THE DANISH

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Contents of Vol. II A.

THE DANISH INGOLF EXPEDITION.

VOLUME II.

1.

THE ICHTHYOLOGICAL RESULTS.

BY

CHR. LÜTKEN.

WITH 4 PLATES, 1 MAP, 2 FIGURES IN THE TEXT AND A LIST OF THE STATIONS.

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The Ichthyological Results of the Expeditions of the „Ingolf".

By **Chr. Lütken.**

The oceanic ichthyological earnings of the 2 expeditions of the Ingolf in 1895 and 1896 are in so far rather considerable as they comprise c. 29 genera and c. 44 species; but they do not comprise many types which are new, viz. not known or described in our own days or in earlier times. But they number several forms which were not formerly known at our museum or from the northern seas more accessible to us, and there are species among them which have been known hitherto in few specimens only and thus from a very limited study-material. The knowledge of the distribution of several types is therefore now extended, as also the knowledge of their occurrence over an area hitherto little examined, and an addition somewhat considerable is thence procured to the earnings of the earlier expeditions of the Challenger, le Talisman, le Travailleur, the Blake, the Albatross, the Vöringen, the Knight Errant, l'Hirondelle and the Princesse Alice etc.

It was so far a disappointment that the expedition did not forward us several rather well known arctic or abyssal types that might have been expected, f. i. apodal *Lophioidei*, arctic picked dog-fishes, *Aphanopus* etc. The impossibility of using the weel of the prince of Monaco in seas of a northern and troublesome character and the difficulties, to say the least, of using angles must wear the blame for the deficiencies in this respect. The types, which will be specially mentioned in the following sheets and partly figured in the accompanying plates, are chiefly *Cottoidei* (in the wider, older sense of the word), the *Lycodes*, *Liparides* and allied types (*Paraliparis*), *Rhodichthys*, *Macrurus* and other deep-sea *Gadoids* and deep-sea fishes (*Alepocephalus*, *Antimora*), deep-sea-*Murænoids*, *Notacanthini* and certain *Raja*-species. That the account of *Scopelini* is rather scarce is due to the difficulties of capturing those fragile fishes. That the results as here exposed may be found somewhat uncertain in several cases — in certain difficult genera — owing in part to my personal defects, I shall not deny, but I hope that the special difficulties of those cases will be my excuse. The number of the plates I have reduced to the most necessary. I have specially made use of the colored sketches made on board of the Ingolf of animals still living or freshly caught, which made it possible to produce some colored figures.

Mr. Adolph Jensen has been kind enough to assist me with the revision of the manuscript and in other ways; I owe to him several important corrections and emendations and bestow on him my best thanks for his aid.

Skates (Rays): the genus *Raja*.

Raja hyperborea Collett.

Collett: Den norske Nordhavs Expedition. Fiskene. p. 9, pl. I, fig. 1—2.

Günther: Report on the deep-sea fishes. Expedition of the Challenger. p. 8, pl. IV, A, B, C.

Also figured in Goode & Bean: "Oceanic Ichthyology", pl. IX, fig. 28, and by Smitt in "Skandinaviens Fiskar", p. 1110—11, fig. 317—18.

The Norvegian North-sea-expedition caught a male specimen, about 20 inches (518mm) long at a depth of 459 fathoms, 115 kilometres West of Spitzbergen (Norskoerne). The "Knight Errant" captured in the Faroe-Channel a larger male, 24½ inches long, at 608 fathoms together with 2 smaller females (6½ inches) and a female (8 inches); a very young male was captured at 400 fathoms. On the "Ingolf"-expeditions were caught 3 specimens, 2 females and a male, similar in size to those of the "Voringen". The localities were the following:

Station **113** (to the south of Jan Mayen), 69° 31' Lat. North, 7° 06' Longitud. West, the depth 1309 fathoms. Temperature at the bottom ÷ 1°.0 C., nature of the bottom: *Biloculina*-clay. A female, 24¾ inches long from the point of the snout to the end of the tail, greatest breadth 20½ inch.

Station **140** (North of the Faroe Islands), 63° 29' Lat. North, 6° 57' Long. West, depth 780 fathoms. Temperature at the bottom ÷ 0°.9 C., its nature: gray mud. A female, its length 21½ inch, breadth 17 inches.

Station **141** (North of the Faroe Islands), 63° 22' Lat. North, 6° 58' Long. West, depth 679 fathoms. Temperature at the bottom ÷ 0°.6 C. Gray mud. Male: length 25 inches, breadth 18 inches.

The description of Prof. Collett may be compared with that of Dr. Günther, *loco citato*. In this Arctic Ray there is apparently no difference according to age in the physiognomy, contour etc. Nevertheless it should be noted, that the delicate dorsal spinous clothing has a larger or more complete extension in the young specimen figured by Günther than in the known larger individuals. The differences attributable to individual variation and appearing by a comparison between the specimens of Collett and Günther are enumerated by Lilljeborg (Sveriges och Norges Fiskar III, p. 604) and by Smitt (Skandinaviens Fiskar p. 1112).

I shall add some remarks on the variations in shape, spinulation etc. which make themselves apparent when comparing the specimens before me, two of which are females. The typical specimen of Collett has on both sides 3 larger spines in a series inside of the upper margin of the eye, the first pair before a line between the anterior margin of the eyes, the hindmost close behind a line between the posterior margin of the parietal foramina. There are further 2 pair of shoulder spines and in the middle line of the body a series of 26 spines and a small spine between the 2 dorsal fins. This little spine is wanting in all our 3 specimens and should therefore be omitted in the specific diagnosis. The supraorbital spines are in all as indicated above, if one of them is not lost on one side, as is apparently the case in one of them. The shoulder spines may be in 2 or 3 pairs. In the unpaired dorsal line the number of spines may be from 21 to 31. The teeth are delicate and acute and show no sexual difference with the exception that one female (from station 140) is almost quite toothless. Two of our specimens are on the back uniformly dark brown, as are those from the

Voringen -expedition; the third, a male, is adorned with numerous light specks which are however not sharply defined. On the belly this specimen is generally dark with some rather regularly distributed smaller or larger light spots; the surroundings of the mouth are white. The other female is light on the lower side of the head and on the whole median party near to the anus, but else dark. The male is generally light on the ventral side with darker patches in a fashion similar to the specimen of the Voringen , but with greater preponderance of the white or colorless parts. In the female with the dark belly the first dorsal fin is proportionally very small. The cards are relatively little developed on the back of the pectoral fins of our male, and its *appendices genitales* are not larger than in the Norvegian typical specimen (ab. 2 inches); therefore all the specimens hitherto obtained of this sex and species are relatively young, though of a rather considerable size. The flat lower surface of the tail is continued as a low dermal fold at both sides.

Raja ingolfiana Ltk. n. sp. (Tab. 1, fig. 1.).

Thus I name provisionally a male specimen of *Raja* — very young, judging from its little developed *appendices genitales* (scarcely an inch long), captured by the Ingolf -expedition at Station 32 (off Holstensborg) at a depth of 318 fathoms on 66 35' Lat. North, 56 38' Long. West, where the bottom was brownish-gray mud with very numerous *Rhabdamminæ* and some pebbles, the bottom temperature of the water 3.9° C. This probably new species belongs to the less acutely pointed species; measured in the usual manner the length of the snout equals half the breadth over the middle line of the eyes. The external angles of the disk are more rounded, less acutely pointed, its anterior margins more straight, less sinuous than in *R. hyperborea*, the external laps of the ventral fins less narrow. The tail is much stouter, both longer and more robust; its length is 12 inches, the distance from the point of the snout to the origin of the tail $13^1/_2$ inches, the total lenght thus $25^1/_2$ inch. 2 -4 supraorbital spines may be counted, some smaller ones on the back of the snout, and some scapular spines (3 placed in a triangle); in the median line of the tail and the back a dense series of 47 spines and along the lateral margins of the tail (where the lateral folds are in *R. hyperborea*) a dense series of somewhat smaller spines. There are no spines between the dorsal fins which are placed close together. Otherwise the dorsal face is only slightly spinulous with few isolated spinules and the ventral face is quite naked. Between the medial series of spines on the tail and the 2 lateral series is on both sides a zone of numerous, hardly visible asperities (spinelets); the dorsal fins are clothed in the same manner, but the ventral ones naked. The teeth are small and pointed. The ventral face of the body is whitish without spots, only with some dark parts on the lower face of the tail and the ventral fins, and delicately furrowed; the dorsal surface is brown.

Before this species can be studied in both sexes and different ages its place in the series of types in the family of Rays can not be fixed. Of the many Eastamerican species only *R. erinacea* and *ocellata* have been accessible to me, none of the more pointed species. I shall refer the reader to S. W. Garmans memoir On the Skates (*Raja*) of the eastern coast of the United States in the Proceedings of the Boston Society of Natural History , Vol. XVII (1874), p. 170 etc., to Goode and Beans Oceanic Ichthyology (1895) p. 24 30, to Gilberts The ichthyological collections of the

U. S. fish commission steamer Albatross (Report U. S. Comm. Fish etc.) 1896 and to Jordan and Evermanns: The fishes of North and Middle America (Bulletin United States National Museum Nr. 47, 1896), p. 67—76.

Raja rostro acutiusculo, pinnis pectoralibus antice rotundatis, cauda sat robusta, spinis nonnullis supraorbitalibus, rostralibus et scapularibus, c. 47 in parte mediana dorsi et caudæ, interpinnalibus caudæ nullis.

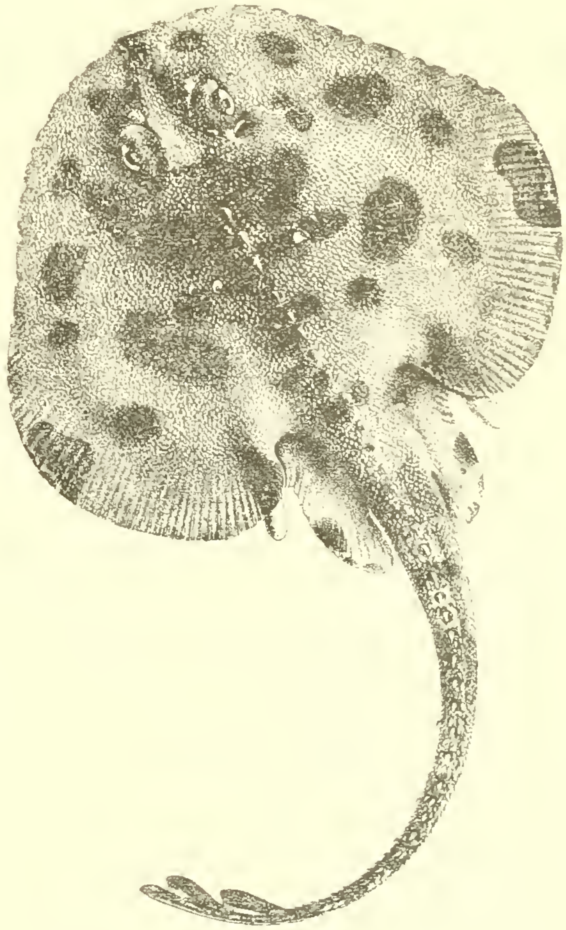
Raja Fyllæ Ltk. (Tab. II, fig. 2).

R. ornata Garman?

A male specimen captured on Station **25** off Godthaab (63° 30′ Lat. North, 54° 25′ Long. West, at 582 fathoms, at a temperature at the bottom of 3°.3 C.), which has a length of 555^{mm} (about 21 inches) and a greatest diameter of the disk of 310^{mm} (11$^{3}/_{4}$ inches), and whose large *appendices genitales* demonstrate that it is adult and capable of procreation, agrees else completely with another specimen somewhat smaller (470^{mm}), taken in 1889 in the Denmark Strait at 426 fathoms, and referred by me (Videnskabelige Meddelelser fra den naturhistoriske Forening 1891, p. 32) to the *Raja Fyllæ*, established not long time before (ibid. 1887, p. 1—4, pl. I) by me as a new species on a younger female specimen from the same seas. This specimen, which is thus the proper original specimen of the species, had, to be sure, in many respects another aspect, and it was therefore with some doubt that I identified the adult male from the Denmark Strait (1889) with the young female from the Davis Strait (1884). I was induced to this determination by the fact, that other species of Rays were not known at that time from the Greenland seas than *Raja Fyllæ* and *R. radiata*, and by the examination of a couple of still younger males from the Davis Strait (likewise from 1889). The new capture from 1895 induced me to take up the question again and to examine as far as possible, if the difference of age or sex is so large as supposed by me or if a specific difference had been overlooked. The two elder specimens I shall mention together, designating however the larger figured Ingolfian specimen (from 1895) as No. I, the somewhat smaller one (from 1889) as No. II.

The incisions of the margins of the disk (at the height of the parietal foramina) are still sharper defined in No. I than in No. II. The other portion of the pectoral fin is rounded in a corresponding manner in both. The genital appendages are 110^{mm} long in No. I, 105^{mm} in No. II. There are larger and smaller spines in a marginal zone more or less broad, commencing at the point of the snout and terminating somewhat before the terminal portion of the groups of pectoral cards which are generally speaking comprised in the said zone; the following zone, comprising the rest of the back of the pectoral fins and of the trunk, is naked with the exception of the proper median party, which begins at the point of the snout, embraces the interorbital space and is continued over the median portion of the trunk and the whole backside of the tail. Covered with larger spines of the *R. radiata*-type are especially the back of the snout, the space between the eyes especially the supraorbital margin, a rather broad scapular party with many spines and a broad zone at the median part of the back, continued on and covering the whole dorsal part of the tail. According to the more or less pronounced stoutness of the tail, there may be counted 3, 4 or 5 spines beside each other, forming rather regular rows, with numerous fine or somewhat larger spinules on the lateral margins of this part of the body. The teeth are small, fine and pointed; I counted c. 34 rows from one corner of the mouth to the other. The dorsal fins are closely approximated, not even completely separated. The specimen No. I is light grayish on the back, uniformly dark on the belly; on the other hand No. II is quite white on the belly, light brownish-grayish on the back. On the ventral face there are, as most commonly in the Skates, no thorns at all.

A younger male, 201^{mm} long and 106^{mm} broad, from the Davis Strait (235 fathoms) with minute genital appendices is mentioned by me previously (l. c. 1891, p. 32). I therefore restrain myself to some brief remarks on this specimen, compared with the here described adult males. The point of the snout is hardly visible as such. The pectoral margin of the disk is slightly sinuous, not forming a quite straight line; but a sharp incision does not occur. The back is quite covered with small spines until towards the posterior margin of the pectoral fins; also the ventral fins are partially thorny, while at a later stage they are naked. But between this uniform clothing of the trunk, the fins and the tail some spines a little larger make their appearance, some on the back of the snout, 3 pairs of supraorbitals, one pair of suprascapulars and a single row of about 37 in the median line of the back, commencing behind the head and continued almost to the dorsal fins on the tail — accompanied on the back of the tail by middle-sized spines forming the transition to the general clothing with spinelets. Thus during the growth of the animal a rich development of larger spines takes place untill the above described stage of evolution is attained. The color of the back is brown with some more or less distinct round specks and 2 lighter parties on each pectoral, rather posteriorly. The ventral surface is light with brownish spots and marbled.



Raja Fyllæ jun. fem. The typical specimen, somewhat diminished.

A still younger male, 115^{mm} long and 60^{mm} broad, likewise from the Davis Strait at 289 fathoms depth, has no distinct point of the snout and no sinuation of the margin of the disk. The spinulation is essentially the same as in the first described younger male, with the difference that there are a few more supraorbital and scapular spines (a group of three on each side of the median line) and that on the tail only the median series is of a superior size. The dorsal surface is handsomely painted with larger or smaller round spots or belts (on the tail) which partially also are apparent on the thinner portion of the pectorals and ventrals.

The young female, previously described and figured by me — historically then the type of the species 198^{mm} in length and 101^{mm} in breadth — from the Davis Strait at the depth of 80 fathoms, resembles the younger males just bespoken, especially the youngest, in shape, spinulation and coloring, which it is not necessary to specify nearer, as the actual reproduction here in the text (p. 5) gives the necessary details. It may be observed however that the colored spots are much smaller than in the smallest male at hand. As older females are not at hand, it can not yet be said if those will habitually be more like the adult male, or how great the difference will turn out between the sexes in the sexually mature state.

Raja ornata Garman which has only been better known to me from fig. 24 of the Oceanic Ichthyology resembles so much to my *R. Fyllæ*, that it would desire a closer examination to determine if it is not the same species, what perhaps is not unlikely. It must be observed however that of the specimens hitherto bespoken of *R. ornata* the typical specimen is from Florida (Alligator Key) at 138 fathoms, the 3 others from 142 fathoms at 32° 24' Lat. North, 78° 44' Long. W., thus from a much more southern zone, a circumstance that might weaken the presumption of this identity, for whose confirmation an immediate comparison would be necessary.

Deep-sea-Eels: *Synaphobranchus* and *Nemichthys [Serrivomer]*.

Of the former genus of deep-sea-eels the Ingolf has brought home 2 specimens, that I have been able to compare with a specimen of *Synaphobranchus pinnatus* from the Northamerican deep-sea expeditions.

Under the name of *Synaphobranchus pinnatus* is mentioned in the Catalogue of fish collected and described of L. Th. Gronov edited by J. E. Gray (1854), a Murænoid described in the Museum Ichthyologicum of Gronov, II, p. 11, Nr. 161, which typical specimen was however wanting in Gronovs collection and therefore not passed to the British Museum, when the museum purchased the said collection. But Johnson & Lowe obtained some specimens at Madeira and the latter described it as *Synaphobranchus Kaupii* (Proceed. Zool. Soc. 1862, p. 169). After Dr. Günther having in his Catalogue of Fishes in the British Museum (VIII, 1874) renamed it with the specific name of Gray and Gronov, it occurs now in the ichthyological literature again as *Synaphobranchus pinnatus*. The American deep-sea-investigations have demonstrated its occurrence at depths of 304—740 fathoms in the sea off the eastern shores of the United States (f. inst. between the St. George bank and South-Carolina). Goode og Bean in Bull. Mus. Comp. Zool. X, p. 223 enumerate 84 specimens from 33°—39° Lat. North and 65°—76° Long. West. Compare the Oceanic Ichthyology p. 143, fig. 164. A great number of Stations is enumerated. The expedition of the Challenger discovered it in greater or smaller numbers of specimens at different stations (off Brasil, south of Japan and south of the Philipines etc.) at depths of 214—1200 fathoms. The French expeditions (le Travailleur, le Talisman) have brought together a great number (56) of specimens from the coast of Marocco and the west coast of North

Africa, from the Azores and from the Canarian and Capoverdian islands and from depths between 405 og 3200 Metres. Also the prince of Monaco obtained it at the Azores in great numbers, in several draughts of the weel, partly in the company of *Simenchelys parasiticus*, relatively 251 and 328 specimens. Compare: Collett's Résultats des campagnes scientifiques, Poissons p. 154. The *S. pinnatus* is figured by Günther (Report on deep-sea fishes pl. 62, fig. A) and by Vaillant (Expéditions scientifiques p. 88, pl. 6, fig. 2). Other species of the same genus are figured and described: *S. bathybius* Gthr. (south of Japan, in the northern part of the Pacific and between Cape and Kerguelen, Report on deep-sea fishes p. 254, pl. 62, fig. B), at 1375 2050 fathoms, perhaps identical with *Histiobranchus infernalis* Gill. (Proc. Un. St. Nat. Mus. VI, 1884, p. 255), The Atlantic: 38° 30' 30" Lat. North, 69 08' 25" Long. West, depth 1731 fathoms. Compare also the Oceanic Ichthyology p. 145, fig. 165. The authors of this work take the genera *Synaphobranchus* and *Histiobranchus* as different, partly also the species of *H. bathybius* and *H. infernalis*, and it would therefore be the most correct thing to retain the later name for the northatlantic type. Further: *S. brevidorsalis* Gthr. (l. c. p. 255, pl. 63, fig. C) from North of New Guinea and South of Japan (345 1070 fathoms).

Ingolf captured 2 specimens of a *Synaphobranchus* (or, according to Goode and Bean, of a *Histiobranchus*), 16 and 18½ inch. long, at the stations **36** and **37** on 61° 50' Lat. North, 56 21' Long. West and on 60° 17' Lat. North, 54 05' Long. W., depth 1435 and 1715 fathoms where the bottom was a grayish or light chocolate-coloured mud and the bottom-temperature 1°.5 or 1°.4 C. It will be sufficient to state of those *Histiobranchi* of the Ingolf, that the small pectorals (of the length of the snout) the position of the anus and the fact that the dorsal fin reaches almost to the head, make it evident that they do not belong to *Synaphobranchus pinnatus*, but either to *H. bathybius* or to Gill's *H. infernalis*, if these are not synonyms.

