XXX

THE SELACHIANS OF GREENLAND

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Introductory remarks.

DURING my leadership of the practical-scientific fishery investigations along the colonized part of West Greenland, carried out on board the brig "Tjalfe" for the Danish Ministry of the Interior, in the years 1908 and 1909, I had rich opportunities of studying at first hand the Greenland fish fauna, which previously I had only known from Museum material and the literature. I am thus able to give a fairly acceptable account of the fish-life of this our northern colony.

In the following I shall deal with the Selachians, certainly a small yet in several respects an interesting group[1]).

In the latest review of the fish fauna of Greenland, that of Dr. E. VANHÖFFEN in the "Grönland-Expedition der Gesellschaft für Erdkunde zu Berlin", 2. Bd., 1897, p. 129, 4 species of Selachii are mentioned: *Centroscyllium Fabricii* (REINHARDT), *Somniosus microcephalus* BLOCH & SCHNEIDER, *Raja radiata* DONOVAN and *Raja Fyllae* LÜTKEN. In "The Danish Ingolf-Expedition", II, 1, 1898, p. 3 CHR. F. LÜTKEN further describes a new species of ray from the Davis Strait, which he called *Raja ingolfiana.*

According to the present revision, however, the last-mentioned supposed new species must be deleted and replaced by *Raja lintea* FRIES, with which it is identical. Further, I have to add to the list *Squalus acanthias* LINNÉ and *Raja hyperborea* COLLETT, as also a new ray discovered on my expedition, which in the following I call *Raja spinicauda.*

According to our present knowledge, therefore, altogether 8 species of Selachians live in the waters of West Greenland, namely

[1]) The following publications on the scientific results of the "Tjalfe" Expedition have till now appeared:

Tjalfiella tristoma. By TH. MORTENSEN. With 10 plates. The Danish "Ingolf" Expedition. Vol. V, 2, 1912.

Report on the *Malacostraca* collected by the "Tjalfe" Expedition, under the direction of AD. S. JENSEN, especially at W. Greenland. By K. STEPHENSEN. Videnskabelige Meddelelser fra den naturhistoriske Forening. Bd. 64. 1912.

Medusæ collected by the "Tjalfe" Expedition. By PAUL L. KRAMP. Vidensk. Meddel. fra Dansk naturhist. Foren. Bd. 65. 1913.

Hydroids collected by the "Tjalfe" Expedition to the west coast of Greenland in 1908 and 1909. By PAUL L. KRAMP. Vidensk. Meddel. fra Dansk naturhist. Foren. Bd. 66. 1914.

The *Echinoderms* are published by TH. MORTENSEN in Vidensk. Meddel. fra Dansk Naturhist. Foren. Bd. 66, 1914, and in Meddelelser om Grønland, XXIII. 1913.

of Sharks or Dog-fishes:

Centroscyllium Fabricii Reinhardt
Squalus acanthias Linné
Somniosus microcephalus Bloch & Schneider

and of Rays:

Raja radiata Donovan
Raja hyperborea Collett
Raja Fyllae Lütken
Raja lintea Fries
Raja spinicauda n. sp.

After these preliminary remarks I may proceed to a more detailed account of the separate species.

Centroscyllium Fabricii Reinhardt.

(*Squalus acanthias* Fabricius (non Linné), Fauna Groenl., 1780, p. 126).

Local name in Greenland: *Kukilik.*

West Greenland: The Copenhagen Zoological Museum contains from an earlier period in addition to 3 embryos 5 large specimens (2 in spirit, 2 as skeletons and 1 stuffed), all females. The largest measures 675 mm[1]). None of these bears a notice of the locality, but from old manuscript records it appears certain, that some of them have come from the district of Julianehaab[2]).

During the "Tjalfe" Expedition *Centroscyllium Fabricii* was obtained partly in the southern part of the Davis Strait outside Fyllas Bank, partly in Bredefjord and Kangerdluarsuk in the northern part of the Julianehaab district. The separate localities were as follows:

St. 429. 63°54′ N., 53°15′ W., 520—737 fm. 3.7° C. 8. 6. 1909. Trawl. 3 spec.
St. 431. 63°24′ N., 53°10′ W., 470 fm. ca. 3.8° C. 9. 6. 1909. Trawl. 1 spec.
St. 549. Brede Fjord, from the north-eastern corner of the island Tugtutok over towards the island Kekertarsuak, 100—300 fm. ca. 2.8—3.7° C. 22. 7. 1909. Lines. 4 spec.
St. 550. Bredefjord, Kangerdluarsuk, across the mouth. 100—250 fm. ca. 2.8—3.7° C. 22. 7. 1909. Lines. Several spec.
St. 553. Bredefjord, Kangerdluarsuk. 120—200 fm. ca. 3.2—3.6° C. 25. 7. 1909. Lines. 5 spec.

[1]) Günther gives the length of a dried skin from Greenland preserved in the British Museum as 29 English inches (ca. 735 mm).

[2]) J. Reinhardt writes (K. D. Vidensk. Selsk. naturvidensk. og mathem. Afh., VII, 1838, p. 132), that he had several times received this fish from Julianehaab and Frederikshaab; regarding the capture of *C. Fabricii* at the last-mentioned locality, however, there is no information, nor has the species been taken there later; the sender has perhaps obtained the fish from the Julianehaab district.

The specimens from the Davis Strait were measured in the fresh condition and showed the following total length:

St. 429. 800 mm ♀; 750 mm ♀; 470 mm ♂.

St. 431. 660 mm ♂.

Of the specimens taken in Brede Fjord and Kangerdluarsuk 6 were preserved; in the preserved condition (thus considerably contracted) they show the following total lengths:

♀♀: 705, 675, 650, 625, 610, 565 mm.

According to these data the males reach a length of 660 mm, the females 800 mm.

The liver which is extremely rich in oil is unusually large comparatively speaking; in one specimen with a total weight of $1^{7}/_{8}$ kg the liver weighed $^{7}/_{16}$ kg, thus about a fourth of the whole fish. In the stomach of specimens from the Davis Strait I have found the lenses of cuttle-fishes, also a large deep-sea jelly-fish (*Atolla Bairdi* FEWKES) and remains of Crustacea (*Rhoda inermis* KR. and *Boreomysis tridens* G. O. SARS(?)).

Centroscyllium Fabricii is viviparous; it has been taken gravid in February, with embryos of 124 mm in length (cf. p. 6).

This shark must be considered luminous like other species of Spinacidae; under a lens the skin between the spines shows minute, dark points, which according to the investigations of JOHANN and BURCKHARDT[1]) are luminous organs.

Remarks.

In 1825 J. REINHARDT[2]) set up a new species of shark, which had been sent to him from Julianehaab, referring it to the genus *Spinax* CUV. and giving it the specific name of *Fabricii* "in memory of our OTTO FABRICIUS so highly esteemed for his services to the Greenland fauna". *Spinax Fabricii* is characterized briefly in the following manner: "Dentibus similibus utriusque maxillae tri-quinque cuspidatis" (cf. fig. 1) and it is added, that the skin "is provided with a great number of small stellate tubercles".

In his "Nye systematisk Fortegnelse over de grønlandske Fiskearter" J. REINHARDT[3]) puts forward the suggestion, that it was this, his new species, which FABRICIUS had recorded in Fauna Groenlandica as *Squalus acanthias* LINNÉ; for though FABRICIUS speaks of "*Squalus acanthias*" in terms which lead one to suppose, that it should not be rare in southern Greenland, REINHARDT had not been able to obtain this species from Greenland, whereas he had several times had *Spinax Fabricii* sent to him.

In a letter to J. REINHARDT in the Zoological Museum, dated 6th July 1840 and written by the Missionary J. F. JØRGENSEN in Julianehaab, the latter states that he is sending

[1]) R. BURCKHARDT: On the Luminous Organs of Selachian Fishes. Ann. Mag. Nat. Hist. 7 Ser., Vol. VI, 1900, p. 558.

[2]) Overs. K. D. Vidensk. Selsk. Forhandl. 1824—25, p. 3. (1825).

[3]) K. D. Vidensk. Selsk. naturvidensk. og mathem. Afhandl., VII, 1838, pp. 116 & 132.

to Reinhardt some sharks, regarding which there could be no doubt that they were Fabricius' *Squalus acanthias*, "on the one hand, because they had the Greenlandic name given them in the fauna of Fabricius (*Kukilik*), on the other, because they were just taken frequently in the manner described by him, namely, in winter through holes in the ice ("capitur tamen praesertim hieme per foramina glaciei")". Jørgensen adds further, that this species of shark occurs in great quantities in the Narssak district in the neighbourhood of Tunugdliarfik.

The specimens referred to by Jørgensen and sent down by him are still present in the Zoological Museum's collection of Greenland fishes; one specimen is an adult female, two others are embryos (the one 124 mm in length, the other somewhat smaller)

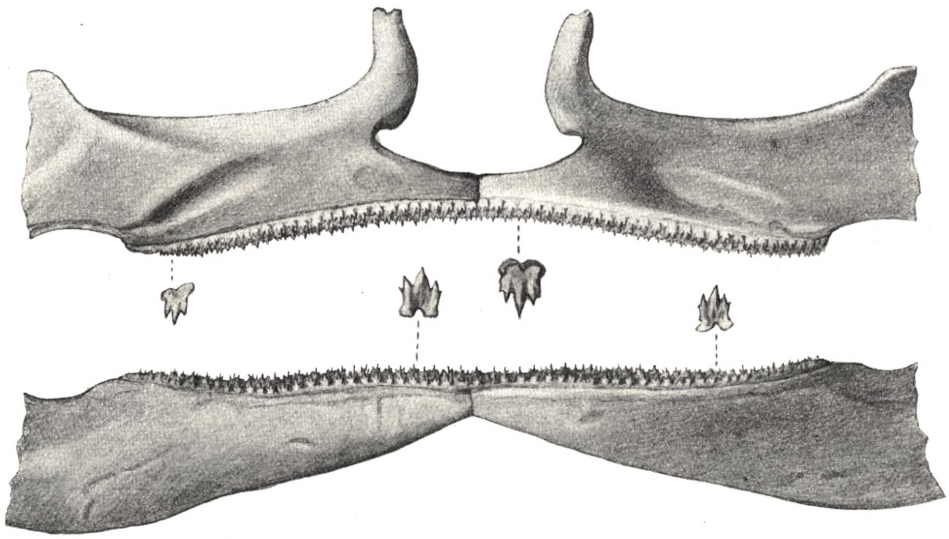


Fig. 1. Dentition of *Centroscyllium Fabricii* ♀, natural size; the separate teeth magnified 4 diameters. From a specimen from Davis Strait (63°54′ N. 53°15′ W.), 520—737 fm.

according to Jørgensen's statement "taken from the stomach(!) of the mother at Nougmiut[1]) in February 1839".

As the specimens sent by Jørgensen belong to *Spinax Fabricii* Reinhardt, the question is thus finally settled: Fabricius' "*Squalus acanthias*" is not identical with Linné's species of the same name, but with the *Spinax Fabricii* described by Reinhardt.

During my stay at Narssak itself in the summer of 1909, when we several times obtained *Centroscyllium Fabricii* on lines, I got it confirmed, that Jørgensen's account was perfectly correct; the Greenlanders at this settlement know this shark well and they call it *Kukilik*.

General Distribution. *Centroscyllium Fabricii* is an Atlantic species. In

[1]) Nougmiut lies north of Narssak, on the north-west corner of the peninsula Ilimausak.

addition to at south-west Greenland it occurs commonly on the banks off Nova Scotia and New England, in depths of 150 fm. and more. On the European side of the Atlantic it was taken in 1902 by the Norwegian research-steamer "Michael Sars" both south-west of the Færoes at a depth of 425—460 fm. and north-west of the Hebrides at a depth of 580 fm. Further, VAILLANT[1]) refers a small Spinax (175 mm in length), which was taken on the Arguin Bank (N. Africa, S. of Cape Blanco) at a depth of 787 fm., to this species, but as the specimen was in a very bad state of preservation, the identification must be treated with caution[2]).

Squalus acanthias LINNÉ.

English: *Picked Dogfish.*

Danish: *Pighaj.*

West Greenland. After J. H. REINHARDT with right had remarked, that the shark "*Squalus acanthias*" recorded by FABRICIUS as occurring in Greenland could hardly be identical with LINNÉ's species of the same name (cf. under *Centroscyllium Fabricii* p. 5—6), the common Picked Dogfish has been deleted from the Greenland fauna. Nevertheless, the Copenhagen Zoological Museum contains from earlier times some examples of *Squalus acanthias* L., namely, an embryo marked "Greenland"[3]) and the body skeleton of a smaller specimen sent from Greenland by the physician PFAFF; but these witnesses to the occurrence of the Picked Dogfish at Greenland have not been recognized for the reason, that both were erroneously referred to *Centroscyllium Fabricii.*

From more recent times, moreover, we have quite certain records of three Picked Dogfish from Greenland. In the year 1885 the then colonial governor, LYTZEN, forwarded a female specimen 870 mm long from Sukkertoppen. Later, in the winter of 1903—04 a specimen ca. 780 mm long was stranded at Sarfanguak south of Holsteinsborg; it was not preserved, but the dorsal spines were sent to the Museum by R. MÜLLER. Finally, the Museum has received from the colonial governor L. BISTRUP a female specimen 940 mm long, taken on August 28th 1905 at Sukkertoppen; immediately after capture it gave birth to 3 embryos 290, 290 and 285 mm long.

From this it is evident, that the common Picked Dogfish may occur at Greenland. Yet it probably belongs to the rare guests and it seems to occur mainly in the districts

[1]) Expéd. scient. du Travailleur et du Talisman, Poissons, 1888, p. 72.

