

MEDDELELSE FRA TRONDHJEMS BIOLOGISKE STATION NR. 10

CONTRIBUTIONS

TO

THE LIFE HISTORY OF THE FISHES IN TRONDHJEM FJORD
AND ENVIRONS

BY

O. NORDGAARD

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DET KGL. NORSKE VIDENSKABERS SELSKABS SKRIFTER 1915. NR. 9

AKTIETRYKKERIET I TRONDHJEM
1917

The principal sources of information as to the fishfauna of Trondhjem Fjord are:

V. STORM: Bidrag til Kundskab om Trondhjemsfjordens Fauna, V. (Fiske) D. kgl. n. vid. selsk. skr. 1883.

KNUT DAHL: Beretning om Fiskeriundersøgelser i og om Trondhjemsfjorden 1898. D. kgl. n. vid. selsk. skr. 1898, nr. 10.

GUST. SWENANDER: Bidrag till kännedomen om Trondhjemsfjordens fiskar. D. kgl. n. vid. selsk. skr. 1905, nr. 9.

Dr. SWENANDER gives 118 species of fish; his list, however, includes some few not recorded with certainty as having been found in Trondhjem Fjord itself. In point of number, the present writer will naturally have but little to add, albeit since 1905 some further finds have been made, and species brought to light which are new to the fauna of the fjord. The following pages will be mainly devoted to placing on record observations concerning species already known. The work already done by previous investigators in this field is both extensive and valuable; it was nevertheless desirable that the ichthyological study of these waters should be continued, among other reasons on account of the economical importance of the fishery.

As regards terminology, I have in the main adhered to that employed by COLLETT in his latest »Meddelelser om Norges fiske«. The English names are those given in the Catalogue (II Ed.) issued by the International Commission for Investigation of the Sea (Cons. perm. intern. pour l'explor. de la mer, Publ. de Circonstance, no. 12, Copenhagen 1914). For the Norwegian, I have used the local terms in general use among the fishermen.

Sparus centrodonatus DE LA ROCHE.

In an earlier work by the present writer, on ocean currents and the Norwegian marine fauna (D. kgl. n. vid. selsk. skr. 1914, nr. 5, p. 21) will be found some information as to the occurrence of this species, which has of late years been not infrequently encountered along the coast outside the Trondhjem Fjord. It may now further be noted as occurring in the fjord itself, a specimen having been taken in a salmon seine at Malvik on the $\frac{6}{8}$ 1913. This was a ♀, length 42.7 cm., with fairly large ovaries. Another ♀ of the same species, measuring 46 cm. was taken on the $\frac{24}{3}$ 1914 off Røberg. There were small eggs in the ovaries; only an indeterminable mass in the stomach. In the same year, 1914, a ♂ l. 41.5 cm., was taken on a hand line baited with mussels at 60 metres depth, in Frøyfjord ($\frac{15}{8}$ 1914). On the $\frac{20}{8}$ 1914, a ♀ l. 45 cm., was taken at Sauøen, Froan, likewise on a line. The ovaries were empty. The species may also occur in the fjord in midwinter; on the $\frac{6}{1}$ 1915 a specimen was sent in which had been netted in Hevnefjord. COLLETT regards it as doubtful whether this species spawns on the coasts of Norway; as, however, the finds made in 1914 include both specimens with full and with empty ovaries, it would seem probable that they did spawn here at any rate during the mentioned year, and spawning should then, according to our observations, have taken place during summer, apparently for the most part in July.

This species is often called by the fishermen »sølvuer«.

Triglops pingelii REINH.

As in the case of *Sparus centrodonatus*, we can now with certainly record *Triglops pingelii* as having been observed in Trondhjem Fjord. I have examined a ♀ taken in the fjord in September 1909. Total length 12 cm., eggs in the ovaries very small, rudimentary penis papilla, nothing in stomach. On the $\frac{18}{5}$ 1910, a ♂ l. 10.2 cm., with well-developed testes and large penis papilla, was taken at the Trondhjem Biological Station. Nothing in stomach; intestine filled with a greenish-grey mass.

Each of these specimens had four large dark spots down back and sides, and dark cross stripes in the anal fin.

Agonus cataphractus LIN.

A ♀, l. 17.5 cm., »full« i. e. with roe mature, and ready to spawn, was taken in a cod trap outside the Biological Station at Hegdalen, on the $\frac{1}{4}$ 1908.

Callionymus lyra LIN.

Specimens of this species (dragonet; Norwegian: »fløifisk«) have of late years been taken at various places in and outside Trondhjem Fjord. On the $\frac{17}{7}$ 1915, a ♂ in mating dress l. 26 cm. was taken in the inner portion of Strømfjord, at Hittra, in a trout net, in 3 fathoms of water. I have also examined a ♀ l. 10.2 cm., taken in Beitstadfjord Sept. 1899, and a ♀ l. 10.5 cm., taken at Steinvikholmen $\frac{20}{6}$ 1898, also a ♀ l. 12 cm., taken at Venneshavn $\frac{29}{5}$ 1899. In the last-named specimen, the eggs were fairly large. A male and two females were taken in an eel seine near the Biological Station at the beginning of May 1915. They were placed in an aquarium, where I had an opportunity of observing the behaviour of the male during mating time. These observations extended over the period from 20 to 30 June 1915. As far as I could see, the male kept to the one female, which would seem to indicate seasonal selection. For the most part, I found the male and female lying resting on the bottom, or taking up a vertical rest position against the walls of the tank. While resting, the dorsal fins were folded down, as also the caudal. The hinder part of the body lay touching the bottom, the forepart slightly raised, the fish here supporting itself by the extreme edge of the ventral fins and the pectorals, which were laid rearwards along the body, with the lower edge curving in under the laterally extended ventral fins. In the vertical rest position, the points of the ventral and anal fins grip on to any irregularities in the supporting surface, the pectoral fins being at the same time kept in motion to maintain equilibrium. While swimming also, the dorsal fins were kept folded down. The ventral fins were extended, as also the anal and caudal fins, but the actual natatory movement was accomplished by means of the large pectorals, the extreme margins of which moved with an undulating motion. The »courting«, as carried out by the male consisted of an almost continuous rolling of the magnificent eyes, the fine dorsal fins being also occasionally unfolded. When moving the eyes, the eye balls were turned simultaneously either to right or left, the longitudinal axes being thus as a rule parallel, the movement being accompanied by a

splendid play of colour in green and blue. The female also rolled her eyes somewhat; these are, however, far less beautiful than those of the male, and lack the peculiar play of colour. The mating dress of the male is throughout extremely fine. The head and gill covers are marked with thick curved blue stripes, and solid spots of the same colour. The ventral fins are also decked with blue, having spots near the base, and farther out, a series of straight blue lines along the fin rays. There were two blue stripes along the sides of the body. There are also blue spots at the base of the pectoral fins, and the caudal is gorgeously ornamented with thick blue stripes running longitudinally. There is often a yellowish tone observable between the blues. An important factor in the courting process is the second dorsal fin, or »vane«, which in the case of the male is so long as to reach, when at rest or folded down, as far as the middle of the caudal fin. The extreme portion could at times be seen lying beside the body. While the female was lying at rest on the bottom, the male would from time to time take a swim up to the surface, now and again unfolding its dorsal fins when nearing the female. The female would frequently appear unmoved by this display, but might occasionally be persuaded to take a short swim side by side with the male, up to the surface of the water. At times also, the female would herself stretch out her second dorsal and caudal fins, showing the greyish-brown patterns in the same. Only once did I observe the female showing her first dorsal fin, which had a characteristic black triangle in the pennant-shaped tip. Altogether, it was a remarkable system of signals which was called into play between the mating pair. The end of June appears to be the height of the mating season for this species in Trondhjem Fjord.

Cyclopterus lumpus LIN.

Dr. SWENANDER gives the spawning season for this species (lumpsucker; Norwegian: »rognkjeks«) in Trondhjem Fjord as from April to June inclusive, but spawning can also take place later in the summer. I have found young fry in their first year at various places, especially on *Laminaria*, throughout the summer, and have thus been able to form some opinion as to the stage at which the spinous protuberances of the skin commence to appear. I give here the following measurements:

²⁶/₁₀ 1907, Fagernes, Borgenfjord, 4—13 m. 1 young fish, 18 mm. smooth.

²⁷/₇ 1909, Lønnemsleiret, Borgenfjord, 0,5—2 m. 1 spec. l. 15 mm. smooth; 1 spec. l. 20 mm. incipient protuberance formation.

- 27/7 1909, Korsenleiret, Borgenfjord, 1—2 m. 3 spec. l. 16—19 mm. smooth.
- 30/7 1909, Rolshavn, Borgenfjord, 0—10 m. 1 spec. l. 20 mm. incipient formation; 1 spec. l. 28 mm. several rows of protuberance developed.
- 18/8 1909, Hestnessund, Hittra, 1 spec. l. 21 mm. smooth.
- 13/9 1909, Talgøra, near Strømmen, 1 spec. taken from the stomach of a 20 cm. long cod, l. 20 mm. smooth.
- 1/9 1910, Rolsøya, Borgenfjord, 1 spec. l. 26 mm. rows of protuberances developed.

It would thus seem that the protuberances of the skin commence to make their appearance at a length of about 20 mm. while at a length of 26—28 mm. several rows are developed.

Lumpenus lampretiformis WALB.

This species has only once previously been observed in the fjord, V. STORM having found it in the stomach of cod. It would thus appear to belong to the rarest species in the fjord. I have, however, examined 3 specimens. Two were from Muruviken, 17/2 1914, l. 21.2 and 21.8 cm., length of head 1/8—1/9 total length. One was a female with very small eggs. The ventricles contained remains of annelida and cumacea, with some few foraminifera. A young specimen, l. 61 mm. was also taken during dredging operations at Beitstadhoøy, 3/7 1915.

Lumpenus maculatus FRIES.

This species is new to Trondhjem Fjord, and there are altogether but few records of its occurrence in Norwegian waters. One specimen was taken on the 10/3 1910 in the fjord near Sundnes, (snurrevad, depth 80 metres). The specimen was a ♀ l. 104 mm., head about 1/6 of total length. Ovaries small, nothing determinable in stomach or intestine. Brownish spots on the sides, both above and below the lateral line. Cross stripes of the same colour running obliquely over the dorsal fin; three vertical cross stripes on the caudal. We also found two specimens of the same species in Muruviken 17/2 1914, together with *L. lampretiformis*. Both were females, total length 13.4 cm. Head abt. 1/6 total length. Very small eggs in the ovaries; remains of annelida in the ventricles. Colour patterns in the two species very much alike, *L. maculatus*, however, having 3—4 cross stripes in the caudal fin, which were lacking in *L. lampretiformis*.

Chirolophis galerita LIN.

This species, the crested blenny, is likewise one of the rarest in the fjord. We took a ♂ l. 8 cm. in Skarnsund, at a depth of abt. 100 m. on the 25/9 1908. Nothing determinable in stomach.

Zoarces viviparus LIN.