The geografical distribution of the same species will at the same time be elucidated as far as it is known at present.

Nemichthys (Serrivomer) Beanii Gill & Ryder.

Of this species Ingolf captured on the Stations **12** and **20**, at 64° 38' Lat. North, 32 37' Long. West, and on 58° 20' Lat. North, 40 48' Long. W., in the Denmark Strait and S. S. E. of Cape Farewell, at a depth of 1040 and 1695 fathoms, on a bottom of soft mud with pebbles and a bottom-temperature of 0°.3 and 1°.5 C. two not fully well preserved specimens of the said deep-sea-eel-genus. A third somewhat better was obtained at Station **45**: 61 32' Lat. N. and 9 43' Long. W., West of the Faroe Islands on a depth of 643 fathoms, light gray muddy bottom with *Globigerina*-shells and a bottom-temperature of 4°.17 C. It is a rather large specimen, 26 inches long; it is noted in the zoological Journal of the expedition in the following manner: lower side of the head quite black, the sides of the trunk and back bronzeously gilt with numerous fine black points.

Goode and Bean have in the Oceanic Ichthyology given a figure (fig. 175) of *Serrivomer Beanii* Gill & Ryder which agrees well with the 3 specimens at hand. The shape is much elongated, the length of the head from the point of the beak to the branchial fissure being contained 6 7 times in the total length, further on somewhat compressed and tapering to a long pointed tail, whose length reckoned from the anus is three fourths of the total length. The jaws are moderately elongated, the length of the upper jaw measured from the anterior margin of the eye is contained twice and a half in the whole length of the head. The mouth reaches backwards under the eyes, which are not absolutely small. The branchial openings are very wide, obliquely placed slits in the median ventral line, almost continuous. The jaws are armed with fine teeth, and the vomer wears a long series of densely placed pointed teeth. The very small pectorals are placed at the upper end of the branchial slit. The dorsal fin is represented by a series of very delicate and short rays beginning somewhat behind the anus, also the rays of the anal fin are very feeble, but perhaps somewhat longer. The soft blue-black skin is more or less lacerated in all the 3 specimens but partially preserved. The measures are the following:

Total length	680mm	570mm	510mm
The length of the head to the branchial slit	100 -	93 -	85 -
The length of the beak to the corners of the mouth	42 -	37 -	35 -
Trunk and head from the point of the snout to the anus	170 -	135 -	123 -
Length of the tail from the anus	510 -	435 -	387 -

The *Serrivomer Beanii* was known hitherto from a single specimen caught by the "Albatross" at 41° 40' 30" Lat. North, 65° 28' 30" Long. W. and at 855 fathoms depth. It is described by Gill and Ryder in 1883 (Proc. U. S. Nat. Mus. VI, p. 260) together with a related type *Spinivomer Goodei*, also taken by the "Albatross" in the northern Atlantic likewise in a single specimen. Both the generic names are derived from the armature of the vomer with large teeth. Goode and Bean have in the "Oceanic Ichthyology" p. 155 distinguished them as a separate group of nemichthyid murænoids: *Spinivomeridae*, to which is further referred the *Nemichthys (Serripes) Richardi* Vaill., captured by the "Talisman" at the Azores on 2995 fathoms and originally considered by Vaillant ("Exp. scientifiques Travailleur et Talisman", p. 93, pl. VII, fig. 1—1 a) as identic with Günthers: *Nemichthys infans* (Chall. Rep. vol. XXII, p. 264, pl. 63), but in the "Appendice" (p. 385) to the said work established as a separate species.

Alepocephalus Agassizii Goode et Bean.

Besides the *A. rostratus* already known to Risso from the Mediterranean and from adjoining parts of the Atlantic as far as the Azores, the Canarian and Capoverdian islands — for which species besides the older figures by Risso and Valenciennes I may refer to Vaillants "Expéditions scientifiques" (pl. XI and XII) and to "Oceanic Ichthyology" (p. 36, fig. 41) — some other atlantic species have been described especially by American ichthyologists: *A. Agassizii* G. B., *A. productus* Gill, *A. Bairdii* G. B., *Conocara Mc. Donaldi* G. B. and *A. (C.) macropterus* Vaill., for which species I may refer to "Oceanic Ichthyology" p. 37—39, fig. 45, 46, 47, 48 og 43. A further addition is *A. Giardi* (Koehler: Résultats scientifiques de la campagne du "Caudan", Annales de l'Université de Lyon fasc. III, p. 513, pl. XXVI, fig. 1) at a depth of 800—1410 metres, Bay of Biscay. On the second cruise of the "Ingolf" was obtained an *Alepocephalus*, 20¼ inch long (530mm), no doubt an *A. Agassizii*, at

Station **83**: 62° 25′ Lat. N., 28° 30′ Long. W., at a depth of 912 fathoms, S. W. of Iceland, with a bottom-temperature of 3°.5 C. The height of the body is contained somewhat more than 5 times (1 : 5.3) in the total length, reckoned to a line between the points of the caudal fin; the length of the head (164^{mm}) is one third of the total length (to the cleft of the caudal fin); the diameter of the eye equals the distance from the eye to the point of the snout, not one fourth of the length of the head; the upper jaw terminates in a line with the posterior border of the pupil; the breadth of the somewhat hollow front is somewhat smaller than the ocular diameter or the snout.

On the southern and eastern hemisphere *Alepocephalus* is partly represented by *Bathytroctes*, which should perhaps be united with *Alepocephalus*. Of the 10 species enumerated in «Oceanic Ichthyology» 7 are Atlantic.

Scopelini.

Species of *Scopelus* are caught at 8 stations, but they have almost all suffered so much from their being taken in dredges or the trawls, that the light-spots are only visible in part. Some specimens I have identified as *S. elongatus*; the others belong to the less elongate species. The following list therefore tells, that in the zone traversed by the Ingolf between 61° and 65° Lat. North are to be found the species of *Scopelus* enumerated at the noted depths, on the bottom, if they are not captured during the hawling up of the implements used; but experience will also show that it is not through bottom fishery, that one may procure a good material of these animals, equalling that furnished by the surface.

I refer the reader to my «Bidrag til nordisk Ichthyographi VIII. Nogle nordiske Laxesild (Scopelini)» in the «Videnskabelige Meddelelser fra den naturhistoriske Forening i Kjobenhavn», 1881, and to «Spolia Atlantica, Scopelini Musei Zoologici etc.» (K. D. Vid. Selsk. Skrifter 6. Række, VII, 6).

Stat.	Lat. N.	Lgtd. W.	Fathoms	
12:	64° 38′	32° 37′	1040	(Denmark Strait, W. of Iceland) *Sc. elongatus* Risso and *Sc. glacialis* Rhdt.
17:	62° 49′	26° 55′	745	(S. W. of Iceland) *Scop. arcticus* Ltk.
25:	63° 30′	54° 25′	582	(W. of Godthaab) *Scop. arcticus* Ltk.
27:	64° 54′	55° 10′	393	(S. W. of Sukkertoppen) *Scop. glacialis* Rhdt.
35:	65° 16′	55° 05′	362	(same place) *Scop. glacialis* Rhdt.
40:	62° 00′	21° 36′	845	(S. of Iceland) *Scop. elongatus* Risso.
81:	61° 44′	27° 00′	485	(S. W. of Iceland) } *Scop. glacialis* Rhdt.
141:	63° 22′	6° 58′	679	(East of Iceland) } *Scop. glacialis* Rhdt.

Cyclothone (Gonostoma) microdon Gthr.

For this widely diffused species I shall refer to my remarks in my «Korte Bidrag til nordisk Ichthyographi VIII» («Videnskabelige Meddelelser fra den naturhistoriske Forening» 1891, p. 216–19, article 5 on *Gonostoma (Cyclothone) microdon* Gthr. and to my description and figure in my «Spolia Atlantica, Scopelini Musei Zoologici etc.» (K. D. Vid. Selsk. Skr. (6) VII, 6, tab. II, fig. 4–5). At an early time (1843) we got this little Scopelid from the Baffin Bay. The «Challenger Expedition» got it from many places in the Atlantic (both in its northern and southern parts) and in the indo-pacific sea (S. of Japan, N. of New Guinea, off Amboina etc.). Other localities are cited by Vaillant (l. c., *Neostoma quadrioculatum*), by Alcock (»Ann. Mag. Nat. Hist.» 1889, p. 399, the Bengal Bay and the Andamans at 265—485 fathoms), by Collett (»Campagnes scientifiques«, p. 130), and by Gilbert (»The ichthyol. Coll. of the U. S. F. C. St. Albatross«, Report U. S. Comm. Fish. a. Fisheries for 1893, p. 402, the Bering-Sea) and in »Oceanic Ichthyology« p. 100. The distribution of the species turns out to be almost cosmopolitic. The latter work cites besides the *C. microdon* (*lusca* G. & B.) *C. bathyphila* Vaill., *C. elongata* Gthr. (*stigmaticus* Gill.), *C. gracilis* Gthr. and *C. quadrioculatus* Vaill., already mentioned as probably identical with *C. microdon*. On the expeditions of the »Ingolf« the *C. microdon* has several times been captured as appears in rather deep water; some of the specimens are, it is true, rather damaged. The station-list given below will at least illustrate the frequency of these small fishes in the subarctic zone of which it treats.

Station	Lat. N.	Lgtd. W.	Fath.	
9:	64° 18′	27° 00′	295	West of Iceland.
11:	64° 34′	31° 12′	1300	West of Iceland.
12:	64° 38′	32° 37′	1040	West of Iceland (numerous specimens).
17:	62° 49′	26° 55′	745	Southwest of Iceland.
18:	61° 44′	30° 29′	1135	Entrance of Denmark Strait.
21:	58° 01′	44° 45′	1330	South of Greenland.
25:	63° 30′	54° 25′	582	Southwest of Godthaab.
36:	61° 50′	56° 21′	1435	Southwest of Sukkertoppen.
40:	62° 00′	21° 36′	845	South of Iceland.
67:	61° 30′	22° 30′	975	Southwest of Iceland.
76:	60° 50′	26° 50′	806	Southwest of Iceland.
81:	61° 44′	27° 00′	485	Entrance of Denmark Strait.
83:	62° 25′	28° 30′	912	Somewhat more to the North.
84:	62° 58′	25° 24′	633	Denmark Strait.
91:	64° 44′	31° 00′	1236	Likewise.
95:	65° 14′	30° 39′	752	Likewise.
96:	65° 24′	29° 00′	735	Likewise.

The depth thus varied, after the trawling journal, from 295 to 1435 fathoms. The bottom-temperatures noted varied from 0°.3 to 6°.1 C. The »Ingolf« expeditions never got this species north of the ridges between Greenland and Iceland, and between Iceland and the Faroe-Islands. On most of the enumerated stations there was fished with vertical nets too, reaching to a depth of 100—200 fath. withouth any *Cyclothone* being caught, although small fishes and young ones were taken.

Cyclothone (?) megalops n. sp. ad int. (Table 4, fig. 6).

Together with a great number of *Cyclothone microdon* captured at Station 12 — 64° 38′ Lat. N., 32° 37′ Long. West, 1040 fathoms — there occurred a single specimen of a length of 70^{mm}, habitually looking much like the said species, but differing by the eyes not being particularly small and by totally wanting the light-glands or »photospheres«. It can therefore apparently hardly be referred to the same genus. The dorsal and anal fins are very like those of *C. microdon*, though with the difference that the dorsal fin begins somewhat before the anal fin, while this on the other hand ends somewhat farther back than the dorsal fin. Quite black. — A somewhat larger specimen (105^{mm}) from Station 9 — 64° 18' Lat. North and 27° Long. W., 295 fathoms — is so badly preserved, that it gives only the information that the eyes are not small and that both jaws are armed with small teeth directed obliquely backwards, with a few longer ones in the foremost part of the lower jaw and the foremost part of the palate or the intermaxillary. The nearer determination of this specimen must be reserved for a future discovery.

It seems evident that these specimens belong to species else unknown, but as the material is so scanty I shall limit myself to the short preliminary notes made above.

The Notacanths.

For a long time, only few specimens of the remareable group, the *Notacanthini*, were known of the type termed *Campylodon* (»Bugtetanden«) by Otto Fabricius (Skrifter af Naturhistorie Selskabet, Vol. IV, fasc. II (1798), p. 22—38, pl. 9, fig. 1), but inserted in the system as *Notacanthus Chemnitzii* Bl. (Abhandlungen der böhmischen Gesellschaft, 1787) or as *Notacanthus nasus* Bl. (Ausländische Fische, IX, Allgemeine Naturgeschichte der Fische, XII, p. 113 (1793), pl. 431); Schneider, »Systema ichthyologiæ« (1801), pl. 77. The older Reinhardt designated it in his »Ichthyologiske Bidrag« (Vidensk. Selsk. Skr. VII) p. 120 as *Campylodon Fabricii*, but now-a-days it is generally better known as *Notacanthus nasus*. These few specimens are 1) The original Greenland specimen of Fabricius, which, it must be deplored, in the course of time has been lost — I can not say at what time. 2) The specimen received by Bloch from Chemnitz, probably from Iceland, though it was stated to come »from India«. It is described and figured in Cuvier's and Valenciennes's »Histoire naturelle des poissons« VIII, p. 467, pl. 241. It is still preserved, as has been stated subsequently, in the Berlin-Museum in a rather deteriorated condition. 3) A third large specimen was received at our museum in 1871 from Greenland; it is mentioned and partly described by me in 1878 in the »Videnskabelige Meddelelser fra den naturhistoriske Forening«. 4) The specimen obtained from Iceland for the Museum of Paris on the voyage of »la Recherche« or rather as a consequence of this voyage (Gaimard: Voyage en Islande et au Gronland, Poissons, pl. XI); Vaillant mentions this specimen (Expéditions scientifiques p. 316) as being from »Greenland«, but that is not correct. It is figured twice in the édition illustrée du »Règne animal« de Cuvier (Poissons pl. 55, fig. 2) and in the above quoted itinerary by Gaimard. The question if these 4 arctic specimens should perhaps represent more than a single species did not attract the attention for a long time to come. But now some Mediterranean species were discovered: *Not. Bonapartii* Risso (Archiv für Naturgeschichte 1840, p. 376; Mem. Acad. d. Sc. Torino, t. XVIII, p. 190) and *N. mediterraneus* Fil. & Verany (Mem. Acad. d. Sc.

Torino, t. XVIII, p. 187; Vaillant: Recherches scientifiques etc. p. 325, pl. 27, fig. 2). Further an Australian species (*N. sexspinis* Richardson, «Voyage of H. M. ships Erebus and Terror», Fishes p. 54, pl. 32, fig. 4—11; described and figured again in Günther's »Report on deep-sea fishes» (Challenger) p. 243, pl. 60, fig. 9—15 and pl. 61, fig. A). Then, in deeper water on the eastern side of North America were found 2 species: *N. analis* (Gill: Proceedings United States National Museum, VI (1883, p. 255) and *N. phasganorus* (Goode: Proc. Un. St. Nat. Museum, III (1881), p. 435, »Oceanic Ichthyology» p. 167, fig. 186). The question did now arise, if the individual or specific variation had not been supposed to be larger than it is in reality, and if not one or some of the arctic specimens enumerated above could be referred to the species established by the American authors. Léon Vaillant has expressed the opinion that the Icelandic specimens from »la Recherche» could be referred to *N. phasganorus* Goode. My own earlier studies of the material at hand or described elsewhere induced me to conclude that the then known Icelandic or Greenlandian specimens should be determined as *N. nasus*. According to Mr. Bean and Goode (»Oceanic Ichthyology» p. 166) *N. Bonapartii* and *N. mediterraneus* should not be different, but some authors are of the opinion, that the species from the westcoast of South America designated with one of these names (*N. Bonapartii*, Günthers »Report» etc. p. 249, tab. 61, fig. C) is a proper species and genus, now termed *Gigliolia Moseleyi* (»Oceanic Ichthyology» p. 169, fig. 187, 193).

To quite another type belongs a *Notacanthus* of the subgenus *Polyacanthonotus* Gthr. and of the particular subdivision termed *Macdonaldia*, brought home by »Ingolf»s expedition in 1895. The species has already been described twice by Collett (»Diagnoses de poissons nouveaux provenant des campagnes de l'Hirondelle»: Bulletin de la Société zoologique, 1883, p. 307; and »Résultats des campagnes scientifiques par Albert Ier, prince souverain de Monaco, pars X, Poissons provenant des campagnes du yacht l'Hirondelle», 1896, p. 48, pl. 5, fig. 21) and by Brown Goode & Tarleton Bean (A revision of the order *Heteromi*, deep-sea fishes, with a description of the new generic types *Macdonaldia* and *Lipogenys*, Proc. Unit. Stat. National Museum t. 17 (1894), p. 455, pl. 18, fig. 2; »Oceanic Ichthyology» p. 171 pl. 51, fig. 189 and pl. 52, fig. 195). Of other species belonging to the same type are known the Mediterranean *N. rissoanus* (Filippi & Verany: Mem. Acad. Sc. Torino, t. XVIII, p. 190; Vaillant: »Expéditions scientifiques» p. 335, pl. 27, fig. 1, coast of Marocco, 2212 metres) and the Japan form, designated by Günther (Report on deep-sea fishes p. 250, pl. 61, fig. B; Vaillant l. c. p. 387) under the same name, but to which Vaillant and the oft mentioned American scientists now agree to apply a new name (*N. Challengeri* Vaill.).

As *Polyacanthonotus (Macdonaldia) rostratus* Coll. is new for the ocean bespoken here the Ingolfian specimen deserves to be mentioned in a more particular fashion. As in the related species the body is elongate, somewhat compressed and tapers to a rather flagelliform caudal portion; the head is small and terminates in a soft, somewhat pointed snout. The total length to the point of the caudal fin is 355^{mm}; the greatest hight (over the anus) c. 29^{mm}, approximatively $^1/_{12}$ of the total length (the specimen described by Collett was 480^{mm}, the tail being 275^{mm}, the greatest height 37^{mm}, the length of the head 46^{mm}). The distance from the point of the snout to the anus is 120^{mm}, or about $^1/_3$ of the total length, that of the tail the double of the length of the head and the trunk taken together or $^2/_3$ of the whole. The eyes are small, their diameter and the distance between them being 5^{mm} or $^1/_8$

of the length of the head (to the posterior border of the gill-cover); the length of the snout from the eye to the point of the snout is 13^{mm} or $^1/_3$ of the total length of the head, from the mouth to the point of the snout about the half (6^{mm}); the mouth is small, semilunar in shape and situated on the lower side of the snout, the corners of the mouth are vertically below the anterior nostrils. The nostrils are placed close together before the eye. The teeth are fine. The upper jaw ends posteriorly with a rather strong spine.

The pectoral fins have a length of 18^{mm}; their rays are 14. The ventral fins number 10 rays, none of which can be termed a spinous ray, the external one being however thin and delicate. The row of spinous dorsal rays begins exactly over the posterior border of the branchostegal membrane; it numbers 33 spinous rays (the specimen of Collett had 27, that of Goode & Bean 28—31, *N. Challengeri* 34, *N. rissoanus* 37), they are short and isolated, their mutual distance somewhat surpassing their length, but they become longer and more distant from each other posteriorly; the connecting dermal part is very slight. The spinous rays of the anal fin are also short, but nevertheless much longer than those of the dorsal fin, and they are much more closely approximated to each other than the dorsals. As they approach to the soft rayed portion the connecting dermal skin becomes more distinct. The number of these spinous rays can be reckoned to be about 45 (in Collett's specimen 53, in that of Goode and Bean it is given as 42—53; in *N. Challengeri* 54, in *N. rissoanus* 27), but an absolute limit can not be drawn between the spinous and the soft-rayed part of the fin, when the rays, preserving their undivided shape, become longer, more delicate, articulate and united with a full fin-membrane. The number of rays in this anal fin may be counted as about 190 (perhaps 192—93). In the last part of the tail the hight of the anal fin considerably exceeds that of the tail itself. A caudal fin of 4 rays may be pointed out.

The scales are very delicate. A distinct lateral line may be traced forwards from a point under the last spinous dorsal ray but three; after this point it is less distinct, and is likewise becomes indistinct towards the eye, but reappears then distinctly as an infraorbital line. On the trunk proper its position is nearer to the back than to the belly, but as the body decreases in height its position becomes nearer to the middle height of the body. On the snout are seen several pores, especially a distinct series of such along the inferior margin of the preopercle and of the lower jaw. The colour is a light chocolate colour, somewhat spotted, the opercle is internally black, pellucid towards the margin; also the lips; the inferior portion of the anal fin is also relatively dark.

