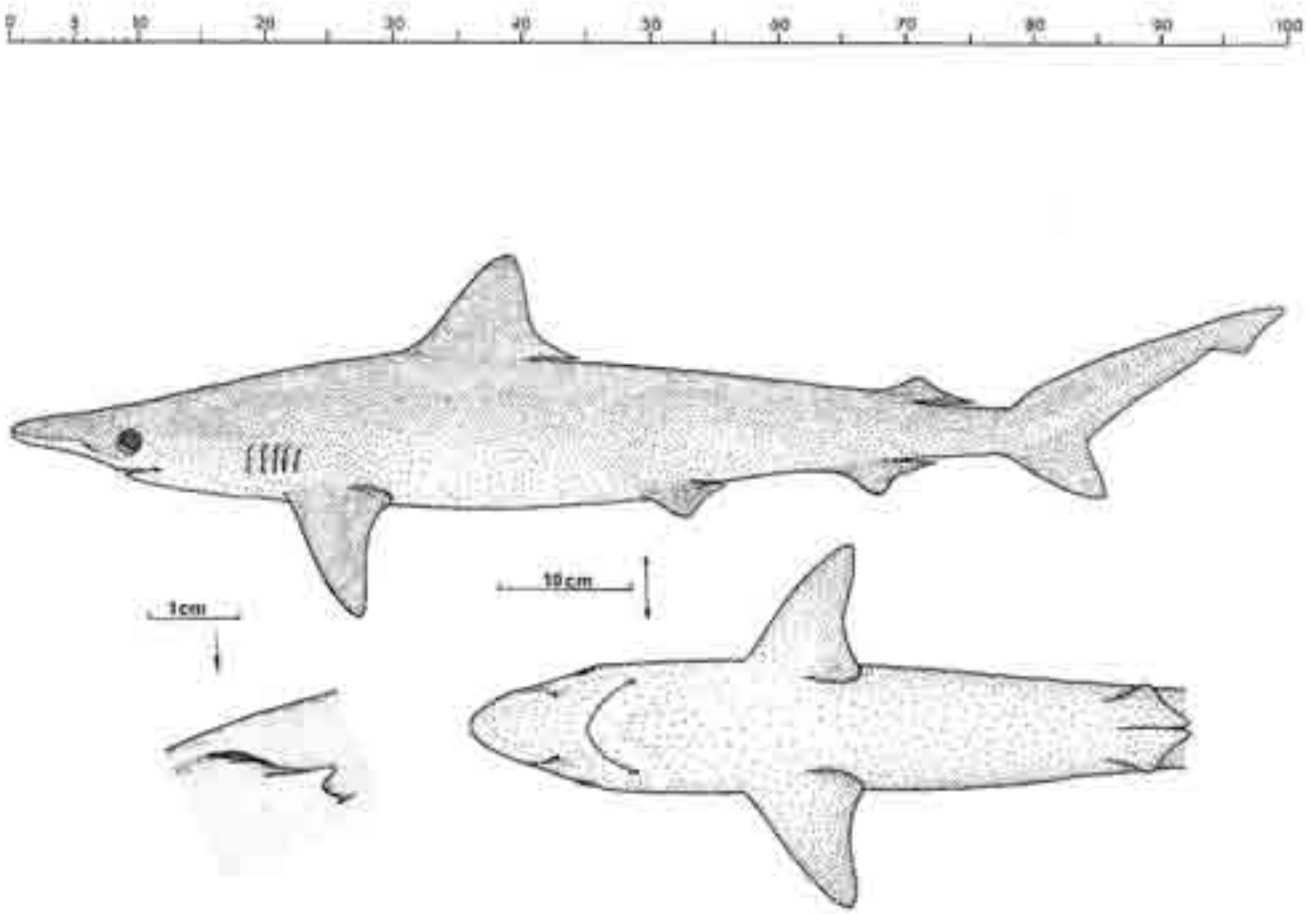

Fig. 23. *Rhizoprionodon acutus*. A 99 cm mature female from Natal.

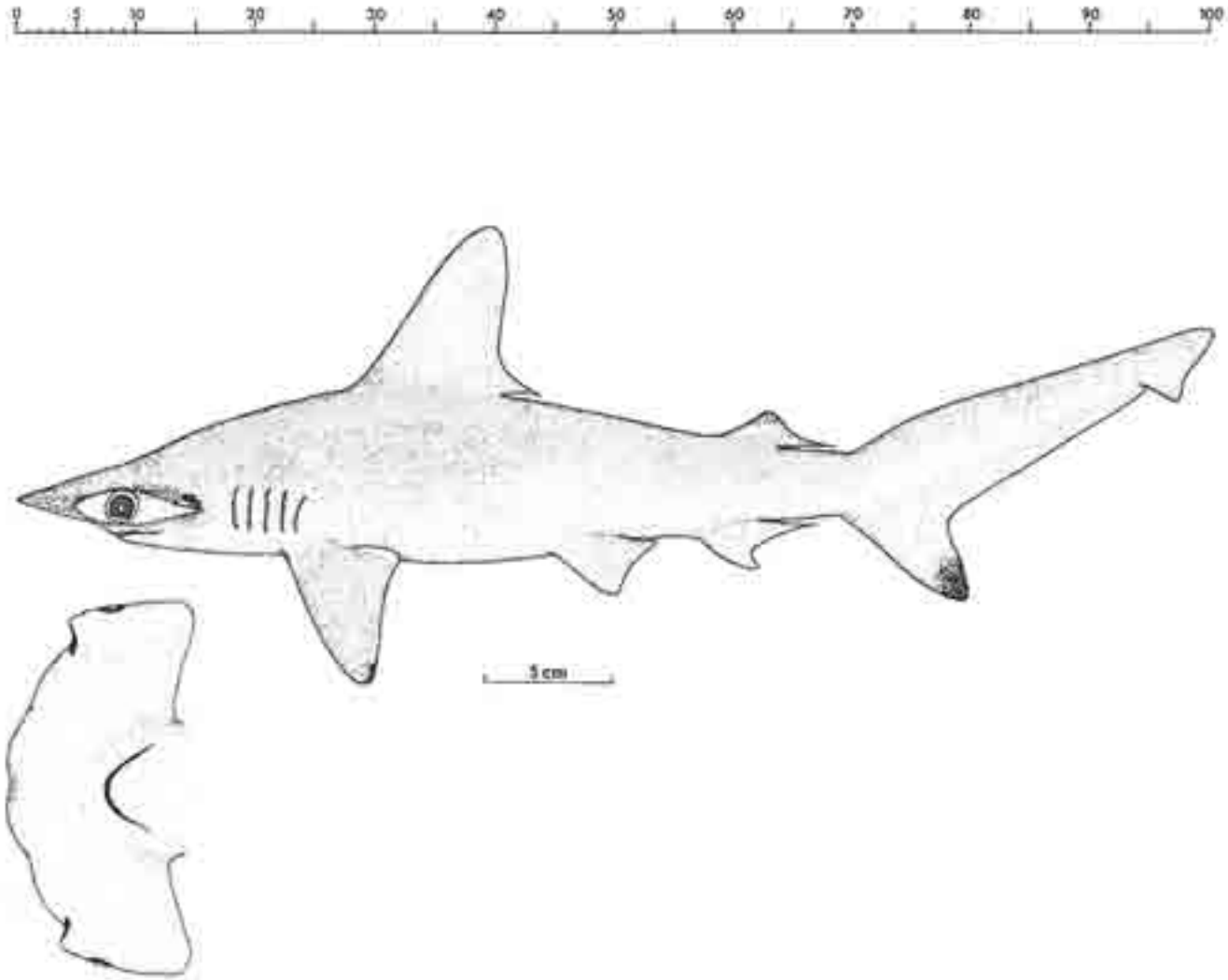

Fig. 24. *Sphyrna lewini*. A 47 cm immature female from Natal.