I have examined several specimens of the viviparous blenny (Norw.: »aalekone«) from different places in the fjord. One individual, taken by KNUT DAHL at Sundnes ^{27/5} 1899, had a total length of 6.9 cm. The stomach was stuffed full of bottom copepoda. In two specimens from Garten ^{11/8} 1899, 1. 9 and 9.4 cm., the contents of stomach consisted of insect larvæ. One specimen taken at Lensviken ^{20/9} 1904 by SWENANDER, 1. 8.5 cm. had remainder of copepoda in the stomach. Another, also taken by SWENANDER, at Hegdalen, ^{8/9} 1904, 1. 9.5 cm., had amphipoda in the ventricle. From a female taken at Rissa, 1. 31.5 cm., on the ^{5/10} 1906, I took 110 young fry of abt. 3.5 cm. length, and with large yolk sac. The largest number of young fry found by SWENANDER in the viviparous blenny in Trondhjem Fjord is 70. It is now evident that the number may exceed 100. One young specimen taken at the mouth of the Gula ^{23/7} 1907, measured 8.2 cm. and would doubtless have been spawned in the autumn of 1906. The Trondhjem Fishery Company sent me a specimen of viviparous blenny taken in a prawn trawl in Trondhjem Fjord in October 1910. It was a ♀ 1. 12.8 cm. Remains of a mussel in the stomach. Ventral cavity greatly distended with eggs. There were 17 large eggs, slightly deformed, but the diameter would be abt. 6—6.5 mm. In addition, there were a number of smaller eggs, abt. ^{1/2} mm. diameter. The species would thus appear to reach maturity, at any rate, in some cases, at a length of abt. 13 cm. SWENANDER states that the species doubtless spawns occasionally in the second year of life, but that spawning takes place as a rule in the third.

Both young and adult stages of *Zoarces* appear to evince a preference in point of food for crustacea. I have, however, on one occasion found remains of a mussel in the stomach.

Trachypterus arcticus BRÜNN.

As far as we know, no specimen of this species (dealfish; Norw.: »sølykveite«) has ever been observed in Trondhjem Fjord before the 1 Sept. 1906. A female was washed ashore on that date at Gjeitestranden. Length 190 cm. Otoliths of fish in the ventricle. The fish collection was then under the charge of V. STORM, but I was able to take out the bilobate ovary, of which a photographic reproduction is here given (fig. 1). The total length of the ovary was abt. 45 cm. The lobes and remainder of the ovary were nearly cylindrical. The lobes were of unequal size, the longer measuring 23 cm. in length, with a diameter of abt. 3 cm.; the shorter 20.5 cm. long and 2 cm. diam. A quantity of eggs, varying in size from 0.5 to 1

mm. in diameter. Judging from the development of the eggs, spawning should have taken place either in September or October. The eggs are probably bathypelagic.

On the $\frac{3}{2}$ 1916, a dealfish was taken at Hegaasen, in Dolmsundet, Hitra, by the fishermen INGEBRET BEØ and G. RAMSLI, of Hegaasen; the specimens was sent in to Trondhjem Museum. It was a ♂, total length 206 cm. I give the following particulars concerning this.

Colour: dark silvery on the left side, somewhat duller on the right side, which was scraped. No trace at all of neck rays. All fins blood-red. Iris greyish, with a silvery gleam, in a reddish circular setting. Small short spines along belly. Lateral line straight from about the eye to root of tail, with small, sharp, spines, curving over in a forward direction. Slightly larger spines on the lateral line near the tail, eight in number, and set symmetrically on both sides. At base of root of tail, on the ventral side, a somewhat larger spine. Length of head from point of snout to posterior margin of gill cover, 24 cm.



Fig. 1. Ovary of *T. arcticus* from Gjeitestränden, $\frac{1}{9}$ 1906.

Breadth of head, across posterior portion 7 cm. Height of head at same place 21.8 cm. Greatest height of body 34 cm. Do. of dorsal fin 10 cm. Diameter of ocular cavity 7.8 cm. Pupil aperture an irregular oval, longitudinal axis 4.15 cm. and transverse axis 2.7 cm. Length of caudal fin 14.6 cm. Minimal height of tail 1.4 cm. Tail somewhat expanded at the root, with a height of 2 cm. Distance from anus to point of snout 97.5 cm. Length of digestive tract abt. 88 cm. Length of stomach and gullet 51 cm. Length of intestine 45.5 cm. Gullet and stomach formed one continuous tick-walled tube, with no expansion in the stomach portion. Thickness 2.7 cm. Intestine thin-walled. Length of stomach appendix abt. 30 cm. Length of liver 46.5 cm., colour of same reddish brown, with a number of small grey spots. Contents of intestine a thin, fluid, yellowish-grey mass, without solid particles. No nutritive matter in stomach; in the lower portion, however, were found some round worms, which were determined by Professor L. A. JÄGERSKIÖLD as being *Ascaris larvæ*. No ektoparasites were observed.

As already mentioned, the specimen from Dolmsundet was

a male. The testes formed a fairly long chord, expanded in the central part, as shown in fig. 2. This chord was, for a length of abt. 36 cm. furnished with lobes and papillæ.

Some days after the finding of a *T. arcticus* in Dolmsundet, another specimen was driven on shore at Lerbotten in Altenfjord, Finmarken. On the $1\frac{1}{2}$ 1916, a fisherman, PEDER ESAISEN, observed a large fish abt. 10 metres out from land, at Lerbotten. The fish had a wound in the neck, but was still alive apparent, and had caught hold of the weed at the bottom with its jaws. The tail portion, however, was visible at the surface. So strong was its hold, that a hook had to be used to tear it away. The specimen was, by request, sent in to Trondhjem Museum for examination, and was found to be a male dealfish. Total length from point of snout to stump of

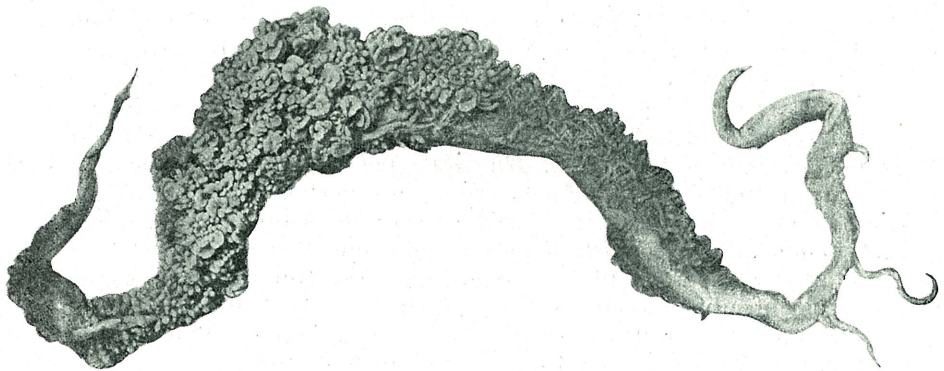


Fig. 2. Testes of *T. arcticus* from Dolmsundet, $\frac{3}{2}$ 1916.

tail (fin rays of the tail altogether lacking) was 211.5 cm. Colour worn off; best described as greyish white in both sides. Dorsal fin blood-red throughout its whole length. Pectoral fin discoloured. No neck rays. 7 fairly large spines on the lateral line near the tail. Maximal height of body 42.5 cm.; do. of dorsal fin 14 cm. Length of head from point of snout to posterior margin of gill cover 28 cm. Diameter of ocular cavity abt. 8 cm. Distance from anus to point of snout 113 cm. Length of digestive tract from beginning of gullet to anus 104 cm. Testes of same shape as in the specimen from Dolmsund. In neither case was there any indication of ventral fin rays, but a shallow furrow on either side of the median line marked the position of the ventral fins below and slightly in rear of the pectorals. In the specimen from Altenfjord, each of these shallow furrows was 12 mm. long.

Regalecus glesne ASCAN.

The banks car-fish, or ribbon-fish, (Norwegian: sildekonge, also called sildtust and sildstørje) is not known to have been observed in the Trondhjem Fjord itself. In the Annual Report of the Museum for 1911, V. STORM refers to an individual of this species washed ashore at Sørflatanger on the $25/3$ 1912. Only portions of the fish were sent in to the Museum, by Mr. FUGLAAR. Total length estimated at over 3 metres. The longitudinal »ribbons« were distinctly apparent.

Gadus callarias LIN.

In the case of the cod, I have made some few observations with regard to their food. In 33 small cod, taken at Ilsviken near Trondhjem on the $24/7$ 1908, ranging in length from 5—8.5 cm., most between 6—7 cm., the contents of stomach was found to be exclusively planktonic, consisting principally of *Cladocera*. One or two specimens of *Calanus finmarchicus* were also found. Three specimens from Muruviken $2/9$ 1912, l. 9—9.9 cm., contained remains of amphipoda and schizopoda. Cod taken at Tønne, in Borgenfjord $15/9$ 1909, l. 17—23 cm., had *Carcinus maenas*, *Crangon vulgaris*, *Hippolyte polaris*, *Idothea baltica*, etc. And in the stomach of cod from Sundneshavn $13/9$ 1909, l. 15—33 cm., the following species were determined: *Liparis* sp. *Crangon vulgaris*, *Mysis flexuosa* and some few amphipoda.

As an instance of abnormal spawning time may be quoted a cod of abt. 65 cm. taken on the $8/9$ 1913 by ANTON GUDMUNDSEN $1\frac{1}{2}$ miles outside Andstenen, Froan. The ovaries were 21 cm. long, and the roe was nearly ripe.

At Trondhjem Biological Station, a number of large cod are constantly kept in the aquarium, and I have there made notes as to the spawning time. On the $23/3$ 1912, general spawning. In 1913, spawning took place in the first week of March, but was also in progress later during that month, and even in April. In 1914, the cod began to spawn on the $14/3$ and continued throughout the rest of March, also in April. On the night of the 8th May likewise, a considerable amount of spawning took place. In 1915, spawning was first observed on the $10/3$. On the $18/4$, as also $1/5$ and $2/5$, a quantity of roe was noticed in the aquarium. In 1916, the first cod eggs were noticed on the $15/3$, but spawning was not then general. Not until the morning of the $22/3$ was any considerable quantity of eggs to be seen. A great deal of spawning also took place on the nights of $23/3$, $26/3$, and $27/3$, also on the nights of $16/4$, $18/4$, $19/4$, $22/4$ and $30/4$. In the first days of May also there was some spawning. The result of these observations may be summed up as follows:

Cod kept in the aquarium have during the last four or five years spawned chiefly in March and April, the spawning time extending, however, until near the 10th of May. This spawning time also agrees with the general spawning season of the cod in the fjord; which, according to SWENANDER, falls »during the months of March, April and May.« As in the case of the plaice, the spawning takes place for the most part at night.

The most important cod fishery in the fjord is that carried on in Verraffjord during the spawning season. As a matter of fact, however, cod fishing is carried on more or less throughout the whole extent of the fjord, right up to Stenkjær. There was a rich cod fishery in Stjørdalsfjord, for instance in January and February 1914. The fish, which were large and fat, were taken in nets, in quite shallow water. At the same time, a considerable net fishery was being carried on i Gulosen, likewise for cod. Drift nets, originally intended for salmon, were used with great success, being here employed as stake nets. The fish were

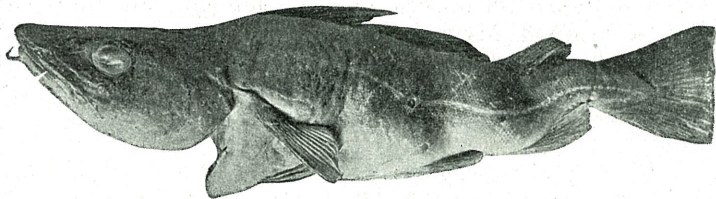


Fig. 3. Deformed cod from Stjørdalsfjord, 15/1 1915.

moving among the small herring, so the fishermen said. During November 1914 and later during the winter, there was good cod fishery in Stjørdalsfjord, though the fish were at first thin and poor. In the course of this fishery, a number of deformed specimens were taken, similar in appearance to that shown in fig. 3. The individual here shown was presented to me by Mr. JOH. FOSS, of Stjørdalen. The fish was 40 cm. long, distance from point of snout to posterior margin of gill cover 12 cm.