[2]) C. T. REGAN is inclined (Ann. Mag. Nat. Hist., (8), 2, 1908, p. 41) to regard *Centroscyllium granulosum* GÜNTHER and *C. ritteri* JORDAN & FOWLER as identical with *C. fabricii* REINHARDT; in this case its distribution would be extended to Falklands and Japan.

[3]) This embryo was sent down in the year 1823 already by Inspector HOLBØLL of Godthaab and thus probably came from this district of Greenland.

of Sukkertoppen and Holsteinsborg, where other southern species roam about in the summer time (halibut, cod).

General Distribution. The Picked Dogfish has a very wide distribution. On the western side of the Atlantic it is of common occurrence on the northern and middle coasts of the United States and is met with as far south as Cuba. On the European side it reaches from the Murman Coast to the Mediterranean, westward over the Færoes to Iceland. In the southern hemisphere it is known from South Africa, Mauritius, Australia, Tasmania, New Zealand, Patagonia and Chili. In the Pacific, further, it is known from Hawaii, China, Japan and the west-coast of North-America, southward to California[1]).

Somniosus microcephalus Bloch-Schneider.

(*Squalus carcharias* Fabricius (non Linné) Fauna Groenl., 1780, p. 127).

English: *The Greenland Shark.*

Danish: *Havkal.*

Greenlandic: *Ekalugssuak.*

West Greenland. The Greenland Shark — or Shark, as it is simply called by the Danish in Greenland — was taken on lines (sometimes in the trawl and with hand-lines) at the following places during the "Tjalfe" Expedition of 1908—09: Nuk inside Ilua, 120—180 fm.; the fjord north of Ilua, 80—310 fm.; Tasermiut, outer part, 180—250 fm.; Agdluitsok, at the mouth, off Lichtenau and in at Nuluk, 150—260 fm.; off Julianehaab harbour, 120—170 fm.; Tunugdliarfik from the mouth inwards to off Nugarsuk, 60—200 fm.; Bredefjord with Kangerdluarsuk, 100—300 fm.; Kvanefjord S. of Frederikshaab, 100—200 fm.; Godthaabsfjord (near Siorarsiorfik, 30—40 fm.; between Hundeø and Ny Hernhut, 80—90 fm.); between Godthaabsfjord and Fyllas Bank, 70 fm.; 2 miles W. of Store Vardeø at Holsteinsborg, 40—30 fm.; 66°41′ N., 56°24′ W., 178—164 fm.; 66°45′ N., 56°23′ W., ca. 175 fm.; 66°49′ N., 56°40′—56°38′ W., 144—154 fm.; off the south-east coast of Disko, 95—193 fm.; north-west end of Jakobshavn Iceberg Bank, 141 fm.; off Nordø at Ritenbenk, 110 fm.; Torsukatak Isfjord at Kekertak, 160 fm.; Umanakfjord, a little S. of the colony, 100—380 fm. and off the north-west point of Talerok Island, 140 fm.

These captures alone show, that the Greenland Shark is common from the south point up to Umanakfjord, in the fjords, on the sea coast and a good way out in the Davis Strait. According to information from local authorities, the shark also occurs further

[1]) The species is here taken as it has been given by Günther (Catal. of Fishes, VIII, 1870, p. 418). C. T. Regan has again (Ann. Mag. Nat. Hist., (8), 2, 1908, p. 46—48) separated the forms from the southern hemisphere and from the Pacific as (5) distinct species, so that only the following distribution is indicated for *Squalus acanthias*: "Atlantic coasts of Europe and North America, southward to the Mediterranean and to Cuba".

north, over the whole district of Upernivik. Even right up in the Wolstenholme Sound (at 76° 30′ N.) there are many sharks, writes PETER FREUCHEN to me.

On most of the long-lines set out by the "Tjalfe" Expedition from the Frederikshaab district and northwards only one specimen at a time was taken, but in the Julianehaab district there were frequently 2, 3, 4, 6, 7 and up to 9 sharks on the line. These figures however do not give a true picture of the frequency of the sharks, for the lines used by the Expedition (for the capture of fish such as the halibut, Greenland halibut and cod) were not suited to the shark fishing. A better estimate of the quantity of sharks is obtained from the number of lost hooks; the shark namely is attracted by the fish caught on the line and bites off the fish, hook and a bit of the hook-line with it. Once, for example, a line with 600 hooks set out in Tunugdliarfik came up with a piece of 100 hooks removed and also 100 other scattered hooks wanting on the part of the line saved, on which were 7 large sharks which had not been able to break away and 19 whole and a number of bitten Greenland halibut. In the fjords of Julianehaab north district we seldom escaped with less than 20 % loss of hooks.

An impression of the abundance of this shark along the colonized part of Greenland is best obtained from the many taken by the natives. As late as 1780 FABRICIUS complained that the sharks were not made useful as they deserved; although they were found in great numbers neither the Greenlanders nor the Danes did capture them — in his time they were only taken occasionally. In 1805 the first experiments were made in extracting oil from the liver; as the experiment gave good oil in large quantities, the burning of the liver was continued, but even in the middle of last century RINK estimated the yearly catch at only about 2000—3000 sharks. The fishery gradually spread, until in the beginning of the nineties it increased to ca. 11,500—15,000 and at the present time it amounts to ca. 32,000 sharks annually[1]).

It is remarkable, on the whole, that the Greenlanders are able to catch so many sharks. If the shark fishery were carried on under the same conditions as elsewhere, for example at Northern Norway and Iceland, where it can only be carried on in open water with expensive vessels and gear and by hardy sea-folk, no shark fishery of importance would ever have been developed. But in Greenland the conditions are such, that the fishing can be carried on just out from the houses, on the fast ice or from the available primitive boats.

Of the shark oil production the greater part takes place in the North Greenland colonies, where the solid ice in winter greatly favours the fishery; the sharks are caught in an extremely simple manner through holes in the ice. No boats are required, and

[1]) Calculated from the production of shark liver, which during the 5 years 1907/08—1911/12 amounted to ca. 6400 barrels yearly and assuming that a shark yields on an average one fifth of a barrel of liver.

the fishermen are not very much dependent on the weather. Of this ice fishery Rink has given the following, instructive description[1]). When the men consider that the ice will continue fairly safe, they make openings into which they put the intestines of seals or the like, to entice the first sharks to the place; later, when the fishing has once started, this is no longer required. Three different methods are used. The simplest consists in attracting the sharks to the surface at night by means of a light, then a short, bent iron hook is simply stuck into them and they are drawn up on to the ice; this requires the strength of two men, when the fish are large. It also happens in the shark fishery, that

Fig. 2. Shark fishing in winter in North Greenland. In the ice are cut openings, through which the long fishing-lines are sunk down to the bottom. To the left is seen a Greenlander, who is watching his line; this is fastened at the upper end of an upright, flexible stick, from the movements of which it can be seen, when a fish is biting. In the foreground a "Tuk" is to be seen, that is an implement for cutting holes in the ice. To the right three Greenlanders are hauling up a captured shark. Round about are scattered bodies of sharks cut open and divided. In the background ice-bound icebergs are seen. — From a drawing by a Greenlander, reproduced in Rink's work.

the animal comes up of itself to the surface and then the hook is simply thrust in it preferably in the eye. The second method consists in hanging a hook with bait on it by means of an iron chain 4—6 feet deep in the water; it is not altogether necessary to be constantly watching over the hooks, as the shark once it has bitten cannot escape

[1]) H. Rink: Grønland geographisk og statistisk beskrevet, I, 1857, p. 136.

or take the chain with it; but in this case the shark may be attacked and devoured by other sharks, which ends in only the head remaining on the hook or another shark coming and attaching itself to the whole. The hook must also be so fixed, that it can turn round like a pivot on the end of the chain, otherwise the shark can bend and break it. A third method (cf. fig. 2) consists in the use of long lines of common thin string and ordinary large fish-hooks, which go right down to the bottom. The dullness or stupidity of the shark, namely, is such that this huge animal allows itself to be hauled up on a line no thicker than stout twine, so that is it not rarely taken by chance on the same lines that are used to catch the Greenland halibut. This method requires a constant watching of the lines, which is made easier, however, by their being fastened round upright, flexible sticks, from which it can be seen when a fish bites, and in this way it is possible for one man to look after several lines at one time.

In South Greenland, where the fast ice only lies at a few places and for a short time, as also in North Greenland in the summer the sharks are fished from small wooden boats and kayaks. As bait on a fishing-line for catching shark from a kayak I have noted, at Narssak, the following: pieces of blubber, pieces of blood-red gills of sharks and pieces of Greenland halibut with attached fins. It is almost incredible, that such a large rapacious fish can be hauled up from the great depths (ca. 125—200 fm.) with the thin fishing lines and killed from the kayak simply with a thrust of a knife. The Greenlanders only fear the very large, says RINK, as their movements and rough skin can make holes in the kayak skin. When the shark is hauled up to the kayak and its spine cut across, its movements become feeble; the belly is then cut open and the liver removed, after which the rest of the body is allowed to sink to the bottom. If the shark is not specially large, one man can do the killing, but when very large two or three kayaks take part.

The shark fishing in South Greenland has gradually and greatly increased in recent years; in the finance year 1907/08 it amounted to 1/8th of the whole Greenland shark fishery, in the year 1911/12 it had increased to almost 1/3rd.

In Greenland I have not seen any Greenland sharks smaller in length than about 6 feet, and RINK is probably right in stating that the usual size of the sharks caught is 6 to 14 feet.

In the stomachs of captured sharks I always found the remains of fish (Greenland halibut, fjord cod or "Uvak", cod, cat-fish, Sebastes, rays and its own species), but it also takes lower animals (Crustacea etc.) and the carcases of seals, whales and birds.

Sometimes a peculiar variety, chalk-white, occurs. A skin of such an albino, caught 11-8-1898 at Jakobshavn was forwarded by then-assistant A. P. OLSEN and is preserved in the Copenhagen Zoological Museum; and when I was staying at Ikerasak in

Umanak Fjord in 1908 I was informed that a chalk-white Greenland shark had been caught in the previous year.

Regarding the reproduction of the Greenland shark we still know nothing beyond that numerous, soft, shell-less eggs (ovarial eggs) have been found in large females, in size up to that of a hen's egg (but spherical), but whether these are later "spawned" or develop to embryos in the mother, is still uncertain[1]).

The principal product of the Greenland shark is the oil extracted from the liver. Self-running oil[2]) is light and clear and readily runs up the wick; it is used in Greenland as lamp oil, as petroleum is not permitted in the houses owing to the danger of fire. In North Greenland especially shark oil is the ordinary means of illumination among the Danes, in South Greenland seal oil is also used[3]). By far the greater part of the shark oil is exported; it is mixed with seal oil to form a specific Greenlandic sort of oil known on the market under the name of "Trekronetran". The Greenland Administration pay the natives 3 Øre per pound for shark liver against 4 Øre per pound of seal blubber, though a barrel of shark liver on burning gives only 57 pots of oil, whilst a barrel of blubber gives 98 pots, of an even more valuable sort[4]).

In North Greenland, where the dog plays such a large part as draught animal for the sledge, the shark fishery has the additional importance of providing food for the dogs. In the dried condition especially shark flesh is an excellent dog food, it gives the animals strength to sustain prolonged exertions without being fatigued. In the fresh condition, on the other hand, it is dangerous for the dogs; when they eat a quantity of it they become heavy and subject to giddiness (they are said to be "shark-intoxicated"); on driving a short distance with them they begin to hang their ears, tumble from side to side and at last fall down in cramp-convulsions, after which they cannot be got to move from the spot; in a couple of minutes the dog may recover, but when it runs again, the whole body quivers and the dog has no power to drag; at the same time, especially when the weather is warm, the animal has diarhoea, its fœces are "squirted out" as greenish water; sometimes the animal dies of the sickness. At places where shark food is plentiful, however, the dogs accustom themselves to eating a large amount of it without being sick; but if they are driven in the warm sunshine

[1]) Cf. H. F. E. Jungersen: On the Appendices Genitales in the Greenland Shark and other Selachians, pp. 2 & 3; The Danish Ingolf-Expedition, II, 2, 1899.

[2]) "Self-running" shark oil is obtained as follows; the frozen shark liver is beaten with a hammer to a mash, which is placed in a tub and when the weather becomes mild the oil runs out of itself.

[3]) The natives prefer seal oil in their lamps, which as is well-known serve not only for lighting purposes, but also for warming the houses; but in the absence of seal blubber they use shark oil.

[4]) It is maintained as a leading principle for the monopoly-trade of the Danish State in Greenland, that the Greenland products that are of special use for the natives are bought at relatively low prices, not to lead the inhabitants to dispose of that which is necessary to support life, and here among other things seal-blubber is reckoned.

they may be very bad from it. From dried shark flesh the dogs never become "shark-intoxicated", yet they can also become sick from it, as dried shark meat tends to swell out in the stomachs of the dogs; the Greenlanders therefore advise to give the dogs only small rations of dried shark meat and first to cut the meat into long and narrow strips, so that the dogs do not gulp down the whole at once, but can regularly work through it with the teeth[1]).

To explain these phenomena it may be said, that the fresh shark flesh contains a compound that acts like alcohol; when the flesh is boiled, the poisonous stuff is removed and the dogs can then eat more of it without suffering than when the meat is fresh. The poisonous substance is probably present everywhere in the body of the shark, also in the cartilage. Rink was of the opinion, that the danger of the shark's flesh was due to its containing a large amount of saline fluids, which were totally swallowed down when the flesh was eaten in the frozen condition[2]). To clear up the matter I consulted the veterinary surgeon S. Hjortlund, who lived for a couple of years in North Greenland and there made investigations on the infectious sicknesses of the dogs; he has kindly sent me the following information.