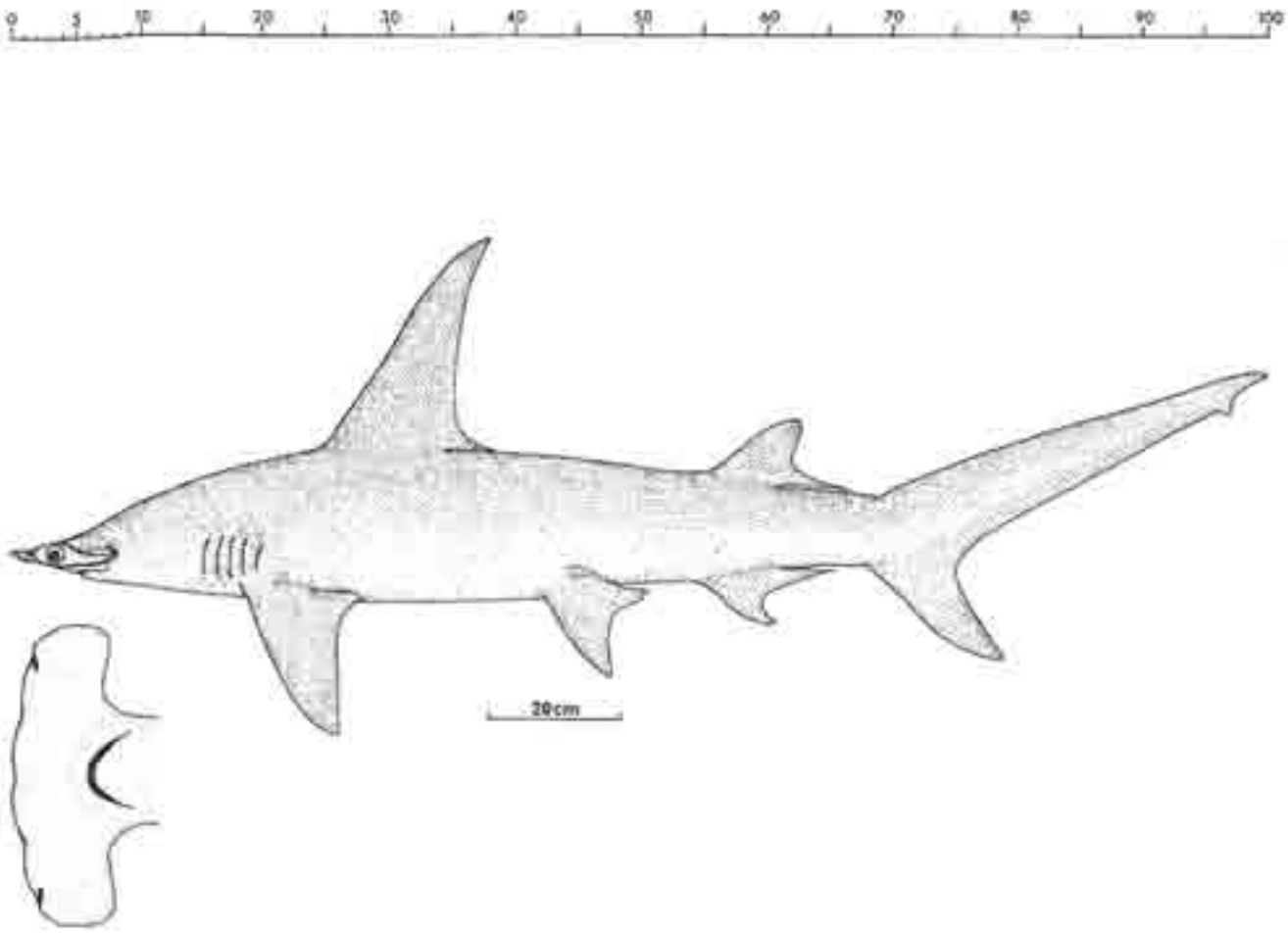

Fig. 25. *Sphyrna mokarran*. A 187 cm immature male from Natal.

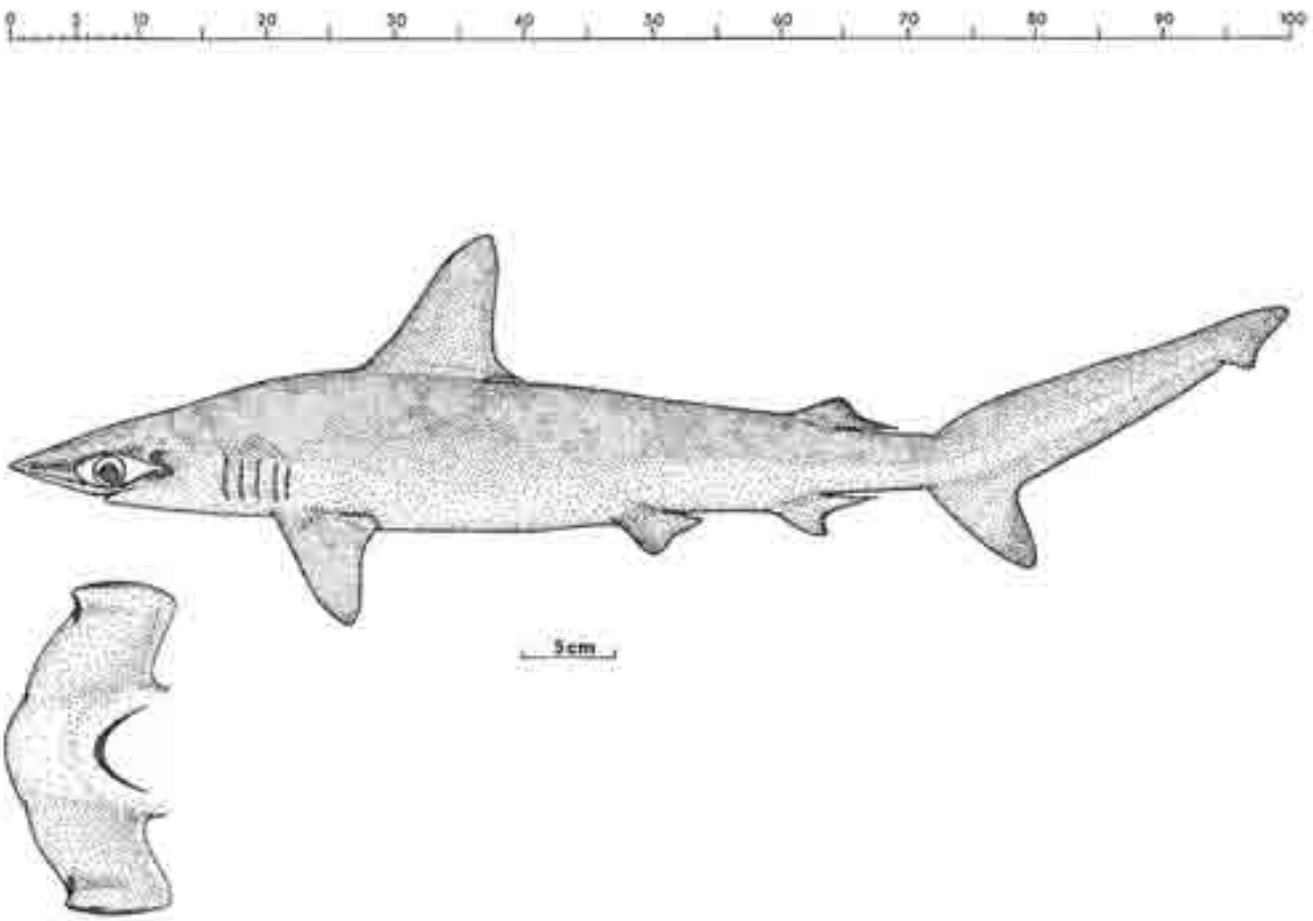

Fig. 26. *Sphyrna zygaena*. A 71 cm immature female from Natal.

Plates
Pages 89 to 100

Each plate shows the central and right lateral teeth as viewed from the front. Some of the teeth are shown in greater enlargement — their position in the jaw is shown by the paired labels (A, B, etc.).