In May 1915 there was a rich cod fishery between Inderøya and Ytterøya. Some of the boats took from 80—90 kg. of fat cod in the space of three or four hours. The fish were taken on the snatch hook (pilk). There were at the same time, according to the fishermen, numbers of herring in the fjord.

It has been found, that beside the coalfish, (»storsei«) there are also cod on the coral banks in summer. During the summer of 1909, JOHAN ARNT KVERNVIK set out cod lines in Skarnsund abt. 6 fathoms from bottom, and caught a quantity of large cod.

There has for a long time been a lucrative fishery for coalfish during summer in the Skarnsund. Evidently, both cod and coalfish feed on certain animal forms which are to be found among the unusually rich colonies of coral here abounding.

Merlucius merlucius LIN.

Little is known as to the distribution of the hake (Norw.: »sølvlyr«) in this fjord. I have seen but a single specimen, a female, l. 90 cm., taken at Blaahammer (Hommelvik) on the ¹⁶/₉ 1913 by JOHN RAANES. The ovaries were empty.

Phycis blennioides BRÜNN.

This species (greater fork-beard; Norw.: »steinbrosme«) has been reckoned as belonging to the rarer fishes of the fjord; I have, however, of late years seen a few specimens taken there. On the ⁵/₂ 1915, a ♀ l. 54 cm. was taken on a line by JOHAN A. NORDBUEN, at Halten, in 100 fathoms. Immature eggs in the ovaries. Remains of crustacea in the stomach. On the ²⁸/₁ 1915, a fisherman named MYHRE took a ♀ of the same species in Munkholmdyb, l. 50 cm. Ovaries quite small. On the ²⁸/₄ 1916, in the deep between Frosta and Leksviken, a ♀ l. 63 cm. with empty ovaries was taken.

Molva molva LIN.

The ling, called by the Trondhjem fishermen »long« or »graalong«, is quite commonly taken on the deepsea line at various places in the fjord. V. STORM states that the largest specimens from the fjord run to a length of 170 cm. I have only once seen a specimen of this size. On the ¹⁶/₄ 1910 a female of the species was taken at Røberg, total length 170 cm. Maximal circumference 74 cm., total weight 27 kg., weight of roe 3.6 kg., weight of liver 2 kg. The roe was firm, but the eggs large.

On the ¹⁵/₅ 1916, Dr. HJ. BROCH, on the fish market in Ravnkloa, saw a ling which had been taken at Vanvik. Its total length was 162 cm.

Molva dipterygia PENN.

This species (trade ling; Norw.: »blaalange« and »bjerkelange«) likewise belongs to those taken on the long line. On the ²⁷/₁₁ 1907, at Ambornes, Leksvikstrand, we caught three specimens, together with various other deep water fish, on a set of lines baited with slightly salted herring. An old man at Lauvtangen, Aasen, informed me that as late as 1850 or thereabouts the trade ling was in his village considered as uneatable. Like

so many other deep-water species, this fish also furnishes its tribute to the food of the shark. On the $4/11$ 1907, a Greenland shark, ♀, l. 245 cm., was taken in Munkholmdyb, with remains of *Molva dipterygia* in the ventricle.

Raniceps raninus LIN.

The lesser fork-beard (Norw.: »paddetorsk«) seems also to be of rare occurrence on the Trondhjem Fjord. A specimen was taken at Ladehammer on the $2/4$ 1910 and placed in an aquarium. At the end of May, it took a herring, which it was three days digesting, the herring partly protruding from its mouth during that time. On the $6/11$ 1914 another specimen was taken at Strindland. This was a ♂, l. 24.5 cm. with sperma running. Nothing determinable in the stomach.

Coryphæoides (Macrurus) rupestris GUNN.

This species (Norw.: »butnæse«) is one of those frequently taken on lines in the deep channels and depressions of the fjord. It goes right up as far as Beitstadfjord; a specimen 1 metre long was taken just before Christmas 1915 in a net 1000 metres S.W. of Vaggen. I have from time to time seen quite a number of specimens brought in from Munkholmdyb. In the ventricle of *Coryphæoides* from this water taken on the $18/4$ 1916, I found several specimens of *Pasiphæa multidentata* ESMARK (this *Pasiphæa* had a wedgescaped upright rostrum, and must thus be *multidentata*. Vide O. SUNDT, The glass shrimps in northern waters; Bergens Museums Aarbog 1912 No. 6) including a few females with roe. There were also several *Meganyctiphanes norvegica* M. SÆRS, as also *Parathemisto oblivia* KRØYER. I have previously found *Parathemisto* in the ventricle of Lofoten »skrei« (i. e. cod which have attained maturity; vide JOHAN HJORT: Fluctuations in the Great Fisheries of Northern Europe, Rapp. et Proc. Verb. du Cons. Perm. Intern. pour l'Explor. de la Mer Vol. XX Copenhagen 1914, p. 3 footnote) $16/3$ 1897, at Svolve¹, as also in coalfish² herring³ and *Myctophum glaciale*⁴. A female of *C. rupestris*, taken on a long line off Ambornes $27/11$ 1907, was spent. This agrees with SWENANDER'S statement that spawning takes place in September and October.

¹ Contributions to the study of Hydrography and Biology on the Coast of Norway, p. 15, in: Norwegian Marine Investigations by HJORT, GRAN and NORDGAARD. Bergen 1899.

² Oplysninger om seiens vekst og aate. Bergens Museums Aarbog 1901, Nr. 3.

³ Jagttagelser om sildens vekst og aate. D. kgl. n. vid. selsk. skr. 1907, Nr. 2.

⁴ Vide under *M. glaciale*, infra.

Hippoglossus hippoglossus LIN.

Large halibuts (Norw.: »storkveite«) are occasionally taken in the Trondhjem Fjord, especially on the Mefjordsgrund between Munkholm and Tautra; the fishery appears, however, on the whole to have declined. At Strømmen, Inderøya, quantities of halibut were taken about 1860. Even in Borgenfjord, which has a maximal depth of only 37 m., large halibut have at times been caught. In 1910, an octogenarian by name AMUND GUSTAD could remember that his father had once taken a halibut weighing 7 »vog« (1 vog = 18 kg.) off Rolshavn. It had got caught by the tail in the plaice-nets. This must have been about 1840. And in the 90's, another halibut of 5 vog was taken in Borgenfjord. It had got entangled in some ordinary lines, and could not use its gills. Small halibuts (called »kveitebarn«) are however, not infrequently caught. The staff of the Biological Station have of late years taken several such in Orkedalsfjord, in the course of the plaice fishery which is carried on with the snurrevad after Christmas.

Hippoglossoides platessoides FABR.

The long rough dab (Norw.: »langkjettflyndre«) has been taken now and again during the plaice fishery for the hatchery; I have not, however, made any close investigation of the species. It goes right up into the Beitstadfjord; on the $\frac{8}{8}$ 1906, while dredging in the Verrafjord, we took a young specimen l. 9.5 cm. Three small specimens were also taken in Muruviken on the $\frac{17}{2}$ 1914. L. 11—12.5 cm. Dr. SWENANDER took a yearling of 4.4 cm. in Buviken $\frac{17}{9}$ 1904.

Bothus maximus LIN.

The turbot (Norw.: »sandkverv« or »pighvarr«) has long been a well-known species in Trondhjem Fjord; although little has been known as to its propagation in these waters. On the $\frac{31}{7}$ 1911, however, during an excursion from the Biological Station, we came across a couple of young fry of these species, at the surface of the water, near Tautra (Pl. II, Figs. 8, 9). They were thus living in a planktonic state. The smaller specimen measured 13.5 mm. and exhibited almost uniform pigmentation on both sides, each side being closely covered with black spots. The right eye somewhat nearer the dorso-ventral plane than the left. Incipient spinous armament on the gill covers. The other measured 22 mm. total length. The left side was here more strongly pigmented than the right, on which latter the pigmentation mainly consisted of small dark spots, whereas on the left, these had in places collected into larger

patches, both on the side of the body, and also on the fins. The right eye almost medially in the dorso-ventral plane; development of the spines on gillcover here farther advanced.

On the ¹⁵/₇ 1913, a young specimen of *Bothus* was taken in an eel seine in Aavikfjord, Aasen. Length 29 mm. (pl. II, fig. 10). Left side here considerable more pigmented than the right. The right eye turned slightly more to the left than in the larger of the two specimens from Tautra; the posterior margin partly hidden by a triangular flap of the fore-end of the dorsal fin, which lay towards the left.

I presume these to turbot fry, not brill, the pigment in the latter at a length of abt. 20 mm. being stated as set in bands. The brill, moreover, has hitherto been lacking among the known fish fauna of Trondhjem Fjord. This is now, as we shall immediately see, no longer the case, but we may nevertheless assert that the brill is of extremely rare occurrence in the actual waters of the Trondhjem Fjord.

Bothus rhombus LIN.

The brill (Norw: glathvarr or slethvarr) is new to the fauna of the fjord. COLLETT states in his last report, that the Biological Station at Bergen received in 1899 a specimen from Statland, this being »the most northerly point from which it has been recorded with certainty«. The northern limit of occurrence can now be extended to the Trondhjem Fjord. On the ²/₆ 1915 JOHAN L. JOHNSEN, off Hangran at Byneset, fishing with a cast net as used for sea trout, in about 5 metres of water, caught a brill, ♂, l. 54.5 cm., with sperma fluid (exuding). Colour on the eye side greyish brown, with here and there yellowish white spots. The blind side white all over. Scales distinctly visible. Remains of fish in the ventricle.

Lepidorhombus megastoma DON.

This species (the whiff; Norw.: glasflyndre) is doubtless of very rare occurrence in the fjord; I have never as yet come across a specimen. V. STORM, in his Report for 1910, states that on the 17th of May that year, he obtained a specimen 53 cm. long in the fish market at Trondhjem.

Scophthalmus norvegicus GÜNTH.

Two specimens of this species (Norway topknot; Norw.: smaahvarr) were taken in Borgenfjord, while dredging, in October 1907. They were as follows:

²/₁₀ 1907. Fagernes, Borgenfj. 1 spec. l. 7.5 cm.

³/₁₀ 1907. Between Rolsøya and Klokkerskjeret, 1 spec. l. 7.8 cm.

Zeugopterus punctatus BLOCH.

This species (MÜLLERS topknot; Norw.: haarflyndre) appears to be more common than the one last mentioned. I can thus quote the following finds:

- ¹²/₁₀ 1898. Hegdalen (K. DAHL), 1 spec. l. 6.5 cm.
³⁰/₉ 1908. Nettet near Munkholmen, a spent ♀ l. 17.3 cm. —
 Remains of gobidæ in ventricle.
¹²/₂ 1909. Selven, Trondhjemsfjord, 1 spec. l. 5.7 cm.
²/₆ 1913. Fjeldværø, Hittra, 1 spec. l. 6.2 cm.
⁶/₃ 1914. Skarsbugten, Rissa, 1 spec. l. 4.7 cm.
²²/₈ 1914. Høvingen, near Trondhjem Biol. St., 1 spec. l. 9.8 cm.
¹⁷/₁₀ 1914. Sauøen, Froan, 1 spec. l. 20 cm.

On the ²⁹/₄ 1916, two specimens of *Z. punctatus* were taken at Ilsviken, and placed in the aquarium. The larger specimen was a ♀ with swollen ovaries. The largest size hitherto known for this species from the district is 20 cm., and for Trondhjem Fjord 17.3 cm.

Arnoglossus laterna WALB.