Our only specimen of this *Polyacanthonotus* or *Macdonaldia* was taken at a depth of 362 fathoms on station **35** (65° 16' Lat. North, 55° 05' Long. West). The bottom was a brownish mud with arenaceous foraminifera and pebbles; the temperature was 3°.6 C. The specimen of the prince of Monaco was taken off Newfoundland on a depth of 1267 metres, those of Goode and Bean at 551 and 563 fathoms, at 39° 47—48' Lat. North and 70° 30—36' Long. West. The vertical distribution may therefore be fixed provisionally at 360—960 fathoms, the geographical distribution to the western part of the Atlantic from Newfoundland to the Baffin Bay.

Cyclopteridæ and *Liparididæ*.

Cyclopterus (Eumicrotremus) spinosus (Fabr.).

Of this well-known arctic species the «Ingolf»-Expedition has brought home a young specimen captured southwest of Sukkertoppen on station 33, 67° 57' Lat. North, 55° 30' Long. West, at 35 fathoms, sandy bottom, with a bottom-temperature of 0°.8 C.

The species is known from Greenland, Norway, Iceland and Spitsbergen and from some parts of the east coast of America («Oceanic Ichthyology» p. 272) and from the Bering-Sea as *Cyclopterus orbis* Gthr. (Catal. Fishes III, p. 158). It is also noted in Gilbert's paper of 1896 on the north-pacific fishes (p. 448) with a note that the identity of *C. orbis* and *C. spinosus* ought to be confirmed through the confrontation of both types, while *C. orbis* is named without any further remark in Jordan and Starks's «The fishes of Puget Sound» (1895) p. 829 (Leland Stanford jun. University publications, Proceedings of the California Academy of Sciences, Series II, vol. V).

Liparis Reinhardti and L. micropus Gthr.

Those, who may have consulted my little paper of 1886 on the *Liparidæ* («Dijmphna expedition») or that of Collett from 1880 («Norske Nordhavs Expedition»), will be aware, that the results arrived at by us with respect to the northern Liparids were generally the following. We know 1) a *Liparis Montagui* Don. and 2) a *Liparis lineatus* (Lepechin), both of which make their appearance in unicoloured, spotted and striated varieties, the latter type perhaps identical as species with *L. tunicatus* and to be considered as a minor variety or stage of evolution of the arctic form, which can attain a considerable size and be furnished with a sort of small corneous tubercles or scales. 3) *Liparis Fabricii* Kr. (with the variety *L. leprosa* m.), best known from the Kara-Sea, determined after an original specimen of Kroyer's species, but after my opinion not to be identified with *L. tunicatus*, as it will be seen has been done. 4) *L. Reinhardti* Kr., regarded by several as type for a particular genus (*Careproctus*), what I do not find necessary, but further identified with *L. gelatinosus* Pall., perhaps correctly, though I can not take upon me the responsibility of his identification.

The result arrived at by F. Smitt in his great and handsome work on the «Fishes of Scandinavia» does not differ much, but somewhat from that exposed above. He has 1) a *Cyclogaster Montagui*; 2) a *C. liparis*, comprising a) as «*forma microps*» the varieties *C. lineatus, vulgaris, barbatus* and *tunicatus*, b) as «*forma megalops*» my *L. Fabricii*; 3) *C. gelatinosus* Pall. ɔ: *L. (Careproctus) Reinhardti*, to which *Liparis (Careproctus) micropus* Gthr. perhaps also must be reckoned as a synonym.

I shall add a review, as short as possible, of the further and extra-Scandinavian development of the *Liparis*-question. Garman's monograph of the *Discoboli (Cyclopteridæ, Liparopsidæ* and *Liparididæ)* (Memoirs of the Museum of Comparative Zoology at Harvard College vol. XIV, No. 2) distinguishes first a division, *Cyclopteridæ* with the genera and species: *Cyclopterus (lumpus), Eumicrotremus (spinosus* and *orbis)* and *Cyclopteroides gyrinops*. The last mentioned type from St. Paul's Island (Alaska) is distinguished partly by the position of small barbels along the margin of the lower jaw (cp. the figures t. XI, fig. 4—9; p. 37 it is said in a less definite manner: «chin with tubular pores, or barbels«). The second division *Liparopsidæ* comprises *Cyclopterichthys ventricosus* (Pallas) [identified with the *Cyclopterus glaber* of Steindachner (»Ichthyologische Beiträge« X, p. 14, pl. 8) from Kamschatka and the sea of Okotsh] and *Cyclopterus amissus* Vaillant (Strait of Magellan, »Mission scientifique du Cap Horn« p. 33) and *Liparops Stelleri* (Pallas). Among the true *Liparididæ* are mentioned of the genus *Liparis* 1) *L. Montagui* (t. VII, fig. 6—20 and VIII, fig. 8—11) with several synonyms from European and Eastamerican places 2) *L. mucosus* Ayr. (Tab. V, fig. 1—5, Tab. IX, fig. 1, Tab. X, fig. A) (California, Alaska etc.); 3) *L. calliodon* (Pall.) identified with *L. cyclopus* Gthr.) (t. VI, fig. 1—5) (Kamschatka); 4) *L. liparis* L. (= *L. lineatus* Lepech., Kr.), *L. vulgaris* Fl., *L. barbatus* Ekst. (from European and American seas) Tab. VII, fig. 1—5, 21, 22; 5) *L. antarctica* Putn. (t. VI, fig. 6—10), according to Gill an *Enantioliparis* (southmost part of Southamerica). To the genus or subgenus *Careliparis* is referred 1) *C. liparis* Bl. Cuv. (= *L. gibbus* Bean) (tab. I—III) (Behring's-Strait etc.), 2) *C. tunicatus* Rhdt. (*L. arctica* Gill, *Fabricii* Kr., *lineatus* Coll. p. p., 3) *C. Steineni* Fischer (*Enantioliparis*, South-Georgia), 4) *L. pulchellus* Ayr. (t. IV, t. V, fig. 6—8, t. VIII, fig. 4—7, 12—14), 5) *L. pallidus* Vaill. (Tierra del Fuego, »Missions scientifiques« pl. IV, fig. 3). Under *Careproctus* are noted *C. micropus* Gthr. (Challenger, Report pl. XII, fig. B); the *Gymnolycodes Edwarsii* of Vaillant (»Expéditions scientifiques« t. 26, fig. 3) is thought perhaps to be the same species, further *C. major* (of which more below) *C. gelatinosus* (Pall.) and *C. Reinhardti*, which is not identified with *C. gelatinosus*, but with *L. ranula* G. & B.

In »Oceanic Ichthyology« are named, not only *Paraliparis* and the nearest allied apodal types, the so called *Amittrinæ*, 3 genera of true Liparids, viz 1) *Liparis* (Artedi): Expl. *Cyclopterus liparis* L. = *C. lineatus* Lepech., Kr., *L. vulgaris* Fl., *L. barbatus* Ekst. 2) *Careliparis* (compare the monograph of Garman cited above). 3) *Careproctus* Kr., distinguished after the old definition by the ventral disk being small and placed below the head. Further is noted *L. (C.) Reinhardti* Kr., in which some have meant to recognise the *Cyclopterus gelatinosus* of Pallas and which is therefore termed *C. gelatinosus* (Pall.); an allied type is designed *C. spectrum* Bean from Alaska; further a *C. ranula* G. & B. (fig. 251), fished off Halifax, and *C. micropus* Gthr.; and finally a species termed *C. major*, answering to the *Liparis* or *Actinochir major* of the Northamerican ichthyologists (the denomination after the »*Cyclopterus liparis var. major*« of Fabricius) and identified with the Greenlandian *L. tunicata* and with the *L. Fabricii* described in »Kara-Havets Fiske« (after my opinion identical with Krøyer's species of the same name, but in no way with *L. tunicatus* Reinhardt). A doubt (well founded I believe) is also expressed, whether this *Liparis* be really a *Careproctus*!

Of other Liparids are named in Jordans and Starks's paper on the fishes of Puget Sound *Neoliparis Floræ* and *N. Greeni*, *N. mucosus* Ayr., *N. callyodon* Pall. (= *L. mucosus* Garm.), *L. cyclopus* Gthr., *L. Dennyi* J. St., *L. fucencis* Gilb. and *L. pulchellus* Ayr. Others are further mentioned in Gilbert's »The ichthyological collections of U. F. C. St. »Albatross« during 1890—91« from the sea off the coast of California: *Careproctus melanurus* G. with the rather important remark, that the »disk« becomes smaller with age, but that its place like that of the anus remains unaltered. Further are named from Unalaska and Alaska etc. a *Careproctus ectenes* Gr., *C. Colleti* G., *C. phasma* G., *C. simus* G., *C. ostentum* Gilb. (the disk reduced to a rudiment), *Gyrinichthys* (n. g.) *minytremus*, *Rhinoliparis* (n. g.) *barbulifer*, *Bathyphasma* (n. g.) *ovigerum* Gilb., *Liparis pulchellus* Ayr., *L. cy-*

clopus Gthr., *L. Agassizi* Putn., *L. cyclostigma* Gilb., *L. fucensis* (= *L. calliodon*) Garman, *Neoliparis callyodon* Pall. (= *L. mucosus* Garm.), *L. gibbus* Bean.

This synopsis should approximatively illustrate the actual floating condition of this rather hopeless *Liparis* question "per tot discrimina rerum".

Some specimens brought home by the "Ingolf" expedition (generally in a less good condition) from cold and deep water are perhaps better or equally correctly to be termed *L. micropus*. Of the relation between this species and *L. Reinhardti* I shall not give a personal opinion. After the localities they are from

Station	Lat. N.	Long. W.	Fath.	
34:	67° 17′	54° 17′	55	Sandy bottom, Bottom-temp. 0°.9 C. West of Greenland, Davis Strait.
67:	61 30′	22 30′	975	Bottom-temp. 3° C. South of Cape Reykjanæs.
92:	64 44′	32° 52′	976	Bottom-temp. 1°.4 C. West of Iceland, Denmark Strait.
116:	70 05′	8° 26′	371	Brown Biloculina clay, Bottom-temp. ÷ 0°.4 C. South of Jan Mayen.
126:	67 19′	15° 52′	293	Grayish brown, blue clayish mud, Bott.-temp. ÷ 0°.5 C. North of Iceland.
141:	63 22′	6° 58′	679	Gray mud, Bottom-temp. ÷ 0°.6 C. North of Faroe Islands.

Thus all specimens were from depths or under conditions where the temperature at the bottom was at the highest 3° C. or below (÷ 0°.6).

A large and handsome specimen (Tab. III, fig. 3 and 3a) from the station **139** (63° 36′ Lat. North, 7° 30′ Long. West, depth 702 fathoms, gray clay, bottom-temperature ÷ 0°.6 C.) surpasses in size (270mm) widely every other known specimen of *L. Reinhardti*. I have had it figured with the aid of a coloured sketch made on the "Ingolf". The differences, that may be found between this individual and other existing descriptions of *Liparis (Careproctus) Reinhardti (gelatinosus)* should perhaps essentially be attributed to the fact, that with the exception of the original type of Pallas ordinarily only smaller (younger) specimens have been studied, while we here have the rare success to have before us an older, adult specimen. On the other hand I can not deny the possibility that it may be identical with one of the other established *Careproctus*-species, or maintain absolutely its identity with Pallas's *L. gelatinosus*, on which the older Reinhardt had already fixed the attention for the type which at a later time bore his name. The length of the fish is stated above; the length, breadth and the height of the head are 55mm, 45mm and 55mm. The largest height behind the head is 74mm; when it apparently decreases relatively slowly backwards, this appearance is due to the considerable height of the dorsal and anal fins. The transversal breadth of the mouth is 35mm; along the upper jaw and between the nostrils 7 pores are seen, along the lower jaw one and in the continuation thereof 7. A couple of low tubeformed nostrils with a mutual distance of 17mm are seen anteriorly on a line, that would unite the anterior margins of the eyes; their distance from the eyes is 7mm, from the margin of the jaw 12mm. The diameter of the globular eyes is 11mm, their mutual distance 32mm and from the jaws' margin 13mm, the height of the branchial cleft 17mm. The whole number of pectoral rays is 31; the pectorals meet approximately below the head; as in the smaller individuals they get a fringed appearance, the rays continuing beyond the connecting membrane, especially those in the anterior (or undermost) part of the fin, where their free portion may obtain the length of 39mm. The small ventral disk has a diameter of 12^{mm}; it is situated under the centre of the eyes. The dorsal fin numbers c. 40 rays, the caudal fin 10, and the anal fin c. 40 rays.

It will perhaps be useful to print here the following extract of Jordan and Starks's conspectus of the American species of *Liparis* and *Neoliparis* („The fishes of Puget Sound" p. 837 og 834).

a. *Liparis*: number of vertebræ c. 39; radii dorsales c. 35; radii anales 27—30.
  b. The gill-clefts very narrow, entirely over the base of the pectorals; rad. caudales 12. *L. liparis.*
  bb. The gill-clefts larger, partly below the uppermost pectoral ray.
    c. Radii pectorales 30; rad. caudales 12. *L. cyclopus* (l. c. pl. 97).
    cc. Radii pectorales 41—43; rad. caudales 15—20. *L. fucensis.*

aa. *Careliparis* Garm.: Number of vertebræ c. 46; radii dorsales 40—44; radii anales 35—36.
  d. Radii pectorales 35—36.
    e. Gill-clefts small, not reaching beyond the first pectoral ray.
      f. *L. tunicatus.*
      ff. *L. Agassizii.*
    ee. Gill-clefts large, reaching down to the fourth pectoral ray. *L. Dennyi* (l. c. pl. 98).
  dd. Radii pectorales 42; gill-clefts large, reaching to and beyond the upper part of the pectorals. *L. cyclostigma.*

aaa. *Actinochir*: Number of vertebræ c. 52; radii dorsales 45—48, radii anales 38—40, radii pectorales 34—37.
  g. *A. pulchellus.*
  gg. *A. major.*

Neoliparis.

a. Gill-clefts very narrow, not reaching beyond the third pectoral ray.
  b. Anterior nostril distinctly tubiform.
    c. Radii dorsales c. 30, radii anales 24. *N. montagui.*
    cc. Radii dorsales 34—36, radii anales 25—28. *N. callyodon* Pall. (*L. mucosus* Garm.).
  bb. Anterior nostril not distinctly tubiform. Radii dorsales 32, radii anales 26. *N. mucosus* (l. c. pl. 95).

aa. Gill-clefts relatively large; nostrils not distinctly tubiform.
  d. Radii dorsales VI + 27, radii anales 21—23, radii pectorales 30. *N. floræ* (l. c. pl. 96).
  dd. Radii dorsales VI + 34, radii anales 30, radii pectorales 35. *N. greeni* (l. c. pl. 96).

Paraliparis bathybii (Coll.).

The establishment of this hitherto unknown form was based upon a single specimen, 208^{mm} long, taken on the Norwegian North-Sea-Expedition to the North Sea, on a depth of 568 fathoms, west of Beeren-Island; it wanted the ventrals, and it had at that time to be left in doubt, whether this was a constant deficiency or it was only due to an accident. It was therefore referred to the genus *Liparis* with the annotation, that it would perhaps form a proper genus (Den norske Nordhavs-Expedition, Fiskene p. 52, t. 2, fig. 14). Then the British Museum also received a specimen, 7½ inches long, fished by the Knight Errant on the North-Sea-Expedition of this vessel in the Faroe Channel on a depth of 640 fathoms (Challenger, deep-sea fishes p. 68, pl. XII, fig. C). It turned out that it really wanted the ventrals and consequently an adhesive disk, formed by them, but is was not confirmed — what has not been found by me neither — that under the chief portion of the pectoral are found c. 4 rudimentary rays; but it was confirmed, that the pectoral fin did consist apparently of 2 divisions, a greater of 12 rays and a smaller party, divided from the other, of 3 rays. At the same time Goode and Bean described a *P. Copei* G. & B. and a *Amitra* or *Monomitra liparina* Goode, which in Oceanic Ichthyology p. 277 is upheld as a proper genus; the localities where these types are found in the northern Atlantic are noted in the said work, where also sketches of them are given (fig. 252 and 253). Concerning the small *P. membranaceus* Gthr. (Challenger, Report etc. p. 69, pl. 12, fig. D) which in the Oceanic Ichthyology is raised as the type of a proper genus, *Hilgendorfia*, it would be more correct to postpone one's judgement until a larger material is at hand. Finally I shall add, that in the Oceanic Ichthyology is mentioned (in the Appendix p. 525) a *Paraliparis rosaceus* Gilb. from the Pacific, and that M. Gilbert (The ichthyological collections of U. St. F. Comm. St. Albatross 1890 91, 1896) further has described a *P. holomelas, ulochir* and *cephalus* from the northern part of the Pacific and a *P. dactylosus* from California.

As M. Collett and Dr. Günther have given a full account of *Paraliparis bathybii* there will be no necessity for occupying myself further with it here. The number of vertebræ is 10 + 54. I shall only give a list of the 6 stations, which have given the 18 more or less well preserved specimens at hand, of which the 2 largest had a length of 185mm—220mm.

Stat.	Lat. N.	Long. W.	Fath.	Bottom-temp.	Condition of the bottom
104:	66° 23'	7° 25'	957	÷ 1°.1	Light grayish brown mud. East of Iceland. 1 specimen.
105:	65° 34'	7° 31'	762	÷ 0°.8	Light brown mud. Likewise. 7 specimens.
111:	67° 14'	8° 48'	860	÷ 0°.9	Brown Biloculina-clay. Northeast of Iceland. 1 specimen.
117:	69° 13'	8° 23'	1003	÷ 1°	Light Biloculina-clay. South of Jan Mayen. 6 specimens.
119:	67° 53'	10° 19'	1010	÷ 1	Light Biloculina-clay. Between Iceland and Jan Mayen. 1 specim.
140:	63° 29'	6° 57'	780	÷ 0°.9	Gray mud. North of the Faroe Islands. 2 specimens.

Blenniodei, Ophidini.

Gymnelis viridis Fabr.

Some few specimens were caught on Ingolf's expedition at localities, S.W. off Sukkertoppen, viz:

Station	Lat. N.	Long. W.	Fathoms	
29:	65° 34'	54° 31'	68	Davis Strait. Sandy bottom, Temperature at the bottom 0°.2 C.
34:	67° 17'	54° 17'	55	Davis Strait. Temperature at the bottom 0°.9 C.

In the Denmark Strait it is previously taken at a depth of 80 fathoms.

The largest Ingolfian specimen is 136mm. The ornamental markings, which concist of lighter and darker transversal bands are on the whole not strong. Some of the specimens have 1, 2 or 3 dark spots on the foremost part of the dorsal fin.

The Norwegian North-Sea Expedition got 4 specimens north of Jan Mayen and Spitsbergen, where it also has been found earlier; it is also known from the east coast of Greenland, f. i. Heklas port at a slight depth (the expedition of Ryder). It has also been found in the Kara-Sea and in Barents-Sea and in the arctic part of the Pacific (Unalaska, at a depth of 49 fathoms).

Lumpenus lampetræformis Walb.

is the only northern *Lumpenus*-species brought home in few specimens from a locality Southwest of Sukkertoppen, Station **34**: 67° 17' Lat. North, 54° 17' Long. West, depth 55 fathoms, temperature at the bottom 0°.9 C. The largest specimen had a length of 190mm. On the distribution of the species may be consulted Collett, Lilljeborg, and "Oceanic Ichthyology".

Flounders.

Drepanopsetta (Hippoglossoides) platessoides (Fabr.).

Of this Pleuronectoid the "Ingolf" expedition has returned some specimens from

Stat.	Lat. N.	Long. W.		Fathoms	
26:	63° 57'	52° 41'	Davis Strait.	34	Bottom sand and shells, temperature 0°.6 C.
33:	67° 57'	55° 30'	Likewise.	35	Bottom gray sand, its temperature 0°.8 C.
35:	65° 16'	55° 05'	Likewise.	362	Bottom brownish mud with arenaceous foraminiferes, tp. 3°.6 C.

known with us as "Haa-Isingen", identical with *Pleuronectes limandoides*, not only from Greenland, also from Iceland, Beeren-Island, Spitsbergen, the Faroe Islands and along the Scandinavian and the Northeuropean shores, from the Murmanian coasts and East-Finmark to the Sound, at Kiel and the southern Danish seas and also from the English-French channel; on the American side to Cape Cod.

The genus *Lycodes*.

It will be well known to the ichthyologists, especially to those studying the arctic fauna, that to distinguish between the species of this genus is connected with special difficulties, because the colouring varies much in the same species, especially after the age, but also individually, likewise the extension of the squamation, and it is therefore extremely difficult to fix the limit between the species by means of characters that may be confided on. As our museum possesses now more or fewer specimens of 15 *Lycodes*-species from the Polar sea, the northern part of the Atlantic[1]) and the Californian part of the Pacific one should hope, that the difficulties might be overcome. But nevertheless my report specially for this department must be given with a certain restraint. The scientific literature amply testifies, that it is a more easy matter to make mistakes in this department than to avoid them. A greater lucidity will not be obtained until the collected material has attained a completeness that at present is only obtained for a few species among the many.