"These cases of poisoning, which in Greenland always occur after eating fresh, raw meat of the Greenland shark (*Somniosus microcephalus*), both in men and dogs, is without doubt due to a specific poison (a toxin) which occurs in its body. Nothing indicates the correctness of Rink's view, that the poisonous nature of fresh shark meat was due to the large quantity of saline fluids it contained, whilst many things speak against this view.

Meanwhile, however, the question has not yet been scientifically investigated and all we know about it is exclusively based on empirical observations.

The clinical symptoms, of which — as mentioned above — tiredness, dullness, uncertain gait, sensory disturbances and a profuse diarrhoea are the most in evidence, depend in virulence on the quantity of meat taken, but in dogs can also be intensified in mild weather and with bodily exertion. In men, where the poison causes a similar complex of symptoms, the sense disturbances both objectively and subjectively give the same impression as acute alcohol poisoning. The symptoms of poisoning may last a shorter or longer time, from a couple of hours to a couple of days. They may be very weak, almost unnoticeable, when the animal has only taken a small quantity; on the other hand dogs have several times been known to die under violent symptoms, almost apoplectic in character, a short time after they had eaten large quantities of shark meat.

[1]) A part of this information I owe to kind communications from the Director of the colonies of Greenland J. Daugaard-Jensen and the Colonial Governor P. Ibsen, who have lived many years in North Greenland and thus had excellent opportunities to become well-acquainted with the sledge-dogs.

[2]) Rink l. c. p. 139.

Of importance in judging of the nature of the poisonous stuff or stuffs is the fact, that the animals can gradually be accustomed to taking larger and larger quantities of it. Obviously antitoxins can be produced in the body of the dog, which counteract the activity of the poison; in other words, the animal can to a certain degree become immune and this gradually occurs spontaneously at places where the dogs have constantly the opportunity of eating fresh shark meat.

The poison however is soluble in water and can thus be extracted from the meat by thorough washing. How far, on the other hand, it is destroyed by heating to temperatures below 100° is more doubtful. In any case the transformation here must proceed slowly; for according to all reports the meat must be cooked in 2 to 3 different waters, before one can be certain that it is unpoisonous. It is most reasonable to assume, that it is resistant to such a temperature.

The usual method in practice of preparing the shark flesh so that it may gradually lose its poisonous qualities, is to cut the meat into thin strips which are hung up to dry in the sun and air; it thus loses its large quantity of water and gradually its poisonous qualities disappear so that it becomes a rather good food for the dogs, though it must still be used with caution and preferable mixed with a little blubber.

Regarding the seat of the poison in the body of the shark we have the most divergent opinions; some assume that it is only in the musculature, others that it is exclusively present in the cartilage and again others that it is chiefly found in the peritoneal and spinal fluids, as it has been found, that these fluids produce a severe pain when received in the eye. A proper judgment on these matters, however, will only be obtained by means of a special investigations of the poison, and such at the same time would elucidate its chemical composition, its physiological properties and various, biological reactions".

In earlier times the natives of Greenland ate shark meat in seasons of scarcity, cooked or dried, but especially after it had been made half-way to putrify; also the cartilagineous parts were eaten. "Yet not all Greenlanders will eat the shark" writes Fabricius 1780; and now a days this scarcely happens to any extent. As human food the shark has now but little importance. Yet in winter, when the shark is "fat", a little of the meat is cooked; but the cooking has to be complete and the "soup" changed several times with fresh water, otherwise cases of poisoning may occur just as with the dogs.

After Fabricius the Greenlanders of his time used the rough skin of the shark to polish the wooden tent-holders, and also bags were sewn of the skins to keep the seal-blubber. — Of latest years the Royal Greenland trade has made experiments in tanning skins, sent to Copenhagen in salt; the spines may be taken off the skin, but the procuring of serviceable leather of this has not hitherto succeeded.

East Greenland. The Greenland shark is very common at Angmagssalik, according to G. HOLM[1]); and Mag. sc. C. KRUUSE, who lived at Angmagssalik in 1901—02, has informed me, that it penetrates right to the head of the fjord. During the wintering of RYDER's Expedition (1891—92) in Scoresby Sound a couple of specimens were taken in the neighbourhood of Hekla Harbour, writes E. BAY[2]). The last-mentioned author reports likewise, that a Greenland shark was captured whilst the ship was in among the pack-ice on July 13th 1891 (at 75°6′ N., 10°29′ W.), where the depth to the bottom was over 500 fathoms; according to the accounts of the sealers, moreover, it is not at all rare out among the drifting ice.

In winter the shark fishing is often of great importance for the Angmagssalikers, writes HOLM (l. c.). "A large hole is cut in the ice and a piece of old blubber fastened to a stone is let down into the water. Above this is placed seal meat, from which the blood gradually flows out into the water. The fishing is carried on when it is dark, the Greenlanders running about on the ice and shouting to attract the sharks up to the surface. When these come to the surface, they remain quite quiet and allow themselves to be killed by the harpoons. The catch is often so great, that the fishing is stopped owing to the superabundance. The women share in the fishing".

Pastor P. RÜTTEL, who worked as missionary among the (at that time) heathen Eskimo on the east coast of Greenland from 1894 to 1904, has kindly give me the following information, which gives a good picture of the use of the sharks among a race of people uninfluenced by civilization.

"The natives at Angmagssalik used shark meat as food both for themselves and for their dogs, and they used shark oil for the lamps. The flesh was prepared by hanging a long piece up under the roof inside the house (thus in winter); the liquid in the flesh dripped of itself, so that the meat at last became a sloppy mess. As soon as it was thought, that enough had dripped off, the meat was eaten (thus raw as it was). How long it was supposed to hang before being eaten, I cannot say, but in times of scarcity it did not have much chance to hang long in any case. That the flesh at last turned bad ("mikiak") by hanging in this way goes without saying, and so far as I know no other method was used of preparing the "mikiak". I believe in fact, that the natives also cooked the fresh shark meat (for human food), but this I can no longer remember for certain. On the other hand, I am certain, that shark meat in the dried condition is used as human food, but it was probably but little that was used in this way. The Angmagssalikers are not unfond of eating shark meat, preferring especially the cartilaginous parts of the head, but it was an inferior kind of food for them and they were not long contented with it at a time. I do not know, whether the Angmagssalikers gave their dogs the

[1]) Meddelelser om Grønland, 10 Hefte, 1888, pp. 54 & 81.
[2]) Meddelelser om Grønland, 19 Hefte, 1896, p. 58.

shark meat in cooked or dried condition, that is, that they cooked or dried it as dog food for the sake of the dogs. At Angmagssalik I have seen fresh shark bodies lying about in the vicinity of the houses and the loose dogs tear these carcases at will, though it was naturally well-known, that the dogs could become intoxicated from eating this meat. We ourselves have at times fed our own dogs on shark flesh, but we always cooked it first and we gave them loads of it and they took no harm. The soup was thrown away. The shark liver we also gave them sometimes and this we never cooked, but let it lie some time to drip beforehand, then they ate it without harm. My impression is that what is necessary to make the flesh safe both for human beings and animals, is to get the fluids to some extent out of the flesh and it is a matter of indifference, whether they are removed by cooking or by dripping".

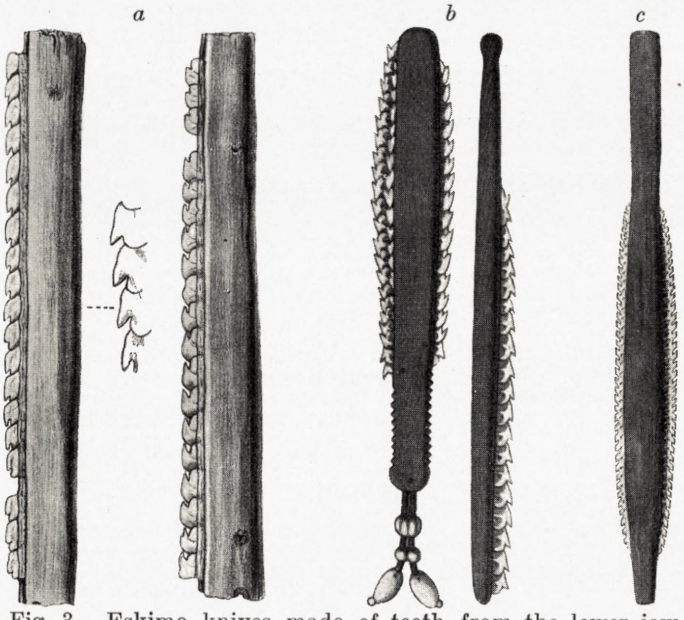


Fig. 3. Eskimo knives made of teeth from the lower jaw of the Greenland shark (*Somniosus microcephalus* Bl.-Schn.). a ca. 5/8, b ca. 1/3, c ca. 3/7.

A peculiar use of the teeth of the Greenland shark is noted by G. Holm[1]). The Angmagssalikers usually have the hair of the head long, but some get the hair cut short already as children, in front alone or the whole head around. This is made by the aid of the teeth of the shark, while from superstition it is not dared to let the hair be touched by iron. On plate XXVI, fig. c Holm figures two such "hair-cutters" (reproduced in my fig. 3 b), that evidently are made of pieces of wood with series of shark-teeth (from the lower jaw) fastened in them. Graah had, indeed, already figured such a "sharks-teeth-saw" (reproduced in my fig. 3 c), that he had found with the Eskimos on the southern part of the eastcoast of Greenland[2]). Also in West-Greenland implements of this description have been used in olden times. Jap. Steenstrup mentions and figures, indeed, a quite analogous implement found in the most northern part of Danish Greenland, in an old Eskimo grave from the heathen times; the cutting edge is made of a row of

[1]) Meddel. om Grønland, X, 1888, p. 62.
[2]) W. A. Graah: Undersøgelses-Rejse til Østkysten af Grønland, 1832, pl. VIII, fig. 2.

sharks-teeth fastened in a furrow in the edge of a blade of wood (cf. my fig. 3 a)[1]).

General Distribution. The Greenland shark has its proper home and occurs in large quantities in the northern Polar Sea at Greenland, Iceland, northern Norway, Bear Island and Spitzbergen. In the eastern Atlantic it is still common at the Færoes; it is sometimes taken at Scotland, but it seldom extends to England and North France; it occurs on the Murman Coast and in the White Sea, and it follows the whole of the Norwegian coast, though decreasing in numbers towards the south, and from the Skagerrak it enters into the northern part of the Kattegat. Further, it occurs in the northern Pacific (the Aleutians, occasionally Japan, the west-coast of North-America from Alaska to Oregon) and in the North American Polar Sea; along the east coast of America its distribution extends down to Cape Cod.

Raja radiata DONOVAN.

(*Raja fullonica* FABRICIUS (non LINNÉ), Fauna Groenl., 1780, p. 125).

English: *Starry Ray.*

Danish: *Tærbe.*

Greenlandic: *Taralikisak.*

West Greenland: From earlier years the Zoological Museum possesses 7 specimens of this ray (2 larger, ♂ and ♀, 2 smaller, ♂ and ♀, 2 very young, ♂ and ♀, as also an embryo in the egg); they are all only marked in general "Greenland". More recently 5 specimens have been received, namely, a male, which is the largest of all and measures 555 mm, from "South Greenland", 2 young females from the Davis Strait off Holsteinsborg, 88 fm., a young female and an embryo[2]) from Holsteinsborg and a young female thrown up on land at Godthaab.

[1]) J. STEENSTRUP: Sur l'emploi du fer météorique par les Esquimaux du Groenland. Congrès internat. d'anthropologie et d'archéologie préhistoriques. Compte rendu de la 6e session, Bruxelles, 1872 (p. 248 & pl. 25, fig. 1 a—b).

[2]) This embryo, which has a total length of 130 mm. behind the dorsal fins has a thin tail-end of no less than 27 mm in length. In MALM's figures of embryos of *Raja clavata* (Bidrag til kännedom om utvecklingen af Rajae. Öfvers. K. Sv. Vet. Akad. Förh. 1876, t. III, figs. 3 & 4) we also see behind two rudiments of the dorsal fins (m and n) a tail-end of considerable length. MALM has remarked on this unusual position of the dorsal fins far forward on the tail and assumes that "these (viz. the fin-like skinfolds) are resorbed, and that, in a more advanced stage, the permanent dorsal fins, in the vicinity of the tip of the tail, are evolved from the lower skin-fold that is to be found there" (l. c. p. 98). On the above embryo of *R. radiata*, however, the dorsal fins are fully formed, so that no reabsorption of them will take place; I imagine rather, on the other hand, that it is the larval tail-end lying behind the dorsal fins that is shortened. Further, the following condition has to be considered. In the adult rays on each side of the tail there is a horizontal fold of skin, which only terminates close in front of the end of the tail; in the present embryo there is a similar margin of skin, but it ends some few mm. behind the dorsal fins; this also indicates, that the greater part of the end of the embryonic tail is meant to be reduced. So far as I know, no investigation has been made into this interesting feature in the development of the *Raja* embryo.

In these 12 specimens the number of the scapular spines is constant, 2 on each side. Of the postorbital spines there are always 2 on each side, of the preorbital spines most frequently 2, sometimes only 1 on each side. Three specimens have 18 spines along the mid line of the back and tail, the others have 14—16. Two specimens possess a well-developed spine between the dorsal fins.