This species (scaldback; Norw.: tungehvarr) is new to the Trondhjem Fjord, and has not hitherto been recorded north of Tananger, on the Stavanger coast, where three specimens were taken in the course of Dr. HJORT'S fishing experiments in August 1898. On the ⁷/₈ 1916, while dredging at Ilsviken, near Trondhjem, we obtained a ♀ of this species, l. 8 cm. This was in quite shallow water, with bottom of mixed sand and clay. The fish was greyish brown in colour, with small dark spots at the base of the dorsal and anal fins. Remains of amphipoda and isopoda in the ventricle. Ovaries distended with quite small eggs. COLLETT states also, in his latest report: »In the Christiania Fjord, the females were full of roe in the months of June—July, but we may in August still find females not yet spent«.

Pleuronectes platessa LIN.

Some particulars with regards to the plaice (Norw.: gulflyndre) will be found in my two reports on the hatching experiments at Trondhjem Biological Station (D. kgl. n. vid. selsk. skr. 1909, nr. 7, and 1913, nr. 6). These two papers may thus also be included among the sources of information as to the fish fauna of Trondhjem Fjord. In the second of these reports, I mentioned some enemies and competitors of the species. At times, the plaice may be lucky enough to escape from the jaws of a sea-otter or a seal; an instance of this may be quoted here. A plaice taken on the ³⁰/₁₀ 1914, at Ranheim, Strindlandet,

was found to have a large incurvation in the back (fig. 4). The fish was thick and fat, total length 44 cm., the length of the incurvation at the base of the dorsal fin was 6.5 cm. and the distance from the outer margin of the dorsal fin to bottom of the incurvation 9 cm. This must evidently have been produced by the bite of a sea-otter or of a seal. The wound had healed entirely at the edges, which were nearly rounded, and even pigmented. The dark colour also extended some little way over on the blind side.

Pleuronectes limanda LIN.

Some particulars regarding the common dab (Norw.: 'sandflyndre or graaflyndre') will be found in my first report on hatching experiments with plaice, p. 40. I have rarely encoun-

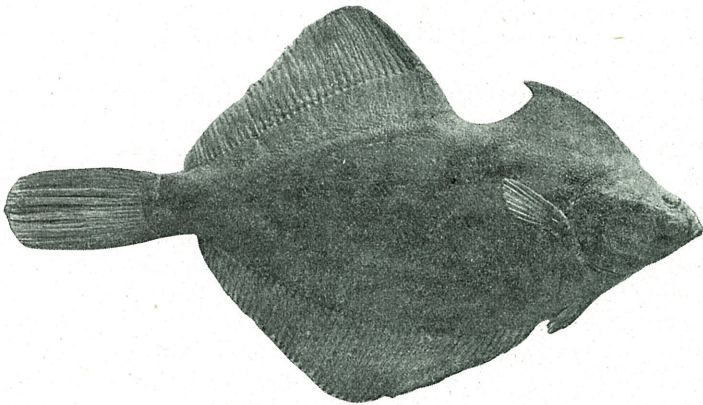


Fig. 4. *Pl. platessa* from Ranheim, ³⁰/₁₀ 1914.

tered young specimens of this species. In the paper above mentioned, mention is made of a individual 5 cm. long, taken on the ²/₁₀ 1907 while dredging at Fagernes in Borgenfjord, at a depth of 4—13 m. I have also found, among material not yet dealt with, a specimen from Børsa, taken on the ⁵/₅ 1899. The total length of the latter specimen was 6.3 cm. Two young specimens, l. 7—8.5 cm. were also taken in an eel seine in Aavikfjord, Aasen, on the ¹⁵/₇ 1913. The species appears to thrive particularly well in closed basins such as Borgenfjord and Eidsbotn, Levanger. Casting with an eel seine at Eidsbotn, on the ⁴/₁₀ 1911, we took several specimens. A ♀, 28 cm. long, had in the ventricle *Ophiura albida*, *Ophiopholis aculeata* and *Echinocyamus pusillus*.

Pleuronectes flesus LIN.

I have made some investigations into the question of nourishment at different stages with regard to this species (flounder; Norw.: skrubbflyndre), believing it to be a principal rival of the plaice in this respect.

Among a number of specimens from Orkla, $\frac{8}{5}$ 1898, 11 were right-sided, l. 4—5.5 cm., and 1 left-sided, l. 3.8 cm. Contents of stomach consisted of insect larvæ. Specimens from Garten, outside the mouth of the fjord, $\frac{20}{8}$ 1903, l. 3.5—3.8 cm., contained insect larvæ, amphipoda and nematoda. Some larger specimens taken at same place and time, l. 9.6—12.4 cm., contained isopoda and annelida. Among 61 young specimens from Garten, $\frac{20}{8}$ 1903, 40 right-sided, l. 3.2—5.8 cm., and 11 left-sided, l. 3.2—5 cm. In a haul made at the mouth of the Orkla, $\frac{14}{9}$ 1904, lengths varying from 4.5—6.3 cm., 6 were right-sided and 3 left-sided. The ventricles contained amphipoda, schizopoda and insect larvæ.

On the $\frac{23}{7}$ 1907, the mouth of the Gula, where there was fresh water at the surface, we took, at a slight depth, a 2 cm. long left-sided young specimen of *Pl. flesus*, and on the $\frac{6}{7}$ 1909, at the inner end of Lofjorden, Aasen, abt. $\frac{1}{2}$ m. depth, 5 right-sided specimens l. 2.2—3.5 cm. From the Borgenfjord, a field of special interest in the hatching investigations. I have several observations to record. $\frac{27}{7}$ 1909. Korsenleiret, abt. 0.5 m. sandy bottom, 23 right-sided l. 2.9—4.2 cm. and 10 left, l. 2.7—4.1. Stomach and intestine contained insect larvæ and nematoda. $\frac{27}{7}$ 1909. Lønnemsleiret, abt. 0.5 m. 22 right-sided, l. 3.7—5.5 cm. and 6 left, l. 3.6—5.4 cm. Similar observations from other parts of Borgenfjord, as Vaasetleiret, Rolshavn, etc. $\frac{29}{7}$ 1909. Vaasetleiret, abt. 0.5 m. 25 right-sided, l. 3.7—5.2 cm. and 14 left, l. 3.2—5.2 cm. Contents of stomach: insect larvæ, nematoda, isopoda and amphipoda.

From the foregoing data it appears, *inter alia*, that the flounder in Borgenfjord exhibit a remarkable tendency to reverse. In an eel seine haul, we may for instance find up to 50 % reversed. Also in other parts of Trondhjemsfjord the percentage of left-sided flounders may run very high. I had occasion to examine 91 flounders from hauls made in Buviken, (Sept. and Oct. 1910), sizes ranging from 3.1 to 9.1 cm., and found 50 right sided and 41 left.

The somewhat larger stages of flounder also live on crustaceans, worms and insect larvæ. In the ventricle of a specimen from Gulosen, $\frac{10}{5}$ 1904, l. 19 cm., were found remains of annelida, and in specimens from Børsa, $\frac{16}{9}$ 1904, l. 10.5—11.3 cm.

remains of crustaceans and insect larvæ in stomach and in testine. A specimen 30 cm. long from Eidsbotn, $4/10$ 1911, had a *Macoma calcarea* in the stomach; others of 10—15 cm. from Rolshavn, Borgenfjord, $20/8$ 1913, had in stomach and intestine: amphipoda, isopoda, insect larvæ, and small gastropoda. On flounders taken in Borgenfjord it was a common thing to see a *Caligus* sp. most frequently attached to the root of the pectoral fin on the under side.

On the 17 1913, casting with eel sein of Steine, Byneset, we found in the haul some specimens of flounder at different sizes. The stomach and intestines contained almost exclusively *Mytilus edulis*. In a similar haul made at Aavikfjorden, Aasen, $15/7$ 1913, there were 20 flounders ranging in size from 9—13.5 cm. with one specimen of 18.5 cm. The intestine of the last-named specimen contained a number of small *Mytilus edulis*. I have also found these in the stomach of plaice, so that the two species are evidently rivals for this particular food. From the observations made up to the present, however, I am of opinion that the plaice is more of a mollusc-eater than the flounder.

Pleuronectes microcephalus DON.

The lemon sole (Norw.: maritunge or langtunge) is found somewhat sparsely throughout the whole of the fjord right up into Beitstadsund, and thus also in Borgenfjord, where it is known as »steinbitflyndre«. An illustration of this species will be found in my second report on hatching experiments, p. 74. The individual in question, which was taken at Grandeviken on the $28/2$ 1914, was a ♀ l. 44.3 cm. The eggs were very small. Stomach and intestine contained 68 specimens of *Acmæa testudinalis*, ranging in size from 6—15 mm., also 1 *Chiton*, 4 *polychæt-annelida*, 1 amphipod and 6 isopoda. Dredge hauls bring up, as a rule, only few specimens of *Acmæa testudinalis*, and the fact that this fish had collected nearly seventy seems to suggest that it had sought them out in preference to other food. Another specimen, purchased at the fishmarket in Trondhjem, $21/7$ 1914, had in the ventricle: 18 *Tectura virginea*, 5 *Margarita groenlandica*, 1 *Gibbula tumida*, 3 *Anomia squamata*, and several *Chiton*. It would thus seem that the lemon sole is particularly addicted to such molluscs as *Acmæa* and *Tectura virginea*.

Pleuronectes cynoglossus LIN.

The pole-dab (Norw.: sleiptunge) is one of the fishes occasionally taken in a dredge working on soft bottom at some considerable depth. During the summer of the present year (1916) we took specimens both at Hegdalen and Tautra. It is not used as food.

Myctophum glaciale REINH.

On the ²¹/₇ 1909, dredging at Røberg on clay bottom, 300—500 m., we brought up a specimen of this species. It was partly digested, and must apparently have been vomited up by some other fish which had been taken in the dredge, either on the bottom or while hauling in, this fish having afterwards made its escape. The *Myctophum glac.* was a ♀ l. 5.8 cm., with eggs apparently mature. Gullet and stomach, were, when preserved, bluish-black in colour. In the ventricle was a large copepod, *Euchaeta norvegica* ♀. While fishing with a prawn trawl in Skjørnfjord, October 1910, three specimens of *Myctophum glaciale* were brought up, l. 6.5—7 cm. These were likewise partially digested, i. e. ejected by some other fish during the haul. In these specimens also, the gullet and stomach had a characteristic bluish-black colour. One of them was a ♀ with small eggs in the ovaries, and a pelagic amphipod, *Parathemisto oblivia*, in the ventricle.

Argentina sphyraena LIN.

Four specimens of this species (lesser silver smelt) length 11—18 cm., were taken on the ²³/₇ 1908 at Orkedalsøren, 2 metres depth.

Argentina silus ASCAN.

This species (great silver smelt; Norw.: stavsild) is not uncommon in the deeper parts of the fjord. I have seen many of them from Munkholmdyb. A specimen taken here in the autumn of 1915 measured 50 cm., the largest size known for this species in the Trondhjem Fjord.

Anguilla anguilla LIN.

A young eel, 7 cm. long, was taken on the ⁷/₄ 1908 close in to shore outside the Trondhjem Biol. Station at the surface of the water.

Castling with the eel seine at Hoøy, near Stenkjær, ²¹/₅ 1900, a young eel l. 6.8 cm. was taken. It appeared to have been brought into contact with the digestive secretions of some other fish, and had probably been vomited up during the haul. On the ²⁷/₄ 1912 a young eel l. 7.5 cm. was taken in the canal at Trondhjem.

Leptocephalus conger LIN.

A conger eel measuring 163 cm. was taken on the ⁴/₇ 1907 in Snillfjorden, Hevne. This is doubtless the largest specimen known from the Trondhjem district. A somewhat smaller one was taken on the ²³/₁₀ 1909, l. 131.5 cm., in Knarlagsund, Hittra.

