International Council for the
Exploration of the Sea.

C.M. 1961
Near Northern Seas Committee
No. 109

Some observations on the Biology of the Porbeagle Shark (Lamna nasus L.)

by

Olav Aasen

I. Introduction.

The family Isuridae is represented by 3 genera in North Atlantic Waters, each with 1 species (Bigelow & Schroeder 1948):

Lamna nasus

Isurus oxyrhincus

Carcharodon carcharias.

Of these Lamna nasus, the Porbeagle shark, is of the greatest economic importance, its flesh being used for human consumption and fetching good prices. The Mako shark (Isurus oxyrhincus) is a favourite game fish for sport fishermen and it also sustains a shark leather industry. The third species (Carcharodon carcharias) is the illfamed Man Eater shark, the chief importance of which is the terror it has struck into the human mind, producing numerous more or less wild accounts of the ferocity of this "monster". Actually, the 3 species have a very similar appearance. They are, however, easily distinguishable by their teeth. The Porbeagle shark is moreover readly recognized by its secondary keel on the tail part which is lacking in the Mako and the Man Eater.

This account is mainly concerned with the observations on the Porbeagle shark made on a commercial fishing cruise to the western part of the North Atlantic. Some data for the Mako shark will also be given for comparison.

II. Range.

According to the literature (Bigelow & Schroeder, loc.cit.) the Porbeagle shark normally occurs in the continental waters in the North Atlantic. In the eastern part from the Mediterranian and northwestern Africa to the North Sea, Ireland, Scotland and Orkneys-Shetland to southern Scandinavia, being less common in northern Norway and the Murman coast. This shark is also fished for around Rockall and the Færoes, but is infrequent north to Iceland. In the western part it occurs on the Flemish Cape and New Foundland Banks, and penetrates into the Gulf of St. Lawrence in the autumn. It is also frequent on the Nova Scotian Shelf and in the Gulf of Maine, its chief sentre being.

the western part of that region. The upper toleration limit for the temperature appears to be about 18°C. The lower limit is not stated, but presumedly it lies around 5°C, judged by the observations now in hand. According to Bigelow and Schroeder (ibid.), the on-and-off shore range in the West is rather narrow. This statement needs some correction. The Porbeagle shark appears to be frequent all along the continental slope. Even as far out as on the Flemish Cape it is fished for commercially, although with no striking results. Quite possibly it may also be found in the open ocean, and a trans-atlantic migration is not out of the question.

With respect to the dept-range Bigelow and Schroeder's (ibid.) statement is confirmed, the fish descends into deeper waters in the winter time when the surface layers cools down. It is then to be found at least down to 200 m depth. In the summer it is frequently seen finning in the surface.

III. The Fish.

1. Length.

It is proved impractical, if not impossible, to measure the total length of any great number of fish during the fishing operations. To circumvent this difficulty, only the "dorsal length" was taken in the majority of the measurements. This "dorsal length" measurement was chosen because one single observer can work both quickly and precisely without interfering unduly with the fishing operation. The "dorsal length" is, by definition, the length in cm from the origin of the first dorsal fin to the anterior edge of the pre-caudal pit. In the Table below are entered the distribution of a part of these measurements (Gulf of Maine July/August, 1961).

cm gps.	50-59	60-69	70-79	80-89	90-99	100-109	110-119	120-129	Total
Number	21	82	154	293	248	213	102	7	1120

In 171 fishes also the total lengths were measured, and on basis of these data a conversion factor of 2.1 was found, i.e. to obtain the total length, the dorsal length is to be multiplied by 2.1. It may then be stated that the length of the Porbeagle shark varies roughly between 1 and 2.5 m with the greatest frequency around 2 m in the Gulf of Maine. The importance of this information is augmented by the fact that this stock is virtually a virgin one from a fisheries point of view.

2. Weight.

If measurements may be difficult to make under sea conditions, weighing, especially of large fish, presents a far worse problem. However, one succeeded in weighing 115 of the fish (less blood) of which total length measurements were taken. The length/weight key (k) turned out to be 1.03 according to the formula $v = k\ l^3\ 10^{-5}$, where v is the weight in kg and l the length in cm. It is then possible, from the dorsal measurements, which comprise nearly all the fish, to arrive at an estimate of the total tonnage caught. From a fisheries point of view it is, however, more important to know the gutted weight of the fish. About 200 gutted fish were weighed, and the corresponding dorsal lengths measured. In a preliminary calculation based on 60 of these measurements, the key (k') for dorsal length/gutted weight turned out to be 0.58 employing the same formula as above. The tonnage caught, as calculated from the dorsal length and k', seems to be in good ac - cordance with the facts. However, the final check, i.e. the data for the landed quantity, will have to wait.