[1]) As this genus was not found formerly in any of the Danish seas, it should be remarked that a fish of this genus, 155mm long, was taken in 1893 in Læso Rende, afterwards several in the Skager-Rack (jfr. S. 21) viz a *Lycodes gracilis* M. Sars.

Lycodes muræna Coll.

A specimen 10¾ inches long (275mm) was obtained in the Davis Strait between Godthaab and Sukkertoppen, at Station **27**: 64° 54' Lat. N., 55° 10' Long. W., at a depth of 393 fathoms (a temperature of 3°.8 C. at the bottom, which consisted of a soft gray clay with numerous pebbles, mostly granite). It agrees substantially with the figure and description of Collett («Den norske Nordhavsexpedition», Fiskene, p. 116, pl. IV, fig. 29—31; compare also F. Smitt: «Skandinaviens Fiskar» p. 618 and Günther's «Deep-Sea Fishes: Challenger Expedition» S. 79, tab. 12, fig. A). The species has been taken in several instances by the said Norwegian expedition at the banks off Helgeland, Beeren-Island and Spitsbergen (Norsk-Oerne) on depths of 350—658 fathoms, the bottom brown, green or bluish-gray clay, the bottom temperature being ÷ 0°.9 à ÷ 1°.2 C. *L. murœna* is further taken by an English expedition in the «Faroe-channel» at 540—608 fathoms. In 1896 «Ingolf» obtained further 12 younger specimens at the following stations:

Station	Lat. N.	Long. W.		Fathoms	Bottom temp.
65:	61° 33'	19°	South of Iceland.	1089	3° C.
102:	66° 23'	10° 26'	East of Iceland.	750	÷ 0°.9 C.
104:	66° 23'	7° 25'	Likewise.	957	÷ 1°.1 C.
105:	65° 34'	7° 31'	Likewise.	762	÷ 0°.8 C.
117:	69° 13'	8° 23'	South of Jan Mayen.	1003	÷ 1° C.
125:	68° 08'	16° 02'	North of Iceland.	729	÷ 0°.8 C.
139:	63° 36'	7° 30'	North of Faroe Islands.	702	÷ 0°.6 C.

The larger specimen from Stat. **27**, the only squamate, has larger eyes than the smaller and younger ones, apparently also a less flattish head and a shorter snout. It is therefore not quite certain that it is identical as species with these. The size of the younger specimens lies between 203mm and 108mm. Of the scales nothing is seen in these smaller specimens. In the larger of them the length of the head is scarcely ⅛ of that of the whole body (trunk and tail), in the smaller ones it varies between 1 ÷ 6.5 and 1 ÷ 8.1. With 2 exceptions (Stat. **27** and **65**, where the bottom temperature was + 3°.8 and + 3°) all these specimens were from stations with a bottom temperature below zero.

Of allied species with a similar longish eel-like shape some other species are described 1) *L. Verrillii* G. & B., 2) *L. paxillus* G. & B. (into which «*L. paxilloides*» is afterwards drawn as a synonym), for these species may be consulted the «Oceanic Ichthyology» p. 309—11 and 527, fig. 277, 279, 280 and 282. Further 3) *L. (Lycodonus) mirabilis* Goode & Bean (Günther: Deep-Sea Fishes, Challenger Report etc. p. 81); 4) *L. (Lycodophis) albus* Vaill. («Expéditions scientifiques du Travailleur» p. 309, pl. 26, fig. 1), caught at a depth of 3975 metres on the way between the Azores and France, and 5) *L. (Lysenchelys) porifer* Gilb. (Proceed. Un. St. Nat. Mus. XIII (1890), p. 104), from South California at a depth of 857 fathoms.

Lycodes frigidus Coll.

«Den norske Nordhavs Expedition», Fiskene, p. 96, pl. III, fig. 24; «Oceanic Ichthyology» p. 335, fig. 274.

As I have no doubt that the numerous specimens of a *Lycodes*, taken in larger or smaller specimens in the eastern part of the North Sea, at the stations enumerated below, belong to the said species, which is carefully described and excellently figured in the Norwegian work cited here, I shall limit myself to a few remarks. As characteristic for *L. frigidus* may be mentioned the uniform dark or brownish colour and the uniform delicate squamation on the entire body to the occiput and the branchial orifice and on the belly. Further the lateral-ventral side-line, starting from the upper end of the branchial orifice, then arches downwards, running parallel with the lower margin of the tail in a great extent. Young specimens (until 110mm length) are entirely naked, in the somewhat greater ones the scales cover a smaller or larger part of the tail, and in the more mature state of the fish they spread over the trunk and the belly.

The Ingolfian specimens are from the following stations.

Stat.	Lat. N.	Long. W.		Fathoms	Condition of the bottom	Bottom temp.
102:	66° 23'	10° 26'	East of Iceland.	750	Brown mud	÷ 0°.9 C.
104:	66° 23'	7° 25'	Likewise.	957	Light grayish brown mud	÷ 1°.1 C.
110:	66° 44'	11° 33'	Likewise.	781	Brown mud	÷ 0°.8 C.
111:	67° 14'	8° 48'	Northeast of Iceland.	860	Brown mud	÷ 0°.9 C.
112:	67° 57'	6° 44'	Likewise.	1267	Biloculina-clay	÷ 1°.1 C.
113:	69° 31'	7° 06'	South of Jan Mayen.	1309	Biloculina-clay	÷ 1°.0 C.
117:	69° 13'	8° 23'	Likewise.	1003	Light Biloculina-clay	÷ 1°.0 C.
118:	68° 27'	8° 20'	Likewise.	1060	Light Biloculina-clay	÷ 1°.0 C.
119:	67° 53'	10° 19'	Between Iceland and Jan Mayen.	1010	Light Biloculina-clay	÷ 1°.0 C.
120:	67° 29'	11° 32'	Northeast of Iceland.	885	Light Biloculina-clay	÷ 1°.0 C.
124:	67° 40'	15° 40'	North of Iceland.	495	Brownish gray blue mud with short arenaceous foraminifera	÷ 0°.6 C.
125:	68° 08'	16° 02'	North of Iceland.	729	Brown mud	÷ 0°.8 C.

The largest specimen of the "North-Sea Expedition" has a length of little more than half a meter; a specimen of a little larger size in the "Ingolf"-collection reminds so much of the *L. reticulatus* Gthr. ("Challenger Expedition" p. 77, pl. XIII), that I must regard them as absolutely identical. The specimens of the "North-Sea Expedition" were from the seas around Beeren Island and Spitsbergen. From the American expeditions of the "Albatross" a series of localities is indicated ("Oceanic Ichthyology" l. c.).

Lycodes Esmarkii (Coll., l. c. p. 84, pl. II, fig. 19—21 and pl. III, fig. 22).

A specimen, 260mm in length, from Station **138**: North of the Faroe Islands (63° 26' Lat. North, 7° 56' Long. West, depth 471 fathoms, temperature at the bottom ÷ 0°.6 C.) having 5 light bands over the dorsal fin and the back and with both a medio-lateral and a ventro-lateral lateral line, agreeing well with Colletts fig. 21, represents this type in the collections of "the Ingolf". Previously known from the banks off Lofoten and from the north-west coast of Spitsbergen and from several points of Finmarken (260—459 fathoms).

Lycodes Lütkenii Coll. (l. c. p. 103, pl. III, fig. 25).

Is likewise taken formerly west of North-Spitsbergen (459 fathoms) and in the Kara sea. The Ingolf Expedition got 6 specimens from station **116**: South of Jan Mayen (70° 05′ Lat. North, 8° 26′ Long. W.), depth 371 fathoms, temperature at the bottom ÷ 0°.4 C. The coloration is essentially as in the specimen figured by Collett: 6–8 light bands.

Lycodes perspicillum Kr. (*L. reticulatus* Rhdt. juv.?). (Tab. IV, fig. 5.)

A young (42^{mm}) specimen of this species with the characteristic dress of many young Lycodidæ — a series of 10 darkly bordered saddle-spots across the back — was fished on sandy bottom off Sukkertoppen, Davis Strait (Station **29**), 64° 34′ Lat. N., 54° 31′ Long. W., at a depth of 68 fathoms.

L. gracilis Sars.

To this species, after having conferred with my colleague, Prof. Collett, I have referred two specimens from station **31**: Davis Strait (66° 35′ Lat. North, 55° 54′ Long. West, depth 88 fathoms, temperature at the bottom 1°.6 C.) They are $5^1/_2$ and $9^1/_4$ inches long, both covered with scales. The relation between the length of the head with the trunk and the entire length ($100^{mm} \div 244^{mm}$ and $55^{mm} \div 143^{mm}$) is about $1 \div 2^1/_3$ à $2^1/_2$. In colour they are light with more or less distinct traces of the juvenile dress.

L. gracilis was known from a small specimen (43^{mm}) from the Christiania Fjord (Nordhavs Expeditionen p. 106) and is later found again in Læso Rende and in the Skager Rack in adult specimens. I suppose that Prof. Collett will give a full account of the species in its more developed condition as it is now known.

L. pallidus Coll.

(Nordhavs-Expeditionen p. 110, pl. III, fig. 26, 27; Lütken: Kara Havets Fiske p. 134, pl. 17, fig. 1–3.)

Of this species there are from the Ingolf-Expedition:

Station	Lat. N.	Long. W.	Fathoms	Temp. at the bottom	
101:	66° 23′	12° 05′	537	÷ 0°.7 C.	East of Iceland.
104:	66° 23′	7° 25′	957	÷ 1°.1 C.	
105:	65° 34′	7° 31′	762	÷ 0°.8 C.	
116:	70° 05′	8° 26′	371	÷ 0°.4 C.	South of Jan Mayen.
124:	67° 40′	15° 40′	495	÷ 0°.6 C.	North of Iceland.
126:	67° 19′	15° 52′	293	÷ 0°.5 C.	
138:	63° 26′	7° 56′	471	÷ 0°.6 C.	North of the Faroe Islands.
141:	63° 22′	6° 58′	679	÷ 0°.6 C.	

Hitherto known from the northern coast of Spitsbergen, 260–458 fathoms (Collett) and from the Kara sea (Lütken). The specimens from the Ingolf expedition have a size reaching to 245^{mm}. The larger specimens are scaled on the belly and uniformly light brown without marks of transverse bands or design on the fins, the smaller have bands on the fins and partly on the body, but want the scales on the belly.

Note. It will perhaps be useful to resume how matters stand at present with the synonymy of the species of *Lycodes* named here. *L. reticulatus* is founded by the older Reinhardt („Forste Bidrag til Grønlands ichthyologiske Fauna" p. 167, t. VI) on specimens from Greenland. Collett (l. c. p. 84) refers to the same species the following descriptions: *L. polaris* Ross. (Spitsbergen), *L. polaris* Mlmgr. (Öfvers. Vet. Akad. Förh. 1864, p. 516) likewise from Spitsbergen, *L. perspicillum* Kr. (from Greenland) and *L. gracilis* Sars (from Christianiafjord). In his great work „Skandinaviens Fiskar" F. Smitt draws the limits of this species still wider, embracing under it not only the type: Reinhardt's *L. reticulatus* and Günther's of the same name („Challenger" p. 77, pl. XIII; which after my opinion as stated above is a large *L. frigidus* Coll.!) and the type described by me under the same name from the Kara Sea („Dijmphna" T. 17, fig. 4—5) as also the *L. perspicillum* of Krøyer (regarded also by Collett and myself as a *L. reticulatus*), but also *L. seminudus* Reinhardt from Greenland and Spitsbergen), by Collett (l. c. p. 113, t. IV, f. 28) upheld as a proper species and further *L. Lütkenii* Coll. (l. c. p. 103, t. 111, fig. 25) a name adopted by me for fishes from the Kara Sea („Dijmphna" p. 128, T. 16, fig. 1—6); and further Beans *L. Turneri* from Alaska (Proc. Un. St. Mus. I, 463), and *L. coccineus* (l. c. IV, p. 144) and my *L. pallidus* („Dijmphna" p. 134, t. 17, fig. 1—3) and finally *L. mucosus* Rich. (Belcher p. 362, t. 26) the type of Bleeker's genus *Lycodalepis*. Of these supposed synonyma the authors of „Oceanic Ichthyology" only cite the „*L. perspicillum* Kr.", „*L. Rossii*" Mlgr. and „*L. gracilis* Sars" to *L. reticulatus*, while they notwithstanding cite (p. 307) a „*L. perspicillum* Kr." as a peculiar type found by the „Albatross" on depths of 59 and 86 fathoms (45° 24'30" Lat. North, 58° 35'15" Long. West and on 47° 29' Lat. North, 25° 18' Long. West). It must also be noted that „*L. mucosus*", formerly only known from the description and picture by Belcher „Last of Arctic Voyages" (Northumberland Sound, afterwards found again in Cumberland Sound) is now described and figured in „Oceanic Ichthyology" (p. 306, t. 78, fig. 273 and t. 81, fig. 283, a, b) after a specimen 17 inches long from Northumberland Sound. In the work cited are not mentioned the species of Bean, mentioned by Smitt (*L. Turneri* and *L. coccineus*; the one being from Alaska, the other from „Big Diomede Island"). I shall further add, that the later paper by H. Gilbert („The ichthyological collections of the U. S. F. Comm. St. Albatross", 1896), containing „Report of the fishes collected in Bering Sea and the North Pacific Ocean during the summer of 1890", describes and figures several new genera and species of the *Lycodes* tribe, while some other species of Gilbert are named, whose original descriptions are not known to me at present. For me and my collaborator it has been a relief in our task, that the „Ingolfian" species were well known to us from Scandinavian ichthyological works.

The *Macrurus* group.

It is well known, that no other group of fishes has received such an accession through the deep-sea-investigations as the Macruridæ („Skolæsts" or „Berglax" as they are termed in Scandinavia). They were known in 1872 in 10–11 species; in the report of the „Challenger expedition" their number is grown to 47, including the species fished by the Northamerican expeditions and published at that period; the French expeditions have added 9–10 species, the Indian 12. Counting the species cited in the „Oceanic Ichthyology" I arrive at the number 80, by American and other ichthyologists it is later increased to 94 or more. Through the two „Ingolf" expeditions there are collected 6 species at least. The difficulty to distinguish species, which after all are very nearly similar, is augmented by the alterations undergone with age by the individuals. My task has been relieved by the „Smithsonian Institution" having in the most benevolent manner placed at my disposal 5 species of duplicates from the American fishings. But there is one difficulty, which is still hardly overcome, viz., to get the large material of c. 100 described species distributed in good genera and subgenera in a satisfying manner. Provisionally I may refer to the list of genera in Oceanic Ichthyology, where 17 genera (or subgenera?) are recognised, to which may be added an 18th, later proposed (*Coelocephalus* Gilbert & Cramer). Until further information I retain the name *Macrurus* as a common name for all the arctic and subarctic species here mentioned.

Macrurus Fabricii Sundev. (*rupestris* Fabr. non Gunn.).

The name *M. berglax* Lac. which has been substituted in later times for this species is less convenient for this form, so well known in Greenland, as one will more easily understand it as alluding to the *M. (Coryphænoides) Strømii*, the Berglax of the Norwegians. The largest Ingolfian specimen has a length of 21 inches, it has therefore not the full size of the species; the smallest is only $4^1/_2$ inches. The stations and localities where they were taken, are

Station	Lat. N.	Long. W.	Fathoms	Temp. of the bottom	
27:	64° 54′	55° 10′	393	3°.8 C.	all from the Davis Strait.
32:	66° 35′	56° 38′	318	3°.9 C.	
35:	65° 16′	55° 05′	362	3°.6 C.	
38:	59° 12′	51° 05′	1870	1°.3 C.	

These localities are partly from the Davis Strait, West of Holsteinsborg and Sukkertoppen, partly from the entrance to the Davis Strait. What shortly can be said of the distribution of the species outside this region is, that it is known more southward, from George's Bank, from the port of New York, were it was found floating at the surface, and from 41° 47′ Lat. North, 65° 37′ 30″ Long. West at a depth of 677 fathoms, and further from the eastern part of the North Sea, the Finnish and Norwegian coasts.

The characters which make this species recognisable are the obtuse shape of the head, the rounded snout, the large eyes whose diameter is the double or more of the breadth of the front between them and equal with or larger than the length of the snout from its points to the orbital margin, the numerous keels along the sides of the trunk and tail, the back and belly, produced by every scale having a strong denticulate keel; on large specimens there is commonly only one such keel, but the greater scales of the head have commonly more (3, 4 or 5) such keels, diverging from forwards backwardly. These larger scales form partly more prominent groups on the opercles and preopercles, partly rows especially on the median line of the snout, round the orbits, along the lower lateral margin of the head etc. A larger naked spot before the eyes gives room for the nostrils; before these there is in larger specimens a smaller naked spot on each side, close to the point of the snout. Below the inferior lateral margin bespoken the skin is naked or only covered with smaller asperities, and the same is the case with the two branches of the lower jaw. In half-grown specimens it is evident, that on the ordinary scales there are besides the chief keel several more or less distinctly serrated accessory keels, 1, 3 or 4 on each side of the chief keel; but the distinct and numerous larger longitudinal keels along the sides of the body are nevertheless equally characteristic for younger and for older specimens. In the very youngest specimens the extension of the scale-covering is more limited — on the belly to the region before the ventrals, while the belly proper is entirely without scales. The shape of the snout is here the same as in other *Macruri*, not bowlike rounded, but sharply triangular. The first dorsal fin begins immediately over the insertion of the pectorals, which again is in the vertical from the first point of the ventrals. The first longest rays of the ventrals are almost equal with those of the pectorals, but shorter than those of the first dorsal fin. The number of rays is 1 + 11 in this fin, 19 in the pectorals, 8 in the ventrals. The teeth are minute, almost hidden between the papillæ of the mouth.

Of the other northern species

Macrurus (Coryphænoides) rupestris Gunn. (**M. Stromii** Rhdt., **norvegicus** Nilsson)

(figured in "Voyage en Scandinavie", Poissons, pl. 11, in Smitt's Scandinavian fishes, pl. XXVII, A, fig. 2, and in Collett's "Poissons provenant des campagnes du yacht l'Hirondelle" (1885—88) 1896, pl. 10, fig. 11) there is also a large number of specimens partly from the same localities, where *M. Fabricii* was caught, f. inst.:

Stat. **27**:	64° 54' Lat. N.,	55° 10' Long. W.,	393 fath.,	bottom temp. 3°.8 C.	Davis Strait.
— **35**:	65° 16'	55° 05'	362 —	— 3°.6 C.	Davis Strait.

partly from others, f. inst.

Stat. **25**:	63° 30' Lat. N.,	54° 25' Long. W.,	582 fath.,	bottom temp. 3°.3 C.,	Davis Strait.
— **41**:	61° 39'	17° 10'	1245 —	— 2°.0 C.,	South of Iceland.

Also two larger specimens from

Stat. **90**:	64° 45' Lat. N.,	29° 06' Long. W.,	568 fath.,	bottom temp. 4°.4 C.,	length 485mm	Denmark Strait.
— **97**:	65° 28'	— 27° 39'	— 450	— — 5°.5 C.,	— 730mm	Denmark Strait.

Young specimens of *M. rupestris* are captured on the following localities:

Stat. **25**:	63° 30' Lat. N.,	54° 25' Long. W.,	582 fath.,	soft blue-clayish mud, bottom temp. 3°.3 C.	Davis Strait.
— **27**:	64° 54'	— 55° 10'	— 393 —	soft gray clay, bottom temp. 3°.8 C.	Davis Strait.
— **40**:	62° 00'	— 21° 36'	— 845 —	dark gray mud, bottom temp. 3°.3 C.	South of Iceland.
— **45**:	61° 32'	— 9° 43'	— 643 —	bottom temp. 4°.17 C.	West of Faroe Islands.
— **69**:	62° 40'	— 22° 17'	— 589 —	mud, bottom temp. 3°.9 C.	South of Iceland.
— **81**:	61° 44'	— 27°	— 485 —	mud, bottom temp. 6°.1 C.	Southwest of Iceland.
— **83**:	62° 25'	— 28° 30'	— 912 —	mud, bottom temp. 3°.5 C.	Southwest of Iceland.

The largest specimen has a length of 28 inches, the smallest of $2^{11}/_{16}$ inches. As to the geographical distribution, for which the above cited work of Collett may be referred to, it may be remarked, that beyond the shores of West-Greenland and Norway (from Helgeland to Christianiafjord and Bohuslän) this "Berglax" is known from the sea between Shetland and the Faroe Islands and has several times found its way to the most northern shores of Denmark. In "Oceanic Ichthyology" p. 403

other stations are noted from the northwestern Atlantic (The specimens of l'Hirondelle were taken South of Newfoundland).

