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Notes on the Greenland Shark

Acanthorhinus carcharias (Gunn)

1. The Reproduction Problem of the Greenland Shark

By
PAUL BJERKAN

2. A Uterine Foetus and the Uterus from a Greenland Shark

By
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A/S JOHN GRIEGS BOKTRYKKERI, BERGEN

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1. The Reproduction Problem of the Greenland Shark.

By *Paul Bjerkan.*

The history of the investigation of the Greenland shark, and especially of the manner of its reproduction is a very intricate one. Now, when a new find has provided obvious facts for a real solution, it is necessary to give a survey of earlier views as presented by the several authors who have treated the matter.

As shown by the following publication by Magister Einar Koefoed a foetus of this shark has, as far as we know, for the first time got into the hands of a scientist to be investigated and described. This foetus was secured by Mr. Levy Carlson from Ålesund on board M/S «Joffre», Captain Olav Støbakk. The shark had been caught off Sudrey on the 24th August 1954. The foetus and the 2 uteri (oviducts) were delivered to «Fiskeridirektoratets Havforskningsinstitutt» by Mr. Carlson. To him as well as to the Captain our thanks are due. It may also be mentioned that Mr. Carlson was interested in the matter through a note by the present author in «Naturen» 1944 p. 384 about a foetus, length 98 cm, found in a Greenland shark by Kristofer Kvernevik, Barmsund off Daviknes, Nordfjord. This foetus was unfortunately used as foxfood. The find was, however, confirmed by the fiskerman's companions.

The Greenland shark, «Håkjerring», as it is called in Norway, has been fished for in Norway from olden times. It was first described by Gunnerus in 1776 and given the scientific name of *Squalus carcharias*. In 1816, however, Blainville gave a description of the shark under the name *Acanthorhinus norvegianus*, and as the generic name Squalus later has been reserved for the spinous sharks (*Spinacidae*) the proper scientific name for the species ought to be *Acanthorhinus carcharias* (Gunn). Although this Arctic shark later has been dealt with and described by several authors and under different scientific names, we know relatively little about its biology, and especially our knowledge about its reproduction is very scanty. This

is mostly due to the fact that the shark is fished for in localities where scientific investigations are very difficult to make, and besides it might be mentioned that usually only the liver is taken and the carcase left to sink to the bottom. Only a small number of carcases, and then only the smaller ones, have been harboured intact, fit for proper investigations.

If we take a view of the scientific publications about the Greenland shark these circumstances are very evident. Thus Kneeland (1847) and Turner (1873—85) only had very young specimens for their investigations, and their descriptions of the generic organs are therefore very defective and incomplete. Especially Turner's statement, that the oviducts were lacking, gave rise to much misapprehension. Although it was rectified by himself later on as being wrong owing to the incompleteness of his material, his first statement was repeated by other scientific workers and caused confusion.

Thus Lütken (1880) refers to Turner's investigations and rejects the opinion set forth by Fabricius (1780) and Faber (1828) that the Greenland shark is viviparous and adopts the assumption by Turner that the shark is oviparous and lays large, naked eggs, which are buried in the bottom mud and hatched there. His arguments are mostly that although he has got foeti of many kinds of viviparous fishes through his connections amoung the fishermen, he has never heard about foeti found in a Greenland shark, although this shark was fished in large numbers off Greenland and Iceland, where he had the best opportunity to get in touch with the fishermen. He states that many of his correspondents have found female sharks with soft eggs, large as small goose eggs, and these eggs were found in large numbers scattered in the body cavity from the gills back to the anus. In a large female was found up to 1½ to 2 barrels of eggs combined by mucous bands. No shell glands were found and he therefore concludes that the naked eggs are deposited on the bottom covered with mud and gravel. He even tells that sharks have been found with mud all over the body presumably a result of the egg-laying occupation. He finds it very curious though, that the related smaller species of the genus from the Mediterranean has been found to be viviparous.

Jungersen (1898) says in a note that although there is no report on finds of foeti in Greenland sharks he personally finds it most likely that the Greenland shark is viviparous like its nearest relatives the little Mediterranean *A. rostratus* and the *Spinacidae*. He also mentions the statement by Cranz (1770), referred to by Günther (1880) that the Greenland shark is viviparous and produces 4 youngs at a time.