In a series of 94 fish both the total weight and the corresponding gutted weight were taken. The mean value of the quotient: total weight/ gutted weight is 1,48. That means that the wastage (head, fins, gut) is quite heavy and amounts very nearly to 1/3 of the whole fish.

During the later part of the cruise, some Mako sharks were caught. These were measured and weighed as far as prevailing conditions per - mitted. The length/weight key (k) for the Mako shark is, according to these observations, 1.04 (4 specimens) and thus very close to Porbeagle shark. The gutted weight was taken in 10 fish, and the corresponding dorsal measurements recorded. The key (k') dorsal length/gutted weight for the Mako shark, calculated from these data, shows a value of 0,68. Again is obtained a result which is in close accordance with the Por- beagle shark, if the relative positions of the first dorsal fin is borne in mind. Evidently, Bigelow & Schroeder's (ibid.) account is confused by the absence of sufficient exact data, and, although perhaps prematurely, it can be stated that the length/weight key for the Mako shark is at least of the same order of magnitude, if not larger, than for the Porbeagle shark.

From the fisherman's point of view (as far as cold storage ships are concerned), it is of some importance to know how much the fish will

lose in weight during freezing. Some 150 gutted fish were therefore weighed and the corresponding dorsal length measured before and after freezing. The preliminary results of this investigation show that the loss is roughly 3-4 % (about 24 hours). On the other hand, the dorsal measurements increase by 2.5 - 3 %. A precise knowledge of these figures will be of importance if (f.i.) sampling is to be carried out on frozen fish.

3. Sexual Maturity.

As a whole the males and females appear to be present in about equal numbers, 49% ♂ , 51% ♀ of 1854 fish, but as a rule the catches showed a striking predominance of one sex, i.e. the sexes will normally move in separate schools.

In the Table below is shown the average length (preliminary figures) of the claspers for a part of the material compared to the dorsal length.

Dorsal length:	50	60	70	80	90	100	110	120	cm
Clasper :	6	7.5	12.5	19	22	22	22		cm

From these data is deduced that the males of the Porbeagle shark matures at a (total) length of roughly 1,5 - 2 m.

Similarly it will be seen from the next Table that the females mature at a (total) length of about 2 - 2,5 m.

Dorsal length:	50	60	70	80	90	100	110	120	130	cm
Uterus :	8	9	10	11	13	15	23	29		cm

Also here the figures given are preliminary .

4. Vertebrae.

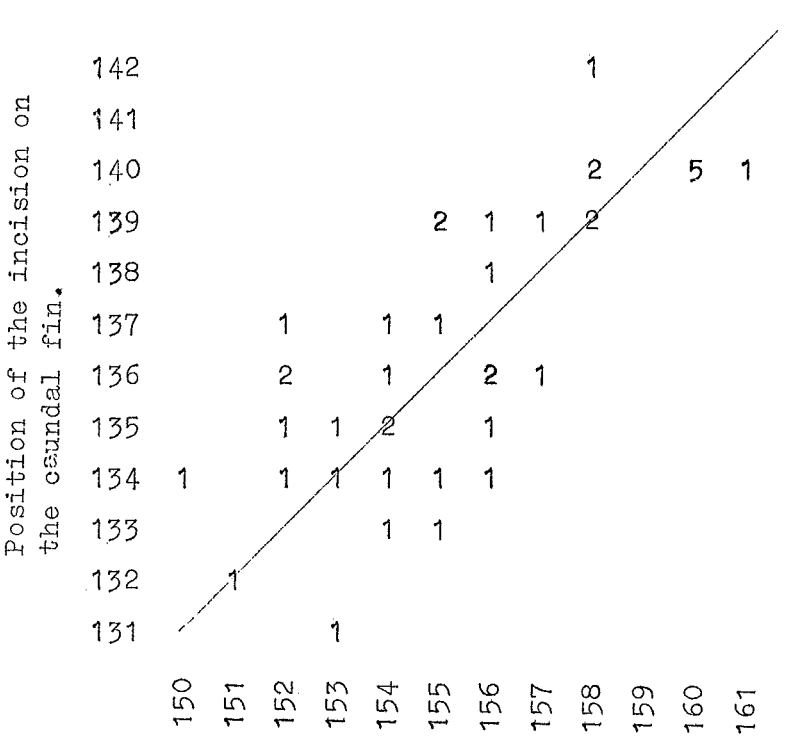
Vertebral counts were performed on 60 fish, mostly small ones since the cost is rather forbidding (one average sized fish about £ 10). The following Table shows the results of the vertebral counts.