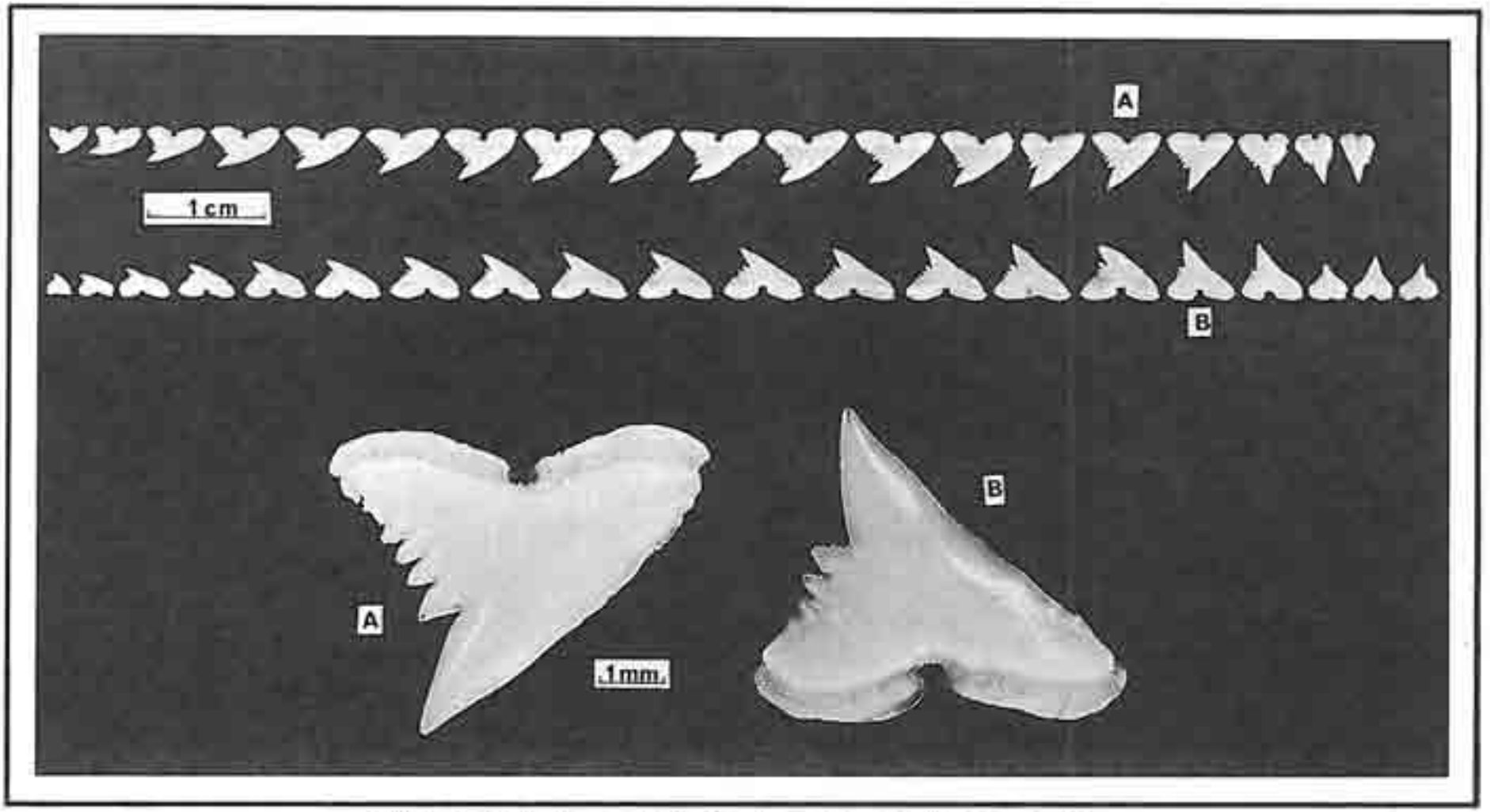

Plate 1. *Galeorhinus galeus*. Teeth of a 140 cm mature female from Algoa Bay.

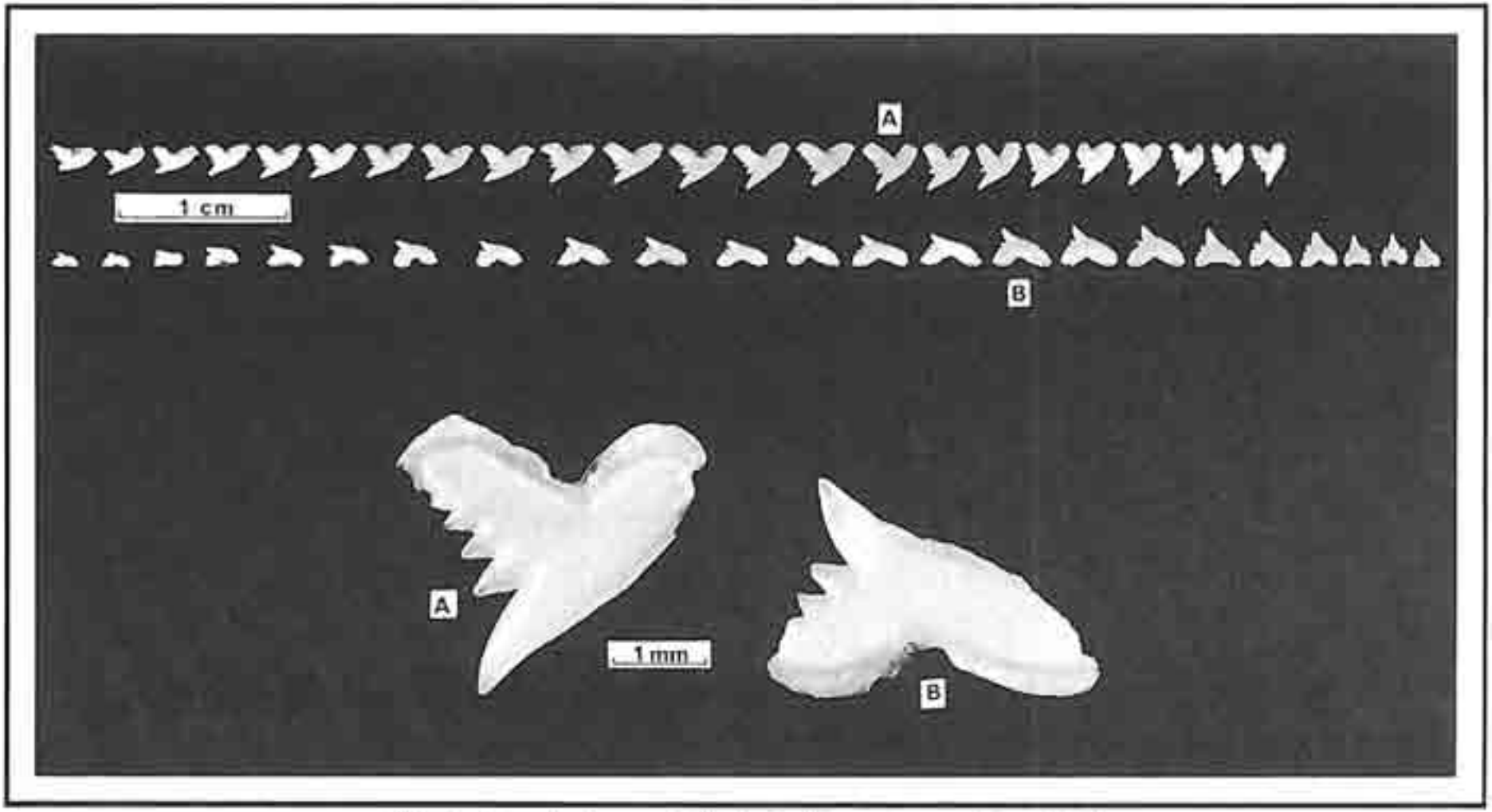

Plate 2. *Hypogaleus hyugaensis*. Teeth of a 115 cm mature male from Natal.