During the "Tjalfe" Expedition *Raja radiata* was frequently obtained along the stretch from Ilua up to Disko Bugt (59°55′—69°17′ N.). It was caught on lines in the following fjords: the fjord at Ilua, Agdluitsok, Tunugdliarfik (from the mouth right into Musartuit), Bredefjord (with Kangerdluarsuk and Sermilik), Kvanefjord S. of Frederikshaab, Godthaabsfjord (right into Kugssuk beyond Kornok); the depths were 30—125 to 330 fm. Further, it was taken with the trawl between Fyllas Bank and the land (63°48′ N., 52°23′ W.) at ca. 100 fm., in the middle of the Davis Strait (66°45′ N., 56°30′ W.) at ca. 200 fm., as also in the southern part of Disko Bay at ca. 150—230 fm. The Starry Ray was very common especially in the fjords round the settlement Narssak[1]) in the district of Julianehaab, and up to 20 could be taken on the long-line. The largest of all the specimens taken by the Expedition was a male of 610 mm, whilst the largest female measured 590 mm[2]). The number of spines along the mid line of the back and tail varied (in 44 specimens) from 13—19; sometimes also there was a spine between the dorsal fins. The other large spines were only counted in 7 specimens, where there were 2 scapular spines, 1 pre- and 2 postorbital spines.

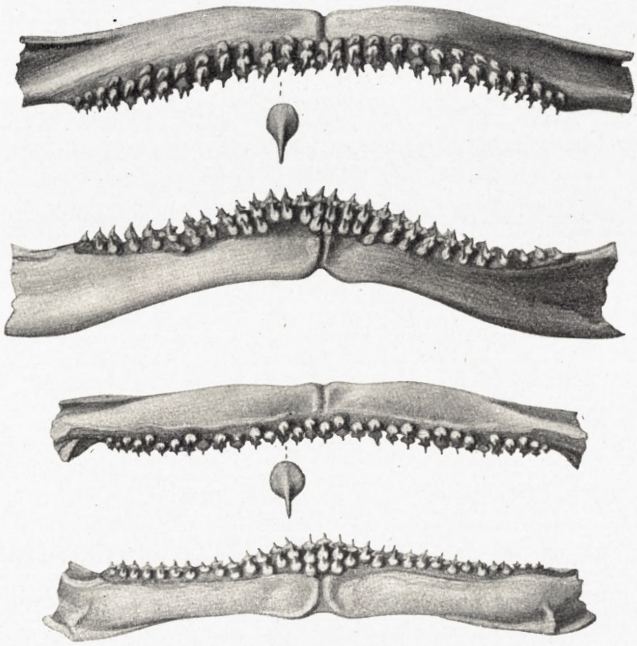


Fig. 4. Dentition of *Raja radiata* ♂ (upper) and ♀ (lower), natural size; the separate teeth magnified 3 diameters. From specimens from Bredefjord, north of Julianehaab in the south-western Greenland, 120—200 fm.

[1]) The Greenlanders at this place know this fish well; they call it "*Taralikisâk*". Its abundance here was also known already to Fabricius: "It lives in the southern deep fjords, especially at Tunnudliorbik" (= Tunugdliarfik).

[2]) The smallest specimen was only 109 mm long, taken at 69°17′ N., 52°14′ W., 227—234 fm; behind the dorsal fins it has a tail-end of 16 mm (see note 2 antea p. 17).

A female taken in Kangerdluarsuk 25. 7. 1909 in addition to several eggs of various sizes contained 2 mature egg-capsules, 66—68 mm long (without the threads).

The deposited egg-capsules[1]) were likewise frequently taken, either in the stomachs of other fishes (especially halibut) which had swallowed them, or in the trawl of the "Tjalfe" from the sea-bottom. Of the places where these were taken the following may be given with information regarding the length in the middle of the capsules.

	Depth	Number of capsules	Length of capsule
Bredefjord, north district of Julianehaab	368 fm.	1	66 mm.
— — — —	226—237 —	1	62 —
— — — —	260 —	1	60 —
— — — —	163—174 —	1	?
Godthaab	....	2	56—57 —
Kangek at Godthaabsfjord	....	2	58—60 —
66°41′ N., 56°17′ W.	150 —	1	ca. 45 —
66°44′ N., 56°08′ W.	ca. 175 —	12	ca. 44—49 —
66°44′ N., 56°16′ W.	ca. 150 —	2	ca. 50 —
66°50′ N., 56°11′ W.	150—170 —	1	66 —
68°20′ N., 54°03′ W.	220—280 —	2	ca. 44—45 —
Godhavn	....	2	ca. 45 —
Off Niakornak (69°26′ N.)	180 —	2	ca. 55 —

To judge from all these observations *Raja radiata* is of common occurrence in the southern part of West Greenland, both in the fjords and at the coasts, on the banks in Davis Strait and outside these. Towards the south it occurs right down to the point of the land; to the north the boundary of its distribution seems to lie in the central part of Disko Bay, the last specimens (at 69°17′ N.) as well as the last egg-capsules (at 69°26′ N.) being taken there (cf. note 2, p. 25).

Regarding its food Fabricius writes, that it feeds on all kinds of fish, especially capelan and sea scorpions, and Crustacea (prawns). I have found remains of Crustacea in its stomach from which the soft parts had been "extracted", only the empty, rolled-up cuticles remaining.

It is taken occasionally on the hand-lines in deep-water and has no importance as food; in any case the Greenlanders at Narssak threw away the many rays we caught, whilst they willingly accepted such to us unappetising fish as *Macrurus Fabricii*. Fabricius however remarks, that "it (the ray) is only eaten half-rotten".

General Distribution. On the American side Disko Bay is thus the northern

[1]) Regarding the interpretation of the "fish", that Fabricius had referred to *Zeus Gallus* L., as being the eggs of rays cf. pp. 32—34.

boundary, and to the south it goes down to the northern United States. It occurs at Iceland and Spitzbergen, and in Europe it is distributed from the White Sea to the British Isles, as also the northern and western coasts of France, where however it is rare. It is specially numerous at southern West Greenland, Iceland and Norway. It is probably most abundant at depths of 30—50 fm., but it goes both higher up and deeper down (sometimes to 460 fm.).

Raja hyperborea COLLETT.

Raja hyperborea COLLETT, Forhandl. Vidensk. Selsk. Chria. 1878, No. 14, p. 7; The Norwegian North-Atlantic Exped., Fishes, 1880, p. 9, pl. 1, fig. 1—2; GÜNTHER, Rep. Scient. Res. Voy. Challenger, Zoology, XXII, 1887, p. 8, pl. 5; F. A. SMITT, Skandinaviens Fiskar, II, 1895, p. 1111, figs. 317—18; LÜTKEN, The Danish Ingolf-Exped., II, 1, 1898, p. 2; COLLETT, Arch. f. Math. og Naturv., XXV, 1903, Nr. 2, p. 7; COLLETT, Rep. Norw. Fishery and Marine-Investig., II, No. 3, 1905, p. 10. — *Raja borea* GARMAN, Rep. Expl. West Coasts Mexico etc. (Albatross 1891) 1899, p. 24. — *Raja radiata* VANHÖFFEN (non DONOVAN), Grönland-Exped. d. Gesellsch. f. Erdkunde, II, 1, 1897, p. 127.

Diagnosis.

The length of the snout, measured to a cross-line through centre of eyes, amounts in general to more than the half, sometimes slightly less than the half part of the breadth of the disc likewise measured along a line across the eyes and is $2^1/_6$—$2^1/_5$ times as large as the least breadth of the interorbit. Of the total length the greatest breadth of the disc amounts to 70.6—81.6 % and the length of the tail from the cloaca 39.5—45.8 %. The ventral surface is quite smooth. The dorsal surface is richly provided with larger and smaller spines. Of large spines we find 1 (rarely 2) pre- and 2 postorbital, 3 (sometimes 2, very seldom 4) scapular spines and along the mid line of the body and tail 22—31 spines, further, frequently 1 (seldom 2) between the dorsal fins. The teeth do not form a pavement, being fairly long and thin with relatively small base. The colour of the upper side is dark blue-gray or gray-brown sometimes with small, light or dark, rounded spots. The under surface is spotted, but very variable, from white with symmetrically arranged dark spots to dark with symmetrically arranged white spots. Length: female 860 mm, male 765 mm.

Raja hyperborea was originally founded by COLLETT on a specimen obtained by the Norwegian North Atlantic Expedition W. of Spitzbergen at a depth of 459 fm. Later the British Museum received 5 specimens taken by the "Triton" in the Færoe Channel; they were described by GÜNTHER (l. c.). Whilst neither of these authors expresses any doubt as to the correctness of the species, F. A. SMITT on the other hand writes in "Scandinavian Fishes", that it still remains undecided, whether this ray has to be regarded as an independent species or merely as a variety of *Raja radiata*, from which it is mainly distinguished by a larger number of spines in the mid line of the back and tail as also by the under surface being spotted.

The present author has been in the fortunate position of having at his disposal a large number of specimens of *Raja hyperborea* of both sexes and at different ages, and from an examination of this material he has come to the result, that *R. hyperborea* is a distinct species from *R. radiata*. The characters by means of which they can most readily be distinguished from one another are the following:

Raja hyperborea	*Raja radiata*
The snout is somewhat prolonged, pointed and projects distinctly in front of the anterior points of the breast fins.	The snout projects extremely little and in outline is very obtuse-angled and almost rounded.
The eyes are comparatively remote from each other, so that the interorbital breadth at the narrowest place is contained less than 3 times in the length of the snout (to a line through the centre of the eyes).	The eyes are comparatively close together, so that the interorbital breadth at the narrowest place is contained more than 3 times in the length of the snout (to a line through the centre of the eyes).
22—31 spines in the mid line of the back and tail[1]).	12—19 spines in the mid line of the back and tail.
The belly variegated, white with dark spots or dark with white spots[2]).	The belly uniform white[3]).

To this must be added, that the spines in *R. hyperborea* are on the whole narrower than in *R. radiata*. Further, *R. radiata* has 2 scapular spines (probably constantly), whilst *R. hyperborea* usually has 3 (sometimes however only 2). Lastly, the structure of the teeth is quite different; the teeth do not form a pavement, as is usual in the rays and also in *R. radiata* (cf. fig. 4); from a relatively small base arises in *R. hyperborea* a fairly long and narrow, needle-shaped point[4]), strongly inclined backwards (cf. fig. 5); there is no recognizable difference between the two sexes.

West Greenland. The occurrence of the species here was first noted in the year 1907, when the Governor of the colony Upernivik, H. KRAUL, forwarded two rays, in which to my surprise I recognized *Raja hyperborea*, which hitherto had only been known from the deep water of the Norwegian Sea. Both were males, 490 and 650 mm long.

[1]) GÜNTHER states (l. c.) that in a specimen from the Færoe Channel he found only 16 dorsal spines, but I imagine, either that some spines have been lost or that his specimen was *Raja radiata*. — COLLETT (l. c. 1905) notes only 20 spines in a specimen. My figures are based on ca. 40 specimens.

[2]) In quite young specimens however the belly may be quite white, which is the case in two of my specimens from the deep water of the Norwegian Sea, 176 and 191 mm long.

[3]) Sometimes however dark spots have been observed on the otherwise white belly in *R. radiata*; cf. KRØYER, Danmarks Fiske, IV, 1852—53, p. 942 and PIETSCHMANN, Annalen des Naturhist. Hofmuseum, 22. Bd., Nr. 4, 1907—08, p. 296.

[4]) In 3 specimens I have found $\frac{40}{40}$, $\frac{41}{?}$ and $\frac{43}{38}$ cross-rows of teeth.

Further, during the "Tjalfe" Expedition 15 specimens were taken at the following places:

St. 650. Nuk in Ilua Fjord. 120—180 fm. 18. 9. 1909. Line. 1 spec. ♂. 560 mm.
St. 152. Kekertak in Torsukatak Isfjord. 100—160 fm. ca. 0—0.5° C. 24. 7. 1908. Line. 1 spec. ♂. 430 mm to end of App. genitales (end of tail wanting).
St. 159. Umanakfjord (70°49′ N., 53°16′ W.). 260 fm. 1.1° C. 30. 7. 1908. Trawl. 1 spec. ♂. 390 mm.
St. 161. Umanakfjord S.W. of Spragle Bugt. 140—320 fm. ca. 0.2—1.0° C. 31. 7. 1908. Line. 1 spec. ♀. 678 mm.
St. 176. Umanakfjord (70°52′ N., 53°6′ W.). 260 fm. 1.1° C. 7. 8. 1908. Trawl. 11 spec. 167—292 mm.

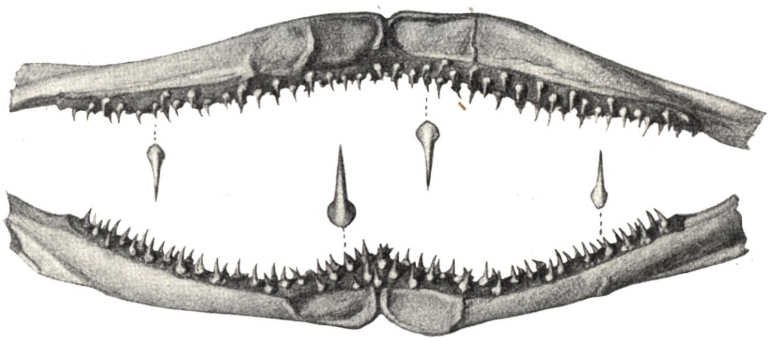


Fig. 5. Dentition of *Raja hyperborea* ♂, natural size; the separate teeth magnified 3 diameters. From a specimen from the Norwegian Sea (62°40′ N. 1°56′ E.), 360 fm.

From West Greenland, therefore, the species is represented in the Copenhagen Zoological Museum by 17 specimens, in size from 167—678 mm. The following information regarding these may be added.