Collett (1905) states that the propagation of the Greenland shark

was not properly known at the time. It must, however, be assumed that the female shark lays its soft (in the oviducts) fertilized eggs at the bottom covered by mud, and they are hatched there. He mentions that the smallest youngs of the Greenland sharks found were of a length of 60—100 cm, and that they mostly follow the larger ones when these are caught. He also relates about the great quantity of eggs, the size of hens' eggs, found in the body cavity of the larger females. They are mostly found packed together in the hindmost part of the oviducts, so close that they take on an angular shape. They are mostly mature in February—March, but some also up to April—June. After that time only smaller eggs are found. Free eggs had not been found by any of his correspondents.

Bigelow and Schroeder (1948) in their memoir of the sharks only states about the Greenland shark: «Adult females have been found repeatedly containing great numbers of soft eggs without horny capsules, with up to as much as 1½ barrels of them in large specimens, these eggs ranging in size up to that of goose eggs. This combined with the fact that none of the many examined have ever been found with embryos, supports the general belief that this shark unlike other squalids is oviparous. If so, it seems likely that the eggs are deposited on the bottom in mud, but eggs naturally laid have not been found as yet. On the contrary the Mediterranean *Somniosus (Acanthorhinus) rostratus* is ovoviviparous, its embryos having been seen by several students.»

Jensen (1948) says: «Regarding the reproduction of the Greenland shark we still know nothing beyond that numerous, soft shellless eggs (ovarial eggs) have been found in large females, in size up to that of hens' eggs (but spherical), but whether these are «spawned» or developed in the mother is still uncertain. In the Zoological Museum is kept an ovary taken out of a female caught near Disco on May 16th 1925, the ovary is 37 cm long and contains about 110 eggs, 90 per cent of which are large, measuring up to 35 mm in diameter, a few being, however, only 12—16 mm and a single one only 8 mm, each egg lies firm in a follicle.»

This last quotation is the only utterance by later authors, where it is mentioned that proper material has been at hand. As to the others we do not know if they are genuine observations by the authors, or only quotations of reports from their correspondents among the fishermen or other interested persons. Their reliability in detail might therefore in many cases be questionable owing to the observers' lack of knowledge. This might be the case regarding the older statements of finds of foeti, as well as the later reports concerning the

conditions in respect to the finds of large numbers of soft eggs. The present find of a foetus, described by magister Koefoed, gives the conclusive evidence concerning the reproduction of the Greenland shark: It is viviparous, and the youngs seem to be of a most varying size when cast. The older statements by Fabricius and Faber are thus correborated. The details concerning the propagation are, however, very obscure. We do not know for certain in which season the gestation takes place, where it takes place or when the shark casts its youngs. The later reports about large lots of mature eggs only obscure the picture. What is the fate of these eggs and are they really fertilized as assumed by Collett?

Summing up we have the following statements to take into consideration. Collett states that large egg-masses are mostly found in early spring, and are not found during the summer, when only small eggs are found.

The foetus, described by magister Koefoed, was found with 9 others in late August, and had a length of about 37 cm. All these foeti were found in the right uterus, the left one being empty. Had the latter contained foeti which had already been given birth? We do not know. The foetus reported in «Naturen» 1944 was found in January and had a length of 98 cm. Collett states that young Greenland sharks of a length of 60—100 cm were found, mostly following the larger sharks, when these were caught. Were they young ones following their mothers? He gives, however, no information as to the season when these young sharks mostly were seen or captured. After this we can only state that the connection between the egg-masses found in the female sharks during the spring and the foeti really found in the late summer and during the winter is very obscure.

As mentioned before, one of the reasons for our scanty knowledge about the biology of the Greenland shark is the range of its distribution. As stated it is an Arctic, deep-sea shark, and it is found in the Arctic seas from the north of Europe, over Spitsbergen, Iceland, Greenland and the northern part of St. Lawrence Gulf. It is also found along the Norwegian coast especially in the north, and penetrates into the deaper fiords where some may be stationary. It may stray still farther south too, but is seldom caught there.

Regular fisheries for the Greenland shark have been going on especially from northern Norway during the summer along the Arctic ice rim, and then by the eskimoes in Greenland. At the time it seems to be scarce in Greenland, and the eskimoes have changed to cod and halibut fisheries. The Norwegians too, now, mostly catch the shark more occasionally during sealing expeditions and other fisheries.