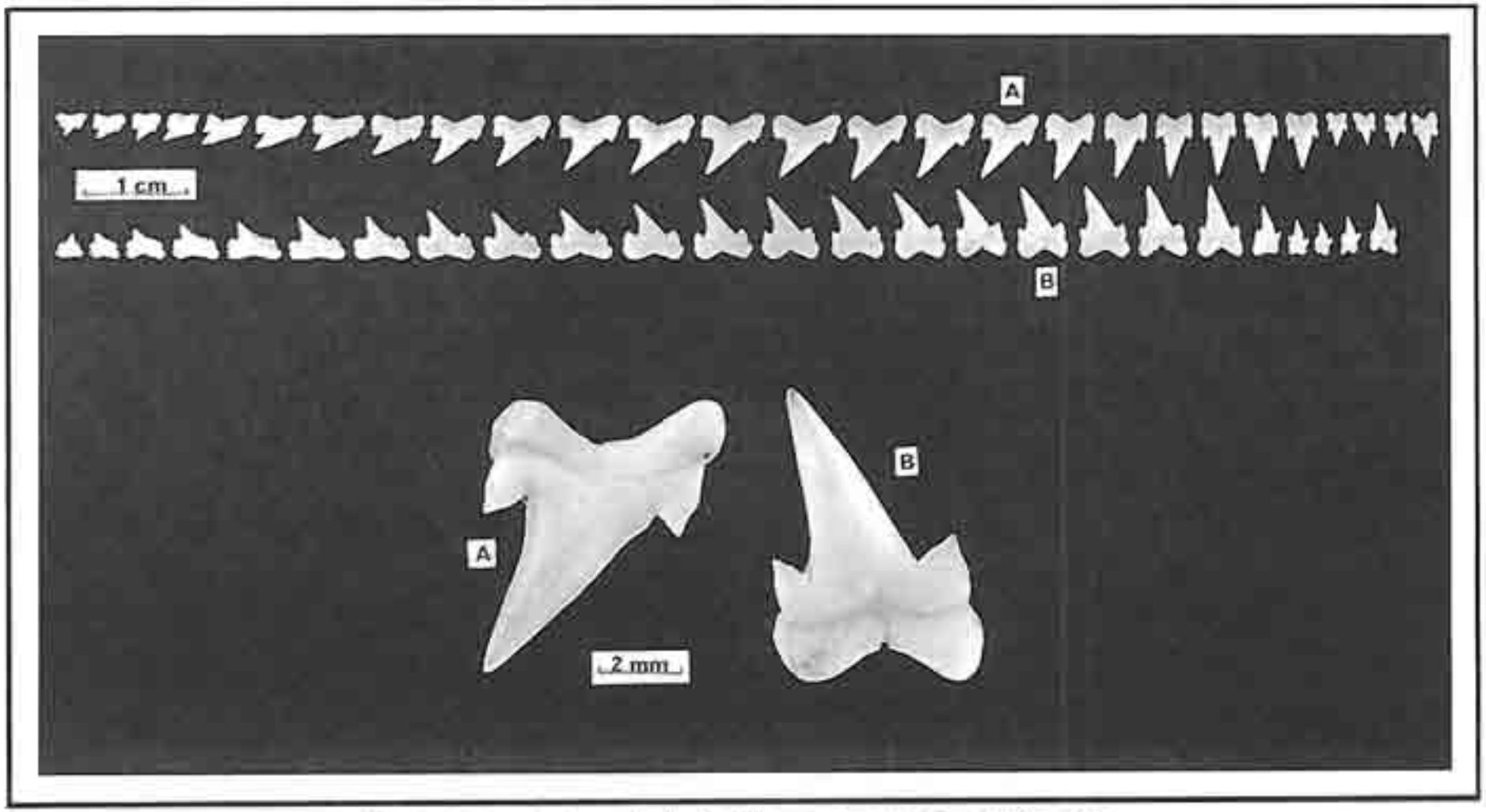

Plate 3. *Triaenodon obesus*. Teeth of a 139 cm mature male from northern Natal.

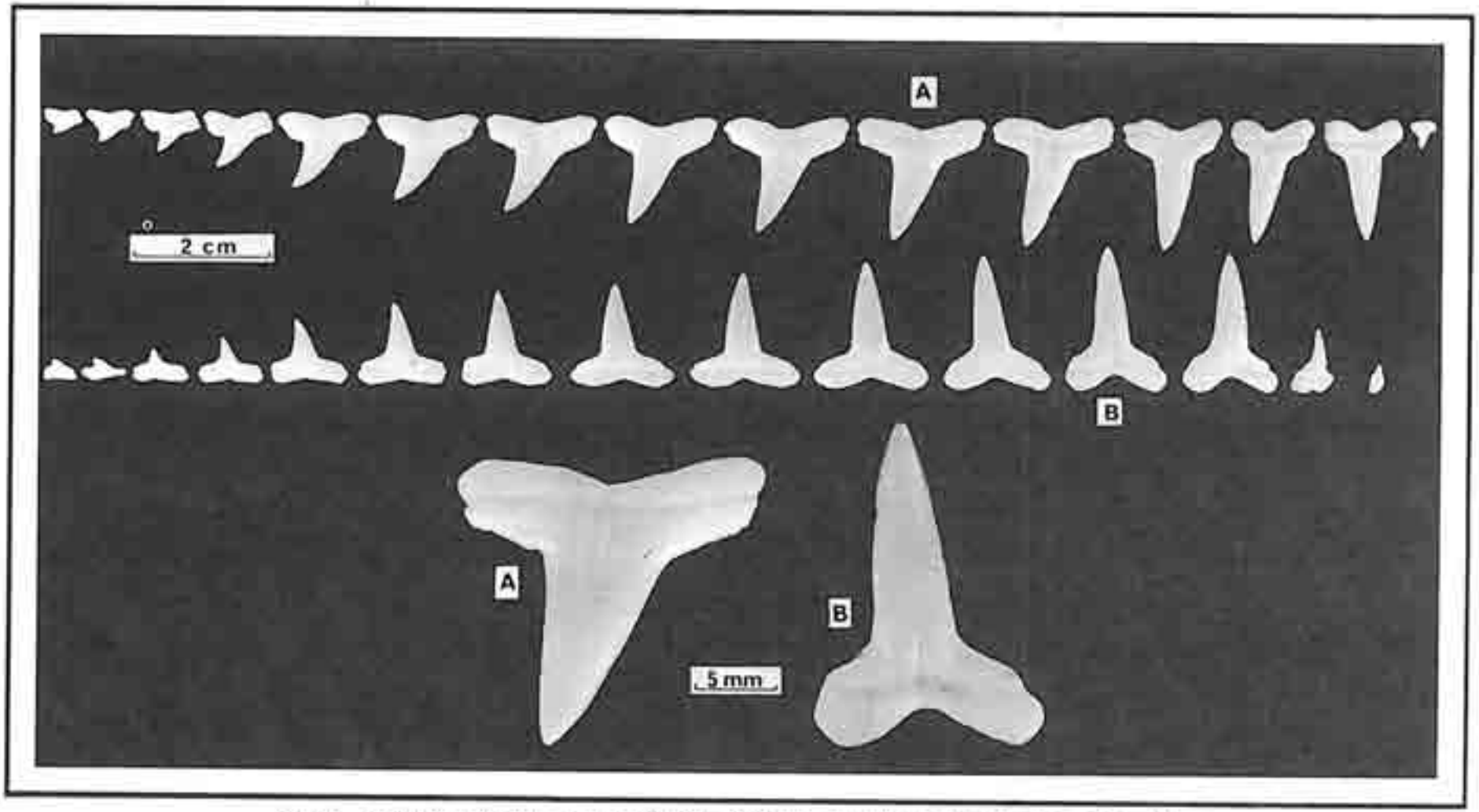

Plate 4. *Negaprion acutidens*. Teeth of an adult female of about 280 cm from southern Mozambique.