Chimæra monstrosa LIN.

This fish (king of the herrings, rabbitfish; Norwegian: sjømus) is called by the local fishermen »spelstrenghyse«. (Vide my notes in Maal og Minne, 1913, p. 113). The egg capsule of this species was first described by COLLETT in Norges Fiske, 1874, p. 206. Further information as to the ova is given by JAMES GRIEG, in Ichthyologiske Notiser, Bergens Museums Aar-bog 1894—95, Nr. 5, p. 11. I have obtained from fishermen two egg capsules of *Chimæra*, one taken at Munkholm, $^{12}/_4$ 1907; length of the capsule itself plus capsule stem 15 cm. the fili-form prolongation of the stem measuring 4.5 cm. The other was taken between Munkholm and Frosta in the first half of August 1909. L. 15 cm. + 5.5 cm. (the filiform prolongation). Both of these must have been newly spawned, only the yolk mass being visible, without any indication of macroscopic embryonal development. The capsules were light yellowish-brown in colour. A photographic reproduction of the one is given in fig. 5.



Fig. 5. Egg capsule of *Chimæra monstrosa*, taken between Frosta and Munkholm first half of August 1909.

According to COLLETT's explanation, the side facing forward in fig. 5 should be the ventral. The ventral carina thus disappears in the broadest part of the capsule; the dorsal, not visible here, and the lateral, continuing along the entire length of the capsule. *A priori*, it would be natural to suppose that when the young fish is ready to emerge, the capsule splits along the lateral carina in the broad part. And this has also been found to be case. On the $^{7}/_8$ 1916, while dredging on clay bottom between Frosta and Leksviken (on the inner side of Tautra), 100—200 m., we found 5 empty *Chimæra* capsules, all split along the lateral carina for a length of abt. $^{2}/_3$ of the broad part. These must, I take it, have been capsules of this year's spawning, the colour when taken being a fresh yellowish-brown. On being dried, the gradually turned black. The terminal thread was in all cases lacking.

Lamna cornubica GMEL.

On the $^{7}/_{11}$ 1914, we purchased from a fisherman, JON A. HAUGRØNNING, a specimen of this species (porbeagle; Norwegian:

haabrand) taken the same day at Frøsetskjerene, Bynesland. The specimen, a ♂, had got entangled in a coalfish net, and could not get away. The ventricle contained a quantity of otoliths and vertebræ of fish. COLLETT has found herring and *Brosmius brosme* in the stomach of *Lamna*. I did not succeed in collecting all the otoliths from the stomach of this Bynesland specimen, but the preparator ARNOLD DIRCKS, took 39 in all. Of these, 26 were from *Coryphænoides rupestris*; thus representing at least 13 *Coryphænoides* devoured by the *Lamna*. There were also 6 otoliths of cod, and 7 others probably of coalfish.

Raja radiata DON.

This species (starry ray; Norw.: trolldskate) is found throughout the whole of the fjord. During the snurrevad fishery for plaice in the first month of the year, a quantity of egg capsules have also been taken, which I have determined as belonging to this species. Such capsules have especially been found in Gulosen, during the month of February, in net hauls from 2—100 metres; the appearance of these I will now describe.

Description of egg capsules of Raja radiata.

The egg consists of the capsule itself, which is rectangular in form, or occasionally barrel-shaped in section (fig. 6). From each corner proceeds a thread, or more properly a tapering tube. The capsule is enveloped in a casing of fine threads, which to some extent mask its true shape. It consists of a horny substance, the outside covered with a stratum of longitudinal threads. Colour a blackish brown, or at times a lighter brown. There is a lateral keel on either side, as in the case of *Chimara monstrosa*. One side of the capsule is almost flat, the other more rounded. Having in this instance been fortunate enough to find the fully developed young ray in the egg, I can without hesitation assert that the flat side is the dorsal, and the domed side the ventral. In several of the capsules from Gulosen ^{1/2} 1910, the contents had been forced out by the pressure of contact with the rest of the haul. It occurred to me that this might furnish means of ascertaining a line of least resistance in the capsules, and on examination, I found that the capsules had in all cases burst between the longer terminal tubes, not near the short. Further, removing the one broad side from an undamaged capsule, I endeavoured to discover by means of a scalpel where lay the weakest part. As a result, I found that the scalpel entirely failed to penetrate at the lateral carinæ and near the shorter tubes, whereas a very slight pressure on the edge between the long tubes sufficed. There is thus no doubt that the young

emerge from between the long tubes, which evidently indicate the fore-end of the egg, the shorter tubes being attached to the posterior part. It would moreover, be reasonable to suppose that the young should emerge head foremost, and not tail first, and we might thus expect to find the point of snout lying towards the fore-end thus determined. This was also found to be the case, albeit the longitudinal axis of the young fish does not coincide with the median line of the capsule, but rather with its diagonal, the point of snout being directed towards the one of the longer tubes. This gives us, then, the orientation of the capsules, the long tubes indicating the fore end, the flat broad side being the dorsal, and the convex the ventral. The tubes of the fore end, which are easily pliable, and terminate in a thin thread, curve in over the lateral plane. The tubes of the posterior end are stiffer and the points curve out from the lateral plane in towards the dorsal side. They are thus more hook-shaped. The fore end of the capsule is as a rule cut off transversely, the posterior edge curving inward. The hooks at the hinder end are presumably designed to act as anchors, holding the egg fast to the bottom and preventing its being carried away by the current and washed ashore. It is then worthy of note that the hooks in question always curve over towards the dorsal side, whence it would seem that the egg is intended to lie on its back. On opening the capsule, the inner side of the walls is found to be extremely smooth and and highly polished, having an almost metallic gleam. The thickness of the wall is $\frac{1}{2}$ —1 mm. Both posterior and anterior tubes communicate with the interior cavity. In old capsules, the



Fig. 6. Egg capsule of *Raja radiata* from Gulosen $\frac{1}{2}$ 1910 abt. 80 m. (capsule nr. 5) l. 54 mm., b. 48 mm., thickness 15 mm. Lateral keels slightly broader than usual and somewhat expanded medially, giving the capsule itself the appearance of a longitudinal section of a barrel. Ventral side of the capsule removed.

lateral carina easily falls away when the outer envelope is removed.

Some idea as to general dimensions may be gained from the following measurements:

Gulosen, February 1909.

- Capsule 1. l. 52 mm., b. 45 mm., long tubes abt. 50 mm., short abt. 25 mm.
 » 2. l. 52 mm., b. 45 mm., long tubes abt. 47 mm., short abt. 20 mm. Length of interior cavity abt. 45 mm., b. abt. 30 mm.
 » 3. l. 50 mm., b. 43 mm., long tubes abt. 50 mm., short abt. 25 mm.

¹/₂ 1910, Gulosen, abt. 80 m. snurrevad.

- Capsule 1. l. 65 mm., long tubes abt. 45 mm., short abt. 35 mm., contents partly exuded.
 » 2. l. 52 mm., b. 40 mm., long tubes abt. 48 mm., short abt. 22 mm. Distinct embryonal formation.
 » 3. l. 57 mm., b. 44 mm., thickness 17 mm., long tubes abt. 70 mm., short abt. 30 mm., contents exuded.
 » 4. l. 60 mm., b. 48 mm., long tubes abt. 60 mm., short abt. 24 mm. Distinct embryonal formation.
 » 5. l. 54 mm., b. 48 mm., thickness 15 mm. (vide fig. 6).

¹³/₂ 1913, Inderøya, abt. 40 m. snurrevad.

- Capsule 6. l. 50 mm., b. 45 mm., length of internal cavity 39 mm., breadth of same 29 mm. Capsule brown in colour, with no covering envelope of threads.

Development of Raja radiata.

The capsule from Inderøya (¹³/₂ 1913) was opened for investigation from the dorsal side. The yolk mass, which was oval in section, was 30 mm. long and 24 mm. broad. The yolk was surrounded by a gelatinous mass, which also extended out into the short and long tubes. Strange to say, I was unable to find, either in this or in any other of the capsules examined, any trace of the fissures in the capsule tubes which are stated as having been observed in the capsules of other *Raja* species. It would also seem that the gelatinous mass in the tubes must prevent any ingress of water. The incipient embryonal formation on the dorsal side of the yolk had a thin white disc in front, the anterior end abt. 5 mm. broad, but narrowing slightly towards the rear. The smallest embryo detached from the yolk was found in a capsule from Gulosen February 1909. Its total length was 18 mm. (pl. I, fig. 1.)

The head has a hook-shaped projection at the base of which, indications of the eye may be observed, as an oval protuberance with a smaller oval in the centre. Towards the point of the hook the first indication of the olfactory organ is apparent as a small furrow. The mouth forms an equilateral triangle, with the apex pointing backwards. Behind the eye there are 6 fissures, of which the first, long and narrow, forms the first indication of the spiraculum. The remaining 5 are gill-slits. At the fore-edge of the 4 first gill-slits there are 2 small knobs, the commencement of the provisory gill-threads. Similar gill-thread knobs are also developed later in the 5th gill-slit, but not in the spiraculum. Indication of digestive tract quite distinct. As in the case of the teleostian fishes, there is a dorsal and a ventral embryonal fin, the dorsal running from the 3rd or 4th gill-slit to the point of the tail, while the ventral extends from the anus to point of tail. The anterior portion of the dorsal

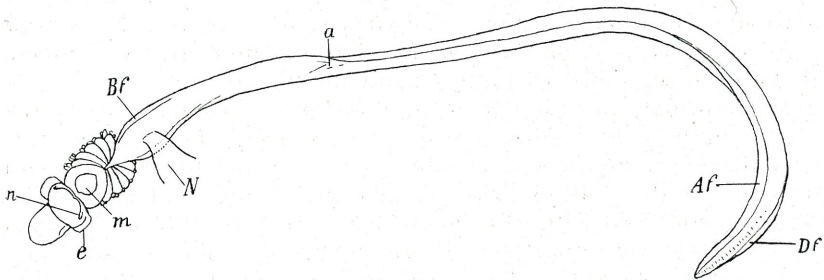


Fig. 7. Embryo of *Raja radiata* from Gulosen, $\frac{1}{2}$ 1910. Capsule 2. L. 23 mm.

embryonal fin is very small. The umbilical cord is attached a little behind the 5th gill-slit. There is no distinct indication of dorsal fins at this stage of development, but the pectorals are seen commencing as a narrow strip along the side, extending from the anterior end of the umbilical cord to a little way back. Behind the pectorals, and in the same plane, is a longish ridge forming the commencement of the ventral fins. The segmentation in the *chorda dorsalis* is distinctly visible.

The next stage which I have been able to procure is that in a capsule from Gulosen, $\frac{1}{2}$ 1910, caps. 2. The total length of the embryo here was 23 mm. (fig. 7).

The head, viewed laterally, is still hook-shaped. The development of the gill-threads is farther advanced, the foremost having now the appearance of short threads, while the hinder ones are more like knobs (pl. I fig. 2). The pectoral fins have grown out forward to the 5th gill slit, and the flaps of the

dorsal fins are commencing to rise out from the dorsal embryonal fin (pl. I, fig. 3). On the edge of the flaps of the dorsal fin and behind the same at the edge of the dorsal and ventral embryonal fins there are small granular spots, possibly integumental glands (pl. I, fig. 3). The distance from point of tail to the posterior dorsal fin is 8 mm. In fig. 7, the embryo is shown in ventral view; *n.* is here the nasal furrow, *e.* eye lobe, *m.* mouth, *N.* the umbilical cord, *Bf.* pectoral fin, *Af.* ventral embryonal fin, *Df.* dorsal embryonal fin.