In the Norwegian fiords it is caught now and then, but there is no regular fishery for the shark. In later years Magnus Halås, fishery adviser, has undertaken some fishery trials for this shark in the fiords. He states in his reports that the sharks migrate into the fiords in the autumn, following the blue ling, the tusk and the halibut. The fiord fishermen are very observant on this immigration as the shark disturbes their fishery by making havoc on their fishing tackle and are only occasionally being caught. When caught in spring it is very lean and the liver gives very little oil.

From what is stated above it is very difficult to make a guess as to the reason why up to this time, as far as we know, only two Greenland sharks with foeti have been found. The most reasonable assumption is that the shark during the gestation period has a kind of «hibernation» in the deeper parts of the sea or fiords, a parallel to the hypothesis intimated by several authors for the basking shark (*Cetorhinus maximus*). Only in this way can we understand that such voracious fish as the Greenland shark is so seldom caught during the gestation period, a stadium in its reproduction which is shown to be a fact by the present find.

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2. A Uterine Foetus and the Uterus from a Greenland Shark.

By *Einar Koefoed.*

The find.

A female Greenland shark (Norw. «Håkjerring», *Acanthorhinus carcharias* Gunn.), 5 m. long and 1000—1200 kg. by weight, was caught by M/S «Joffre», skipper *Olav Støbakk* at N. 60°4′, W. 6°35′ ca. 80 n. m. S. to W. of the Sudrey on the 24th August 1954.

The right uterus was reported to contain 10 foeti, all of the same size. The left uterus was said to be empty. The uteri were out of situ sheared off on board, and certainly not by an anatomist. The uteri were salted and a single foetus preserved in formalin; another foetus is kept in Ålesund Museum. The material was kindly forwarded to «Fiskeridirektoratets Havforskningsinstitutt» by Mr. *Levy Carlson,* Ålesund, to whom our thanks are due. The following descriptions are based on the single foetus preserved in formalin, and on the salted uteri.

The foetus.

The foetus of the *Acanthorhinus carcharias* Gunner is exactly like a small specimen of this species. The shape and proportions of the fish are not at all different from the adult, but its small size makes it convenient for an examination (figs. 1 & 2).

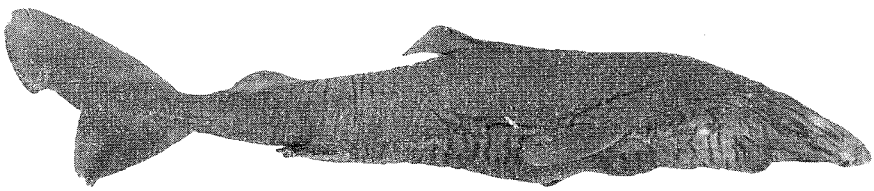


Fig. 1.