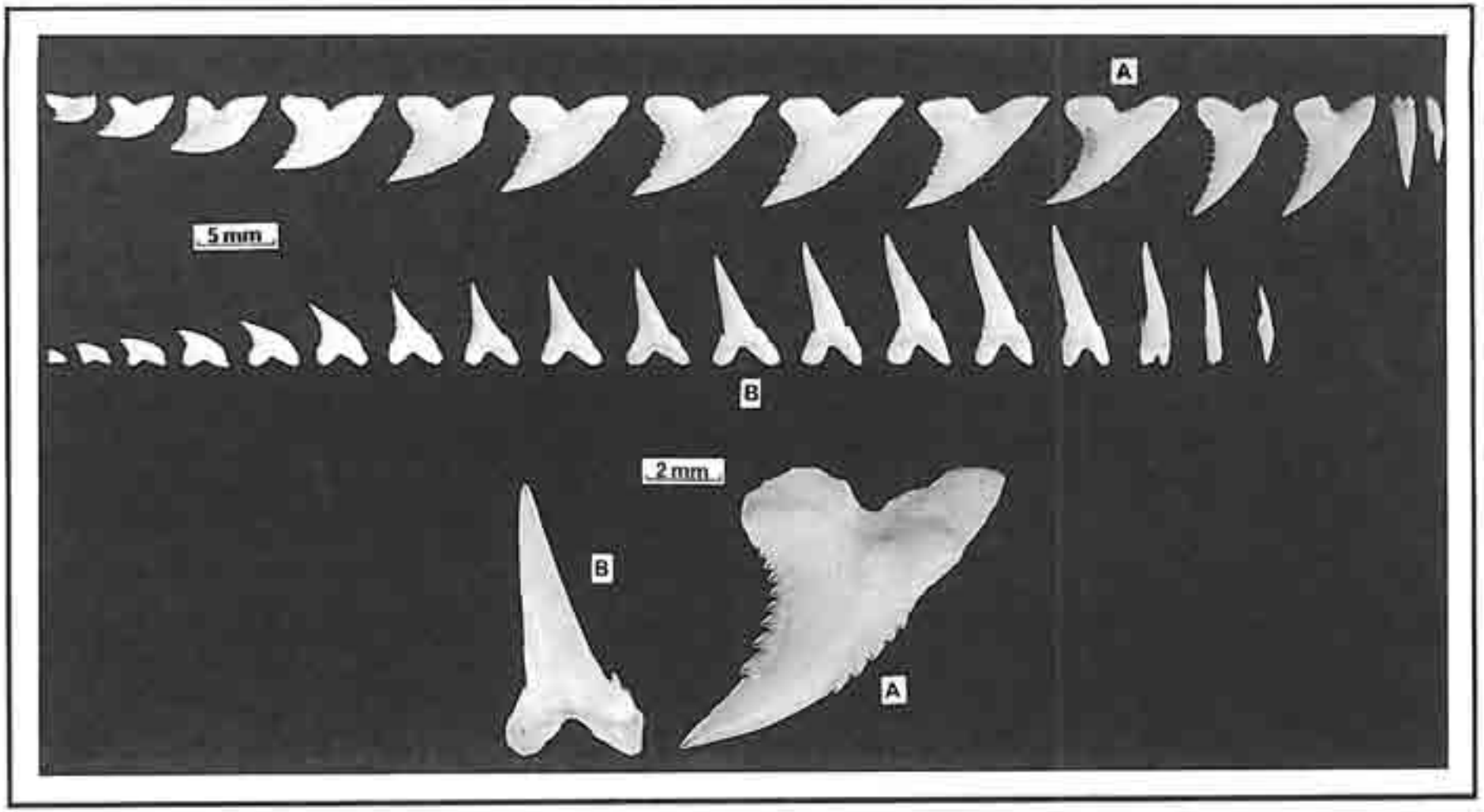

Plate 5. *Hemipristis elongatus*. Teeth of a 137 cm immature female from Zanzibar.

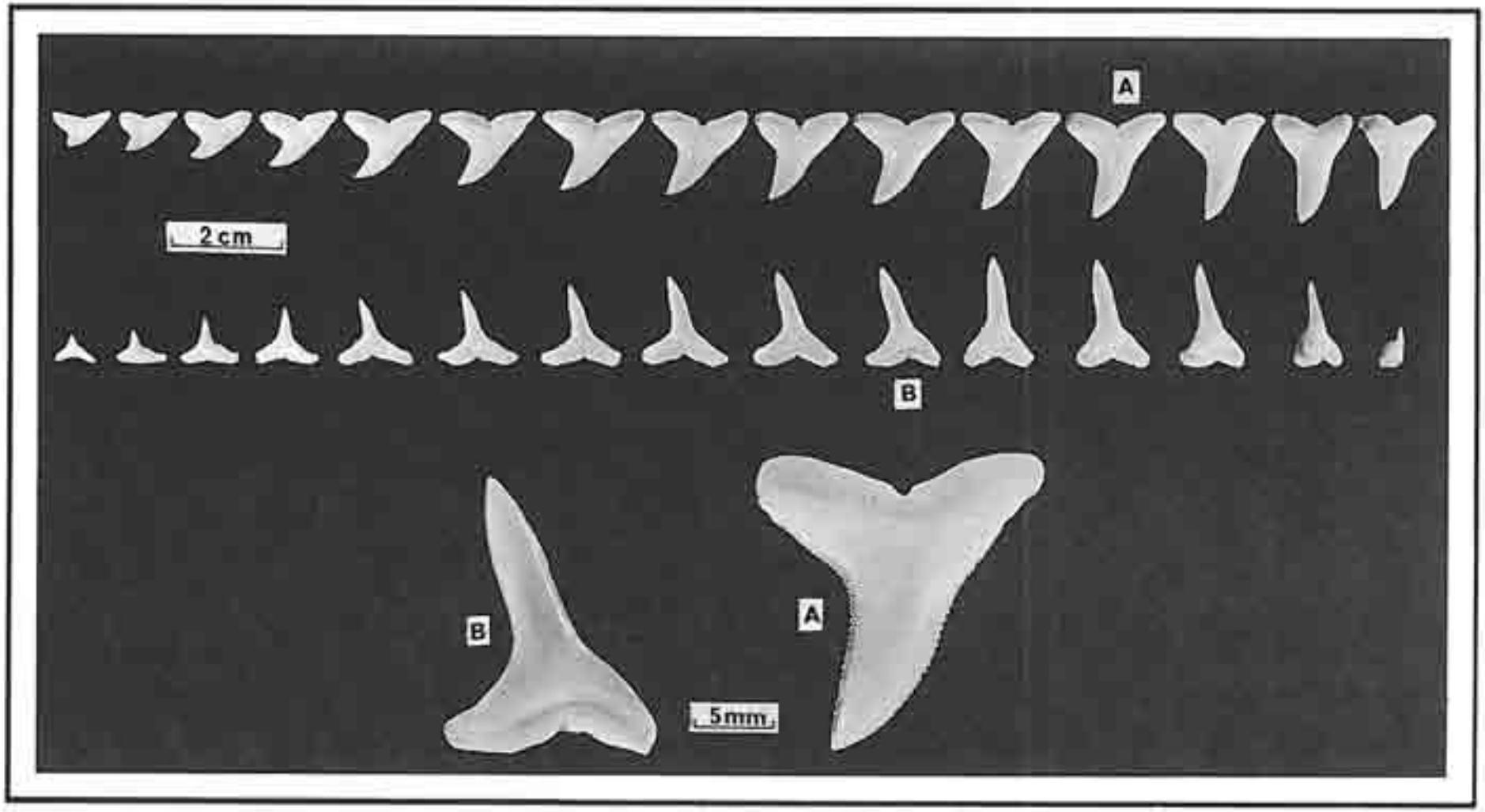

Plate 6. *Prionace glauca*. Teeth of a 274 cm adult male from Natal.