The head, whose length is contained 5 or somewhat more than 6 times in the total length (in *M. Fabricii* a little more than 4 times) is obtusely rounded, terminating in a small knob in the point of the snout, but without prominent crests or keels with larger scales. In younger specimens the crests of the head may be as it were indicated and the obtusely rounded snout may assume a little more angular figure. The oral orifice reaches to the middle of the eyes or almost to the vertical from their posterior margin in large specimens. The jawteeth are very delicate, placed in a single series. The scales are delicately ciliated, relatively small, but numerous, covering in a very regular manner the head, the body and the tail; the smallest are found on the snout and nearest to the eyes, and this covering reaches to the protrusile part of the jaw, there being no naked or half naked papillous surface at the lower part of the head. Only the throat and the gill-membrane are naked. The naked spot where the nostrils are placed is not so great as in *M. Fabricii*. Of the scales it may further be stated, that they are without keels, but densely covered with spinules without any strong tendency to arrange themselves in transversal rows, but are best said to be arranged in no particular order; the tendency to a serial arrangement is perhaps more distinct in younger individuals. The second dorsal fin, whose anterior rays are very insignificant, begins only at a long distance from the first, about at a line with the points of the pectorals (in younger individuals partly somewhat nearer to the first dorsal), the anal however below or close behind the last rays of the first dorsal, the anus being placed so much forwardly, that there is at most the length of an eye-diameter between the anus and the ventrals. The first ray of the ventrals is very long ($^2/_3$ or $^3/_4$ of or, in younger individuals, equal to the length of the head), therefore reaching far out on the anal, whose rays are relatively strong and well developed. The eyes are great, their diameter is equal to or a little smaller than the distance between the orbita and the point of the snout, but commonly much lesser than — $^2/_3$ of — the frontal breadth. The number of rays is D' 1 + 11, P. 16, V. 8; the first dorsal ray is delicately serrated. The barbel is very small, the lateral line very distinct.

As I have had the opportunity of comparing two half-grown specimens of *Macrurus Bairdii* Goode & Bean (Oceanic Ichthyology p. 393, fig. 335) with *M. Stromii (rupestris)*, I shall — without entering upon a detailed description and perhaps superfluously — observe, that this Northatlantic type is not specifically identical with *M. Stromii* or founded on younger specimens of this — a suspicion that might perhaps offer itself to an ichthyologist not having this opportunity to an immediate comparison.

Macrurus (Hymenocephalus) Goodei Gthr.

(Oceanic Ichthyology p. 407, fig. 340.)

To this species I refer — after comparison with two specimens sent from the Museum at Washington under the names of *Macrurus asper* and *Hymenolaimus Goodei* — the first name being that, under which the species was first described by Goode and Bean, which name however had to be withdrawn, Günther having used it for a Japanese fish — some individuals from the following localities:

Station	Lat. N.	Long. W.		fathoms	temper. of bottom
11:	64° 34′	31° 12′	(Denmark Strait)	1300	1°.6
36:	61° 50′	56° 21′	(Davis Strait)	1435	1°.5
37:	60° 17′	54° 05′	(Davis Strait, at its mouth)	1715	1°.4

From the localities enumerated for *M. Goodei* by Goode and Bean it will be seen that the species is taken so far south as "off Havanna", and that the depths noted are between 154 and 1434 fathoms.

The largest specimens have a length of 325mm and 310mm. Their "habitus" reminds somewhat of that of the *Malacocephali*. The length of the head is contained 5 times or somewhat more in the total length. The diameter of the eyes is somewhat smaller than the diameter of the front and much smaller than the length of the snout. The head is completely scaled with the exception of two parties back of the anterior margin of the snout and an adjoining part of the lower side of the snout. The branchial membrane and the throat are also naked, but the belly proper is scaled like the rest of the head. The scales may be described as ciliate or lineate-ciliate, delicately ribbed with 6—9 scarcely diverging or parallel, low, serrated thorny ribs; the squamification therefore makes a striated impression. The intermaxillary teeth are arranged in two rows, the greater ones in the external row; those of the lower jaw are placed in a single row. The foremost (second) dorsal fin ray, whose point in its depressed condition does not reach to the first low ray of the second dorsal, is serrate anteriorly. The first dorsal has its ordinary place over the ventrals, a little behind the pectorals. The first elongate ray of the pectorals may reach to the anus; the pectorals are not relatively long. The number of the rays are counted thus: D′ 11 + 9; P. 19; V. 9—10. The lateral line is distinct.

Macrurus ingolfi Ltk. sp. n.

Of this apparently hitherto undescribed species 2 specimens (270mm long) are at hand from

Station	Lat. N.	Long. W.		fathoms	temp. at bottom
40:	62° 00′	21° 36′	(South of Iceland)	845	3°.3 C.

and one specimen (length: 277—340mm) from each of the following stations:

Station	Lat. N.	Long. W.		fathoms	temp. at bottom
11:	64° 34′	31° 12′	(Denmark Strait)	1300	1°.6 C.
18:	61° 44′	30° 29′	(Southwest of Iceland)	1135	3°.0 C.
64:	62° 06′	19° 00′	(South of Iceland)	1041	3°.1 C.
83:	62° 25′	28° 30′	(Southwest of Iceland)	912	3°.5 C.

This species has a considerable likeness with the proceeding species, from which it may be easily distinguished among other things through the larger eyes, the distinct knobs of the snout and a higher first dorsal.

The head is contained about 5 times in the total length. The superior or frontal surface of the snout is separated from the inferior or more forwardly directed part by a well developed crest or edge, terminating in 3 spinose osseous tubercles, one directly in the middle and one on each side, close before the naked spot, where the nostrils have their place, and continued both above and below the orbita. The broadly triangular snout is prolonged fairly over and before the mouth, which is relatively little, the corners of the mouth falling in a line with the anterior margin or the middle of the orbits. The eyes are large, their diameter surpassing the breadth of the front between the eyes. The teeth form a fine card in both jaws. The head is scaled with the exception of the gill membrane, the isthmus and its foremost superior margin, and almost the whole lower surface. The naked part of the snout is handsomely embroidered with rows of slime glands. The first dorsal counting 11 + 9 rays is singularly high and its longest (second) ray is serrate and as long as the head. The second dorsal begins much forward, its foremost rudimentary rays may be followed until not far from the posterior margin of the first dorsal fin. The pectorals contain 20 rays, and the ventrals, whose external ray tapers to a fine thread and reaches a long stretch beyond the anus have 8 rays. It may also be remarked, that the tail as in other Macrurians is really pointed behind, but in several specimens has lost a shorter or longer part; but the wound has healed, and on the thus truncated point of the tail is developed a distinct caudal fin, a phenomenon which is also observed in some specimens of the proceeding species. The scales show distinct rows of thorns, not however so much projecting as in *M. Goodei.*

Macrurus ingolfi n. sp. differt a *M. Goodei* præcipue oculis majoribus, tuberculis rostralibus magis distinctis et pinna dorsali altiore, longitudinem capitis æquante, pinna dorsali secunda usque ad pinnam dorsalem fere continuata.

Macrurus (Chalinura) simulus Goode et Bean.

(Oceanic Ichthyology p. 412, fig. 345.)

Of this species the Ingolf expedition obtained 4 smaller specimens from

Stat. **18**: 61°44' Lat. N., 30°29' Long. W. (Entrance of Denmark Strait), 1135 fath., temp. at bottom 3°.0 C.
Further 2 specimens (280 og 160mm) from

Stat. **83**: 62°25' Lat. N., 28°30' Long. W. (Denmark Strait), 912 fathoms, temp. at bottom 3°.5 C.
and 2 specimens (280 and 330mm) from

Stat. **91**: 64°44' Lat. N., 31° Long. W. (Denmark Strait, 1236 fathoms, temp. at bottom 3°.1 C.

For the determination of this species I have made use of a specimen sent from the Museum at Washington. The head, whose length to the branchial cleft is contained almost 5 to fully 5 times in the total length, is thick with a rather long and obtusely rounded snout. The eyes are small, their diameter being only about a half frontal diameter. The mouth is very large and almost terminal, the snout being almost regularly truncate and only little protruding; the upper jaw wearing a card of teeth whose external teeth are exceedingly the largest, the lower jaw wearing a single row. The first dorsal numbers 11 rays, of which the first is very short and the second long and serrate as in most other Macrurids; the second dorsal begins at some distance from the first, the point of the first dorsal in its depressed state reaching to or a little beyond the beginning of the second. The first ray of the ventrals is produced in filiform shape and reaches not a little beyond the anus. The scales are rather small, but distinctly pluricarinate, specially in the head, which else shows some soft and naked parts: the preopercle, the margin of the jaws, parts of the snout and the whole lower surface of the head.

As to other localities the reader is referred to Oceanic Ichthyology p. 412.

Trachyrhynchus Murrayi Gthr.

(Deep-Sea Fishes, Challenger Report p. 153, pl. 41, fig. A.)

Of this species a young one (120mm) was obtained at station **73** (62° 58′ Lat. N., 23° 28′ Long. W., Southwest of Iceland at 486 fathoms, at a temperature at the bottom of 5°.5 C.). Previously it has been taken in the Faroe-Channel at a depth of 555 fathoms.

Gadoids and allied Fishes.

Motella (Onos) Reinhardti Kr. (Tab. IV, fig. 8).

Compare the description and figure in den norske Nordhavs Expedition, Fiskene, S. 131, pl. IV, fig. 34 and the Challenger Report p. 97, pl. XIX, fig. B.

After this Gadoid having been sent down from Greenland several times in earlier years, it was found again in the sea between Spitsbergen and Beeren-Island in the ice-cold water at a depth of 658 fathoms. Later it is found again in the Faroe-Channel at a depth of 540—640 fathoms. Ingolf obtained it in a few specimens on Station **116** (70° 05′ Lat. North, 8° 26′ Long. West, South of Jan Mayen, at 371 fathoms, brown Biloculina-mud, at a temperature at the bottom of ÷ 0°.4 C.) and at Station **140** (63° 29′ Lat. North, 6° 57′ Long. West, North of the Faroe Islands, 780 fathoms, gray mud and a bottom temperature of ÷ 0°.9 C.), also at Station **43** (West of the Faroe Islands, 61° 42′ Lat. North, 10° 11′ Long. West, 645 fathoms, sandbottom (?), bottom temperature 0°.05 C.). Some young specimens were obtained at Station **2** (63° 04′ Lat. North, 9° 22′ Long. W., 262 fathoms, Southeast of Iceland, clay and gravel, temperature at the bottom 5°.3 C.) and on Station **91** (Denmark Strait, 64° 44′ Lat. N., 31° 00′ Long. W., 1236 fathoms, Globigerina mud, bottom temperature 3°.1 C.). The new localities do not much extend the known geographical distribution, but seem to show, that it may occur at less considerable depths and under a less cold temperature, but also at somewhat greater depths and under low degrees of warmth, a little over or under zero. A sketch executed on the Ingolf gives it a light testaceous colour.

Of larves (on the so termed *Couchia*-stage) several were fished by the Ingolf of this or other arctic species, especially between the Faroe and the Shetland islands as well as east and south east of these and south of Iceland, at the surface. Of the other arctic *Motella*-species, *M. septentrionalis* Coll. and *M. ensis* Rhdt. (compare Norske Nordhavs Expedition p. 138, pl. IV, fig. 35—36; Oceanic Ichthyology p. 381, fig. 327) nothing new was ascertained through the Ingolf Expeditions.

Haloporphyrus eques Gthr. (Tab. IV, fig. 7).

Of this species, known from the Report of the Challenger expedition (p. 91, pl. 18 B) the Ingolf expedition obtained on Station 9 (West of Iceland, Denmark Strait at 64°18' Lat. North 27°00' Long. W., at a depth of 295 fathoms, bottom clay, bottom temperature 5°.8 C.) two specimens $7^1/_4$ inch. long (one of them defect). Several larger and smaller specimens were obtained from the stations 81 and 89, at 61 44' Lat. North, 27°00' Long. West, 485 fathoms, bottom temperature 6°.1 C. and 64°45' Lat. North, 27 20' Long. West, 310 fathoms, bottom temperature 8°.4 C., partly from Denmark Strait, West of Iceland, partly southwest of this island. Previously the species is taken (specimens 12—13 inches long) in the Faroe-Channel at a depth of 530 fathoms and later in Gascony bay at depths of 1410 and 800 metres (Koehler, Résultats scientifiques de la Campagne du Caudan fasc. III, 1896). Nearly related types are known from the Mediterranean: *H. lepidion* Risso (cfr. Vinciguerra: Anal. Mus. Civico Genova vol. XVIII, p. 554, pl. III) and *H. Güntheri* Gigl. (can obtain a length of 24 inches, Günther, Report p. 91, pl. 18, fig. B; also off Portugal and at Madera). From more distant localities are known *H. enosimæ* Gthr. (Günther, l. c. pl. XX, fig. B, 12 inches, Inosima, 345 fathoms) and *H. ensiferus* Gthr. (l. c. pl. XIX, fig. A, mouth of Plata River, 600 fathoms).

Of one of the largest Ingolfian specimen I shall insert some measures.

Total length 275^{mm}, head 63^{mm}, consequently not $^1/_4$ of the total length.

Diameter of the eye 21^{mm}, $^1/_3$ of the length of the head, a little more than the length of the snout (20^{mm}) and about $1^1/_2$ time the interorbital space.

The upper jaw terminating below the anterior margin of the lens; the filamentous ray of the ventrals c. 35^{mm}, the pectoral 44^{mm} (about equal to the length of the head without the snout); the length of the first dorsal ray equals the length of the head.

A sketch made on the expedition gives to the fish a chocolate-brown colour with a bluish tint especially on the fins.

Antimora viola Goode & Bean.

The genus *Antimora* numbers two species, a southern and a northern, if really different, a question, on which Dr. Günther apparently speaks with some diffidence. They really must be very nearly related, but I have no doubt that the Ingolfian specimens are here correctly determined. *A. rostrata* Günther (Report on deep-sea fishes p. 93, pl. XVI A) was found off the mouth of the Plata River and off Montevideo, at a depth of 600 fathoms, between Kerguelen and Cape, and in the neighbourhood of Marion Island at 1375 fathoms; the largest specimen was 24 Engl. inches. *A. viola* G. & B. (ibid. p. 94, pl. 15) was first captured at a depth of 4—500 fathoms on the edge of le Havre bank, later in 25 specimens in localities between 33 35' Lat. North and 41 34' Lat. North and between 76 00' Long. West and 65 54' Long. West at depths between 306 and 1242 fathoms. The expedition of the prince of Monaco (Collett, Résultats des campagnes scientifiques etc. p. 59) obtained 12 specimens a little more to the north (45° 20' Lat. North) on the Newfoundland bank at a depth of 1267 meters; the largest specimen was 358^{mm}.

The stations from which Ingolf has brought home Antimores, 6 specimens in all, are

Station	Lat. N.	Long. W.		Fathoms		Temp. of bottom
50:	62° 43′	15° 07′	(South of Iceland)	1020	Gray mud with basalt grains	3°.13 C.
76:	60° 50′	26° 50′	(Southwest of Iceland)	806	Gray mud	4°.1 C.
83:	62° 25′	28° 30′	(Likewise)	912	Gray mud	3°.5 C.
93:	64° 24′	35° 14′	(Denmark Strait)	767	Gray mud	1°.46 C.

All these localities are, as it will be seen, south, southwest or west of Iceland though one of them rather near to the coast of East-Greenland. The largest specimen has a length of 15½ inch. When the first dorsal ray is well preserved it proves to be considerably larger than it is figured in *Antimora viola* (comp. the figure of *Haloporphyrus viola* in Goodes The fisheries and fishery industries of the United States, Sect. I, pl. 64).

Rhodichthys regina Coll. (Tab. III, fig. 4).

Of this species, which is classed with the *Brotulidæ*, and which was discovered by the Norwegian North sea expedition in the sea between Beeren Island and Finmarken at a depth of 1280 fathoms (Biloculina-clay, bottom temperature ÷ 1°.4), only this single specimen (297^mm) was known which is described and figured by Prof. Collett (den norske Nordhavs Expedition, Fiskene, p. 154, pl. V, fig. 37—39). The Ingolf expedition brought home several more or less well preserved specimens; the length of the largest does not exceed 122^mm. In one of them the left ventral is tripartite instead of bipartite, as usual. They are not uniformly red as the original type of the species, but spotted or figured, with small brownish spots, which interrupt the reddish bottom colour of the skin. The number of vertebræ of the body is between 9 and 11, of the tail between 53 and 58. The localities are the following:

Station	Lat. N.	Long. W.		Fathoms	Condition of the bottom	Temp. of the bottom.
104:	66° 23′	7° 25′	(East of Iceland)	957	Light grayish brown mud	÷ 1°.1 C.
105:	65° 34′	7° 31′	(Likewise)	762	Light brown mud	÷ 0°.8 C.
111:	67° 14′	8° 48′	(Likewise)	860	Brown Biloculina-clay	÷ 0°.9 C.
117:	69° 13′	8° 23′	(South of Jan Mayen)	1003	Light Biloculina-clay	÷ 1°.0 C.
118:	68° 27′	8° 20′	(Between Iceland and Jan Mayen)	1060	Light Biloculina-clay	÷ 1°.0 C.
119:	67° 53′	10° 19′	(Likewise)	1010	Light Biloculina-clay	÷ 1°.0 C.
120:	67° 29′	11° 32′	(Likewise)	885	Light Biloculina-clay	÷ 1°.0 C.
140:	63° 29′	6° 57′	(North of Faroe Island)	780	Gray mud	÷ 0°.9 C.

Colloïdei (s. l.).

Sebastes marinus L. (norvegicus Ascan.)

was found at the following places, Davis Strait, off Holsteinsborg, by the "Ingolf" expedition:

Station	Lat. N.	Long. W.	fathoms		temp. at bottom
31:	66° 35′	55° 54′	88		1°.6 C.
32:	66° 35′	56° 38′	318	Brown gray mud with *Rhabdammina*	3°.9 C.
34:	67° 17′	54° 17′	55		0°.9 C.

The arctic-ichthyological literature often cited will illustrate sufficiently the geographical and bathymetric distribution of the redfish. It is known besides from Greenland, from Iceland, from Spitsbergen and Beeren Island, from the whole Norwegian coast, from the Danish shores (occasionally), from the Irish and North-british coasts and from the eastern coast of North America to Cape Cod (cfr. the enumeration of the stations in "Oceanic Ichthyology" p. 261) in so far that it is not the *S. viviparus*, which here represents the type. I shall not here repeat what I have formerly said ("Vidensk. Medd. Naturh. Foren.", 1876) of the difference between the true redfish and "Lysougeren" (*S. viviparus*) — may this be a distinct species or a fjord or shore variety of *S. marinus* — but only remark, that *S. viviparus* is found at the Faroe Islands, at the coast of Norway and Bohuslän and at the coast of New England (specimens from Eastport and Gloucester sent me from the Smithsonian Institution), but so far known not at the coast of Finmarken or of Great Britain. Small ones of *S. marinus* were taken in the nets south and southwest of Iceland and in the open sea at Denmark Strait.

Phobetor ventralis C. V. (tricuspis Rhdt.).

This arctic sea-scorpion has not been brought home with the "Ingolf", but it may nevertheless reasonably be mentioned here. My remarks on its relation to *Cottus pistilliger* Pall. ("Videnskab. Meddelelser" 1876) have occasioned that it is named *Gymnacanthus pistilliger* (Collett: "Norske Nordhavs-Expedition", Fiskene, p. 26, and elsewhere). As I have said that there was no experience of its being fished at a greater depth than 20 fathoms, I will add that we have obtained young ones of this species in Baffin Strait at 50 fathoms, and that "den norske Nordhavs-Expedition" has obtained it at the same depth at Spitsbergen. On Ryder's expedition to East-Greenland a specimen was taken at the shore of "Hold with Hope" on very low water. For its other known geographical distribution my remarks in "Videnskab. Meddel. Naturh. Foren." 1876, p. 365 may be consulted, also Collett l. c. p. 28. Also the works of Lilljeborg and Smitt may naturally be consulted for facts of this nature. It is thus known from different East- and West-Greenland-localities and from places in Arctic America, at Labrador and Nova Scotia, in the Fundy Bay, at Iceland, Finmarken, Novaja Semlia, in the Behring Sea, at Kamschatka and — if no mistake — at Japan. In Gilbert's "The ichthyological collections of the U. S. Fish. C. S. "Albatross", Report of the U. S. Commission of fish and fisheries for 1893" an other species is mentioned from Unalaska, *Gymnacanthus galeatus* Bean, which is said to be nearer related to "*P. tricuspis*" than to "*P. pistilliger*". It is stated, it must be observed, by this author in agreement with Dresel (Proceed. Un. St. Nat. Museum 1884, p. 250), that the North-atlantic type (*G. tricuspis*) differs specifically from the Northpacific (*G. pistilliger*). I refer the reader to the notes of Gilbert (l. c. p. 424). As I have also previously bespoken the relation between *Phobetor (Gymnacanthus)* and the species *Cottus claviger* and *C. diceraeus*, I shall further add, that these two species now (Gilbert l. c. p. 426) are cited as species of a genus *Enophrys*.