A capsule from Gulosen, $\frac{1}{2}$ 1910, capsule 5, contained an embryo 32 mm. total length. The pectoral fins had here grown out as far as the 4th gill slit. The anal fin is indicated by a greater breadth of the original fold in the skin. It extends from a little distance behind the ventral fins to level with the end of the first dorsal fin. The granular spots previously mentioned as apparent on the edge of the dorsal fin and behind the same in the dorsal and ventral embryonal fin are now very distinctly marked. The oral aperture is shaped semicircularly. No ocular pigment apparent. Gill threads in 5th slit now also developed. Distance from point of tail to 2 dorsal fin 10 mm.

In another capsule, also from Gulosen, February 1909, the total length of the embryo was 40 mm. Here the anal fin was also distinctly marked, extending back almost on a level with the end of the 1 dorsal fin. The pectoral fins had grown forward to the 3rd gill-slit. There are three gill threads in each slit, making 15 on either side (pl. I, fig. 4). The rays in pectoral and ventral fins distinctly visible. Oral aperture semicircular. Some of the hinder gill-threads are above the pectoral fin, but as this thrusts forward a loose flap, they are able to get to the underside before the pectoral fins grow in definitely to the side. Distance from point of tail to 2 dorsal fin 15 mm. No ocular pigment apparent.

A capsule from Gulosen February 1909 contained an embryo measuring 45 mm. total length. In this, the loose flap of the pectoral fins had grown forward to nearly the 2 gill-slit, the junction of the pectoral fins with the side extending as far as the 5th slit. The gill slits above the loose flaps of the pectoral fins are distinctly visible, but the ingrowing process, or more properly, perhaps, the growth of the skin over the slits opposite the pectoral flaps is now farther advanced. The ventral fins show a slight incurvation, indicating division. Mouth a longish oval, trace of pigment formation now apparent in the eye. Anal fin comparatively broad. The most characteristic feature at this stage is the incipient formation of an oral disc, growing out from the sides under the eyes and forward under the head.

The importance of this will be further discussed under the following stage.

In a capsule from Gulosen, February 1909, was found an embryo total length abt. 50 mm. Here the loose flap of the pectoral fins has grown out past the 1st gill-slit, reaching almost to the spiraculum. The free flap of the pectoral fin extends from the 5th gill-slit forward in front of the first. Thus, while the juncture, or overgrowing of the gill-slits is taking place, the foremost part of the pectoral fins is free. During the joining process, the gill threads are forced over down to the ventral side, which can take place as they are in a position to pass

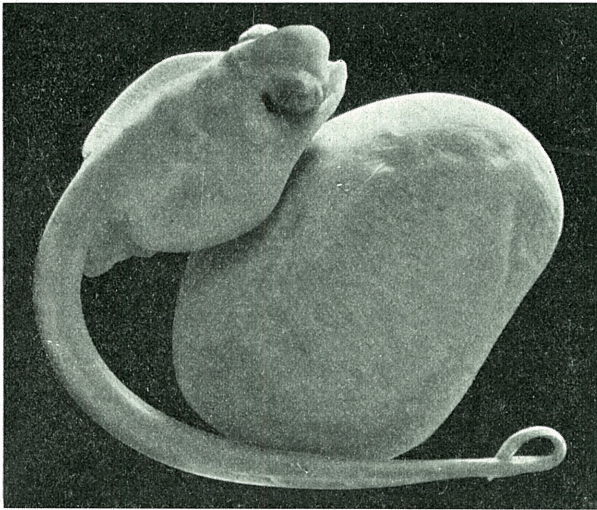


Fig. 8. Embryo of *R. radiata* from Gulosen $\frac{1}{2}$ 1910, total length abt. 60 mm., dorsal view.

the free pectoral fin flap. At this stage of development, at 50 mm., the gill-slits above the pectoral fins are also closed, but their position may be observed with slight magnification, and the gill threads, which are fairly long, have come on the ventral side (pl. I, fig. 5). The anal fin is still comparatively broad, and in the ventral fins there is a slight incurvation denoting the incipient division of the same. The mouth is now shaped as a transverse slit. Ocular pigment distinct. In front of the mouth is a triangular disc-shaped extension, which later grows together at the lateral edges with the advancing flap of the pectoral fins (pl. I, fig. 5). In an embryo total length abt.

60 mm. taken from a capsule from Gulosen $\frac{1}{2}$ 1910, capsule 4, this juncture had taken place (figs. 8, 9). The oral disc has now at its fore end grown out into a point, reaching nearly to a level with the fore end of the head. In the object itself, the suture of the joint is distinctly visible, although it is not apparent in fig. 9. On holding the object up to the light, the pectoral fin rays are also visible right up to this suture. The mouth and olfactory organs are approaching their ultimate form. There is no pigment formation either on the upper or under side except in the eye. The so-called »eyelid« distinctly apparent, with small finger-shaped lobes at the edge. The yolk sac is still

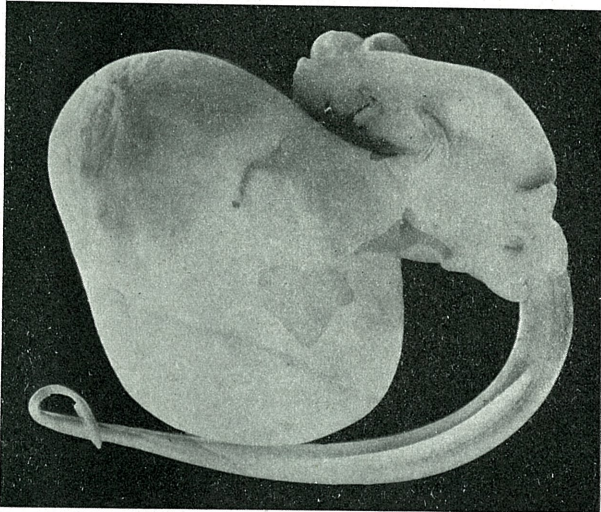


Fig. 9. Embryo of *R. radiata* from Gulosen, $\frac{1}{2}$ 1910, capsule 4, total length abt. 60 mm., ventral view.

comparatively large, with a length of 25 mm. and breadth 19 mm. The ventral fins present a distinct indication of division, and the anal fin is clearly apparent (fig. 9). The gill-threads are still present, and there are 15 of these in each row of gill-slits, i. e. 30 in all. The dorsal fins are in their original position; distance from 2. dorsal fin to point of tail 16 mm. The spines in the dorsal line now indicated as small knots under the skin. The two scapular spines also are seen in their incipient stage as two small knots. The lateral folds of the caudal part are now beginning to appear.

Finally, we have a capsule from Gulosen, Febr. 1909, con-

taining an embryo of complete ray-shape. Total length, 94 mm., pigmentation on dorsal side complete. The fore-end of the head had now grown together with the oral disc, forming one united whole, but the boundary between the blunt fore end of the head and the protruding oral disc still visible. Gill threads have now disappeared. Spines on the dorsal side now indicated; not only the larger ones in the medio-dorsal line, but also the small ones on the disc. All spines covered by the skin, leaving the upper surface smooth to the touch. The yolk sac now reduced to a diameter of 16 mm. Lateral folds of the caudal part developed, reaching a little way behind the 2 dorsal fin. The embryonal anal fin still existing, but apparently dwindling. Distance from 2 dorsal fin to point of tail 17 mm. The caudal part was curved up along the right side, owing to lack of space, the pectoral fins being for the same reason somewhat folded. The description here given applies also to an embryo of *R. radiata* which I found in the collection of the late curator V. STORM. This is doubtless from Trondhjem Fjord, but no date or locality stated (pl. II, fig. 7). Total length 102 mm. In this case, however, the tail part is curved up along the left side. Pectoral fins slightly folded at the edges. Yolk sac abt. 18 mm. diameter. Division of the ventral fins far advanced. Here also, the distance from 2. dorsal to point of tail was 17 mm. (vide pl. II, fig. 7). I have also a specimen of a similar stage from Stjørdalsfjord, ^{18/2} 1907. This is shown in pl. II, fig. 6, in its actual position in the egg capsule. It will here be noticed that the median line of the disc coincides more or less with the diagonal of the capsule cavity. The caudal part curved along left side, and the pectoral fins partly folded. Diameter of the yolk sac abt. 15 mm. Total length of the embryo abt. 103 mm. and distance from 2. dorsal fin to point of tail 17 mm.

I have no newly emerged specimens of *R. radiata* in my possession. The smallest free specimens I have measured myself are respectively 170 and 220 mm. total length (pl. III, figs. 11, 12, 13). Figs. 11 and 12 show the dorsal and ventral sides of a *R. radiata* from near Munkholm, ^{20/10} 1914. It was 170 mm. long. Fig. 13 shows the dorsal side of a specimen taken at the same place and time. The first was a ♀, the second a ♂ with small pterygopodia. In both specimens the boundary between the oral disc and therewith connected flaps of the pectoral fins were visible (pl. III, fig. 12). The embryonal tail end behind 2. dorsal fin is now no longer found, and instead of the anal fin, we find on the under side of the tail a small furrow, as shown in pl. III, fig. 12.

Professor COLLETT (Meddelelser om Norges Fiske 1884—1901,

p. 110) has examined a specimen of this species taken in the Kristiania Fjord, near Drøbak, in August 1897. Total length was 93 mm. »and probably newly emerged«. The largest embryonal stages I have examined were 102 and 103 mm. The free young stage mentioned by COLLETT was thus smaller than these embryos. It should be borne in mind, however, that the capsules vary a good deal in size, the embryos probably also. Moreover, in the embryonic stages there is a tail end which is doubtless cast off either shortly before, or, more probably, immediately after the embryo emerges from the capsule, whereby the total length will be reduced. Judging from my experience, therefore, we might well suppose that the specimen mentioned by COLLETT as measuring 93 mm. would at the close of the capsule stage have measured abt. 110 mm. (93 + 17 mm.).

The egg capsule of *R. radiata* and other *Raja* species have been described, with illustrations, by Dr. H. C. WILLIAMSON¹, whose observations agree entirely with my own; the embryonal development of *R. radiata*, however, has, as far as I am aware, not hitherto been treated. There is, however, a study on the development of *Raja batis* by WYMAN². I have not had access to this work in the original, but some extracts are given by LÜTKEN (Skildringer af Dyrelivet i Fortid og Nutid, Copenhagen, 1880) who also reproduces WYMAN's figures. From these there appears to be a very high degree of similarity between the development in the two species of *Raja* in question. As far as I can see, however, WYMAN does not appear to have noticed the free flap of the pectoral fin, which in my opinion is of fundamental importance. The presence of this feature during a part of the embryonal development reminds one of certain transition forms between the sharks and the rays. In one such, *Raja squatina*, where pectoral and ventral lie in the lateral plane of the body, a free flap of the pectoral fin extends out beyond the laterally adjacent gill slits. LÜTKEN (l. c. p. 244) here correctly observed, that if »the pectoral fin had grown in to the head, and the gill slits therefore been shifted over to the ventral side, we should certainly have had to class this shark among the rays«. Worthy of note is the fact that *Raja radiata*, at a certain stage in its embryonal development, with the free flaps of the pectoral fins, bears some resemblance to the above-men-

¹ Fisheries. Scotland Sci. Invest. 1912 I (July 1913).