The snout forms a sharp angle. The anterior margins of the disc form a slight curve or bend immediately behind the snout; a second in-curving begins behind the spiracles and the anterior margins thus have a wavy appearance. The point of the pectorals forms almost a right angle, rounded at the end. But the contour undergoes some change with age; the snout becomes drawn out into a longer and more distinct point, and the incurving in the lateral margin behind the eyes becomes deeper, so that the regular, rhombic form of the young individuals changes and the pectoral fins become marked off from the front part of the disc like "wings".

The large spines in the mid line of the back and tail, at the eyes and over the shoulder are grooved from the base outwards towards the point, which is sharp and bent somewhat backwards; on the tail they are fairly high and compressed. The other spines are stellate, of medium size or quite small. The medium spines are found over the front part of the snout cartilage; on the lateral margins of the disc opposite the eyes; on an area beginning opposite the shoulder spines and extending backwards to the posterior margin of the pectoral fins; on both sides of the middle row of the back, but not quite

in front or behind. The quite small spines are mostly close to the snout, between the eyes, inside the shoulder spines, on the anterior, lateral margins of the pectorals and on each side of the upper surface of the tail. The adult males (560 and 650 mm) have on each pectoral the well-known "card" of 18 needle-shaped spines, concealed in great part under the skin and with the point directed inwards; they are partly situated in two alternate rows.

The colour on the under surface of all the West Greenland specimens is mainly dark, the light being restricted to symmetrically placed spots. Frequently the snout and mouth are white, as also a spot on the breast, a longitudinal streak medially on each pectoral fin and spots or stripes on the ventral fins; but these white parts may partially be wanting or restricted in extent.

For the sake of completeness I add the principal measurements in mm of some of the West Greenland specimens.

Locality	Total length	Greatest breadth of disc	Length of disc to a line connecting posterior margins of pectorals	Length of tail from anus	Length of snout to a line across centre of eyes	Breadth of disc across same line	Least interorbital space	Sex
Umanakfjord..	245	192	137	117	42	81	18	♂
Umanakfjord..	275	217	157	126	50	95	20	♀
Umanakfjord..	390	307	220	174	65	124	30	♂
Upernivik.....	490	400	285	205	88	165	35	♂
Nuk	560	440	315	233	95	190	35	♂
Upernivik.....	650	505	380	275	113	205	45	♂ [1]
Spragle Bugt..	678	500	390	280	110	217	49	♀

It should be mentioned, further, that *Raja hyperborea* has already some time since fallen into the hands of a naturalist from West Greenland, but has not been recognized. At the place cited VANHÖFFEN reports, that during his stay in North Greenland in 1891—93 he obtained 4 rays, namely 2 from Jakobshavn and 2 from Umanakfjord (Ikerasak and Igdlorsuit); they were caught by the Greenlanders on hand-lines, with which they fish for sharks and the Greenland halibut, thus in very deep water. All four were females, of considerable size, namely 575, 640, 795 and 860 mm. VANHÖFFEN determined them as *Raja radiata* DONOVAN and states expressly, that there could be no talk of referring them to *Raja hyperborea* COLLETT.

It appears however from the information given by VANHÖFFEN regarding these

[1]) The appendices genitales in this specimen are 190 mm long measured from the posterior margin of the cloaca.

North Greenlandic rays, that they must just be considered to belong to *Raja hyperborea*. Regarding the colour for example it is stated, that the colour in all specimens was uniformly brown on the upper surface; below, in both the larger specimens white on the snout and middle of the belly, dark spots on the sides and a white longitudinal streak extending downwards over the pectoral fins; in the smaller specimens only the snout was white, the rest of the under surface was coloured brownish. This dark colour of the belly points with certainty in the direction of *Raja hyperborea*, and Vanhöffen is mistaken when he writes, that the colour in the two species is the same; *Raja radiata* is precisely (as a rule) white over the whole under surface.

Vanhöffen writes further, that in his North Greenland rays there were three larger spines on the shoulder instead of two as in *Raja radiata*. The fact is however that *Raja radiata* — probably constantly — has two spines on the shoulder, whilst *Raja hyperborea* as a rule just has three[1]).

Again, the relatively considerable size of the North Greenland specimens should also lead one to think not of *Raja radiata*, whose maximum length lies about 600 mm.

Lastly, Vanhöffen writes that *Raja hyperborea* is distinguished at the first glance from his specimens by the fact, that the spines of the sides and fins are all considerably smaller than those of the mid line, whilst in *Raja radiata* a number of the lateral spines approach in size those of the mid line. In reality there is no essential disagreement in this regard between the two species, but the lateral spines are perhaps more evident in *Raja radiata*, as the spines are on the whole more strongly developed in this species than in *Raja hyperborea*.

Only one thing raised a doubt and caused me to hesitate in referring all Vanhöffen's specimens to *Raja hyperborea*. He states namely, that the number of spines in the mid line of the back and tail were respectively 22, 17, 11 and 24; the first and the last numbers agree with *Raja hyperborea*, the intermediate are far too low for this species. Through the kindness of the Zoological Museum of Berlin and particularly Dr. P. Pappenheim I have however obtained the opportunity of seeing 3 of Vanhöffen's specimens, namely the two from Umanakfjord (Ikerasak and Igdlorsuit) and the largest from Jakobshavn. It appears now, that the low number of dorsal spines which Vanhöffen gives for his specimen from Ikerasak is due to the fact, that a large number of the spines have been rubbed off, specially all those of the tail except two, so that their number cannot be given; but there have clearly been many more than Vanhöffen notes; the specimen from Igdlorsuit has 24 dorsal spines, the large one from Jakobshavn has had 27.

[1]) The specimen of *Raja hyperborea* described by Collett — the only one known when Vanhöffen wrote his paper — was stated to have only two shoulder spines. Collett however has become aware later, that it can be seen in his type specimen of the species, that the third (inner) spine has originaly been present, but has been quite rubbed off (Collett l. c., 1905, p. 15).

In addition, I was able to determine, that Vanhöffen's North Greenland rays agree in every respect with *Raja hyperborea*. By comparison with the Greenland specimens of our Museum only the specimen from Jakobshavn differed somewhat, the white colour on the belly had a comparatively large extension, but in this regard it is exceeded by specimens from other seas (depths of the Norwegian Sea), in which the white ground-colour of the under surface is just as widely distributed as or greater than the dark colour.

For the sake of completeness it may further be mentioned, that Pietschmann notes casually, that the Vienna Museum possesses two specimens of *Raja hyperborea* from "North-west Greenland"[1]).

Thus from West Greenland we know 23 specimens of *Raja hyperborea*. Of these 22 have been taken on the stretch from Jakobshavn to Upernivik, at the following places: Jakobshavn, Kekertak, Umanak Fjord (various places from Ikerasak to Igdlorsuit) and Upernivik. The species must therefore be considered to be common in deep water at Danish North Greenland, from the northern end of Disko Bay and northwards[2]). On the other hand, a single specimen has been taken right down in the sounds at the south of Greenland, at Nuk in Ilua Fjord (60°12′ N.).

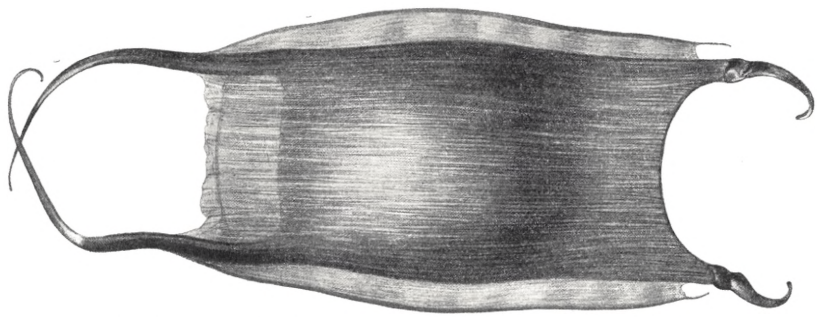


Fig. 6. Egg-case of *Raja hyperborea*, reduced (1/2), from Jakobshavn. The longitudinal striation indicates the layer of golden, silk-like hairs in which the capsule is enveloped.

At the northern Danish West Greenland a number of egg-capsules of *Raja hyperborea* have also been taken[3]) (cf. fig. 6). The data of the localities are given here, with information regarding the length of the capsules (in the middle, thus without the threads):

[1]) V. Pietschmann: Ichthyologische Ergebnisse einer Reise ins Barentsmeer; Annalen des K. K. Naturhist. Hofmuseums, Bd. 22, Nr. 4, 1907—08 (p. 296).

[2]) It has been shown under *Raja radiata*, that this so common species at South Greenland has not been found farther north than in Disko Bay at 69°17′ N. As the southernmost locality for *Raja hyperborea*, Jakobshavn, lies in Disko Bay at 69°13′ N., it seems as if these two common Greenland species of rays each inhabits its own part of the west coast and only touch each other's region of distribution in Disko Bay (as also right down at Ilua Fjord at the turning point to East Greenland, where *R. hyperborea* again reappears).

[3]) Some have been taken from the stomachs of other fishes (Greenland Shark), which had swallowed them, others were taken up from the sea-bottom by the trawl of the "Tjalfe".

Locality:	Depth	Number of capsules	Length of capsules
Disko Bay	....	1	110 & 110 mm
Jakobshavn	....	5	81, 103, 110, 110, 115 mm
Umanakfjord (70°47′.5 N., 52°21′ W.)	311 fm.	2	87, 95 mm
— (70°49′ N., 53°16′ W.)	260 —	1	109[1])
— (70°52′ N., 53°6′ W.)	260 —	2	85, 90
Prøven	....	1 (dried)	?

It may be added here, that the egg-capsules of *Raja hyperborea* and *R. radiata* have a great resemblance to each other. So far as my experience goes however, the capsule is

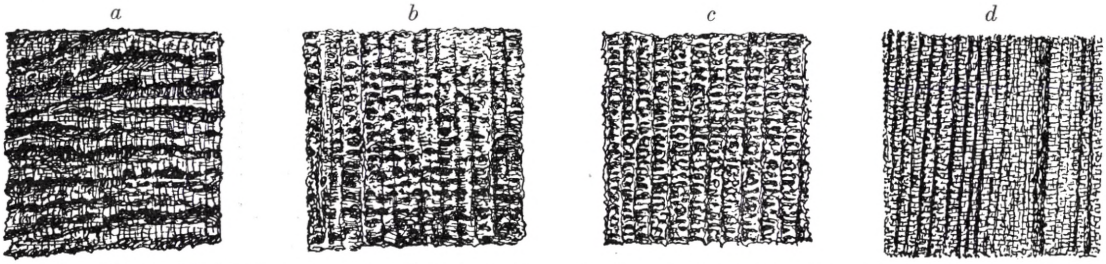


Fig. 7. Pieces of dried egg-cases of *Raja radiata* (*a*, *b* and *c*) and *R. hyperborea* (*d*) magnified 6 diameters to show the different structure of the capsule-wall.

considerably larger in the former than in the latter species; in 14 specimens of *R. hyperborea* it varies from 81—125 mm[2]), in 29 specimens of *R. radiata* from 44—68 mm (cf. p. 19)[3]).

[1]) This egg, which was taken in the trawl on 30. 7. 1908, contains an embryo with fairly large yolk-sac. The total length of the embryo is 140 mm; behind the 2nd dorsal fin is a tail-end 35 mm long, thus quite as long as in the embryo of *R. radiata* (cf. p. 17, note 2).

[2]) In addition to the above-mentioned I have been able to examine another, 125 mm long, egg-capsule, which was taken by Vanhöffen from a specimen of *R. hyperborea* from Jakobshavn (erroneously described by this author l. c. p. 128 as belonging to *R. radiata*). With the aid of this egg, which had been kindly lent to me by the Berlin Museum, I was able to identify the other eggs of *R. hyperborea* with absolute certainty.

[3]) As a supplement some further measurements of egg-capsules of both species may be added here.

	Length of capsule without threads	Length of capsule with threads	Breadth of capsule
Raja hyperborea	125 mm	260 mm	77 mm
	115 —	225 —	75 —
	109 —	210 —	69 —
	103 —	240 —	71 —
	81 —	174 —	54 —
Raja radiata	68 —	172 —	51 —
	66 —	171 —	50 —
	62 —	127 —	42 —
	57 —	135 —	45 —
	56 —	139 —	44 —

The relatively great total length of the two *R. radiata* egg-capsules first-mentioned is due to their having been taken from the uterus and the outermost, hair-fine parts of the threads were thus preserved.

Further, the structure of the covering is different somewhat, being smoother in *R. hyperborea* (fig. 7d) than in *R. radiata* (fig. 7a, b, c), where the capsule is rather rough and uneven, frequently wrinkled transversely [1]).

Remains of small fishes and Crustacea (prawns) were found in the stomach of *Raja hyperborea*.

General Distribution. *Raja hyperborea* is distributed in addition over the "cold area" north of Russia and from Norway over towards East Greenland and from Spitzbergen down towards the Shetlands, Færoes and Iceland. It was here, in the depths of the Norwegian Sea, taken at depths of down to 1309 fm., and upwards the boundary for its distribution falls at the boundary layer between the cold polar water and the overlying warm Gulf Stream water, thus at ca. 300 fm. It is also taken in the "cold area" North of Russia. (cf. besides pp. 37—38 and the chart, fig. 12).

Raja fyllae Lütken.