Cottunculus microps Coll.

Cottus or *Cottunculus microps* is first (1875) established (Collett: Norges Fiske, med Bemærkninger om deres Udbredelse, Tillæg til Videnskab. Selsk. Forhandl. 1874, p. 20, pl. I, fig. 3) on a very young sea-scorpion, fished by Mr. O. Sars at the depth of 200 fathoms in the vicinity of Hammersfest. Afterwards den norske Nordhavs-Expedition (l. c. p. 18—25, pl. I, fig. 5—6) obtained it in 3 specimens, taken Northwest of Hammersfest and West of Norskoen (Spitsbergen) at depths from 191 to 459 fathoms (size 93—175^{mm}); the bottom sandy or grayish blue clay, the temperature at the bottom ÷ 0.1 à 3°.5 C. Still later it was found in the Faroe-Channel, so called, by an English expedition (Günther: Report, Challenger, p. 60, t. IX, fig. A) and by an American expedition still nearer to the American side, two small specimens from a depth of 260 fathoms, 39° 59′ Lat. N. and 70° 18′ Long. W. (Tarleton Bean and Brown Goode: Report on the results of dredging, Bull. Mus. Compar. Zool. 1883, p. 212). From Greenland itself we have obtained 3 specimens (200—260^{mm}) sent down by M. Müller, inspector of the colony Sukkertoppen, and Prof. F. Smitt states (Skandinaviens Fiskar I, p. 159), that a male of the length of 157^{mm} was taken on Nordenskiöld's expedition on the eastcoast of Greenland at 130 fathoms depth on clay bottom and at 65° 30′ Long. North. The most northern point where this sea-scorpion of the cold and deep sea is known is 80° Lat. North (Spitsbergen), the most southern on the European side is the Trondhjemsfjord (63½°); according to the statement of F. Smitt it is there taken in rather numerous specimens at depths from 100—200 fathoms. After a note by T. Bean (Notice of the remarkable marine fauna occupying the outer banks of the southern coast of New England, Nr. 2; American Journal of Science, October 1881, p. 296) it is taken at 7 stations at the depth of 310—396 fathoms on the banks off the southcoast of New England. Günther (l. c.) also states, that several specimens are known from the southcoast of New England at depths from 238 to 372 fathoms. Compare also Oceanic Ichthyology p. 269, fig. 257 and 261 a, b.

This species is figured by Collett at the places cited in Norges Fiske and in den norske Nordhavs Expedition, by Günther in the deep-sea fishes of the Challenger (l. c.), and by F. Smitt (Skandinaviens Fiskar, I, p. 158, fig. 45), further in Oceanic Ichthyology pl. 1. As it is also described by the said authors, by Lilljeborg and by Jordan and Gilbert (Synopsis of the fishes of North America 1882, p. 688) I may limit myself to an enumeration of the Ingolfian localities and to the addition of a few descriptive notes.

The skin is densely rough everywhere on the head, body and tail, weakest on the belly, from small round asperities; at some places they are grouped together in small heaps and may be continued on the dorsal rays — more sparsely on the pectorals. The interorbital space is rather large. Behind the eyes is found an arc of 4 coniform knobs; somewhat more behind, on the occiput, are two and at both sides in a line with the upper end of the branchial cleft one or two smaller knobs with some more farther down at the inferior part of the preopercle. In the young ones they are hardly to be distinguished with the exception of two tubercles behind the eyes. There are four dark-coloured bands, one over the base of the tail, one over the hind part of the dorsal fin and downwards to the anal fin, a third over the foremost part of the dorsal down towards the pectorals and a fourth — especially distinct in the younger — transversely over the front, the eyes and the cheeks.

The Stations of *C. microps* at the Ingolf voyages were:

Stat. Lat. N. Long. W.

9: 64° 18′ 27° 00′ (West of Iceland), 295 fathoms, clay, bottom temp. 5°.8 C. (size 45 and 30mm).

28: 65° 14′ 55° 42′ (West of Sukkertoppen), 420 fathoms, soft brown gray mud with many *Rhabdamminæ*, bottom temp. 3°.5 C. (45mm).

32: 66° 35′ 56° 38′ (Davis Strait, off Holsteinsborg), 318 fathoms, brown gray mud with many *Rhabdamminæ*, bottom temp. 3°.9 C., male and female (160 and 80mm).

35: 65° 16′ 55° 05′ (Southwest of Sukkertoppen), 362 fath., brownish mud with arenaceous foraminifera, bottom temp. 3°.6 C. (52mm).

126: 67° 19′ 15° 52′ (North of Iceland), 293 fathoms, gray brown, blue claylike mud, bottom temperature ÷ 0°.5 C., female (154mm).

141: 63° 22′ 6° 58′ (North of the Faroe Islands), 679 fath., gray mud, bottom tp. ÷ 0°.6 C., male (170mm).

Cottunculus torvus Goode (**Thompsoni** Günther)

was described almost contemporaneously under the name cited, by Brown Goode and Tarleton Bean (Report on the results of dredging under the supervision of Alex. Agassiz, Report on the fishes, Bulletin of the Museum of Comparative Zoology, X, 5, 1883, p. 213) and by Alb. Günther (Report on the deep-sea fishes, the voyage of H. M. S. Challenger, 1887, p. 61, pl. XI, fig. B). It is figured by Günther and by Léon Vaillant (Expéditions scientifiques du Travailleur et du Talisman 1880—83, Poissons (1888), p. 361, pl. 28, fig. 3), whose figure however, as stated in the text, is defective, the artist having overlooked the first part of the dorsal. The localities, from which this species is known, are 1) The Faroe Channel at 535 fathoms depth (size $7^1/_4$ inches). 2) The 5 specimens of the length of 62—407mm, fished by the American deep-sea expeditions at 464—723 fathoms at 33° 42′ Lat. North to 41° 32′ Lat. North and at 65° 55′ Long. West to 76° Long. W. 3) The French expeditions obtained 9 specimens (35—146mm) off the Sudan coast and at the banc d'Arguin at depths of 1139—1459 metres. 4) With the Fylla a specimen, 150mm lang, was obtained in Davis Strait (66° 49′ Lat. North, 56° 28′ Long. West, at a depth of 235 fathoms, sand and ooze bottom, bottom temp. 4°.4 C.) (Vidensk. Meddel. fra den naturh. Forening 1891, p. 29). 5) With Ingolf finally a specimen was obtained, a female, 184mm, at station **83** (Denmark Strait, South west of Iceland), 62° 25′ Lat. North, 28° 30′ Long. West, depth 912 fathoms, temperature at the bottom 3°.5 C.

This *Cottunculus* is smooth without granulations etc., light gray without designs; the head is strongly provided with coniform tubercles on front, top and sides of the head, opercles etc. A specimen from the American deep-sea expeditions has been before me for comparison; young specimens are not at hand.

Cottunculus inermis Vaill.

was hitherto only known from the description and figure of Vaillant (l. c. p. 365, pl. 28, fig. 2) and was misjudged by the authors of Oceanic Ichthyology (p. 525) who identified it with *C. microps*. The French expeditions obtained 3 specimens (86mm in length) from the localities already cited (the coast of Sudan and Banc d'Arguin) at a depth of 930 and 1,495 metres. More northerly it was hitherto unknown. Ingolf obtained 4 specimens:

Stat. Lat. N. Long. W.

102: 66° 23′ 10° 26′ (East of Cape Langanæs), 750 fath., brown mud, bottom temp. ÷ 0°.9 C., size 58mm.

104: 66° 23′ 7° 25′ (East of the northeastpoint of Iceland), 957 fathoms, light graybrown mud, bottom temperature ÷ 1°.1 C., female, size 94mm.

125: 68° 08′ 16° 02′ (North of Iceland), 729 fathoms, bottom brown mud, temp. ÷ 0°.8 C., a female, 150mm, and a younger specimen, 50mm.

Uniformly grayish without any design, almost quite naked and smooth, only a very little rough to the sense of feeling. No tubercles either on the crown of the head, the occiput or opercles. The distance between the small eyes is very large, more than thrice a diameter of the eye. Palatal teeth not observed. Could therefore on so termed technical reasons be cut off as a peculiar generic type, but I prefer with Vaillant to keep it in the genus *Cottunculus*. It may still be added that in younger specimens the granulation is very distinct and dense, though not so dense and complete as in *C. microps*.

A note about the northern *Cotti*.

Cottus scorpius L. That the Greenland sea-scorpion (*C. grönlandicus*) is not specifically different from the common North-european species is well known now-a-days, though it may still happen that now and then a „*Cottus grönlandicus*" is mentioned from European (Norwegian, Scottish, English) localities, most likely in cases where uncommon large specimens of *C. scorpius* have occurred. The „Ingolf" expedition has brought home specimens of this species from stat. 33 (67° 57′ Lat. North, 55° 30′ Long. West, S. W. of Egedesminde, depth 35 fathoms, gray sand bottom, bottom temperature 0°.8 C.). From the east coast of Greenland (Jameson's Land, „Hekla's harbour" etc., from the shore to the depth of some [11] fathoms) the expedition of Ryder brought home some specimens, partly young ones, partly rather adult individuals. It is added, that in „Hekla's harbour" it was found the whole year round. *C. scorpius* is otherwise known from almost the whole west coast of Greenland to Umanak and Upernivik, it is noted from Boothia, Port Leopold, the Wellington channel and the Northumberland sound, on the eastern side of America to Cape Hatteras, at Iceland, Spitsbergen, the White Sea and Novaja-Semlia, at the Faroe-Islands and at the British coasts to the mouth of the „Channel" and at the Scandinavian shores, in the Baltic to Uleåborg. If the „Jaok" of the Kamtschadales (*C. jaok*) is correctly referred by Malmgrén to our common sea-scorpion, it meets in the northern part of the Pacific with several other species of *Cottus*, for which I must refer to the literature, as it would be too prolix to make a detailed account of it at this place.

C. scorpioides Fabr. (on which I must refer to my elucidations in „Vidensk. Meddel. Naturh. Forening" 1876) was not found by the „Ingolf" expedition, nor are there from other sources turned up any new informations on it. That Dr. F. Smitt (l. c.) regards it as a variety of *C. scorpius* does, after what I have set forth formerly, of course not agree with my conception.

C. Lilljeborgii has not been found on any of our arctic expeditions. On the other hand it is named (Proc. Royal Soc. Edinburgh, Vol. XV, p. 207, tab. IV, fig. B) between the deep-sea fishes obtained on the north coast of Scottland by Murray.

Cottus quadricornis L. has not been found neither by the „Ingolf" expedition. On the other hand the expedition of Ryder to East-Greenland obtained a specimen at the depth of 3—6 fathoms at „Hekla's harbour" („Meddelelser om Grønland", XIX, Hvirveldyr by E. Bay p. 52). Otherwise it is well known that it has been found at

Mellville island and near the „Copper mine" (67° 12' Lat. North) in the Gulf of Bothnia and in the adjoining part of the Baltic, in the Swedish and Russian lakes, in the White Sea and at Novaja-Semlia. Cfr. my former communication the on the northern Cottoids in „Vidensk. Meddel. Naturh. Forening" 1876. Further information on its distribution at the east coast of Greenland may probably be awaited through a future Eastgreenland expedition.

Icelus hamatus Kr.

The places where this little arctic *Cottoid* was obtained at the «Ingolf» expedition were:

Station	Lat. N.	Long. W.		fathoms		bottom temp.
31:	66° 35'	55° 54'	off Holsteinsborg	88		1°.6 C.
33:	67° 57'	55° 30'	S.W. of Egedesminde	35	gray sand	0°.8 C.
34:	67° 17'	54° 17'	off Holsteinsborg	55		0°.8 C.
127:	66° 33'	20° 05'	North of Iceland	44	sand bottom	5°.6 C.

Other informations on its distribution and occurrence will be found in the report of the «Dijmphna» expedition and in «the Norwegian North-Sea expedition», in «Oceanic Ichthyology» etc. In the last cited work and in Gilbert's report on the fish-collections made in the northern part of the Pacific (at Alaska, Unalaska etc.) it is named *Icelus bicornis* (Reinhardt), the author probably following the hypothetical suggestion by Collett, that an *Icelus* may have been the foundation of Reinhardt's *Cottus bicornis*, which can not be determined with certainty, the original specimen not existing. To change a denomination of scientific certitude with another of dubious applicability can only involve uncertainty and want of clearness. Gilbert also infers the possibility that the Pacific type might differ specifically from the Atlantic North-Sea type. There are further named by North-american ichthyologists quite a series of Northpacific species: *Icelus spiniger, canaliculatus, vicinalis, euryops* and *scutiger. Icelinus borealis, tenuis, filamentosus, fimbriatus* and *oculatus*, as well as some species of new genera unknown to me. The relation between those «representative» species from the same region of both oceans is, it is true, of great interest, but requires for its solution a relatively great material placed in one single hand.

Artediellus (Centridermichthys) uncinatus (Rhdt.). (Tab. IV, fig. 9.)

Of this small Cottoid many specimens were captured at station **33** (67° 57' Lat. North, 55° 30' Long. West, at a depth of 35 fathoms, on gray sand, at a temperature at the bottom of 0°.8 C.), some at station **29** (65° 34' Lat. North, 54° 31' Long. West, depth 68 fathoms, on sandy bottom, temperature at the bottom 0°.2 C.) and a single specimen at station **31** (66° 35' Lat. North, 55° 54' Long. West, at 88 fathoms, temperature of bottom 1°.6 C.), all on localities off the west coast of Greenland, not farther south than Sukkertoppen, not farther north than Egedesminde. On its occurrence elsewhere may be referred to my former «Meddelelser om nordiske Ulkefiske» («Vidensk. Medd. Naturh. Forening» 1876, Novaja Semlia, coast of Norway down to 59°) and to «Bidrag til Kundskab om Kara Havets Fiske» («Dijmphna-Togtet» 1886, p. 124, west coast of Novaja Semlia); to Collett: («den norske Nordhavs-Expedition», Fiskene, p. 29, between North Cape and Spitsbergen) and his «Meddelelser om Norges Fiske» («Nyt Magasin for Naturvidensk.» Bd. 29, 1884); also Hubrecht («Niederl. Archiv f. Zoologie, Suppl. Bd., 1882, east of Beeren Island) and Bay (l. c., East Greenland, 127 fathoms, 74° 17' Lat. North, 15° 20' Long. West). In »Oceanic Ichthyology« (p. 267) numerous localities from various northatlantic places are cited. As a synonym *Cottus bicornis* Rhdt. is also cited here; concerning this the reader is referred to what is remarked above on *Icelus hamatus*.

Triglops Pingelii (Rhdt.).

was found by »Ingolf« at the following localities:

Stat.	Lat. N.	Long. W.		fathoms	Bottom	bottom temp.	
29:	65° 34'	54° 31'	off Sukkertoppen	68	sand	0°.2 C.	1 specimen.
33:	67° 57'	55° 30'	S.W. of Egedesminde	35	gray sand	0°.8 C.	Numerous specimens of both sexes and younger stages.
34:	67° 17'	54° 17'	off Holsteinsborg	55	sandy	0°.9 C.	8 specimens.

From the earlier literature it will be seen, that *Triglops Pingelii* is found not only on the west coast of Greenland, but also from Spitsbergen, from the Barents Sea (East and South of Beeren Island), from the sea East and South of Jan Mayen, at Iceland, northern Norway to Christianssund at South, at the Faroe Islands, and at the Northamerican shores. A long list of Eastamerican localities are cited from the western Atlantic to the latitude of New England. A *Tr. pleurosticus* Cope from Godhavn has been put on record (»Proc. Acad. Philad.« 1865), but in »Oceanic Ichthyology« (p. 269) it is as by myself (»Vidensk. Medd. Naturhist. Forening« 1876, p. 378) withdrawn to *Tr. Pingelii*. A new species (*Tr. Murrayi* Gthr.) has meanwhile been established (»Report of fishes obtained in deep water on the Northwest coast of Scotland«, Proc. Roy. Soc. Edinburgh XV, p. 209, tab. IV, fig. A) on a form found in Mull of Cantyre at 64 fathoms and Southeast of the island of Sonda, said to be distinguished by a lesser number of rays, the size of the eyes, another shape of the head and a more compressed tail. From the northern part of the Pacific is cited *Tr. Beani* (Gilbert: Ichthyological collections p. 426, t. 28), *Tr. scepticus* (p. 428, pl. 28) and *Tr. xenostethus* (p. 429, pl. 29); the 2 first named of these species at least are established on a greater number of specimens.

Agonus decagonus Bl.

is fished on the following places:

Station	Lat. N.	Long. W.		fathoms		bottom temp.	
31:	66° 35'	55° 54'	Davis Strait	88		1°.6 C.	
125:	66° 08'	16° 02'	North of Iceland	729	brown mud	÷ 0°.8 C.	
126:	67° 19'	15° 52'	Likewise	293	graybrown mud	÷ 0°.5 C.	
143:	62° 58'	7° 09'	North of Faroe islands	388	sandy botom	÷ 0°.4 C.	Two younger specimens.

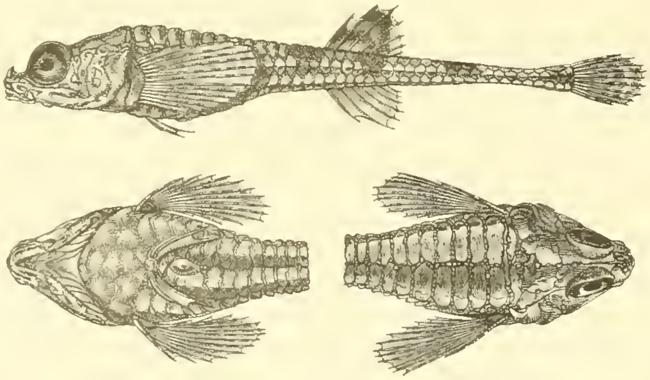
In »Oceanic Ichthyology« placed in the genus *Podothecus*. Outside of Greenland known from Spitsbergen, the Barents Sea, Iceland, Varangerfjord and West-Finmarken. *A. malarmoides* Deslongchamps, probably the same species, is said to be from Newfoundland (cfr. »Vidensk. Meddel.« 1876, p. 381). On other mailed Cottoids in the northern part of the Pacific the cited works of Gilbert, Jordan and Starks may be consulted.

Aspidophoroides monopterygius Lac.

Beyond the sea of the west coast of Greenland, where it is collected several times («Vidensk. Meddel.» l. c. p. 385) and where the «Ingolf» expedition has obtained it at station **31** (Davis Strait, 66° 35′ Lat. North, 55° 54′ Long. West, South of Egedesminde, at a depth of 88 fathoms and a bottom temperature of 1°.6 C.) and at station **33** (67° 57′ Lat. North, 55° 30′ Long. West, on 35 fathoms, Southwest of Egedesminde, on gray sand, at a bottom temperature of 0°.8 C., it is found repeatedly in the sea of the eastern coast of Northamerica, even South of Cape Cod («Oceanic Ichthyology» p. 284). From Vancouvers Island is known a *A. (Angelogonus) inermis* and from the west coast of America further *A. Güntheri* Bean.

Aspidophoroides Olrikii Ltk.

known from the Greenland sea (Hellefiskebankerne, 32 fathoms depth) («Vidensk. Meddel. Naturhist. Foren.» 1876, p. 386), the Kara Sea («Dijmphna», «Kara Havets Fiske» p. 120, pl. XV, Fig. 1—3) and the Barents Sea. Was captured plentifully at stat. **33** (cfr. above). A «dubious» specimen is mentioned in «Oceanic Ichthyology» (p. 284) from a depth of 44 fathoms at 46° 45′ Lat. North and 50° 02′ 30″ Long. West. The prince of Monaco obtained 2 specimens on the banks of Newfoundland (Collett, «Résultats des Camp. scientif.» p. 39). It is cited also from the White Sea and the eastern part of the Murmannian sea («Verzeichniss der Fische des weissen und murmanschen Meeres; l'Annuaire du Musée zoologique de St. Pétersbourg» 1897).



Aspidophoroides Olrikii.