² Observations on the development of *Raja batis*, Memoirs of the American Acad. of Arts and Sciences, new Ser. Vol. IX, part I, Cambridge and Boston, 1867.

tioned species of shark. WYMAN has, at a certain stage in the embryonal development of *Raja batis*, remarked the presence of an anal fin; as a matter of fact two such (vide LÜTKEN, l. c. p. 269). In such stages of *R. radiata* as I have had at my disposal, there was only 1 anal fin, which is perhaps most distinctly prominent in the 60 mm. stage (fig. 9) but which becomes reduced during the subsequent capsule stages, until at last the fold of skin representing the anal fin presents the appearance of a dermal tube, situated in the median line on the underside of the tail. The presence of this anal fin is one of the points which serve to distinguish the rays as an adaption from the shark type. The anal fin is, for practical reasons, subsequently discarded, as the rays, living as they do on the bottom, would have no use for such; on the contrary it would rather be a disadvantage. Beside the features already mentioned, the free flaps of the pectoral fins, and the anal fin, the development of the rays is, like that of the sharks, characterised by the existence of provisory gill threads. In *R. radiata*, these commence as small knobs in the upper edge of the gill slits, some being visible already at the 18 mm. stage. It is worth noting, that although the first formation of the spiraculum proceeds in a manner similar to that of the gill slits, there is yet no gill thread in this, thus indicating a functional difference between gill slits and spiraculum. The gill threads disappear, in the case of *R. radiata*, when the development of the embryo is so far advanced that the dorsal side has attained pigmentation.

Special mention should be made of the comparatively long tail end behind the dorsal fins, as this is not found in *R. radiata* after the young have emerged from the egg capsule. The Swedish naturalist A. W. MALM (Bidrag till Kännedomen om Utvecklingen av Rajä; Öfvers. Kgl. Vet. Akad. Förh. 1867, Nr. 3, p. 91—102, tab. III, figs. 1—4) noticed that the dorsal fins are formed fairly far forward on the tail of *R. clavata*, and he supposed that these fins disappeared in the course of the embryonal development, the fins subsequently formed being situated nearer the point of the tail. This suggestion, in itself somewhat unreasonable, was contradicted by AD. S. JENSEN¹, who found, in an embryo of *R. radiata* from Greenland, that the tail end was also present in the later part of the capsule period. JENSEN therefore supposed that the dorsal fins maintained their original position, and that it must be the tail end which was discarded. My observations here recorded serve to confirm JENSEN's supposition.

¹ The Selachians of Greenland; Særtr. av Mindeskift for JAPETUS STEENSTRUP, Copenhagen, 1914.

As proof that the dorsal fin persists in its original position, I give the following figures:

Length of embryo of <i>R. radiata</i>	Distance from 2. dorsal fin to point of tail
23 mm.	8 mm.
32 —	10 —
40 —	15 —
60 —	16 —
94 —	17 —
102 —	17 —
103 —	17 —

The embryo of *R. radiata* examined by JENSEN measured 130 mm. total length; the distance from 2. dorsal fin to point of tail was here no less than 27 mm. (vide footnote 2, l. c. p. 17).

The table above shows, that the distance from the original indication of dorsal fins to point of tail increases during development, and reaches its maximum at the close of the capsule period. As this tail point has never, so far as I am aware, been observed in free young specimens of *R. radiata*, the only explanation must be that the part behind the dorsal fins falls off either just before or immediately after the young emerge from the capsule, and commence their free existence. In pl. II, figs. 6 and 7, this prolongation of the tail is very distinctly visible.

It would be natural now to ask, whether this point of tail is of any importance to the embryo during its development. The answer must be, that this is most unlikely. The prolongation of the tail is not a necessary apparatus, but must be hereditarily derived from earlier long-tailed forms according to the biogenetic law. On the other hand, this small stump of tail serves to show, that the long-tailed rays are older than the short-tailed in the phylogenetic development.

Raja nidrosiensis COLL.

The egg capsules of this species (Norw.: svartbukskate) are mentioned both by COLLETT and SWENANDER. The former¹ gives the length of the capsule from middle of anterior transverse edge to middle of posterior do. as 220 mm., breadth 95 mm., and comparatively short terminal tubes (abt. 30 mm.). SWENANDER² obtained in January 1905 in Trondhjem Fjord, a female with one fully developed egg in each of the oviducts. The dimensions of the egg capsules were 200 × 120 mm.

In a ♀ of *R. nidrosiensis*, taken in the Munkholm deep ²⁰/₈

¹ Meddelelser om Norges Fiske 1884—1901, III, p. 128, Kristiania, 1905.

² Bidrag till Kännedomen om Trondhjemsfjordens Fiskar. D. kgl. n. vid. selsk. skr. 1905, nr. 9, p. 77.

1908, total length 1.9 metres, I found two egg capsules. These I will now describe. The capsules were enveloped in a loose net of yellowish threads, which I removed. In addition, there was a covering of straw-coloured threads, running longitudinally, resembling raw silk. The capsules were apparently mature. There was a considerable mass of yolk, surrounded by a mass of gelatinous matter, but no macroscopic indication of the embryo.

Capsule 1. Length from upper to lower edge 222 mm., maximal breadth 112 mm. The fore-end tubes extended abt. 15 mm. out over the terminal edge, and the lower ones abt. 20 mm. Length of the interior cavity 119 mm., maximal breadth of same 90 mm. Distance from upper end of the cavity to upper terminal edge 57 mm. Thickness of capsule walls $\frac{1}{2}$ —1 mm. The fore or upper edge cut off straight, the lower having a concave curve. In the orientation of the capsule, I cut out the one broad side and then proceeded to feel the way in with a scalpel round the cavity. The scalpel entered by the straight cut edge, which is the part where the young emerge, and thus the fore end of the capsule. The one broad side being here considerably more convex than the other, we may conclude, by analogy with *R. radiata*, that the more rounded side is the ventral, and the other the dorsal. The lateral keels are fairly broad. Terminal tubes not particularly curved, but stand out almost straight from the corners. They communicate with the cavity of the capsule, and are filled with a gelatinous substance. The capsules are yellowish brown in colour, and the walls of the cavity smooth and glistening in the inner side.

Capsule 2. Most of what has just been said also applies to this; we find, however, that capsules taken simultaneously from one and the same individual need not to be of the same size.

Fig. 10 shows the ventral side of capsule 2, with the fore end up. The length of the capsule from upper to lower edge 212 mm., maximal breadth 109 mm. The fore-end tubes extend abt. 20 mm. out from the upper end, and the lower abt. 25 mm. Length of the interior cavity 111 mm., maximal breadth of

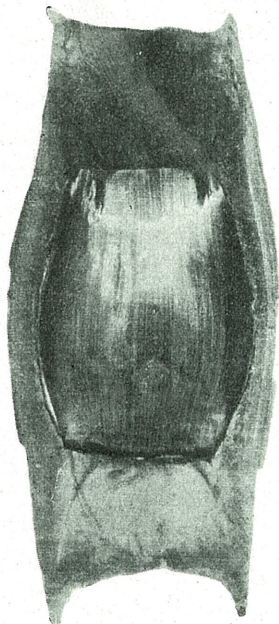


Fig. 10. Egg capsule of *R. nidrosiensis*, ²⁰/₈ 1909, Munkholm deep. The fore end tubes have fallen off.

same 75 mm. Distance from fore end of cavity to upper edge 57 mm. Thickness of capsule walls $\frac{1}{2}$ —1 mm.

Fig. 11 shows the dorsal side of the same as in fig. 10. It will here be seen that the end tubes are in reality not so short as indicated above, for as a matter of fact, these tubes should be reckoned as commencing from the corners of the capsule cavity, with which they are connected. It is only the free portion of the tubes in capsules of *R. nidrosiensis* which is comparatively short; between both apical and basal end tubes there is a disc consisting of two leaves stuck together. This is, in the case of *R. nidrosiensis*, very broad (abt. 57 mm.). On glancing at fig. 6, it will be noticed that in *R. radiata* the capsule has very narrow terminal discs. As it is an advantage to have brief terms for the various structural parts of the capsule, I suggest that the tubes at the fore end be named the apical, and those at the hinder end the basal, the corresponding terminal discs being similarly indicated as apical and basal.



Fig. 11. Egg capsule of *R. nidrosiensis*, ²⁰/₈ 1908, Munkholm deep.

On the ¹³/₁₀ 1916 I got 2 specimens of *R. nidrosiensis* from the Munkholm deep, male and female.

Female. Total length 196 cm., breadth 136.5 cm. Length from anus to the end of the tail 81 cm. On the dorsal side there were 3 series of spines, of which the middle one was least developed. The distance from the base of the 2. dorsal fin to the end of the tail was 9 cm. In the ovaries was found large and small eggs, the greatest eggs had a diameter of 5.5 cm. In both of the oviducts there was an egg capsule, the apical end of which was straightly cut and directed towards the genital opening. Yellowish threads were covering the capsules. The outer basal tube was also bent, but the inner basal tube stood straight out from the capsule. Each of the broad sides was somewhat convex and most curved was the side which lay up to the dorsal side of the fish. According to my former conclusions I suppose that the side with the greatest convexity is the ventral one. Thus the dorsal side of the capsule is likely turned to the ventral side of the fish.

In the following I shall give some measurements of the capsules:

Left capsule:		Right capsule:	
Length between the terminal discs	26 cm.	Length between the terminal discs	25 cm.
Maximal breadth	11.3 -	Maximal breadth	11 -
Length of the apical tubes	2 -	Length of the apical tubes	2 -
Length of the basal tubes	3 -	Length of the basal tubes	3 -

The yolk in each capsule formed an almost circular disc of abt. 6.5 cm. in diameter and was surrounded by a transparent gelatinous mass.

Male. Total length 174.5 cm., maximal breadth 123.5 cm. Distance from the anus to the end of tail 77 cm. On the dorsal side of the tail was only seen the middle series of spines. A quite big spine was found between the dorsal fins. Distance from the base of 2. dorsal fin to point of the tail 11 cm. Thus the tail end is comparatively longer in the male than in the female. The pterygopods reached abt. 2 cm. into 1. dorsal fin.

On the ¹¹/₁₁ 1916 I bought 2 egg capsules, which a fisherman had taken out of a *R. nidrosiensis*, caught on the same day in the Munkholm deep.

1. capsule:		2. capsule:	
Total weight	238 gr.	Total weight	230 gr.
L. between terminal discs	18.2 cm.	L. between terminal discs	18.6 cm.
Maximal breadth	10.3 -	Maximal breadth	10.2 -
Maximal thickness	4.5 -	Maximal thickness	4.5 -
L. of apical tubes	2.3 -	L. of apical tubes	2.6 -
L. of basal tubes	3.0 -	L. of basal tubes	3.0 -

The yolk was milk-white in a transparent gelatinous mass. In none of the egg capsules here described there was any macroscopic development of the embryo.

It is hardly likely that the terminal tubes in *R. nidrosiensis* are of any importance as means of attachment. There is, moreover, but little need of such, as this species, being a deep-water form, would doubtless deposit its eggs in fairly deep water. It is otherwise with *R. radiata*, the eggs of which are found in comparatively shallow water, and would thus need some such arrangement as the hooked basal tubes provide, in order to prevent their being washed up on dry land. Some writers have expressed the opinion that *R. macrorhyncus* RAF. = *R. nidrosiensis* COLLETT. I have not seen the former and can thus

express no definite opinion in the matter, but would nevertheless point out that the egg capsule of *R. macrorhyncus* drawn by Dr. WILLIAMSON (l. c. pl. III, fig. 7) differs so greatly from the capsule of *R. nidrosiensis* that I consider the identity as doubtful.

Petromyzon marinus LIN.

A specimen of this species (sea-lamprey) was brought in from Fevaag, Skjørn, where it was taken on the ¹⁰/₇ 1910 among *Zostera marina*. Total length 67 cm.

Myxine glutinosa LIN.