Raja fyllae Lütken, Vidensk. Medd. Naturhist. Foren., 1887, p. 1, tab. 1; Lütken, ibid., 1891, p. 32; The Danish Ingolf-Expedition, II, 1, 1898, p. 11, tab. 2; Jensen, Vidensk. Medd. Naturhist. Foren. 1905, p. 227. — *Raja circularis* Collett (non Couch), Nyt Mag. for Naturvidensk., 29, 1885, p. 119. — *Raja falsavela* Smitt (non Bonaparte), Skandinaviens Fiskar, II, p. 1112, fig. 319.

West Greenland. Four specimens of this small ray were caught in the Davis Strait

The type-specimen of the species was taken on the cruise of the cruiser "Fylla" in 1884; according to the record it was taken at 65°35′ N., 54°50′ W. and a depth of 75 fm., but the comparatively slight depth would indicate, that an error has taken place and that the specimen comes from another, neighbouring trawl-station in considerably deeper water (256 fm.).

Later the species has been taken at the following, certain stations:

63°30′ N., 54°25′ W. 582 fm. 3.3° C. "Ingolf" 1895. Adult male, length 555 mm
65°30′ N., 55°26′ W. 289 fm. 4.5° C. "Fylla" 1889. Young male, length 115 mm
66°49′ N., 56°28′ W. 235 fm. 4.4° C. "Fylla" 1889. Young male, length 201 mm

At the above-cited places Lütken has discussed in detail the structure of this ray and the changes its form undergoes with age.

General Distribution. In addition to the Davis Strait *Raja fyllae* has been taken in the southern part of Denmark Strait, S.W. of the Færoes, in the Skagerak,

[1]) The egg of *Raja hyperborea*, of which I also have 2 specimens, 108 and 123 mm long, 66 and 71 mm broad, from the Norwegian Basin (64° 58′ N., 11° 12′ W., 300 fm., bottom-temp. — 0.38° C.), was hitherto unknown. H. C. Williamson has recently given an instructive, illustrated account of a number of the egg-cases of other European skates, in "Fisheries, Scotland, Sci. Invest., 1912, I" (July 1913).

in the western part of the Barents Sea, on the Bear Island-Spitzbergen plateau and the banks off West Spitzbergen (cf. Jensen l. c. and the chart in the present paper, p. 38).

Raja lintea Fries.

Danish: *Hvidrokke.*

Raja lintea Fries, K. Sv. Vetensk. Acad. Handl. 1838, p. 154 (1839); Müller & Henle, System. Beschreib. der Plagiostomen, 1841, p. 147; Günther, Catal. of Fishes, VIII, 1870, p. 466; Smitt, Skandinaviens Fiskar, II, 1895, p. 1117, Fig. 321. — *Raja ingolfiana* Lütken, The Danish Ingolf-Expedition, II, 1, 1898, p. 3, tab. I.

West Greenland. In the Davis Strait, west of the "Store Hellefiskebanke" 3 specimens in all have been taken of this large ray, namely at:

66°35′ N., 56°38′ W. 318 fm. 3.9° C. 11. 7. 1895. "Ingolf" St. 32. Trawl.
66°45′ N., 56°39′ W. 241—202 fm. 3.4—3.3° C. 6. 7. 1908. "Tjalfe" St. 103. Line.
66°53′ N., 56°17′ W. 225—210 fm. 3.4° C. 21. 8. 1908. "Tjalfe" St. 206. Line.

The first of these specimens was described by Lütken, who thought it was a new species, *Raja ingolfiana.* It is a male 662 mm long, still young, the *appendices genitales* being only 35 mm long and quite undeveloped. It has the typical form of *Raja lintea* (cf. figure in Lütken). This ray belongs to the long-snouted species; in the present Greenlandic specimen the length of the snout, measured from the point to a cross-line drawn through the centre of the eyes amounts to 123 mm or more than half the breadth of the disc across the eyes (224 mm). The length of the tail, from the posterior margin of the anus, amounts to 327 mm or almost half the length of the whole body. The principal measurements otherwise are the following: greatest breadth of the disc 427 mm, least distance between the eyes 33 mm, longitudinal diameter of the eye 15 mm, longest diameter of the spiracle 14 mm, distance of the nostrils from each other anteriorly 57 mm, distance of the mouth from the tip of the snout 125 mm, breadth of the mouth 60 mm.

The largest spines, 47 in number, are situated along the mid line of the back and tail; on each side of the tail there is a row of smaller spines, and the upper side of the tail is rough from numerous, very fine spines, which form a longitudinal band on each side, between the rows of large spines. In front of the eye there are 2 spines, at its inner border 1 spine, behind the eye 4 spines and 3 over the shoulder forming a triangle. Otherwise the upper surface of the body is sparsely provided with small spines, excluding the anterior lateral margins of the disc, where there are coarse small spines with stellate base, as also the cartilaginous snout, over the anterior part of which is an elongated area with ca. 15 similar, but somewhat larger spines. The belly is completely naked.

The upper side is slaty gray, the under side white but with a dark spot on each side of the anus and a dark band, dissolving posteriorly into spots, along the middle of the tail.

Of the two specimens from the "Tjalfe" Expedition the first-mentioned was a male 1080 mm long with 48 dorsal spines, the second a female 810 mm long with 45 dorsal

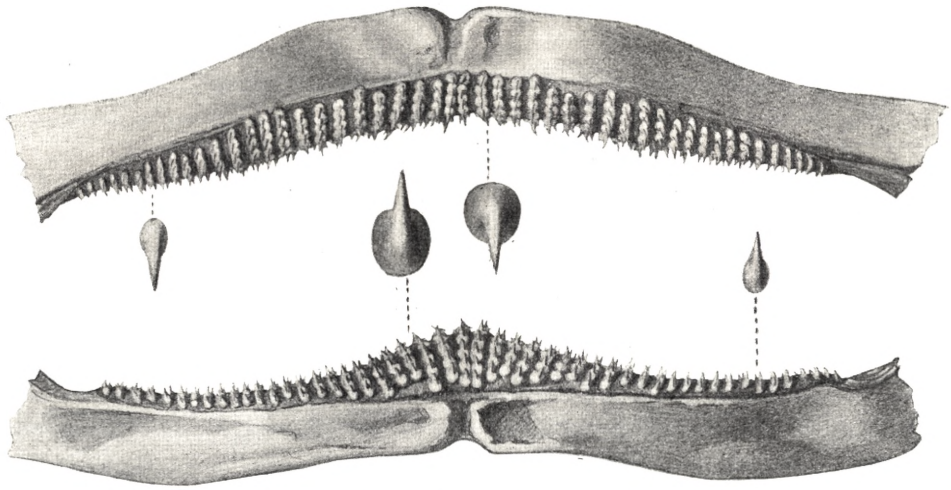


Fig. 8. Dentition of *Raja lintea* ♂, natural size; the separate teeth magnified 4 diameters. From a specimen from Davis Strait (66°45′ N. 56°39′ W.), 241—202 fm.

spines. Regarding the colour of the last specimen I have noted the following: The upper side uniformly clay-gray; the under side milk-white, with a gray longitudinal band under the tail, from the end almost to the anus and with a white edge on each side; a dark, reniform spot on each side of the anus. Of these specimens only the jaws were preserved; in the male (fig. 8) there are 49 rows of teeth in the upper jaw, 50 in the lower, in the female (fig. 9) 47 in the upper jaw and the same number in the lower. The teeth of the female have shorter points and broader bases than the teeth of the male.

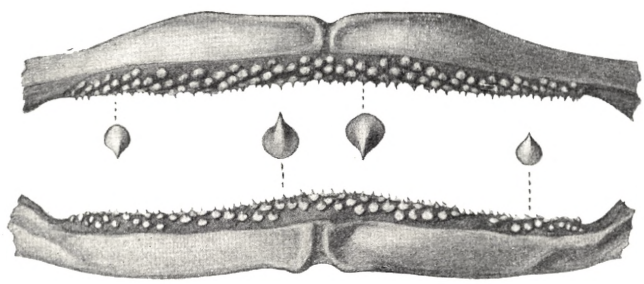


Fig. 9. Dentition of *Raja lintea* ♀, natural size; the separate teeth magnified 3 diameters. From a specimen from Davis Strait (66°53′ N. 56°17′ W.), 225—210 fm.

General Distribution. From the foregoing details it will be seen, that *Raja lintea* certainly occurs in the central part of the Davis Strait, which is to some extent a surprising extension of its region of distribution. Hitherto *Raja lintea* has only been known from the eastern side of the Atlantic. It has long been known, that the species

lives on the banks off Jæderen in Norway; here it is taken in the months of May, June and July in depths of 80 to 120 fm. In 1902 the present author had the opportunity on board the Norwegian research-steamer "Michael Sars" to determine its occurrence N. E. of the Shetlands and east of the Færoes, in depths of 185—250 fm. Further, it has several times been taken in recent years by the Danish research-steamer "Thor" in the Skagerrak at depths of 275—350 fm. Probably it occurs still further south along the European coasts, but it is not easy to see, whether any of the rays described by English and French authors under other names are identical with the present.

Raja spinicauda n. sp.

Pl., figs. 1—5.

Diagnosis.

The snout forms a pointed angle; its length to a cross-line drawn through the centre of the eyes amounts to more than half of the breadth of the disc along the same cross-line and is almost or quite 4 times as great as the least interorbital breadth. The lateral corners of the disc form almost a right angle and are rounded at the tip. The under surface is quite smooth. The dorsal surface is richly provided with quite small spines, situated in particular densely along the mid line of the body and tail, of larger spines there is only one row (21—26) along the mid line of the tail, and they are erect or but slightly bent backwards. The colour in the fresh condition is blue-gray on the upper surface, the free border of skin along the sides of the tail white; the under surface is milk-white with dark-gray spots along the lateral margins of the pectorals behind the angles and along the margin of the pelvic fins as also on the tail, especially the anterior part.

Of this ray, which is new to science, 6 specimens were taken by the "Tjalfe" Expedition at southern West Greenland, partly out in the Davis Strait, partly in Tunugdliarfik Fjord and Skovfjord in the northern part of the Julianehaab district. The following are the separate localities:

a. St. 408. Davis Strait. 64°14′ N., 55°55′ W. 440 fm. ca. 3.8° C. 2. 6. 1909. Trawl.
b & c. St. 565. Mouth of Tunugdliarfik Fjord. 125—200 fm. ca. 1.7—3° C. 30. 7. 1909. Line.
d. St. 566. Mouth of Tunugdliarfik Fjord. 125—200 fm. ca. 1.7—3° C. 31. 7. 1909. Line.
e & f. St. 598. Skovfjord, from Kingitok right across the narrowest place towards the island Igdlokasik. 120—160 fm. 1.7—2.3° C. 13. 8. 1909. Line.

The specimen a is a female 740 mm long with 26 dorsal spines[1]); it is the specimen which has been figured in the plate, figs. 1 & 2. The specimen b was a female 1390

[1]) In addition a spine in the distinct interspace separating the comparatively well-developed dorsal fins.

mm long weighing 18½ kg; the greatest breadth of the disc was 970 mm; it had 21 dorsal spines. The specimen c is a female 1120 mm long with 22 dorsal spines[1]); its stomach contained prawns (*Pandalus*). The size of specimen d lay between those of the two foregoing. Specimen e was a female 980 mm long with 22 dorsal spines and specimen f a female 900 mm long with 25 dorsal spines.

Of these specimens only a and c were preserved; their principal measurements in mm are the following:

	Total length	Greatest breadth of disc	Length of tail from hind margin of anus	Length of snout to a line across centre of eyes	Breadth of disc across line through centre of eyes	Longitudinal diameter of eyes(cornea)	Least inter-orbital space	Longest diameter of spiracles	Distance of nostrils from each other anteriorly	Breadth of mouth	Distance of mouth from tip of snout
a.....	740	485	360	149	283	?	36,5	14,5	56,5	72	143
c.....	1047[2])	725	493	212	400	18	57	26	76	95	194

Of specimen b the jaws were preserved (see the plate fig. 3); they bear 32 rows of teeth above and 31 below; the single teeth greatly resemble those in *Raja lintea* (cf. fig. 9 in the text) of the same sex, but here the basal disc of the tooth is relatively a little broader.

Remarks. In Bull. Essex Institute, XI, 1879, p. 28 Goode & Bean describe a new ray to which was given the M. S.-name *Raja granulata* by GILL as follows: "A remarkable species with back and ventral surface covered with minute sharp granular ossifications . . . . . A species of the same type as *R. lævis*, and having 30—31 teeth on each side; the back granulated and slate colored; the ventrals distinguished by reticulate markings, and the claspers slender and scarcely expanded". This species is referred to later by other American authors in the same brief manner.

There seemed to be the possibility, that the above-described ray from southern West Greenland was identical with *Raja granulata* from Newfoundland; this is also suggested by the figure given of *R. granulata* by GOODE & BEAN in "Oceanic Ichthyology" (Plates, fig. 30).

It was thus of considerable importance for me to see this ray and on Prof. JUNGERSEN's reference to the U. S. National Museum it became possible, an authentic specimen of *Raja granulata* (GILL) GOODE & BEAN being sent from there for comparison; it was taken at 42°37′ N., 62°55′ W., 200 fm. It then proved, that this species is different from that brought home by the "Tjalfe" Expedition. *R. granulata* posses-

[1]) In this specimen there has also been a spine — now broken off — between the dorsal fins.
[2]) In the fresh condition the total length was 1120 mm.

ses large orbital and scapular spines (on each side 1 pre- and 2 postorbital spines and 2 scapular spines), whilst these are wanting in *R. spinicauda;* further, *R. granulata* has a row of large spines not only on the upper side of the tail, but also along the mid line of the back (7 in the present specimen) which are wanting in *R. spinicauda*[1]). Apart from this the two species have no small resemblance to each other; thus it is characteristic for them both, that the upper surface is covered with fine, small spines, which gives the skin to the naked eye a grained (granulated) appearance[2]).