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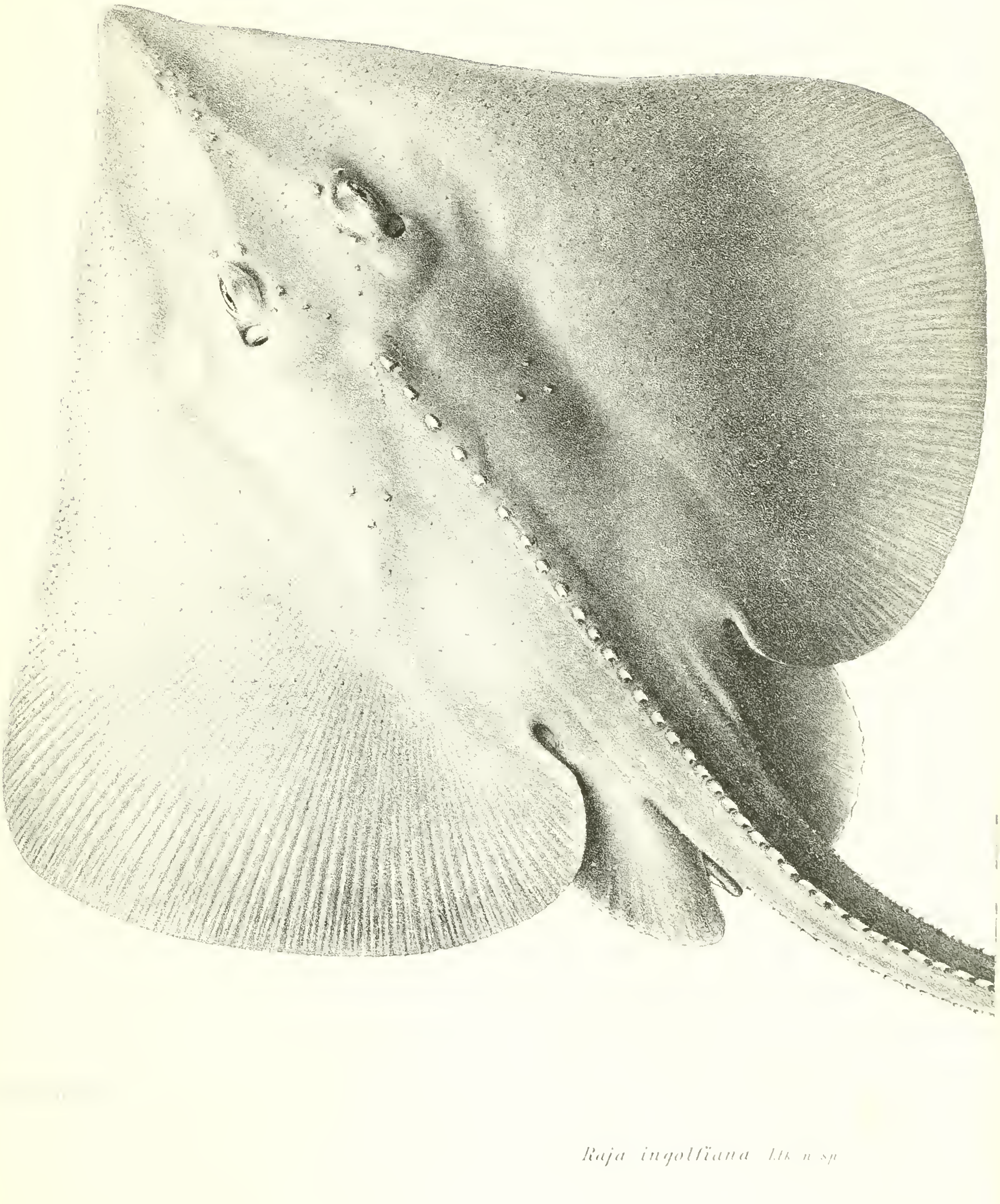


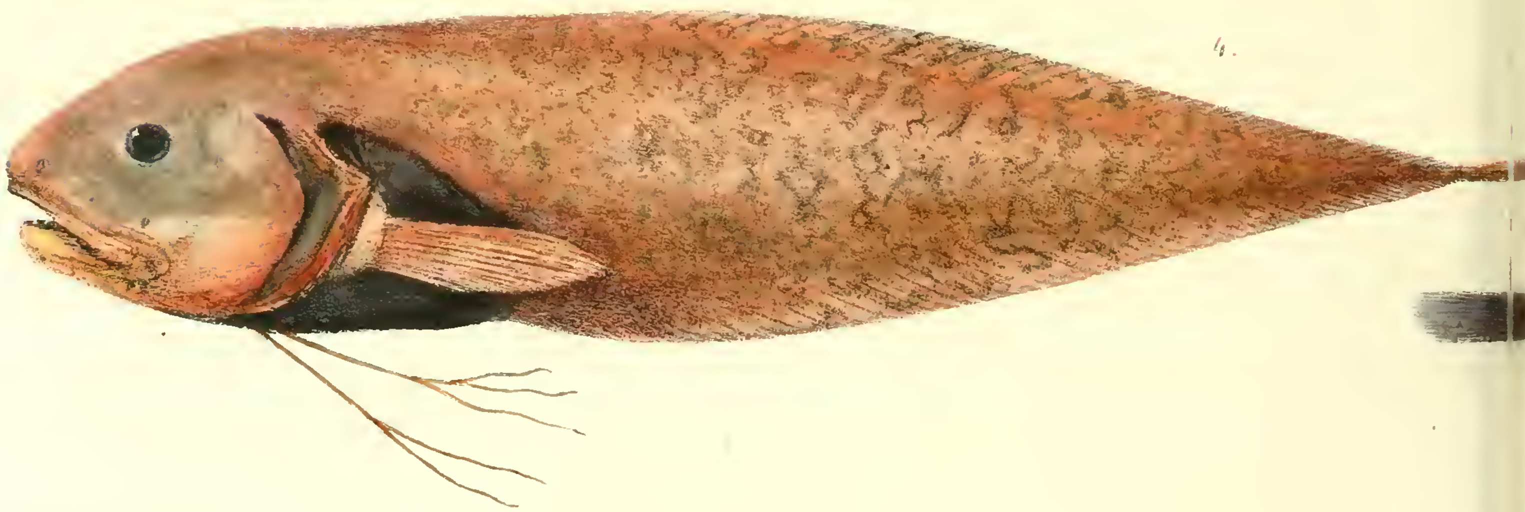
Raja ingolfiana Ltk. n. sp.

Raja Fyllæ Ltk

3

3 a.

4.



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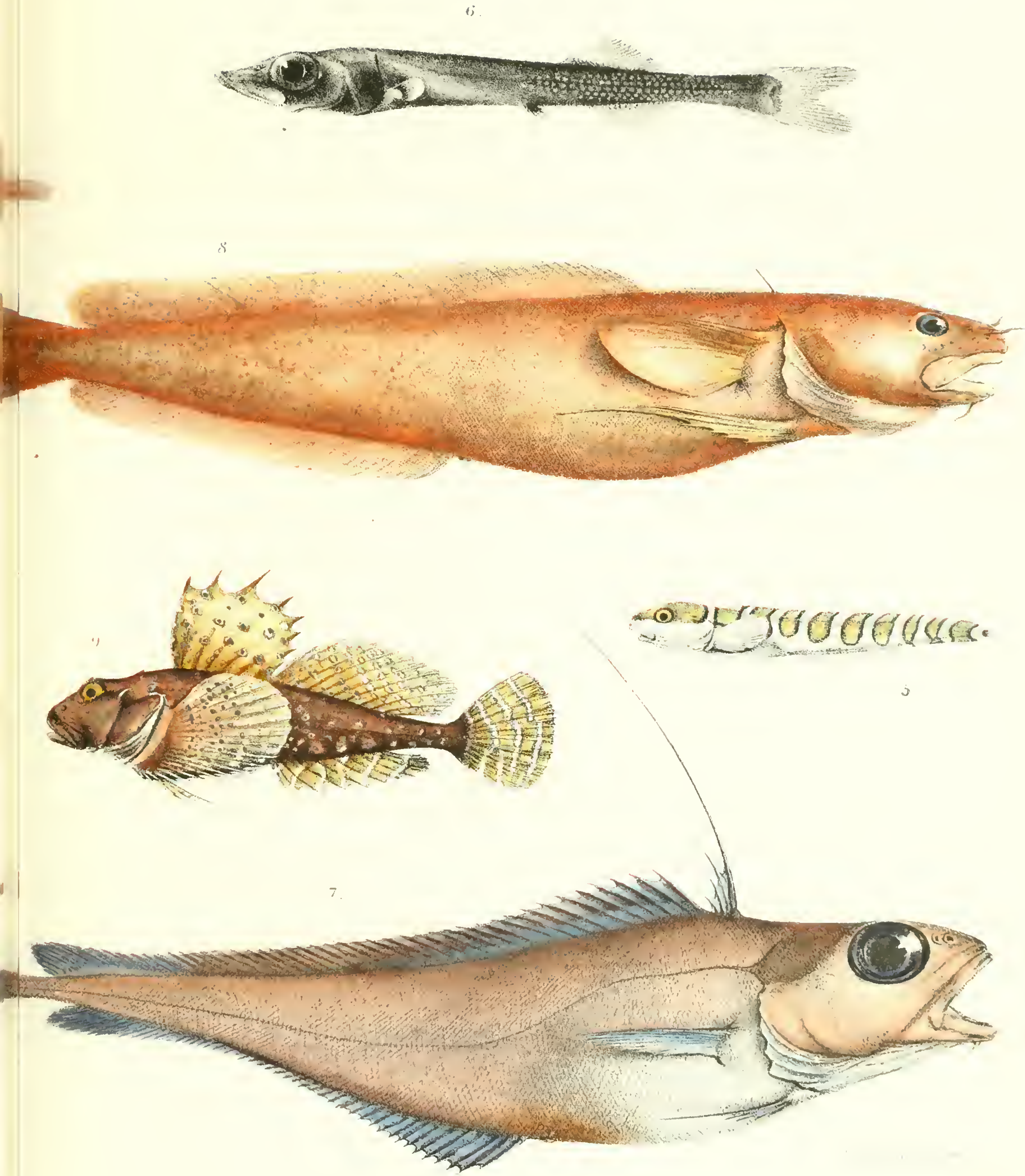

7 Haloporphyrus eques Gthr. 8 Motella (Onos) Reinhardti Kr. 9 Artediellus (Centridermichthys) uncinatus (Rhdt.)

THE INGOLF-EXPEDITION

1895—1896.

THE LOCALITIES, DEPTHS, AND BOTTOMTEMPERATURES OF THE STATIONS.

Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.
1	62° 30′	8° 21′	132	7°2	24	63° 06′	56° 00′	1199	2°4	45	61° 32′	9° 43′	643	4°17
2	63° 04′	9° 22′	262	5°3	25	63° 30′	54° 25′	582	3°3	46	61° 32′	11° 36′	720	2°40
3	63° 35′	10° 24′	272	0°5		63° 51′	53° 03′	136		47	61° 32′	13° 40′	950	3°23
4	64° 07′	11° 12′	237	2°5	26	63° 57′	52° 41′	34	0°6	48	61° 32′	15° 11′	1150	3°17
5	64° 40′	12° 09′	155			64° 37′	54° 24′	109		49	62° 07′	15° 07′	1120	2°91
6	63° 43′	14° 34′	90	7°0	27	64° 54′	55° 10′	393	3°8	50	62° 43′	15° 07′	1020	3°13
7	63° 13′	15° 41′	600	4°5	28	65° 14′	55° 42′	420	305	51	64° 15′	14° 22′	68	7°32
8	63° 56′	24° 40′	136	6°0	29	65° 34′	54° 31′	68	0°2	52	63° 57′	13° 32′	420	7°87
9	64° 18′	27° 00′	295	5°8	30	66° 50′	54° 28′	22	1°05	53	63° 15′	15° 07′	795	3°08
10	64° 24′	28° 50′	788	3°5	31	66° 35′	55° 54′	88	1°6	54	63° 08′	15° 40′	691	3°9
11	64° 34′	31° 12′	1300	1°6	32	66° 35′	56° 38′	318	3°9	55	63° 33′	15° 02′	316	5°9
12	64° 38′	32° 37′	1040	0°3	33	67° 57′	55° 30′	35	0°8	56	64° 00′	15° 09′	68	7°57
13	64° 47′	34° 33′	622	3°0	34	65° 17′	54° 17′	55		57	63° 37′	13° 02′	350	3°4
14	64° 45′	35° 05′	176	4°4	35	65° 16′	55° 05′	362	3°6	58	64° 25′	12° 09′	211	0°8
15	66° 18′	25° 59′	330	—0°75	36	61° 50′	56° 21′	1435	1°5	59	65° 00′	11° 16′	310	0°1
16	65° 43′	26° 58′	250	6°1	37	60° 17′	54° 05′	1715	1°4	60	65° 09′	12° 27′	124	0°9
17	62° 49′	26° 55′	745	3°4	38	59° 12′	51° 05′	1870	1°3	61	65° 03′	13° 06′	55	0°4
18	61° 44′	30° 29′	1135	3°0	39	62° 00′	22° 38′	865	2°9	62	63° 18′	19° 12′	72	7°92
19	60° 29′	34° 14′	1566	2°4	40	62° 00′	21° 36′	845	3°3	63	62° 40′	19° 05′	800	4°0
20	58° 20′	40° 48′	1695	1°5	41	61° 39′	17° 10′	1245	2°0	64	62° 06′	19° 00′	1041	3°1
21	58° 01′	44° 45′	1330	2°4	42	61° 41′	10° 17′	625	0°4	65	61° 33′	19° 00′	1089	3°0
22	58° 10′	48° 25′	1845	1°4	43	61° 42′	10° 11′	645	0°05	66	61° 33′	20° 43′	1128	3°3
23	60° 43′	56° 00′	Only the Plankton Net used		44	61° 42′	9° 36′	545	4°8	67	61° 30′	22° 30′	975	3°0

Station Nr.	Long. W.	Lat. N.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.
68	62° 06′	22° 30′	843	3°4	92	64° 44′	32° 52′	976	1°4	118	68° 27′	8° 20′	1060	—1°0
69	62° 40′	22° 17′	589	3°9	93	64° 24′	35° 14′	767	1°46	119	67° 53′	10° 19′	1010	—1°0
70	63° 09′	22° 05′	134	7°0	94	64° 56′	36° 19′	204	4°1	120	67° 29′	11° 32′	885	—1°0
71	63° 46′	22° 03′	46			65° 31′	30° 45′	213		121	66° 59′	13° 11′	529	—0°7
72	63° 12′	23° 04′	197	6°7	95	65° 14′	30° 39′	752	2°1	122	66° 42′	14° 44′	115	1°8
73	62° 58′	23° 28′	486	5°5	96	65° 24′	29° 00′	735	1°2	123	66° 52′	15° 40′	145	2°0
74	62° 17′	24° 36′	695	4°2	97	65° 28′	27° 39′	450	5°5	124	67° 40′	15° 40′	495	—0°6
	61° 57′	25° 35′	761		98	65° 38′	26° 27′	138	5°9	125	68° 08′	16° 02′	729	—0°8
	61° 28′	25° 06′	829		99	66° 13′	25° 53′	187	6°1	126	67° 19′	15° 52′	293	—0°5
75	61° 28′	26° 25′	780	4°3	100	66° 23′	14° 02′	59	0°4	127	66° 33′	20° 05′	44	5°6
76	60° 50′	26° 50′	806	4°1	101	66° 23′	12° 05′	537	—0°7	128	66° 50′	20° 02′	194	0°6
77	60° 10′	26° 59′	951	3°6	102	66° 23′	10° 26′	750	—0°9	129	66° 35′	23° 47′	117	6°5
78	60° 37′	27° 52′	799	4°5	103	66° 23′	8° 52′	579	—0°6	130	63° 00′	20° 40′	338	6°55
79	60° 52′	28° 58′	653	4°4	104	66° 23′	7° 25′	957	—1°1	131	63° 00′	19° 09′	698	4°7
80	61° 02′	29° 32′	935	4°0	105	65° 34′	7° 31′	762	—0°8	132	63° 00′	17° 04′	747	4°6
81	61° 44′	27° 00′	485	6°1	106	65° 34′	8° 54′	447	—0°6	133	63° 14′	11° 24′	230	2°2
82	61° 55′	27° 28′	824	4°1		65° 29′	8° 40′	466		134	62° 34′	10° 26′	299	4°1
83	62° 25′	28° 30′	912	3°5	107	65° 33′	10° 28′	492	—0°3	135	62° 48′	9° 48′	270	0°4
	62° 36′	26° 01′	472		108	65° 30′	12° 00′	97	1°1	136	63° 01′	9° 11′	256	4°8
	62° 36′	25° 30′	401		109	65° 29′	13° 25′	38	1°5	137	63° 14′	8° 31′	297	—0°6
84	62° 58′	25° 24′	633	4°8	110	66° 44′	11° 33′	781	—0°8	138	63° 26′	7° 56′	471	—0°6
85	63° 21′	25° 21′	170		111	67° 14′	8° 48′	860	—0°9	139	63° 36′	7° 30′	702	—0°6
86	65° 03′ 6	23° 47′ 6	76		112	67° 57′	6° 44′	1267	—1°1	140	63° 29′	6° 57′	780	—0°9
87	65° 02′ 3	23° 56′ 2	110		113	69° 31′	7° 06′	1309	—1°0	141	63° 22′	6° 58′	679	—0°6
88	64° 58′	24° 25′	76	6°9	114	70° 36′	7° 29′	773	—1°0	142	63° 07′	7° 05′	587	—0°6
89	64° 45′	27° 20′	310	8°4	115	70° 50′	8° 29′	86	0°1	143	62° 58′	7° 09′	388	—0°4
90	64° 45′	29° 06′	568	4°4	116	70° 05′	8° 26′	371	—0°4	144	62° 49′	7° 12′	276	1°6
91	64° 44′	31° 00′	1236	3°1	117	69° 13′	8° 23′	1003	—1°0					

GRÖNLAND
ISLAND
Jan Mayen
Færöerne
Danmarks Stræde
Davis Stræde
Godhavn
Egedesminde
Holsteinsborg
Sukkertoppen
Godthaab
Frederikshaab
Julianehaab
C. Farvel
Angmagsalik
Reykjavik
under (below) 0°
over (above) 0°
30° V. f. Greenwich

THE DANISH INGOLF-EXPEDITION.

VOLUME II.

2.

ON THE APPENDICES GENITALES IN THE GREENLAND SHARK, *SOMNIOSUS MICROCEPHALUS* (BL. SCHN.), AND OTHER SELACHIANS.

BY

HECTOR F. E. JUNGERSEN.

WITH 6 PLATES AND 28 FIGURES IN THE TEXT.

TRANSLATED BY TORBEN LUNDBECK.

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1899.

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On the Appendices Genitales in the Greenland Shark, Somniosus Microcephalus (Bl. Schn.), and other Selachians.

On the Appendices Genitales (Claspers) in the Greenland Shark, Somniosus microcephalus (Bl. Schn.), and other Selachians.

By

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The following treatise has its origin from the circumstance that during the stay at Iceland of the cruiser Ingolf I endeavoured to gather informations as to several facts concerning the Greenland Shark, not yet elucidated. I succeeded only in throwing light upon a single one of these obscure facts by gathering a suitable material. At the subsequent examination of this material I soon perceived that the appendices genitales or claspers of the Selachians generally had hitherto been very imperfectly examined although these organs on account of their conspicuous — sometimes almost colossal — dimensions have from time immemorial been known as characteristic for the males of cartilaginous fishes. Of their functions only little is known with certainty, and on this point I am not able to bring new facts of any importance; but though the function must be supposed to be the same in all Selachians, a rich variation is found in their structure, especially in the skeleton, the structure being different from genus to genus or even from species to species. That, however, through all this variation a common type may be shown to exist, also with respect to the skeleton and the muscles, has not hitherto been seen, but will, I hope, with sufficient clearness be shown by the following treatise. As a consequence of the way, in which the work has come into existence, I have divided it into two parts, of which one deals with the Greenland Shark only, while the other treats of other Plagiostomes and Holocephales.

I.

The Appendages of the Ventrals in the Greenland Shark.

The words with which Gunnerus[1]) commences his treatise of the Greenland Shark: This fish of the Haaekind deserves to be somewhat better known to the learned than hitherto it has been may be said to some extent to be in force to this day, our knowledge of this species of sharks being still rather defective, although it is not only very frequently found in the northern seas, but is also in several places the object of a large and regular fishery, as in our northern dependencies, especially off the coast of Iceland. It is so far less extraordinary, that many things with regard to

[1]) Om Haa-Skierdingen. Det Throndhiemske Selskabs Skrifter. 2, 1763, p. 330.

its biological conditions are unknown, as the same thing may be said of many common species of fishes on our own coasts; but it seems more remarkable that we do not even know for certain whether the Greenland Shark is viviparous or oviparous, and that several features of the anatomical structure of the animal are unknown or only deficiently known. Although this species of Sharks is rather frequently found on the more populated European coasts — also on ours — and more than once has come into the hands of naturalists, even anatomists, we are thus far from being perfectly acquainted with the structure of its urinary and reproductive organs.