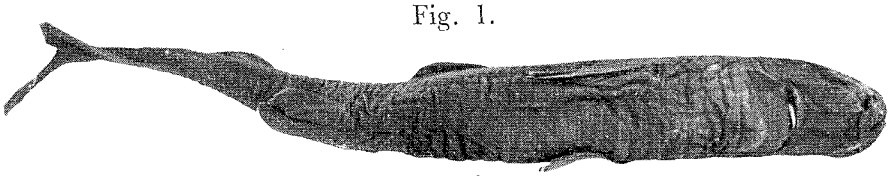


Fig. 2

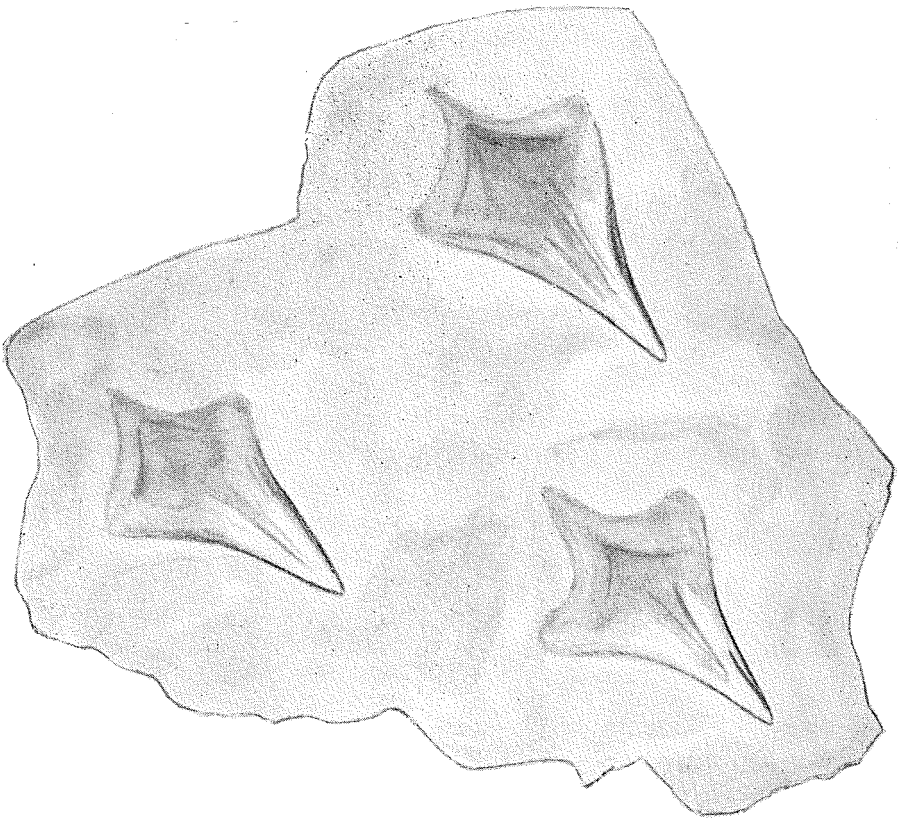
	Measurements in mm
Total length to end of the upper lobe of the caudal fin	367
—»— the cleft of the caudal fin	332
Distance between tip of snout and the dorsal origin of caudal fin	295
—»— —»— ventral origin of caudal fin	286
—»— —»— origin of first dorsal	150
—»— —»— origin of second dorsal	241
—»— —»— pectoral	94
—»— —»— ventral	225
Height of body at the mouth	34
—»— — origin of the pectoral	48
—»— —»— ventral	39
Height of caudal peduncle at origin of lower caudal lobe	16
Distance between tip of snout and the eye	37
—»— —»— mouth	40
—»— —»— spiracle	57
—»— —»— first gill-opening	78
Width of the mouth	28
There are 5 gill-openings of the same width of	7
The eye-opening is oval, its diameter is	11

The snout is rounded anteriorly and its surface is flat. The nostrils are situated shortly behind the tip of snout and covered by a flap issuing from their foremost margin. The mouth is crescent-shaped, from its foremargin a fold runs towards the gillopenings. In the upper jaw the teeth are erect pointed, inside a protecting fold, in the lower jaw they are oblique saw-shaped.

The skin is very corrugated, able to stretch in proportion to the growth of the young fish. The skin is densely beset with small curved spines, the bases of which are firmly anchored in the skin (figs. 3 & 4 Th. Rasmussen del). The colour is uniformly dark, only the median fins have partly a narrow white margin.

On opening the belly a large liver is seen covering the stomach, the duodenum with the spiral valve, the pancreas and in its hindmost part the kidneys with their excretory ducts.

Obviously the foetus was in an advanced state, i.e. not far from parturition, as no trace of yolk-sac could be observed. Connection between foetus and uterine mucosa could neither be observed. Accordingly, the nutrition of the Greenland shark foeti remains unsolved so far. No trace of a temporary shell, as for instance known from ovoviviparous selachians, was observed. From this fact, stressed by the lack of shell-gland in the oviduct (se below), may be con-



Part of the skin vith denticles seen from above.

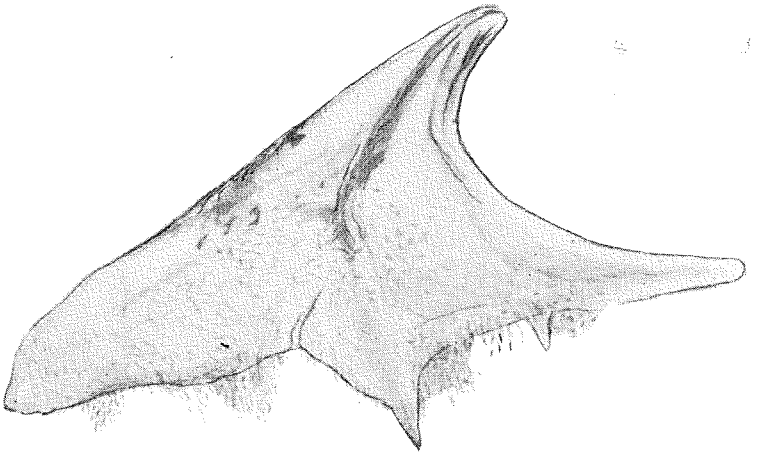
Fig. 3.

cluded that the Greenland shark is viviparous, as already mentioned by earlier authors.