On the ⁷/₈ 1910, dredging at Røberg, at a depth of abt. 150 m., we brought up two eggs of *Myxine*, connected by a ribbon. The eggs measured when preserved 21 mm. in length; greatest thickness 6.5 mm. The bottom at place of capture was probably rocky.

Branchiostoma lanceolatum PALL.

A specimen of this species, l. 40 mm., was found on the ¹⁷/₈ 1909 in fine sand at Ostervaagen, Hitra, at a depth of 2—3 m.

Pl. I

Pl. I.

Figs. 1—5. Developmental stages of *Raja radiata*.

Fig. 1. Embryo from an egg-capsule, taken in Gulosen, Trondhjemsfjord, February 1909. Total length 18 mm. On the hook-shaped prolongation of the head there is a small furrow forming the first indication of the olfactory organ. Under the hook the mouth is present as an equilateral triangle. The eye may be seen as a rounded protuberance at the base of the hooked prolongation. Behind the eye there are 6 fissures, of which the first one indicates the origin of the spiraculum. For further description see p. 27.

- » 2. The anterior part in dorsal view of an embryo from Gulosen, $\frac{1}{2}$ 1910. Total length of the embryo 23 mm. (see fig. 7 in the texte). Here the commencing gill-threads may easily be seen. The pectoral fins have grown forward to the 5. gill-slit.
- » 3. From the posterior part of the embryo from Gulosen, $\frac{1}{2}$ 1910, showing granular spots, possibly integumental glands, at the edge of the dorsal and ventral embryonal fins. The flaps of the dorsal fins commence to rise out of the embryonal dorsal fin.
- » 4. Anterior part in dorsal view of an embryo from Gulosen, February 1909. Total length of the embryo 40 mm. The spiraculum is seen behind the eye as a tubular aperture. The pectoral fins have grown forward to the 3. gill-slit. In the ventral fins there is not yet any incurvation. See description on p. 28.
- » 5. The foremost part of an embryo from Gulosen, February 1909. Total length 50 mm. Here the loose flaps of the pectoral fins have grown forward past the 1. gill-slit. This figure shows the triangular oral disc, which later grows together at the lateral edges with the advancing flaps of the pectoral fins. See description on p. 29.

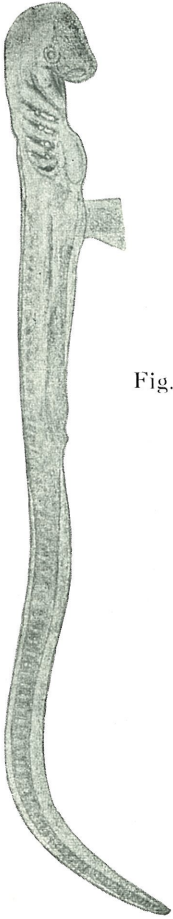


Fig. 1

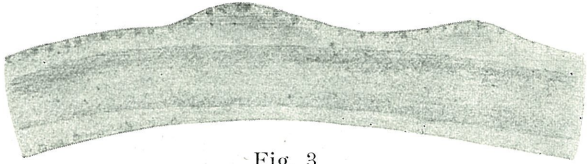


Fig. 3

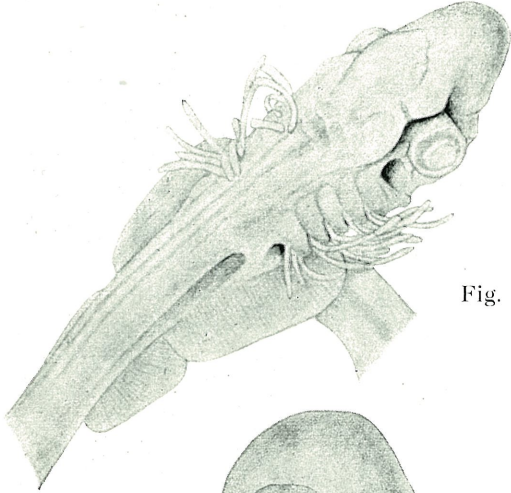


Fig. 4

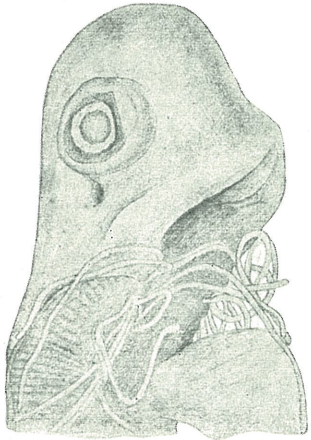


Fig. 5

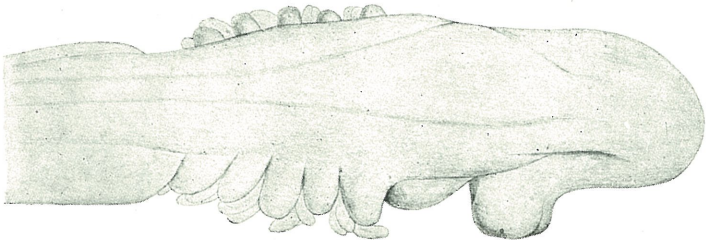


Fig. 2

Dr. Hj. Broch del.

Pl. II

Pl. II.

Figs. 6—7. Developmental stages of *Raja radiata*.

Fig. 6. Egg-capsule with embryo from Stjørdalsfjord, ¹⁸/₂ 1907. Ventral view. Total length of the embryo abt. 103 mm. Distance from 2. dorsal fin to the point of the tail 17 mm. Description on p. 31.

» 7. Embryo from the collection of the late curator V. STORM. Total length 102 mm. Distance from 2. dorsal fin to point of the tail 17 mm.

Figs. 8—10. Developmental stages of *Bothus maximus*.

Fig. 8. Planctonic young from Trondhjemsfjord, ³¹/₇ 1911. Total length 13,5 mm. Description on p. 16.

» 9. Planctonic young from the same place at the same time with a total length of 22 mm. Description on p. 16.

» 10. Young specimen taken in an eel seine in Aavikfjord (branch of the Trondhjem fjord) on the ¹⁵/₇ 1913. Total length 29 mm. Description on p. 17.



Fig. 7

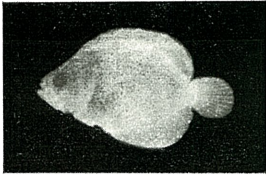


Fig. 8

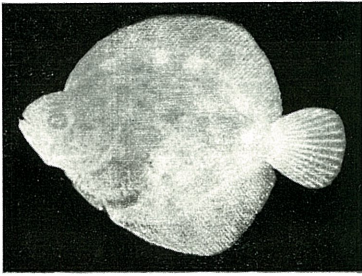


Fig. 9

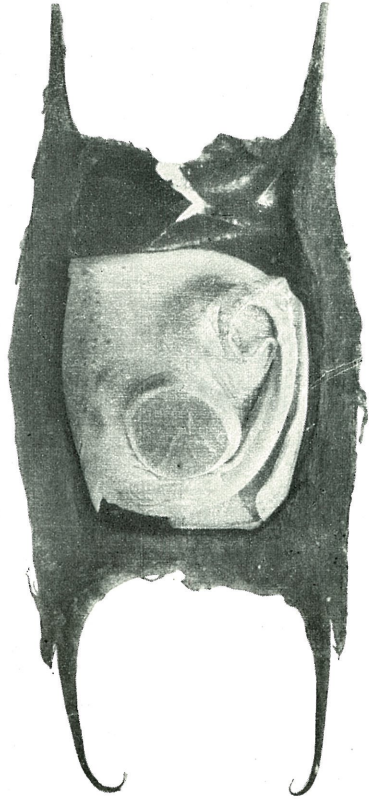


Fig. 6

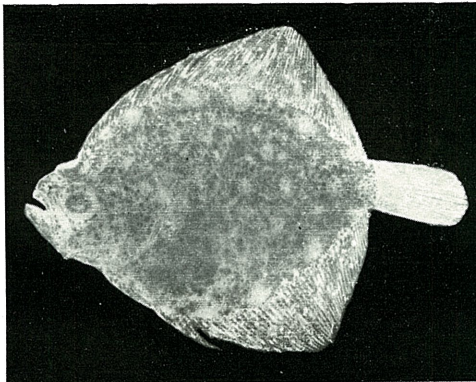


Fig. 10

Pl. III

Pl. III.

Figs. 11—13. Young specimens of *Raja radiata*.

Fig. 11. Female from near Munkholm, ²⁰/₁₀ 1914. Total length 170 mm. Description on p. 31.

» 12. The same specimen in ventral view showing the boundary between the oral disc and therewith connected flaps of the pectoral fins. Description on p. 31.

» 13. Male from near Munkholm, ²⁰/₁₀ 1914. Total length 220 mm. The small pterygopodia can not be seen in dorsal view. Description on p. 31.

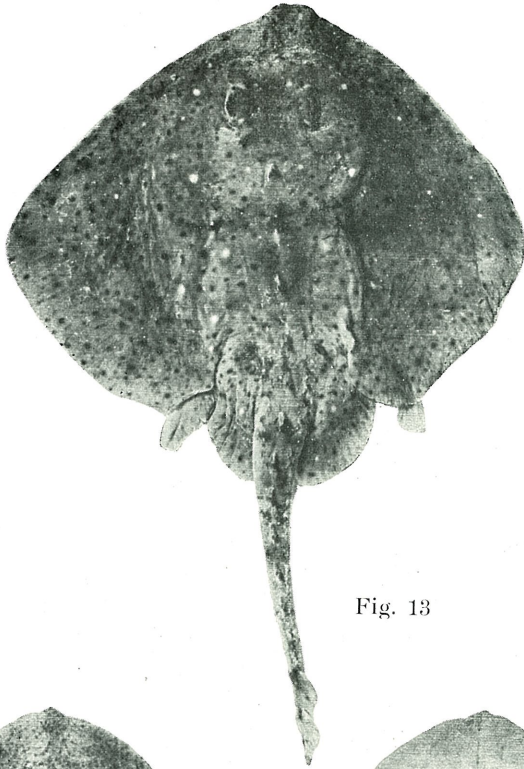


Fig. 13

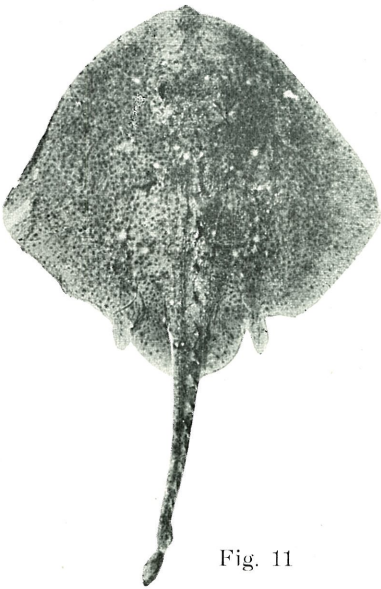


Fig. 11

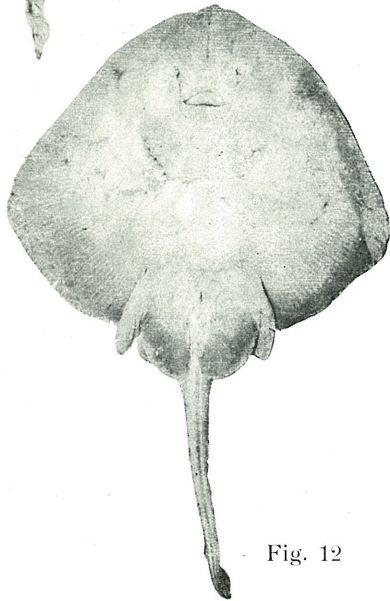


Fig. 12