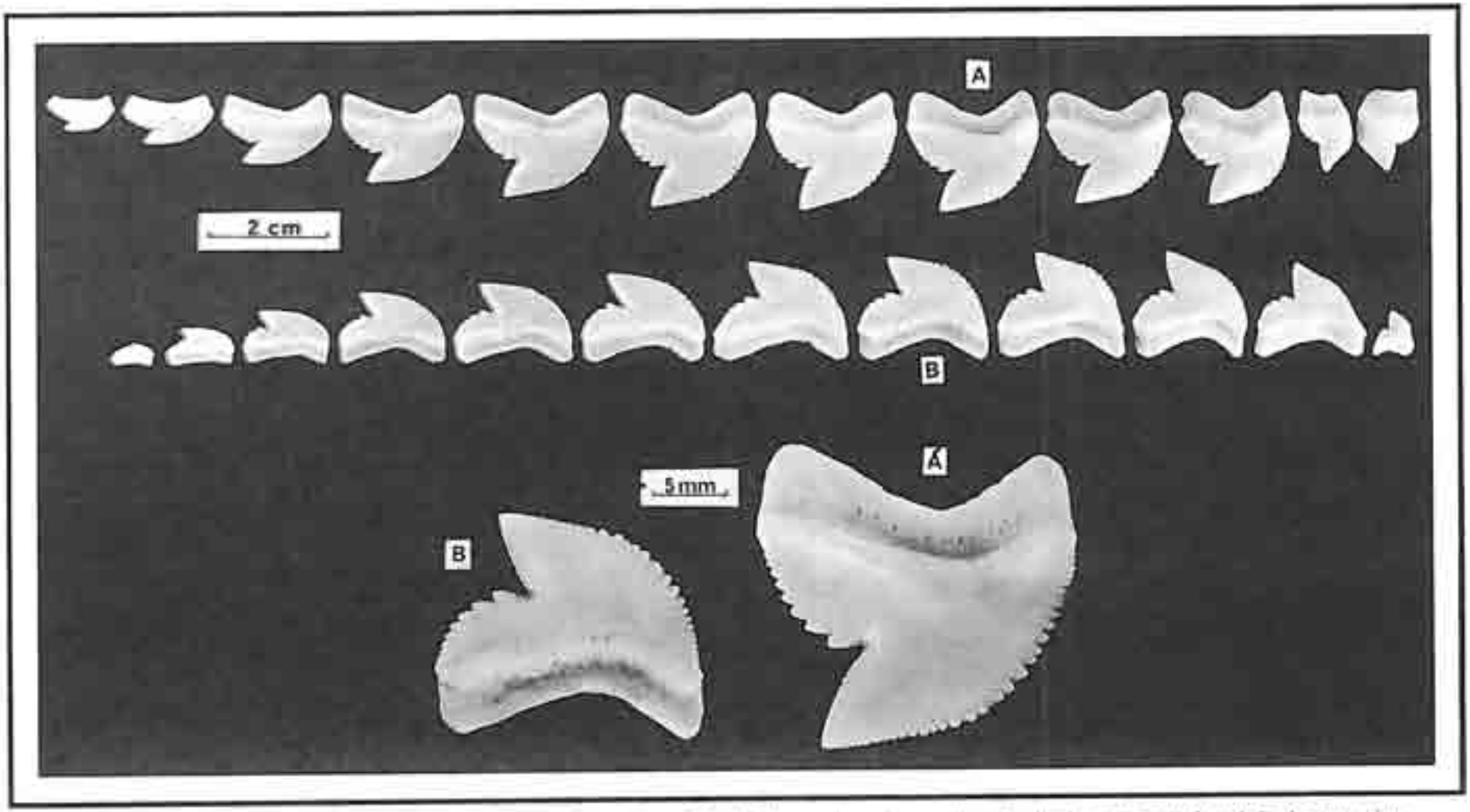

Plate 7. *Galeocerdo cuvieri*. Teeth of a 239 cm immature female from Natal. This specimen is exceptional in having two central teeth in the upper jaws. The majority of specimens have only one central tooth.

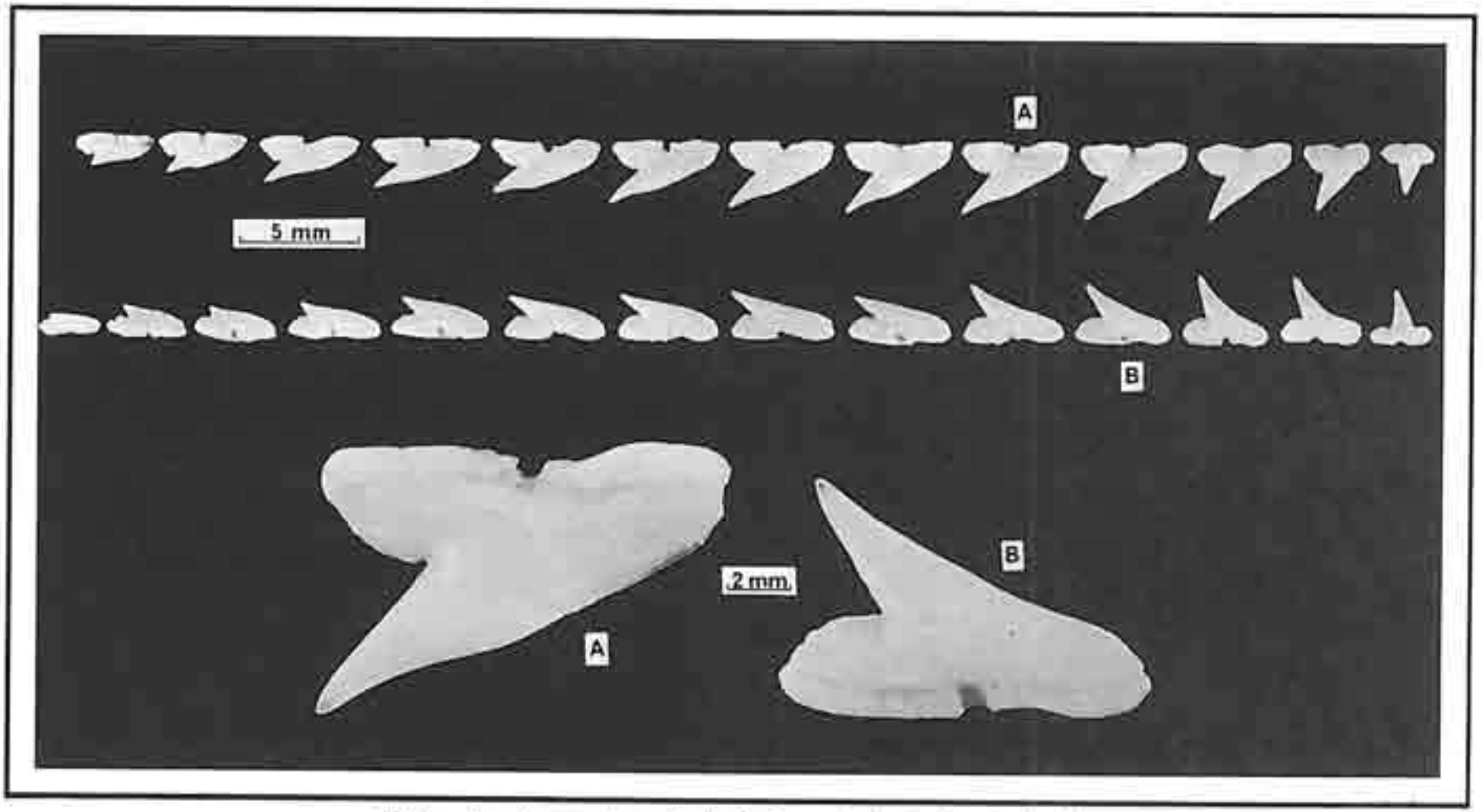

Plate 8. *Loxodon macrorhinus*. Teeth of a 78 cm adult male from St. Brandon.

