

## Occurrence of the Porbeagle Shark, *Lamna nasus*, in the Tasman Sea

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The genus *Lamna* Cuvier, 1817 is placed in the family Lamnidae together with *Isurus* Rafinesque, 1810, and *Carcharodon* A. Smith, 1838 (Compagno, 1981). Two distinct species of *Lamna* have been recognized from temperate, boreal and antiboreal oceans (Bass et al., 1975). *Lamna nasus* (Bonnaterre, 1788) is widespread in the North Atlantic (Bigelow and Schroeder, 1948; Aasen, 1963; Templeman, 1963) and also occurs in the south-west and south-east Atlantic (Nakaya, 1971; Bass et al., 1975; Menni and Gosztanyi, 1977), the south-east Pacific (Kato et al., 1967) and the southern Indian Ocean (Duhamel and Ozouf-Costaz, 1982). *Lamna ditropis* Hubbs and Follett, 1947 is common in the North Pacific (Bigelow and Schroeder, 1948; Lindberg and Legeza, 1967). The status of two other nominal species of *Lamna*, both from the Southern Hemisphere, is doubtful (Garrick and Schultz, 1963). *Lamna philippi* Perez Canto, 1886 from Chile apparently lacks lateral denticles on its teeth and, since it is unclear whether a secondary caudal keel is present (Bigelow and Schroeder, 1948), may be referable to *Isurus*. *Lamna whitleyi* Phillips, 1935 is recorded from Australasia (Whitley, 1940; Graham, 1953; Munro, 1956) but it has been suggested by Garrick and Schultz (1963) that this species may not be separable from *L. nasus*. Bass et al. (1975) stated that positive identification of *Lamna* species from Australasia is dependent on further

collection of specimens.

During an oceanic squid survey of the Tasman Sea, nine *Lamna* taken incidentally by gillnet were examined, three in detail. Measurements on three *Lamna* caught during previous fisheries surveys in the Tasman Sea were also made available to us by Japanese scientists.

### Material and methods

Three female *Lamna*, 810~1,721 mm total length (TL), caught in December 1981 by the squid vessel 'Ryoun Maru No. 1' under charter to Japan Marine Fishery Resource Research Center (JAMARC) were examined in detail by the authors. The 810 mm TL female (CA 2854) together with the jaws of two female specimens, 1,594 and 1,721 mm TL (CA 2855 and 2856) were deposited at CSIRO Marine Laboratories, Cronulla, New South Wales (CSIRO ML). Lengths, weights, sex, some body measurements and biological observations, and in two cases photographs, on nine *Lamna*, 823~1,960 mm TL, were also available. Six were caught during the above survey and measured by one of us (SM) while three others were obtained during previous JAMARC investigations and measured for us by Drs. Tanaka and Ohtake and Messrs. Makihara and Kuroiwa. Table 1 summarizes data on date, locality and method of capture of these specimens. Terminology and methodology for tooth counts and body measurements follow those of Bass et al. (1973).

### *Lamna nasus* (Bonnaterre, 1788)

(Figs. 1, 2)

*Squalus nasus* Bonnaterre, 1788: 10, pl. 85, fig. 350 (type local., Wales); *Lamna nasus*: Bigelow and Schroeder, 1948: 112, figs. 15, 16, 17 (Synonymy; mainly North Atlantic).

Table 1. Date, position and method of capture of *Lamna* from the Tasman Sea.

Date	Position	Fishing method	Number of specimens	(females)	TL (mm)
4. 1.78	42°40'S, 165°12'W	Surface longline	1	*	≈ 1,100
12. 3.79	45°44'S, 170°07'W	Surface longline	1	(1)	1,295
13. 4.80	52°14'S, 170°33'E	Bottom trawl	1	*	1,960
17.12.81	44°58'S, 160°44'E	Surface gillnet	2	(2)	1,594~1,721
21.12.81	43°41'S, 154°09'E	Surface gillnet	5	(3)	810~1,726
22.12.81	41°41'S, 153°33'E	Surface gillnet	1	(1)	823
24.12.81	40°51'S, 153°41'E	Surface gillnet	1	(0)	824

\* Not recorded.