Raja spinicauda also recalls *Raja lintea*, both in form and colour. But *R. lintea* has more numerous large spines in the mid line of the back, and these are present not only on the tail but also on the body; further, this species possesses both orbital and scapular spines, whereas its skin is comparatively little provided with small spines, thus not "granulated".

On the *"Kollivsiuternak"* of the Greenlanders and *"Zeus Gallus"* of O. Fabricius.

In his Fauna Groenlandica, 1780, p. 160 Fabricius includes *Zeus Gallus* L. among the fishes of Greenland, stating: "To this, I believe, may be referred the fish which the Greenlanders call *Kollivsiuternak* to which they ascribe 4 very long threads, 2 in front and 2 behind, and which I have never succeeded in finding, as it is very rare in the waters of Greenland".

In his review of "Fabricii Fortegnelse over de grønlandske Fiskearter" (K. D. Vidensk. Selsk. naturvidensk. og mathem. Afh., VII, 1838) J. Reinhardt writes: "That *Zeus Gallus* should occur in the Greenland seas is extremely improbable" (p. 110) and in noting the species without serial number and placing it in brackets (p. 107) he indicates that this tropical fish[3]) should be excluded from the list of Greenland fishes, without however another being known to put in its place (cf. the remark uppermost p. 106).

In Reinhardt's collection of letters preserved in the Zoological Museum, however, there is one written to him by the missionary J. F. Jørgensen and dated Julianehaab July 6th 1840, in which among other things the following information is given regarding the *Kollivsiuternak* of the Greenlanders: "In the same bottle there are two eggs of a ray. The Greenlanders have taken them from the stomach of a couple of sharks and curiously

[1]) The cited figure in "Oceanic Ichthyology" gives in so far an erroneous picture of *R. granulata*, as it only shows the large spines on the tail, but not those on the mid line of the back, at the eyes or on the shoulder.

[2]) *Raja granulata* is described as also having small spines on the belly, but this is incorrect; the specimen I have had the opportunity to examine was perfectly smooth on the under side, as was indeed to be expected.

[3]) *Zeus gallus* L. = *Caranx gallus* (Red Sea and Indian Ocean).

enough they give this animal, as they call it, the name *Kollivsiuternak*, and it has undoubtedly been this form, which the Greenlanders had in mind, when they led FABRICIUS to set up *Zeus Gallus* (Fauna Groenl. Nr. 116). Some Greenlanders give this ray egg the name *Kanalik*".

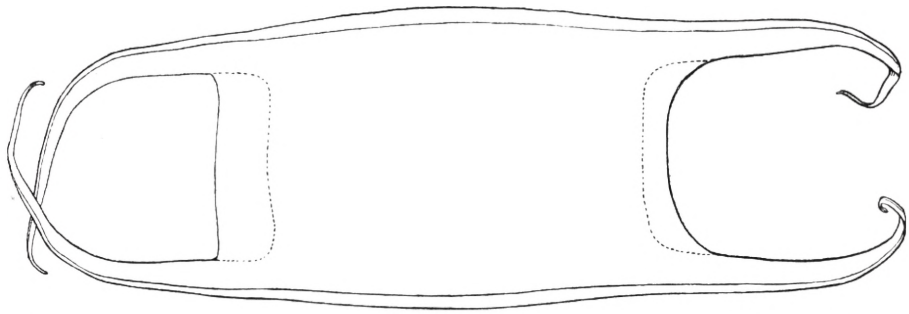


Fig. 10. Sketch of the egg-case of a large species of *Raja* (*spinicauda*?) from Julianehaab district, reduced (1/2). It was undoubtedly the "fish" which the Greenlanders called "*Kollivsiuternak*" and which FABRICIUS recorded, from their descriptions, as "*Zeus Gallus*".

This equally surprising and striking interpretation was undoubtedly known to KRØYER, when he wrote in his work "Danmarks Fiske" (III, 1852—53, p. 958, note **), that it was the egg-capsule of a large species of ray, which the Greenlanders referred to by the name *Kollivsiuternak* and which FABRICIUS records in his fauna with the systematic name *Zeus Gallus*.

Fig. 11. In the middle a piece of a dried egg-case of *Raja spinicauda*?, magnified (6/1) to show the spinous structure of the capsule-wall. To the side are represented some of the denticulated spines with which the case is densely covered, magnified 10/1.

KRØYER was aware, that the egg-capsules in question could not belong to the only species of ray known from Greenland at that time (*Raja radiata*), and he imagined that they were of *Raja batis*.

The two egg-capsules referred to are still preserved in the Zoological Museum; one of them is represented in fig. 10. In the dried condition they are ca. 115 mm long without the threads and ca. 80 mm broad and have a remarkable structure; the longitudinal

ribs are densely beset with small stiff rods serrated at the tip and ca. 2 mm in length, so that the capsule has a velvety appearance (fig. 11). Lütken put forward the suggestion, that they perhaps belonged to *Raja fyllae* (Vidensk. Meddel. Naturhist. Foren. 1887, p. 4), but this has later proved to be a small species. For my part I am inclined to believe, that these large egg-capsules belong to *Raja spinicauda* discovered by the "Tjalfe" Expedition, which is indeed a species of considerable dimensions and which occurs just in the district (Julianehaab), from which the missionary Jørgensen forwarded the capsules.

On the other hand, it is not only the egg-capsules of the present species, but also the comparatively common capsules of *Raja radiata*, which have given rise to the Greenlanders' "*Kollivsiuternak*" and the *Zeus Gallus* of Fabricius. In a letter of 30th September 1841 the above-mentioned missionary Jørgensen writes to J. Reinhardt: "I have convinced myself, that the Greenlanders at Frederikshaab also call a ray egg "*Kollivsiuternak*" and have no doubt therefore, that Fabricius has been misled by their description to record *Zeus Gallus* as a fish of Greenland". But at Frederikshaab, so far as I know, no other ray occurs but *Raja radiata.*

The distribution of some Greenlandic Selachians elucidated by the hydrographical conditions.

It is well-known, that the broad arms of the sea which extend up between Greenland—Iceland—the Faeroes—Shetlands and which connect the Norwegian Sea with the Northern Atlantic, are cut across at a certain depth by submarine ridges. Thus, almost in the middle of the Denmark Strait between Greenland and Iceland (at 66° N. L.) there is a submarine ridge, which at its shallowest part lies quite 300 fm. under the surface. Between East Iceland and the Faeroes there rises a broad ridge in a depth of about 250 fm.; its shallowest part, N. W. of the Faeroes, lies not more than ca. 275 fm. below the surface. From the Faeroes this ridge is continued as the narrow, so-called Wyville-Thomson ridge, with a maximum depth of 330 fm., towards the Hebrides and is connected with the large plateau which forms the bottom of the North Sea.

The depths of the ocean north of these ridges are thus completely separated from the depths of the Atlantic and it is only in the uppermost 300 fm. that there can be an exchange of water-masses between them. The ridges thus constitute the dividing line between two kinds of bottom-water: north of the ridges below ca. 300 fm. there is always cold water characterised by low temperatures, below 0° C. (down to

— 1.3° C.), whereas the southern slope of the ridge is washed by Atlantic water with positive temperatures.

It will thus be natural to extend the "Deep Norwegian Basin" as far to the south as the ice-cold bottom-water reaches, thus almost to the place where the 300 fm. line touches the northern slope of these ridges and the banks which they connect. If we now draw a line on the chart (cf. fig. 12) along this level, its course will be as follows: from East Greenland over towards North-west Iceland, north round this island towards the northern slope of the Faeroes, whereafter it bends to the south and forms a curve down into the channel between the Faeroes and Shetland, then north round Shetland over towards Norway, where it joins the slope from the coastal banks almost opposite Stat.

We find similar conditions along the west of Norway; here there is a bank which taken as a whole slopes gradually outwards from the land until at a varying distance from the coast of from 40 to 200 kilom. it dips down into the depths with a more abrupt slope called "Eggen". Ice-cold water lies against this "Edge" at a depth greater than 300 fm., whereas the over-lying, warmer Gulf Stream water spreads out over the coastal banks. Thus on this side also the cold bottom-water (Deep Norwegian Basin) follows nearly the curve for 300 fms. depth, from the level of Stat up along the coast of Norway first in a northerly direction, then towards the north-east until the Norwegian Basin almost at 70° N. L. bends away from Norway, the banks here widening out and forming the bottom of the Barents Sea, whilst the "Edge" and the adjoining, ice-cold Norwegian Basin continue westward round Bear Island in an almost straight line northwards to the west side of Spitsbergen[1]) (cf. fig. 12).

The "Deep Norwegian Basin" is thus taken to mean the ocean depths which lie below the 300 fm. line, abutting in the east the Spitsbergen—Norway "Edge", in the south the Shetland—Faeroes—Iceland—Greenland ridge, in the west the coast of Greenland; this deep basin has everywhere water with negative temperatures down to the bottom (in the north-eastern part from Lofoten to Spitsbergen however the warm water extends somewhat deeper down, to about 400 fm.)[2]).

On an earlier occasion the present author[3]) has discussed the quantitative and

[1]) A detailed description of the physical and hydrographical conditions outlined here will be found in the fundamental work of H. MOHN: The North Ocean. Its Depths, Temperature and Circulation (The Norwegian North-Atlantic Expedition). 1887. See also the more recent work of BJÖRN HELLAND-HANSEN and FRIDTJOF NANSEN: The Norwegian Sea. Rep. on Norwegian Fishery and Marine Invest., II, No. 2, 1909.

[2]) BJÖRN HELLAND-HANSEN and FRIDTJOF NANSEN: The Sea West of Spitsbergen. Videnskapsselsk. Skrifter. I. Mat.-naturv. Klasse, No. 12, 1912.

[3]) AD. S. JENSEN: On the fish-otoliths in the bottom-deposits of the sea. I. Meddel. fra Kommiss. for Havundersøgelser. Serie: Fiskeri. Bd. I, Nr. 7. 1905.

qualitative composition of the fish fauna of this deep basin. It is very poor as regards the number of species. From the Shetland—Faeroe channel up to the height of Spitsbergen the trawl constantly brings up the same forms in tedious monotony; if we include all the species, both the common and the rare, the number is only 23. They are distributed among the following groups:

Sea-scorpions:

Cottunculus microps Collett
* — *subspinosus* Jensen
Artediellus uncinatus Reinhardt
Agonus decagonus Bloch-Schneider

Liparids:

Liparis Fabricii Krøyer
Careproctus Reinhardti Krøyer
* — *micropus* Günther
**Paraliparis bathybii* Collett
**Rhodichthys regina* Collett

Lycodes:

**Lycodes frigidus* Collett
— *Esmarkii* Collett
— *eudipleurostictus* Jensen
— *pallidus* Collett

Lycodes:

**Lycodes platyrhinus* Jensen
* — *Lütkeni* Collett
— *seminudus* Reinhardt
**Lycenchelys muræna* Collett
**Lycodonus flagellicauda* Jensen

Gadoids:

Onus Reinhardti Krøyer

Flat-fish:

Platysomatichthys hippoglossoides Walbaum

Sharks:

Somniosus microcephalus Bloch-Schneider

Rays:

Raja radiata Donovan
— *hyperborea* Collett

The 9 species marked with an asterisk must be regarded as characteristic of the Deep Norwegian Basin[1]), being a part of the special fauna of this deep basin and not known from any other region of the sea. In my "Ichthyologiske Studier"[2]) I have shown, namely, that the statement of the presence of some of these species (*Lycodes frigidus*, *Lycenchelys muræna*) in the warm Deep Atlantic Basin (i. e. south of the above-mentioned ridge between Europe and Greenland) arose from erroneous determinations, as also the reverse statement that a species described from the Deep Atlantic Basin (*Cottunculus inermis* Vaillant) may occur in the cold Deep Norwegian Basin. The remaining 14 species do not have their proper home in the Deep Norwegian Basin; they are for the most part arctic fish which in the high north live in shallower depths,

[1]) It should be expressly remarked, that by the "Deep Norwegian Basin" is understood only the region of the Norwegian Sea which lies 300 fathoms and more below the surface of the sea.
[2]) Vidensk. Meddel. fra Naturhist. Foren. i København, 1901, pp. 191—215.

in part even in shallow water; they penetrate with decreasing frequency into the upper part of the Deep Norwegian Basin.

Of the Greenland rays mentioned in the list *Raja hyperborea* occurs everywhere in the Deep Norwegian Basin; here it goes down into some of the greatest depths where trawling has ever been carried on (1309 fm.) and upwards the boundary of its distribution coincides with the boundary layer between the cold polar water and the overlying warm Gulf Stream water (cf. Chart fig. 12)[1]).

When I wrote my paper cited above I included *Raja hyperborea* among the special forms of the Deep Norwegian Basin, as at that time it was only known from the depths of the Norwegian Sea. In the interval howewer it has been found by the Russian investigations in the eastern Barents Sea[2]), which is in itself not surprising, as this region has ice-cold water at the bottom (cf. Chart fig. 12).