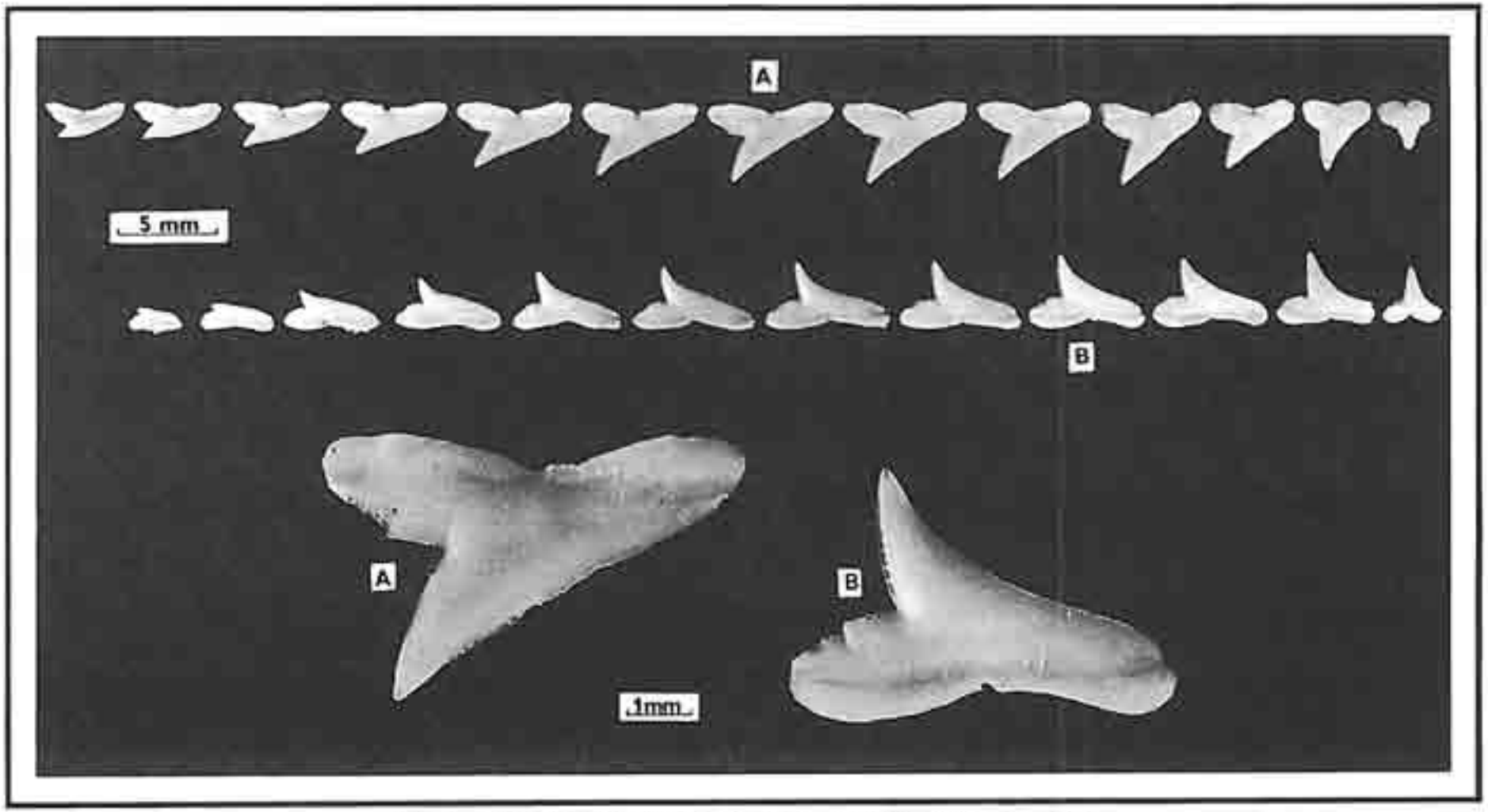

Plate 9. *Rhizoprionodon acutus*. Teeth of a 95 cm mature female from Natal.

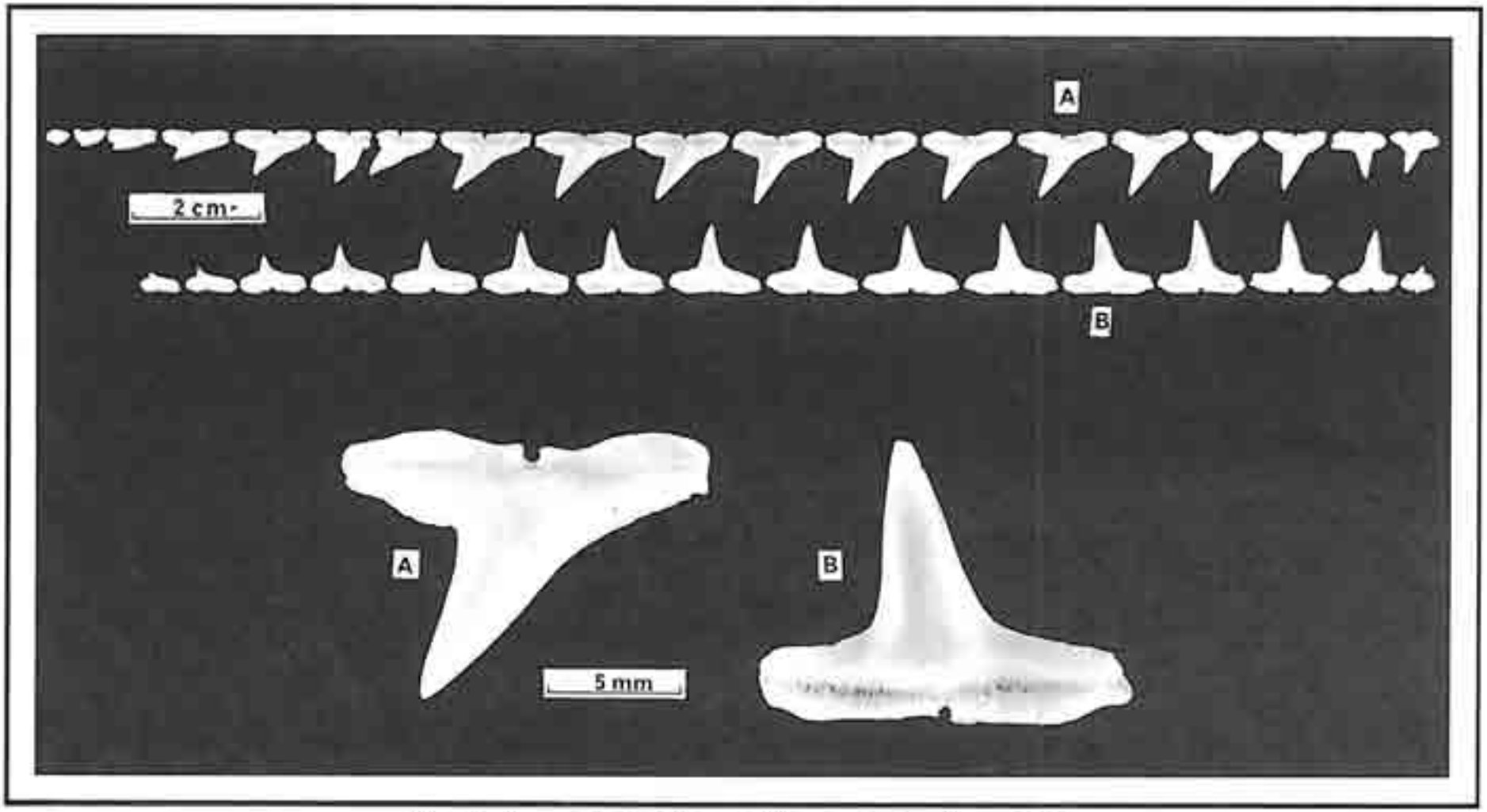

Plate 10. *Sphyrna lewini*. Teeth of a 307 cm mature female from Natal.