Vert. S	150	151	152	153	154	155	156	157	158	159	160	161	Tot.
No.	1	1	5	6	9	8	9	7	8	1	4	1	60

In addition were established the positions of the pre-caudal pits in relation to the number of vertebrae counted from the atlas. The position of the dorsal pit varies between the 84th and the 89th vertebra.

The corresponding numbers for the ventral pit are 83 and 89. On an average the ventral pit lies 1 vertebra in front of the dorsal one.

Similarly was found that the position of the incision on the upper lobe of the caudal fin varies between the 131st and the 142nd vertebra following more or less the variations in the Vert.S. It is possible that feature may be used in reducing the cost of the vertebral counts, and the phenomenon deserves a closer investigation.



The accompanying diagram - Table serves to illustrate the relationship.

5. Age.

The vertebrae shows typical calcium-incrusted annulæ which were interpreted as year-rings. In all 50 specimen were analysed for age. These were chosen from different size groups of males and females so as to give an idea of the growth rate rather than of the age distribution. The preliminary results of this investigation show no significant difference in the growth rates for males and females (28 ♀, 22 ♂) The following Table gives the average length of the fish from 0 to 10 years, and the yearly increment.

Age	0	1	2	3	4	5	6	7	8	9	10	years
Incr.		30	23	20	18	17	16	15	14	14	13	cm
L	80	110	133	153	171	188	204	219	233	247	260	cm

It may be mentioned in this connection that vertebra from 1 Mako shark was examined and it appears that this fish grows more than twice as fast as the Porbeagle shark while the length at birth is much the same (81 cm). The examined specimen was 258 cm at an age of 4+ years.

With the knowledge of the length at onset of maturity earlier mentioned, it may now be stated that the Porbeagle shark matures at an age of 3-6 years for the males and 6-9 years for the females.

6. Liver.

The liver content of the Porbeagle shark is very varying. Some are virtually disfigured by an enormous swollen liver. The largest on record was 27 kg or about 18 % of the total weight. In average, however, the liver weight is about 8 % of the total weight based on weighings of the whole fish and its liver in a series of 105 fish.

7. Blood.

The total weight earlier mentioned is the weight of the whole fish less blood. During the fishing operation it was more than amply demonstrated that the blood content of the Porbeagle shark was high. In order to get the correct picture of the total weight a correction for the loss of blood have to be introduced. 5 fish were measured for blood. This investigation yielded as a result that the weight of the blood is on the average 6.6 % of the total weight or more or less the same as in f.i. a human being.

The temperature of the blood was measured in 6 specimen, and the range was found to be between 17.3° C and 12.3° C. This is within the range for the temperature variations in the thermocline (17.8° in 3 m and 7.0° C in 20 m).

The Porbeagle shark has a very slow heart beat. Repeated checks showed a heart beat of about 20 per minute.

8. Food.

No systematic investigation of the stomac content was carried out, but more often than not the stomacs were empty. Some notes taken when comparatively undamaged specimens were found, revealed a varied

menue. Of identified food species may be mentioned: Shad (Alosa sp.), Mackerel (Scomber sp.), Herring (Clupea sp.), Cod (Gadus sp.), Hake (Merluccius sp.), Lump sucker (Cyclopterus sp.), Squid (Ommatostrephus sp.), Euphauciacea. The Merluccius sp. were most often met with.

Literature cited:

Bigelow & Schroeder, 1948:
"Fishes of the Western North Atlantic, Part one."
Memoir Sears Foundation for Marine Research, New Haven 1948.