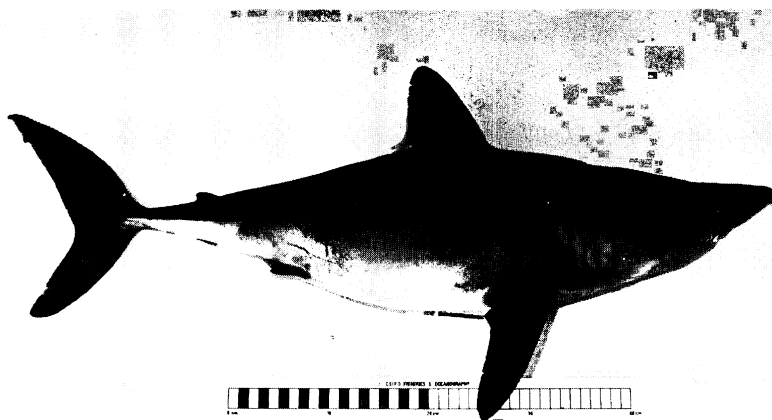


Fig. 1. 810 mm TL female *Lamna nasus* (CA 2854) from the southern Tasman Sea.



Fig. 2. Teeth of a 1,594 mm TL *Lamna nasus* (CA 2855) from the southern Tasman Sea. Note that the fourth upper tooth projects nearly at right angles to the second upper tooth (see text).

**Description.** Proportional body measurements, expressed as percentages of TL, for three *Lamna* from the Tasman Sea are presented in Table 2.

The following description is based on the 810 mm TL female (CA 2854). Snout conical and sharply pointed, orbit circular. Spiracle minute (similar in size to sensory pores), located behind posterior edge of eye by a distance equal to 1.3 times eye diameter. Upper labial furrow extending about 1/3 towards symphysis, upper furrow 1.8 times length of lower furrow. Nostril with two small lobes on anterior inner margin. Body very stout, its maximum depth above pectoral inner corner 20% of TL. Pectoral fin origin at base of fifth gill slit, first dorsal fin origin over middle of pectoral fin free inner edge. Second dorsal fin origin slightly in advance of anal fin origin. Second dorsal fin very small its vertical height about 1/7 of first dorsal fin height. Anal fin similar in size and shape to

second dorsal fin. Caudal peduncle flattened dorso-ventrally its maximum width about 5% of TL. Caudal peduncle with prominent sharp edged primary keel extending for 12.6% of TL, from middle of second dorsal fin lobe to middle of caudal fin. Secondary keel about 1/5 as long as primary keel and extending from just behind lower caudal fin origin to middle of caudal fin.

**Teeth:** Smooth edged and similar in both jaws with all but extreme laterals lanceolate. Most teeth with a small basal denticle on each side of cusp. Central teeth absent, first two teeth in upper jaw largest, third much smaller than second or fourth. Fourth upper tooth directed somewhat posteriorly, but not to the extent of being parallel to second upper tooth as in *L. ditropis* (Nakaya, 1971). In additional dental material examined (excised jaws CA 2855 and 2856) the fourth upper tooth projects nearly at right angles to the second upper tooth. The following description is based on the excised jaws. Upper teeth 1~6 with a distinct, narrow lateral denticle on each side of cusp. Teeth 7~11 with denticles becoming broader and shorter and gradually merging into base. Teeth 11~12 onward with no distinct denticles. Gap between third and fourth tooth considerably wider in the 1,721 mm TL specimen than in the 810 or 1,594 mm sharks and third tooth row of 1,721 mm shark with some individual teeth without denticles. Third lower tooth in all specimens not noticeably smaller than fourth. Lower teeth 1~6 with a distinct, narrow lateral denticle on each side of cusp. Teeth 7~10 with broader

denticles with some individual teeth having the appearance of two denticles on one side of cusp. Tooth 10 onwards generally with no distinct denticles, although variable with some individual teeth having denticles on one side of cusp, some on the other. Tooth counts on three specimens

of 1,295, 1,594 and 1,721 mm TL were respectively

15-15 16-15 15-16  
13-14' 13-15' 15-14'

Colour: Body dark grey dorsally with uniformly white ventral surface without blotches. Dorsal surface of all fins dark except for pale

Table 2. Proportional dimensions in percent of TL for *Lamna* from the Tasman Sea.