Returning now to West Greenland it will be recalled, that *Raja hyperborea* proved to be common in the northern part of colonized Greenland, namely from the northern part of Disko Bay up to Upernivik (cf. Chart fig. 12). This occurrence was also unknown, when I wrote the paper mentioned, but if we consider the hydrographical conditions this discovery is not surprising either. The arm of the sea, which separates Greenland from northern America, like the arms between Greenland and Europe, is divided into two basins distinct in hydrographical regards by a ridge, which lies ca. 250—300 fathoms under the surface and extends right across the Davis Strait almost at 67° N. L., namely: (1) the southern part of Davis Strait up to the ridge between Greenland and Baffins Land, which is filled from the bottom and upwards to a depth of ca. 100 fm. below the surface with Atlantic water with high temperatures (ca. 2,5°—5° C.); (2) the northern part of Davis Strait, north of the ridge mentioned, and Baffins Bay, where the bottom-water at the greatest depths has temperatures below 0° C.[3]) (nearest the Greenland coast however, in depths of ca. 150—350 fm., we find a mixed product, with temperatures of about 1° C., of polar water and warm

[1]) The occurrences marked on this chart are based on the results of the expeditions with "Vøringen", the "Triton", "Ingolf", "Michael Sars" and "Thor". On the cruise of the "Michael Sars" in 1902 I had the opportunity, thanks to the kindness of Dr. JOHAN HJORT, of making personal observations and can thus guarantee, that on this expedition *R. hyperborea* was exclusively taken on the sea-bottom with negative temperatures, though R. COLLETT in his elaboration of a part of the fish material from this expedition states that *R. hyperborea* was also taken where the bottom temperature was positive. Unfortunately several errors of a similar, regrettable kind have slipped into COLLETT's report (Rep. Norw. Fishery and Marine Invest., II, 1905, No. 3).

[2]) Exped. f. wissenschaftlich-praktische Untersuchungen an der Murman-Küste, I, 1902, von N. KNIPOWITSCH, pp. 426, 448, 466; Faune de la Russie, Poissons par L. S. BERG, vol. I, 1911, p. 103.

[3]) AXEL HAMBERG: Hydrografisk-kemiska Iakttagelser under den svenska Expeditionen til Grønland 1883. Bihang til Kgl. Svenska Vet. Akad. Handlingar, Bd. 9, No. 16, 1884 (p. 53).

Atlantic water flowing over the ridge). And just here in the northern basin *Raja hyperborea* has its home, the species that is only found north of the corresponding submarine ridge between Greenland and Europe.

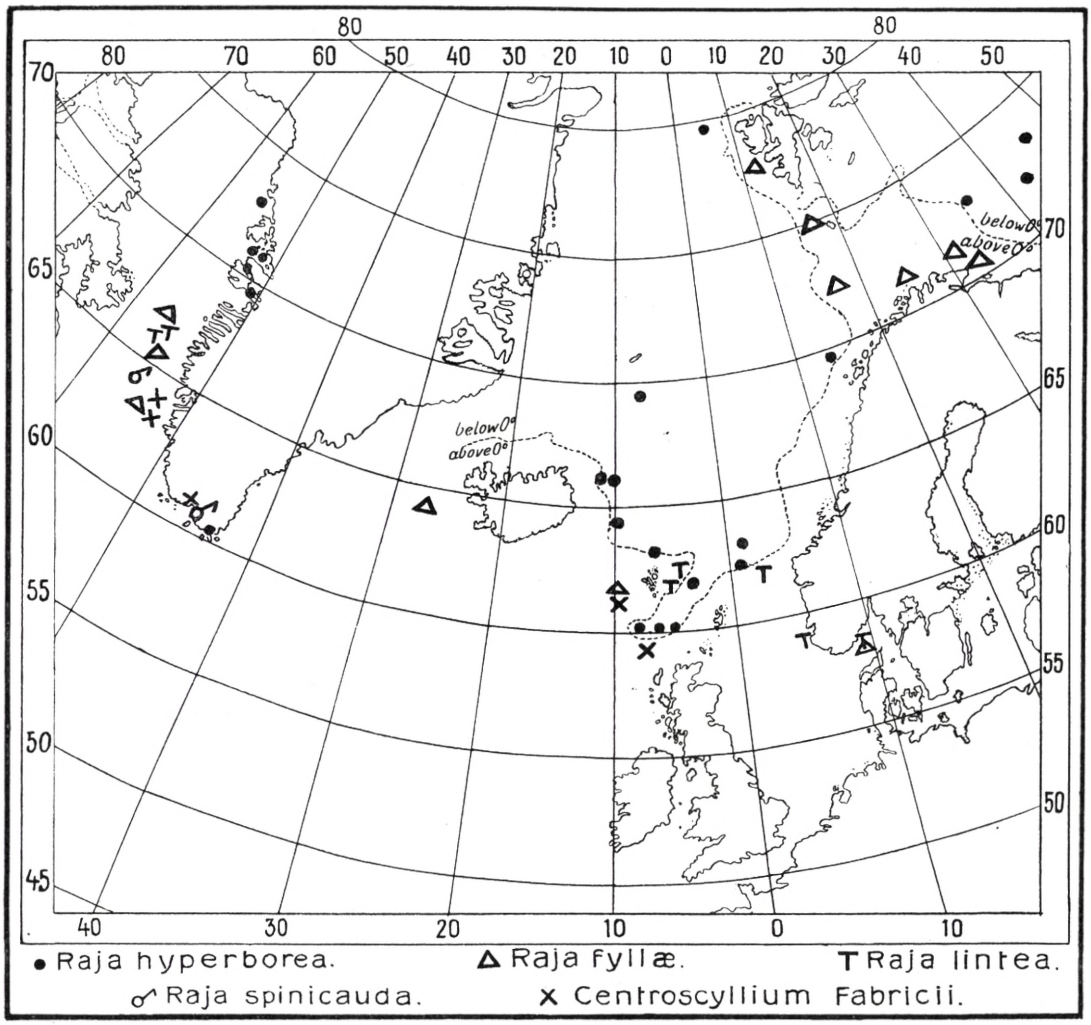


Fig. 12. Chart illustrating the distribution of the above-named Selachians in the seas between Europe–Greenland–America. The dotted line indicates the limit between bottom-water with degrees above and below zero.

But in addition to this northern occurrence at West Greenland *Raja hyperborea* has still another, namely in a fjord at the southernmost point of Greenland (at Nuk inside Ilua). This however is easily explained, since at the bottom of several deep fjords of West Greenland there is a water-layer with constant temperatures about 0° C., almost as in Baffins Bay. The fjord referred to is undoubtedly of this nature;

no temperature observations were made in it, but in two adjacent fjords (Sermilik east of Sermersok and Lichtenau Fjord) bottom-temperatures of respectively — 0.4° and 0.6° C. were found; thus, an arctic-abyssal species like *R. hyperborea* would easily be able to live in such a fjord.

Turning now from such a distinctly cold-water form like *Raja hyperborea* to the other Selachians occurring at West Greenland, we find among them some which in the sea between Greenland and Europe only occur inside the line forming the boundary between the two kinds of bottom-water. These species are *Raja fyllae*, *Raja lintea* and *Centroscyllium Fabricii*. As is seen clearly and distinctly from the Chart (fig. 12), these occur with respect to the hydrographic boundary line mentioned only on the opposite side to *R. hyperborea*. They may, as is the case with *Raja fyllae*, go almost as far north as *R. hyperborea*, right up to the west side of Spitsbergen, but they keep constantly to that part of the sea-bottom where the temperature is positive (ca. 3° C. and above), the so-called "warm area" of the Northern Ocean.

In good agreement with this these warm-water forms occur at West Greenland only in that part of the deep Davis Strait which lies south of the submarine ridge between Baffins Land and Greenland (cf. Chart fig. 12). They go right to the top of the ridge, but not beyond it.

But along with this occurrence in the warm water of the Davis Strait some of these species have still another, as they have been taken by the "Tjalfe" Expedition in the fjord region of the northern part of the Julianehaab district, namely in Brede Fjord and Skov Fjord. This is the case with *Centroscyllium Fabricii* and *Raja spinicauda*, the latter having been taken on the Atlantic side of the ridge in the Davis Strait (and undoubtedly will also be found in future at other places in the Atlantic). The reason for the occurrence of these Selachians in the West Greenland fjords mentioned is, that their hydrographical conditions, so far as the deeper water-layers are concerned, agree precisely with those obtaining in the southern Davis Strait, as will be seen from a comparison of the following temperature observations:

Brede Fjord		Davis Strait (63° 48′ N., 53° 12′ W.)	
Depth in fathoms	Temperature	Depth in fathoms	Temperature
0	3.9° C.	0	0.3° C.
50	— 0.2 -	50	0.1 -
100	3.2 -	100	1.4 -
200	3.7 -	200	3.5 -
350	3.6 -	350	4.1 -
		700	3.7 -

Brede Fjord thus forms in hydrographical regards a contrast to the above-mentioned "cold" fjords; the reason for this must certainly be, that the mouth of Brede Fjord is so deep, that it allows a direct inflow of the warm water-layers from the Davis Strait, whilst the "cold" fjords in West Greenland are separated by barriers from the warm water in the Davis Strait[1]).

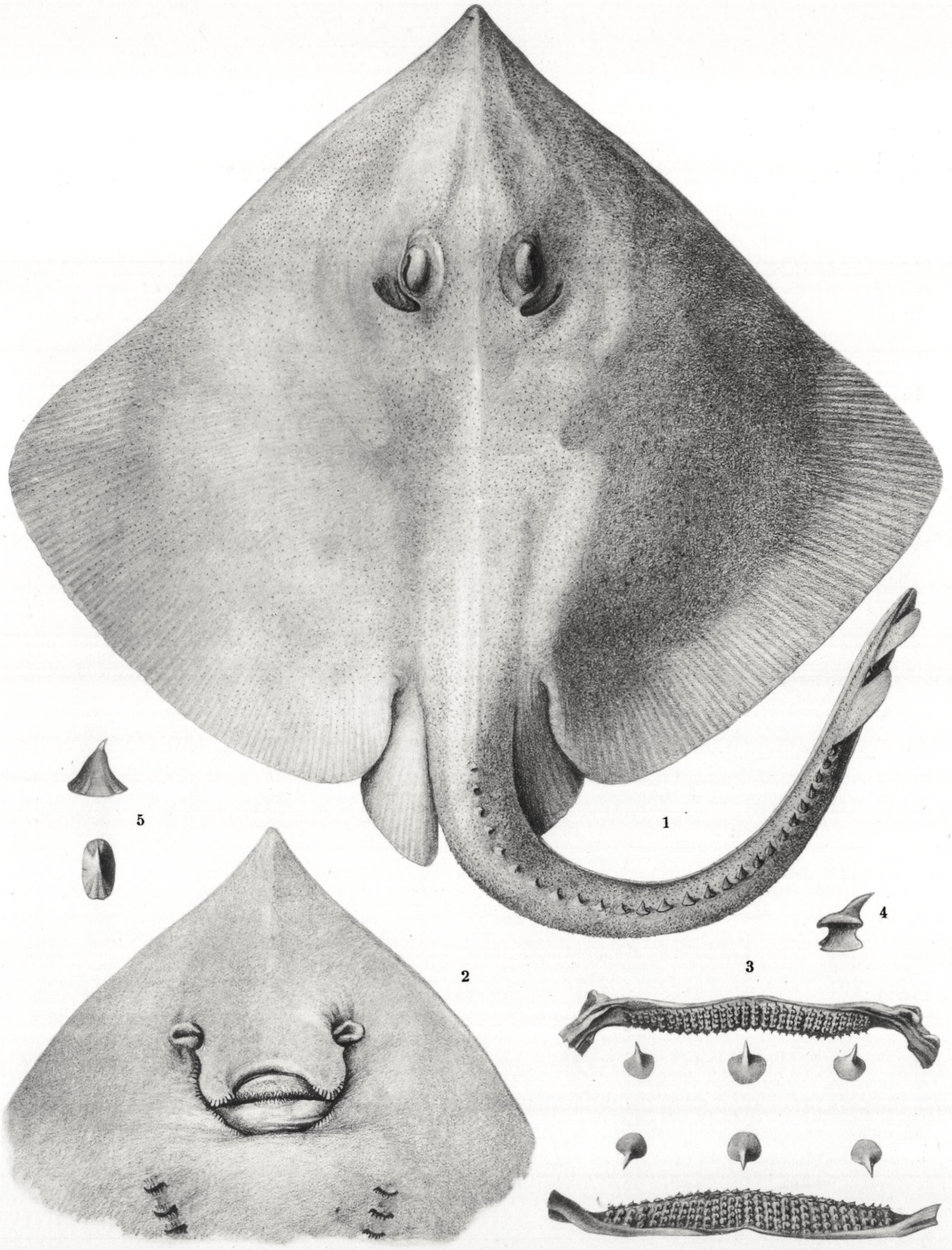
As main result of the above considerations we can thus state, that the distribution of the Selachians mentioned is not at all determined by the geographical latitude, but is in the closest connection with the bottom-temperature.

[1]) For the hydrography of West Greenland cf. the preliminary report of the hydrographer of the "Tjalfe" Expedition, Dr. J. N. Nielsen, published in: Beretninger og Kundgørelser vedrørende Kolonierne i Grønland, 1909, No. 2, pp. 24—27 and No. 5, pp. 34—38.

EXPLANATION OF PLATE

Raja spinicauda n. sp.

Fig. 1. A female specimen, 740 mm long, from Davis Strait (61° 14′ N. 55° 55′ W.), 440 fm.
— 2. The anterior part of the disc of the same specimen, from below.
— 3. Dentition of a female specimen from the inner side of jaws and reduced (ca. 1/2); the separate teeth magnified 2 diameters. From a specimen, 1390 mm long, from the northern part of Julianehaab district (mouth of Tunugdliarfik Fjord), 125—200 fm.
— 4. A tooth from the side, × 3 1/2.
— 5. One of the large spines from the upper side of the tail, seen from the side and from above, × 1 2/3.



H. V. Westergaard del. *Raja spinicauda* n. sp. *Pacht & Crone phototyp.*