The oviduct, uterus and cloaca.

This section has been compiled in co-operation with Professor *August Brinkmann* to whom I express my best thanks for his kind assistance.

Narrow oviducts lined with undulatory longitudinal mucous membrane-lamellae lead each uterus. The oviducts inspected are not complete, however; 12 cm were left, but their foremost part and the ostium tubae had been cut away. No macroscopic indications of shell-glands in the wall of oviducts could be observed. — During several fishery cruises in northern waters I have investigated many Green-



An isolated denticle in lateral view.

Fig. 4.

land sharks and never found any shell gland. — The uteri are lined with about 2 cm long villi, or trophonemata, in the distal part arranged in longitudinal rows. Distally each uterus continues in a separate vagina about 8 cm long. The two vaginae open in the cloaca on each side of the urinary papilla. The vaginae are lined with wavy longitudinally arranged mucous-membrane-lamellae, which end in a transversal circular hymenal rim. This rim is dorsally and ventrally separate for each side, ending close side by side basally on the urinary papilla in its ventral midline, and ending dorsally on the sides of the urinary papilla somewhat more distally (fig. 5). In other words there are two distinct and separate vaginae.

The urinary papilla itself is conical, about the size of a mans thumb, situated dorsomedially in the bottom-roof of the cloaca, between the two vaginal orifices. As the cloaca had been cut transversally, rather close to the papilla, the rectal opening and the abdominal pores are not observed. So far as can be solved from the present material, we find in the Greenland shark very much the same arrangement of the described organs as in most sharks, differences in details only. Detailed descriptions as regards this species have, as far as we can find, not been given, although some rather old and not lucid descriptions were published by *Turner* (1878 & 1885). In the dogfish (*Scylliorhinus caniculus* L.) each oviduct opens independently into the cloaca, the two being separated by a delicate membrana

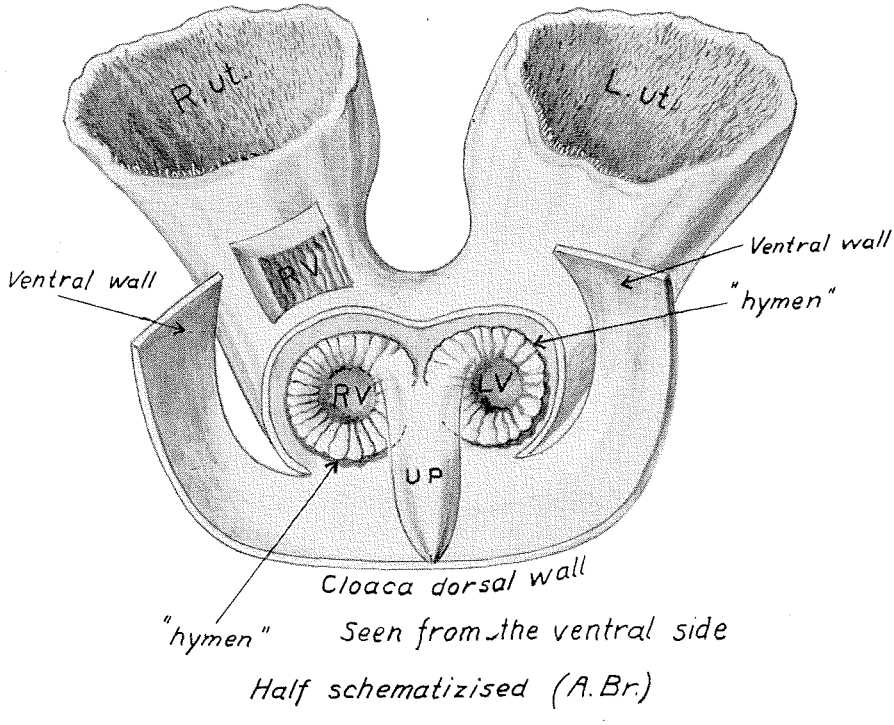


Fig. 5.

extending from the middle of the urinary papilla to the floor of the cloaca. In the basking shark *(Cetorhinus maximus* Gunner) *Matthews* (1950) found a short common vagina leading to the two separate vaginae. From these types the Greenland shark departs, having the vaginae distinctly separated ventrally as well as dorsally, by two separate hymenal rims, which are not continuous for both vaginae. It further departs by the lack of shell-glands and by exhibiting a large urinary papilla.

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