Dimension	810 mm TL female (CA 2854)	1,594 mm TL female	1,721 mm TL female
Snout tip to:			
nostrils	6.5	4.7	5.8
mouth	9.0	7.3	7.2
eye	8.2	7.5	7.0
spiracle	14.7	12.8	12.7
1st gill slit	23.2	19.3	20.3
pectoral fin origin	27.6	24.8	27.6
1st dorsal fin origin	35.0	32.7	32.2
pelvic fin origin	55.8	54.6	56.1
upper caudal fin origin	78.7	79.4	78.7
Origin of:			
1st dorsal to 2nd dorsal fin	34.5	38.6	38.3
pectoral to pelvic fin	28.8	29.0	28.8
pelvic to anal fin	14.2	15.7	15.1
Space between:			
dorsal fin bases	24.9	27.5	27.3
2nd dorsal and caudal fins	9.0	7.3	7.7
anal and caudal fins	8.5	7.7	7.4
Distance between			
1st and 5th gill slits	—	8.0	8.5
Eye diameter	2.8	1.9	1.7
Nostril length	1.0	0.9	1.0
Internasal distance	4.0	3.6	3.5
Mouth width	9.6	8.7	8.8
height	5.6	4.5	3.9
Height gill slit 1	7.0	7.5	7.6
3	7.2	8.2	7.2
5	6.7	7.8	6.9
1st dorsal fin height	10.6	11.9	12.3
base	9.6	11.9	10.7
lobe	3.2	3.9	4.1
2nd dorsal fin height	1.6	1.5	1.4
base	1.5	1.4	1.3
lobe	2.6	2.8	2.8
Anal fin height	1.8	2.2	2.0
base	1.7	1.6	1.9
lobe	2.7	3.4	3.0
Pectoral fin anterior margin	20.1	20.7	20.2
fixed width	7.7	7.1	7.6
free inner margin	3.2	4.8	4.6
Upper caudal fin length	22.1	25.2	25.0
Lower caudal fin length	17.5	19.0	18.1
Caudal notch to fin tip	4.3	6.0	4.8

edge to pectoral inner corners, pale lobe to first dorsal extending to the trailing edge, and pale posterior half to pelvics. Ventral surface of pectoral fins dark and anterior half of pelvics dusky.

The *Lamna* of 1,295 mm TL had a total vertebral count of 162. Total lengths and weights of 9 specimens were: 810 mm, 4.7 kg, female; 823 mm, 5.7 kg, female; 824 mm, 6.2 kg, male; 1,219 mm, 17 kg, male; 1,295 mm, 22.6 kg, female; 1,350 mm, 25 kg, male; 1,411 mm, 30 kg, female; 1,594 mm, 44 kg, female; 1,721 mm, 55 kg, female.

**Biological observations.** The stomach contents of four *Lamna* were examined. Two were empty.

A 1,594 mm TL female contained lower beaks of two squid, identified as *Moroteuthis* 'A' (Clarke, 1980) with lower rostral lengths (LRL) of 9.4 and 9.5 mm. Using data presented by Clarke (1980), we conclude that these beaks came from squid of approximately 200 mm mantle length.

A further six squid beaks (four uppers and two lowers) tentatively identified as also from *Moroteuthis* 'A', were found in the stomach of an 810 mm *Lamna*. These beaks had LRL's of 2.9 and 3.2 mm, representing with 304 mantle lengths less than 100 mm. Isopod and stomatopod fragments and flesh remains of an epipelagic teleost, probably *Cubiceps*, were also found in this stomach.

Reproductive information was limited to the observation that three females of 1,295, 1,594 and 1,721 mm TL were immature as judged by the condition of their ovaries and genital tracts.