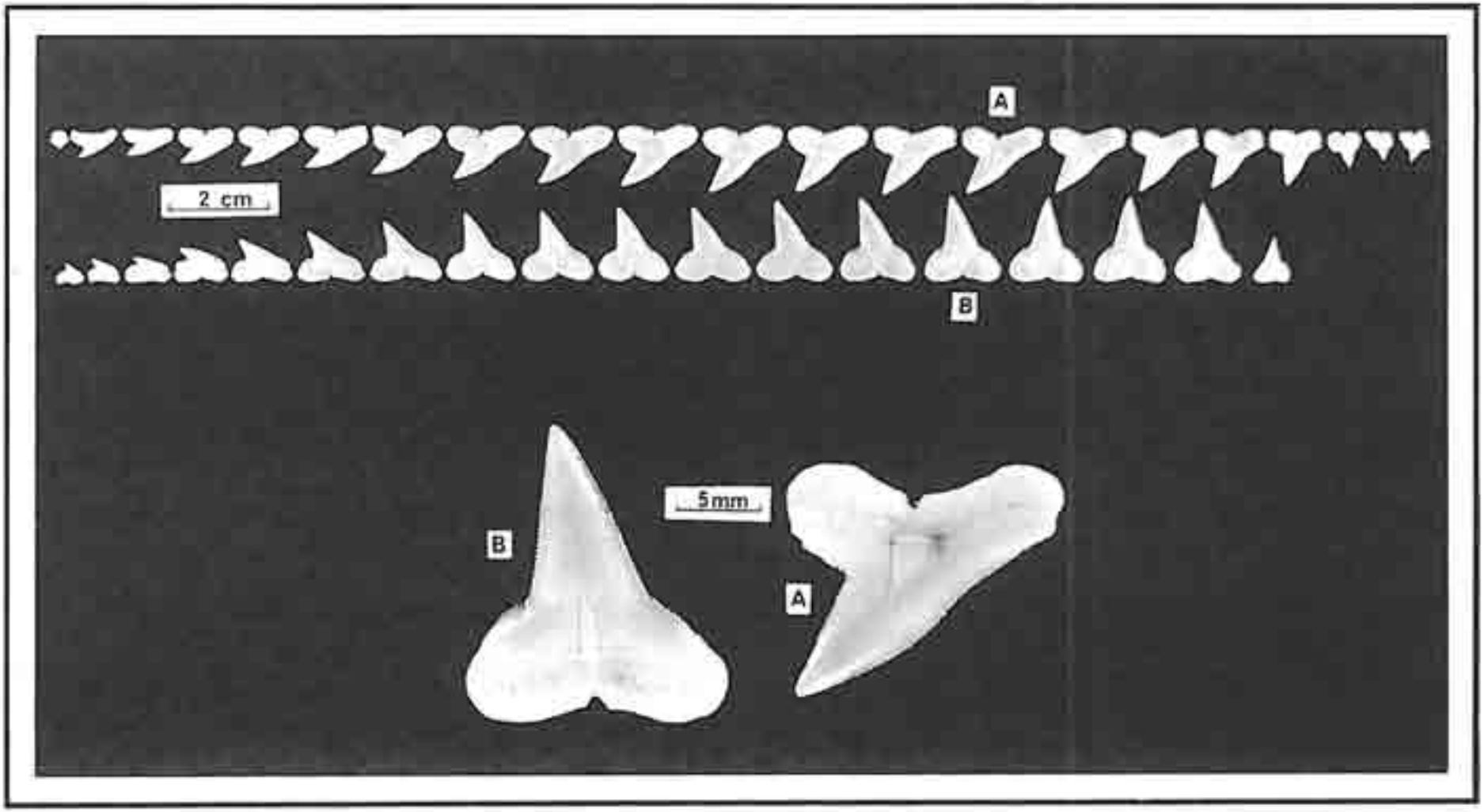

Plate 11. *Sphyrna mokarran*. Teeth of a 338 cm mature female from Natal.

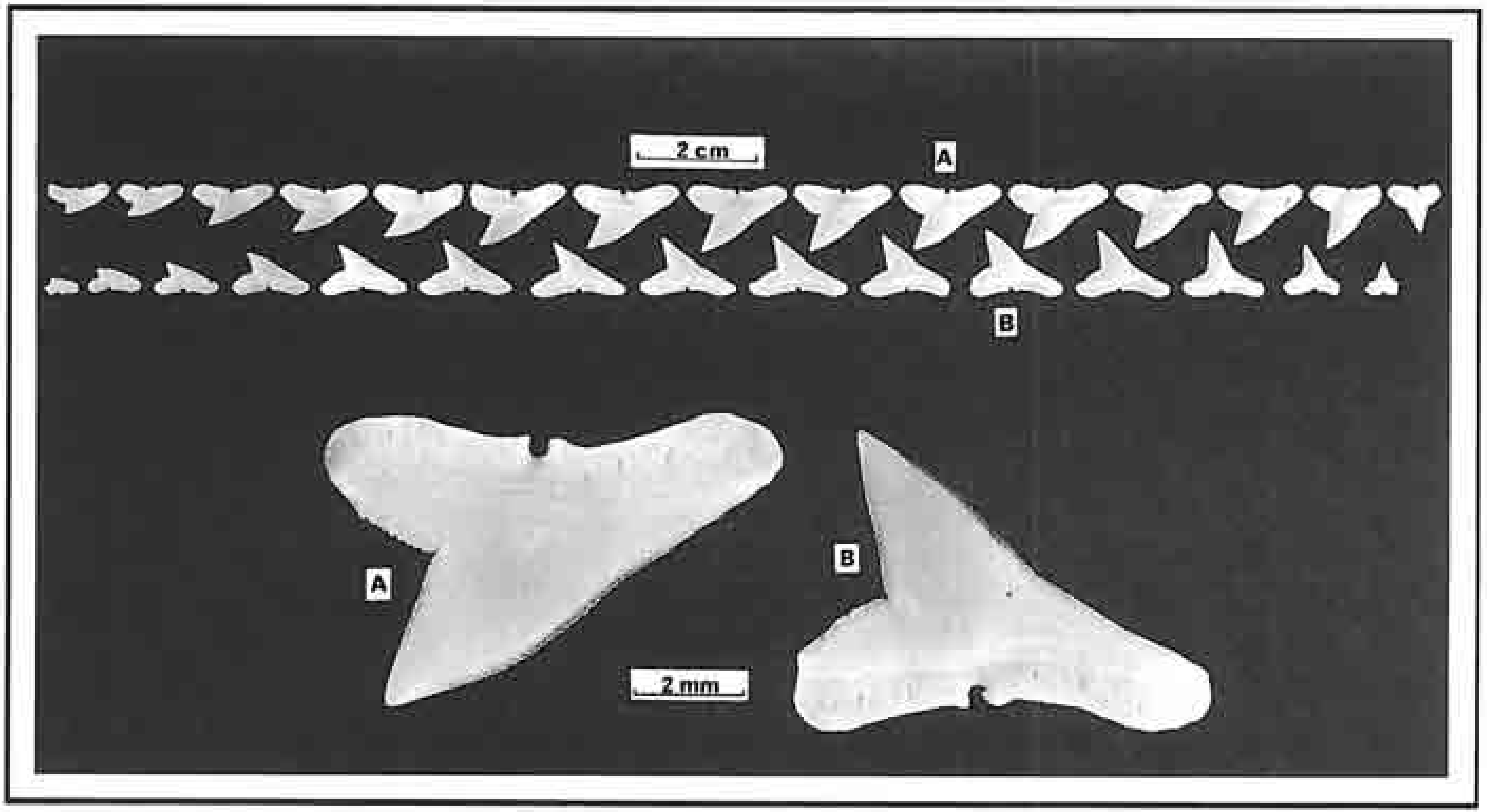

Plate 12. *Sphyrna zygaena*. Teeth of a 305 cm mature female from Natal.