### Discussion

The characters used to separate *Lamna nasus* from *L. ditropis* are given by Bigelow and Schroeder (1948) and Nakaya (1971). To compare body proportions in different species the relationship between a particular dimension and fish length at different stages of growth should be known. However, insufficient data are available for *Lamna* in the literature to make this possible. To obtain the most valid comparison we compared measurements of our *Lamna* with those of similar sized specimens of *L. nasus* and *L. ditropis* from the literature (Bigelow and Schroeder, 1948; Strasburg, 1958; McKenzie and Tibbo, 1964; Nakaya, 1971). This com-

parison (Table 3) showed, firstly, distinct differences with no overlap between *L. nasus* and *L. ditropis* in five individual body measurements (agreeing, in part, with the findings of Nakaya (1971)) and secondly that the *Lamna* from the Tasman Sea are clearly referable to *L. nasus*. All other dimensions showed some overlap between the two species, including three measurements (snout tip to caudal fin origin and lengths of upper and lower caudal fin margins as percentages of TL) considered by Nakaya (1971) to be 'remarkably different' in *L. nasus* and *L. ditropis*. Table 3 also shows other diagnostic characters of *L. nasus* and *L. ditropis* in which the Tasman Sea material again agrees with *L. nasus*. Tooth counts of our three *Lamna* are slightly higher ( $\bar{x} = \frac{30.7}{28.0}$ ) than the mean value of  $\frac{28.2}{26.2}$  for seven *L. nasus* from elsewhere (Templemen, 1963; Nakaya, 1971; Menni and Gosztonyi, 1977; Svetlov, 1978). It is possible that counts reported in the literature may not have included some of the last lateral teeth. These teeth are very small in *Lamna* and may be overlooked if the jaws are not excised. The mean tooth count for three *L. ditropis* reported by Nakaya (1971) was  $\frac{30.7}{27.3}$ . Total vertebral counts for 63 *L. nasus* ranged from 150 to 162 (Springer and Garrick, 1964). A total count of 162 vertebrae was provided by JAMARC scientists for one *Lamna* from the Tasman Sea.

Phillips (1924) originally identified *Lamna* from New Zealand waters as *L. nasus* on the basis of a specimen which he subsequently included in his synonymy of *L. whitleyi* (Phillips, 1935). Both of these papers by Phillips are confusing as he apparently muddled *Lamna* and *Isurus* stating (1935) that New Zealand *Isurus* have teeth with lateral denticles. He also recorded that the origin of the first dorsal fin was further forward in *L. nasus* than in *L. whitleyi* (1935: 240) while on the following page he stated the opposite. Phillips (1935) described the first dorsal fin origin in *L. whitleyi* as being just behind the pectoral base (although this is not evident from fig. 11 of his 1924 paper). In *L. nasus* he said the dorsal origin was over the posterior pectoral base, generally above the middle of it. In subsequent descriptions of *L. nasus* the first dorsal fin origin was reported as over, or slightly posterior to the pectoral axil (Bigelow and

Table 3. Comparison of *Lamna* from the Tasman Sea with *L. nasus* and *L. ditropis* from different regions.

Character	TL range 760~1,250 mm				TL range 1,260~1,830 mm		
	<i>L. ditropis</i> <sup>1</sup> (mean of 2)	<i>L. nasus</i> <sup>2</sup> (mean of 7)	<i>L. nasus</i> <sup>3</sup> (1 specimen)	<i>Lamna</i> <sup>4</sup> (1 specimen)	<i>L. ditropis</i> <sup>5</sup> (1 specimen)	<i>L. nasus</i> <sup>2</sup> (mean of 6)	<i>Lamna</i> <sup>4</sup> (mean of 2)
Total length (mm)	960	1,006	935	810	1,830	1,570	1,658
Snout tip to nostrils (%TL)	5.2	6.6	6.0	6.5	3.6	5.8	5.3
Snout tip to eye (%TL)		8.0		8.2	4.6	7.0	7.3
Snout tip to mouth (%TL)	6.7	8.4	7.1	9.0		7.4	7.3
Space between 2nd dorsal and caudal fins (%TL)	7.8	8.6	9.2	9.0	6.6	8.6	7.5
Space between anal and caudal fins (%TL)	7.8	9.1	9.2	8.5	6.0	8.9	7.6
	<i>L. ditropis</i> <sup>5</sup>		<i>L. nasus</i> <sup>5+6</sup>		<i>Lamna</i> <sup>4</sup>		
Posterior of eye to 1st gill slit Snout tip to anterior of eye	2.5~2.8		1.1~≈2.0		1.2~1.7		
Fourth upper tooth	considerably oblique <sup>5</sup>		almost erect <sup>5</sup>		almost erect <sup>4</sup>		
Colour of ventral surface	white with dark blotches <sup>5</sup>		white <sup>5</sup>		white <sup>4</sup>		

1, Strasburg, 1958 (North Pacific; 30°~50°N, 125°~175°W).

2, McKenzie and Tibbo, 1964 (North-west Atlantic).

3, Bigelow and Schroeder, 1948 (North-west Atlantic).

4, Present data (Tasman Sea).

5, Nakaya, 1971 (South-west Atlantic; 47°S, 62°W).

6, Svetlov, 1978 (54°28'S, 35°29'W).

Schroeder, 1948) or over the inner margin of the pectoral fin (Nakaya, 1971). There is thus no real difference in the position of the first dorsal fin in *L. nasus* or *L. whitleyi*. Phillips (1935) stated that the second dorsal fin origin was over the posterior part of the anal base in *L. whitleyi* whereas in *L. nasus* it was over the anal fin origin. These two fins are so small in *Lamna* that slight errors or variations in measuring technique could account for this difference. Phillips (1935) also mentioned that the gill slits in *L. nasus* extend further onto the ventral surface than in *L. whitleyi* and that some of the smaller teeth in the latter species appeared to have two basal denticles on each side of the cusp. As was noted in our description of the Tasman Sea *Lamna* the lateral denticles, particularly in the lower jaw, become broader towards the mouth corners giving the appearance in some teeth of two denticles. No real difference was apparent in the position of the gill slits in *L. whitleyi* figured by Phillips (1935) relative to their position in *L. nasus*. However, one notable difference evident from the measurements of *L. whitleyi* given by Phillips (1935) is the value of 2.6 for the ratio back of eye to first gill slit: snout to eye. That value clearly falls within the range for *L. ditropis* (2.5~2.8, Table 3). However, Phillips' (1924, 1935) colour description of *L. whitleyi* agrees with that of *L. nasus* not *L. ditropis*.

In the absence of any type material (G. S. Hardy, J. A. F. Garrick, personal communication) and in view of Phillips' (1924, 1935) scant and confusing description there seems little basis for regarding *L. whitleyi* as a valid species. We consider that the shark described is most probably referable to *L. nasus*.

Sea surface temperatures for stations where *Lamna* were captured by surface gillnet or longline in this study varied from 13.8~15.8°C. One specimen was taken in 1980 by demersal trawl at 438 m in position 52°14'5", 170°33'E, where the bottom temperature was 7.5°C. One hundred and ninety six *Lamna* were taken by longline in the Tasman Sea between 32°06'S, 175°54'W, and 53°42'S, 172°52'E, with sea surface temperatures between 7.6 and 22.8°C. The majority were caught where surface temperatures ranged from 7.6 to 16.7°C (JAMARC, 1978).

Elsewhere *L. nasus* has been captured by

trawl in bottom temperatures as cold as 3.1~6.2°C (surface temperature 13.0~14.1°C) (Templeman, 1963; Nakaya, 1971). One specimen was taken in Antarctic waters at a depth of 260 m where the bottom temperature was 1.7°C and surface temperature 3.2°C (Svetlov, 1978).

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タスマン海における *Lamna nasus* (Bonnatere) の記録

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タスマン海南部で漁獲されたネズミザメ属 12 個体をプロポーシオン計測値、歯の構造および配列、体色にもとづいて調査した結果、標本は *L. nasus* と同定した。またオーストラリア産 *L. whitleyi* の分類学的位置を検討した結果、本種はおそらく *L. nasus* と同一であるとみなした。

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