The facts which have in later years been brought forth as to the latter — and upon the whole concerning the viscera of the Greenland Shark — are due to Sir William Turner, who has examined several specimens from British coasts and has given his results in The Journal of Anatomy and Physiology [1]).

As to the female the first of these communications (1) showed the surprising result that oviducts were wanting. Consequently the Greenland Shark would necessarily be oviparous, and the ova, detached from the ovary, would presumably leave the abdominal cavity through the abdominal pores to be impregnated outside the mother. That the ovaries were immature in both the examined animals of a respective length of 11 ft. 8 inches and $8^1/_2$ ft. is however evident from the description. Later (3) the first statement is corrected: oviducts [2]) are found, opening as usual in the Sharks with wide, funnelshaped, closely united mouths before the liver, and running along the lower side of the kidneys to the cloaca; in the examined specimen of 7 feet length they were about as thick as a goosequill; the ovaries were quite immature. Still later (4) these parts are described in a somewhat more developed state in a Greenland Shark 11 ft. 6 in. long; the diameter of the oviduct was only $^3/_8$ inch (about 1 ctm.); the ovaries were quite immature. In none of these communications is shown, whether any shell gland, any indication of an uterus, indications of folds of the mucous membrane or the like were found. To judge from the fact of these structures not being mentioned, that nothing of the kind is found, I do not think justifiable; a shell-gland for inst. is generally always found in Sharks, whether they be oviparous or viviparous; more probably these structures on account of the immature state of the animals have not been prominent, and therefore have not been noticed. For that all the females examined by Sir W. Turner have been immature and young animals admits, I think, of no doubt. The fact is that we know to a certainty that the mature ovarial eggs are about as large as goose-eggs, but the largest mentioned by Sir W. Turner were only of the size of shot or at most of small bullets, and we know that the Greenland Shark grows to a still more considerable size than 11 ft. 8 in.; therefore if the oviducts showed so small a size and besides (presumably) so simple a shape, it is only, what might be expected in younger individuals [3]), and I see no reason at all to

[1]) 1) A Contribution to the Visceral Anatomy of the Greenland Shark (Læmargus borealis). L. c. 7, 1873, p. 233. 2) Additional observations on the Anatomy of the Greenl. Shark. L. c. 8, 1874, p. 285. 3) Note on the Oviducts of the Greenl. Shark. L. c. 12, 1878, p. 604. 4) Additional Note on the Oviducts etc. L. c. 19, 1885, p. 221.

[2]) The oviducts had already been seen in 1847 by Kneeland (Boston Journ. Nat. Hist. 5, p. 479, 485) in a specimen of the length of 7 ft. 5 in.; the ovaries were immature. The first statement by Sir W. Turner has been repeated by Fürbringer: Zur vergl. Anat. u. Entwickelungsgesch. der Excretionsorgane der Vertebraten (Morphol. Jahrb. 4, 1878) p. 53, 83; it is found as late as in Guido Schneider: Ueber die Entw. der Genitalcanäle bei *Cobitis tænia* L. und *Phoxinus lævis* Ag. (Mém. Ac. Imp. d. Sc. de St. Pétersbourg [8] T. 2, 1895) p. 9.

[3]) Comp. Joh. Müller: Untersuchungen über die Eingeweide der Fische, Schluss der vergleicheude Anatomie der Myxinoiden (Abhdl. K. Ac. Wiss. Berlin 1843 [1845]), p. 133, 134.

suppose, as Sir W. Turner[1]) does, another mode of bringing forth the ova in this than in other Sharks; the ova certainly all get into the oviduct, and are impregnated there; whether they later are laid or develop into embryos in the uterus must for the present be left undecided[2]).

On the internal reproductive organs of the male only one communication (2) has been given, concerning a specimen of the length of 6 ft. 1 in. The testes were immature; neither by the direct examination of them and their mesorchium nor by injection from the renal duct was Sir W. Turner able to detect any duct for the sperm, and from that he infers that distinct sexual ducts are also wanting in the male, and that the sperm is evacuated into the abdominal cavity, thus quite corresponding to the case of the females, as it the previous year had been understood with regard to those; but while the statement has been corrected by T. himself with regard to the latter, nothing has as yet come to light concerning the male. I think, however, that the supposition is allowable, that T.'s inference is premature also with regard to the male; it is likely that vasa efferentia in this young, immature specimen (which T. himself declares to be of immature growth) were either not formed at all or at all events not in a directly visible way[3]). It must appear quite natural that also the external male genitals were quite undeveloped in this specimen; the copulatory appendages were only of a length of $1\,^3/_8$ inch, and were far from reaching the end of the fin-membrane (see the fig. l. c. p. 287). But these copulatory appendages seem always to have shown a quite similar undeve-

[1]) Sir W. Turner evidently has not been able quite to dismiss his original conception of the evacuation of the ova through the abdominal pores (to which for the rest every parallel would be wanting, as the Cyclostomes have no abdominal pores); even in his latest communication (4, 1885 p. 222) T. says: But, as it is very doubtful if the entire surface of each ovary could be embraced by the spathe-like canal (i. e. the mouth of the oviduct), a proportion of the ova would probably be shed into the peritoneal cavity, and be evacuated through the abdominal pores .

[2]) Professor Lütken in: Smaa Bidrag til Selachiernes Naturhistorie. 2. Om Havkalens Forplantning (Vid. Medd. Naturh. Foren. i Kbhvn. 1879—80; p. 56) has tried to make it probable that the Greenland Shark should be oviparous, and moreover have soft, shell-less eggs, which is known in no other plagiostome. Among the reasons that might give some countenance to this notion Sir W. Turner's anatomical results are quoted. It is quite evident that if T.'s first communication of the want of oviducts had been correct, a deposition of the eggs, and an impregnation of them outside of the body of the female would have been as good as proved; but the later informations from the same author are in my opinion of such a nature, that they can be used as proofs neither for nor against a deposition of the eggs, but might — connected with my demonstration in the following, that the male Greenland Shark has fully developed copulatory organs — be used as proofs of the eggs, as generally in Sharks, being impregnated in the oviduct. The other reasons for a deposition of the eggs, quoted by Professor L., viz. the negative one that we have never hitherto got any foetus of the Greenland Shark, and the more positive accounts from several laymen of numerous large eggs, but always in the females, cannot, I think, prove anything either in one or the other direction. Against the first of these reasons may be quoted the equally negative circumstance that we have never found eggs of the Greenland Shark outside the animal neither, and against the second that the large eggs are evidently ovarial eggs still coherent by the thin, distended ovarial stroma; for all informations — also those I have got personally from an Icelandic Shark-fisher — state that the large eggs, which are only seen by the flensing, always cohere by thin membranes or the like; but large and soft ovarial eggs, as is well known, are not only found in oviparous, but as well in viviparous Sharks and Rays. As however the only earlier authors, who state anything at all about the propagation, declare quite positively, that the Greenland Shark is viviparous, viz. besides Otto Fabricius and Faber, who are both cited by Professor Lütken, also David Cranz, who says in his Historie von Grönland , 2. Aufl. 1770 p. 138, Er bringt gemeiniglich 4 Junge zugleich zur Welt (from this work the statement is adopted by Couch, from whom Günther probably has his remark: It is stated to be viviparous, and to produce about four young at a birth [Introd. to the study of Fishes, 1880 p. 333]) — and as moreover the very nearest relative of the Greenland Shark, the *Somniosus rostratus* of the Mediterranean, is known quite certainly to be viviparous, as also the somewhat more distant relatives, the *Scymnus* species and the other *Spinacidæ*, I, to be sure, think it most probable — I feel tempted to use a stronger expression — that also the Greenland Shark, the other *Somniosus*-species, must be viviparous.

[3]) According to Semper: Das Urogenitalsystem der Plagiostomen etc. (Arb. Zool. Zoot. Inst. Würzburg. 2. S. 3) vasa efferentia are in several Sharks already formed in the embryo; but I think it is doubtful whether they can be recognized here without the assistance of the microscope, and it does not appear that Sir W. Turner has used a microscopical examination, but he says that the mesorchium was so transparent that he must have seen a duct, if there had been one. The part of the testis itself, which T. especially examined to trace a possible duct in it, can scarcely contain such a one, as it is evidently the Vorkeimfalte of Semper, i. e. the part where the new ampullæ are formed.

loped condition in the other (and it turns out to be very few) male specimens, mentioned as examined by naturalists.

In this circumstance, in connection with the interpretations by Sir W. Turner of the genital apparatus in both sexes, is most likely to be sought the reason of the idea that the Greenland Shark only should be possessed of rudimentary copulatory appendages. This supposition has been set forth by Professor Lütken in the communication on the propagation of the Greenland Shark, cited on p. 3 note 2. In this paper Sir W. Turner's description of the reproductory organs both of the male and female is reported with the following remark: "Of what use the copulatory members of the male were was not evident; but perhaps these organs are in this species of Sharks rudimentary structures without any importance? At all events I know no descriptions giving them a size like that found in the Spiny Dog-fish or the Basking Shark". I must confirm the latter sentence myself. It was to be expected beforehand that, if the male of this species had really copulatory appendages of proportions relatively as those of other species, so prominent formations would scarcely have escaped the notice, but would probably have been mentioned by one or more of the many earlier authors, who have written of the North and the Northern nature, in which writings the Greenland Shark and the catching of it bear a part, and of whom more, I suppose, have had the opportunity of knowing the animal by autopsy.

However, I have in vain sought in authors as: Egede, Cranz, O. Fabricius, Scoresby, Eggert Olafsen, Mohr, Olaus Olavius, Faber, Pontoppidan, Strom, Leem, Rosted, Landt, and others; I find nothing concerning this point. Only Gunnerus [1]) mentions these organs, which "we have reason to take to be the external characteristics of the male", but in undeveloped condition. Gunnerus had 3 male specimens, the largest not exceeding 5 ells (Danish) in length, and the smallest being $2^1/_2$ ell; the figure shows the appendages quite small, shorter than the fin-membrane; besides it is evident from his description, that he himself justly thinks his specimens to be young animals.

Later authors too do not mention appendages in more developed condition; they are on the whole (as far as I know) only mentioned by Yarrell and by Malm. Yarrell [2]) says of a specimen described by Valenciennes [3]): "The fish was a male; the ventral fins and sexual appendages or claspers very small". Valenciennes himself, however, says nothing of the sex, and does not at all mention the appendages; he only says that the ventrals are small, so that possibly the cited remark of Yarrell has it origin from a misreading. Malm [4]) mentions two males, which he correctly declares to be young, respectively of a length of 1850^{mm} and 1880^{mm}; the length of the "hjelpgenitalia" was in both 25^{mm}; they did not reach the end of the ventral fin. Only in one place I have found a statement suggesting, that the authors in question have had the opportunity of seeing the appendages of the Greenland Shark in a more developed state, viz. in Müller and Henle [5]). They divide the genus *Scymnus* in two subgenera: 1) *Scymnus* (to which *Sc. lichia* and *S. brasiliensis*), characterized among

[1]) l. c. p. 330 seq., pl. X, fig. 1, Lit. a. Pl. XI, fig. 1, Litt. a, a.

[2]) History of British Fishes, 3^d ed., 2, p. 527.

[3]) Nouv. Ann. du Muséum. 1, p. 455, pl. 20.

[4]) Göteborgs och Bohusläns Fauna. 1877. p. 627, 629.

[5]) Systematische Beschreibung der Plagiostomen. 1841. p. 91, 93.

other things by: Die männlichen Anhänge ohne Stachel , and 2) *Laemargus* (to which *L. borealis* [the Greenland Shark], *L. Labordii* and *L. rostratus*) in which: die Männchen haben einen Stachel an den Anhängen . But whence have M. & H. this latter information? The work itself tells nothing about it, and in none of the works cited is found anything about a spine on the appendage in *S. borealis* (and no more in the other species).

After Professor Lütken having given the cited communication about the propagation of the Greenland Shark the Museum of Copenhagen has got a male specimen of a length of 9 ft. (2835^{mm}), whose ventrals are preserved in the collection; also in this specimen the copulatory appendages are very small as hereafter mentioned, and so far they might serve as a corroboration of the advanced conjecture, that in this Shark these organs should be rudimentary and functionless.

As I, however, had some doubts of the correctness of this supposition — as also of the other that the Greenland Shark should be oviparous — I endeavoured during the last cruise of the Ingolf to get fins of the Greenland Shark for examination, and as far as possible to procure reliable informations of this Shark in all respects. During a stay in the close of June 1896 in Dyrefjord, where a manufactory for train-oil of the Greenland Shark is found, I took the opportunity of communicating with a fisher of Greenland Sharks, whom I for some time questioned by means of an interpreter. The conversation was rather difficult, as the man was somewhat embarassed, only answered to my questions, and would not speak himself or give his own opinion. However I got the information that the fishermen know very well to distinguish between male and female, that eggs (i. e. the large ovarial eggs) are only found in large specimens, and that the males are smaller than the females; he had however never seen a Greenland Shark smaller than about 3 ells (Danish)[1]. I drew a sketch of the ventrals for him, and asked, if he had seen the appendages on the ventrals, which he affirmed; then I promised him a reward, if he would obtain for me as many pairs of ventrals as possible, and with as large appendages as possible, which he might preserve in brine, as also a whole and sound male, as I supposed that I should be back in Dyrefjord about at the time, when he should return to deliver his next cargo of liver, this, as is well known, being the only part of the animal made use of. Circumstances however would that the Ingolf did not return on the Dyrefjord until the beginning of August, and so I did not find the man again. But I found at the manufactory a great deal of pairs of ventrals in brine, all with the appendages and with these in different stages of development, together with a whole male, the last the fisherman had caught; he had during the whole time very carefully kept the last caught male for preservation, and had come on the Dyrefjord with a quite sound specimen, which was also the very smallest he had got; but as I did not return in due time, also this specimen was put into brine. Apparently everything had kept very well by this mode of preservation, the fins at all events excellently; but by the dissection of the whole Shark it soon became apparent that all the internal organs were sadly damaged: the kidneys and the internal reproductive organs were completely disorganized, so that nothing whatever was to be recognised; not even the renal ducts that use to be rather resistant, were to be traced at all. I was thus disappointed in my

[1]) Collett however states that specimens of a length of about 2 ft. sometimes have been obtained; probably newborn youngs. Meddelelser om Norges Fiske i Aarene 1879—83, p. 118. Nyt Mag. f. Naturv. vol. 29.

hope of being able to give a good account of the structure of these organs, and must be content to give informations of the external copulatory organs.

The whole Shark was about 8 ft. (2^{m} 50^{cm}) in length, and its ventrals, as also their appendages, were smaller than any of the other cut off ventrals and their appendages, which latter were also much more developed; unfortunately no statement of the length of the respective animals was given. But if we start from the supposition, which I think most likely, that the ventral proper grows in proportion to the animal itself, we can with some certainty calculate the size of the animals, to which the cut off fins have belonged; and judged by that they have all been large animals between 3 and 5 metres, the largest at all events upwards of 6 ells (Danish).

I am not able to decide with perfect certainty, if any of the obtained ventrals have the appendage so large and developed, as it possibly can be; but at all events these organs are so far developed in the largest specimens that they will scarcely change their structure in any considerable degree, even if they become somewhat longer. In the largest fins the free end of the copulatory organ reaches about 5^{cm} farther back than the point of the fin-membrane itself; in the somewhat smaller ones $3—4^{cm}$, and in two a little smaller still about 1^{cm} behind the point of the fin. In the smallest specimen finally (the above mentioned animal 2^{m} 50^{cm} long) the point of the ventral on the contrary reaches $2—3^{cm}$ farther back than the point of the appendage. Between this last specimen and the immediately preceding the above mentioned specimen of the museum (which however is partly skeletonized) may be placed with regard to size and development. Here accordingly we have a series showing the stages in the growth of these organs, well known from the other Sharks, from small short rudiments, shorter than the ventral itself, to a more or less considerable length beyond the inner edge of the ventral. Thus every idea of the Greenland Shark differing from other Sharks in only possessing rudimentary ventral appendages must be dropped.

About the remaining external features of the organ I shall confine myself to state, that its whole dorsal surface (i. e. the surface which in the natural position is in contact with the ventral side of the body) as well as the adjoining part of the fin itself is quite naked and smooth without dermal teeth, which is also the case with the medial surface, where those of the same pair are in contact, while the ventral surface (as in the remainder of the fin) is clothed with dermal teeth, however more sparsely and sparingly towards the point, the outermost part of which is naked and quite soft. Otherwise these organs are in their developed state stiff and hard on account of the strong internal skeleton. On the lateral side of the end is felt through the skin a particularly hard and movable part of the skeleton, and in most of the specimens this part is naked and appears as a pointed, polished thorn or spine. I can however assert with certainty that in all the specimens, I have brought home, it has only been laid bare by the skin on the spot being torn; it is also seen quite covered in the right clasper of one of the largest specimens. I suppose, however, that before the member comes into function, or at the function, this spine is uncovered; in fully developed appendages of *Acanthias* and *Spinax* at all events both the corresponding part and one or two more parts of the skeleton protrude naked, uncovered by the integument; and in the circumstance that in all these fins the spine surely only has been set free by damage or by bad preservation, I find a positive intimation of their appendages not yet having reached their greatest development. This spine is still plainly felt in the somewhat smaller fins, excepting the two smallest; in these evidently it has not yet been calcified, no more than most of the other parts of the skeleton, characterizing the end or terminal part of the developed organ; therefore these small appendages are upon the whole rather soft to the feeling and with flexible ends.

The form of the developed appendage is straight, somewhat dorso-ventrally flattened; a distinction may be made between the considerably longer proximal part, which might be called the shaft, and the short distal part, the terminal part, which is free of the fin, and, as will be more particularly bespoken hereafter, possesses a certain limited mobility; the largest breadth is found immediately before the terminal part; on the dorsal side, somewhat nearer to the lateral than to the medial edge, is seen the peculiar cleft, the appendix-slit, which is found in all Selachians; it reaches to the posterior end of the member, and leads in the free part of this into a deep canal, more anteriorly into a glandular bag, which, like a deep pocket, at the base of the appendage goes round to the ventral side of the fin, and here under the skin reaches — according to age and development — a longer or shorter distance towards the pelvis. The inner walls of this bag are smooth, partly pigmented, and from their epithelium is secreted a peculiar fluid, which when coagulated is tallowy, but whose function is not certainly known. This bag, as to its origin, is simply a folding in of the outer skin [1]; it is surrounded with muscles, able to press the secretion into the canal and through the slit to the exterior. The inner (medial) lip of the slit is immovable and cannot be displaced, while the outer (lateral) one till near the terminal part consists of soft tissue, and is therefore easily opened, so that a finger may be introduced into the bag; but at the end of the shaft, immediately before the terminal part, all distension is prevented by the inner skeleton, which is found here, and straightens the slit, so that it becomes very narrow; to the distal side of this straightening, in the terminal part itself, the canal may again be opened, and it will open spontaneously, if the terminal part is bent a little in the ventro-medial direction, in which case the spine will at once erect.

The following measures referring to the largest appendages, may be added:

Length from the anterior border of the cloaca to the terminal point of the appendage	24–26 cm.
— of the terminal part of the appendage	5–5·5 cm.
Breadth of the appendage before the terminal part	3·3–4 cm.
Length of the slit	16 cm.
— of the part outside the fin	6 cm.
Part outside of the point of the fin-membrane	5 cm.

The skeleton (pl. I, fig. 1–9). The skeleton of the ventral fin in the male consists of 1) the pelvis, 2) the axial part or the stem, which laterally wears 3) the rays, and as a continuation 4) the skeleton of the appendage.

The structure of the pelvis is as commonly in the Sharks, it consisting of an unpaired, somewhat arcuated cartilage, the surface of which is rather slightly calcified; it has the greatest thickness

[1] I have followed its development in embryos of *Acanthias*, as has also been done by Petri: Die Copulationsorgane der Plagiostomen. Zeitschr. f. wiss. Zoologie, vol. 30, 1878.

in the middle, and here projects from the posterior edge a clumsily rounded process. The stem of the ventral articulates by its principal piece, the basale, (pl. I, fig. 1 *B*), with the lateral end of the pelvis, as do also a pair of the foremost rays. The foremost ray (*R*) is always short and big, shaped like the blade of an axe, whose head articulates with the pelvis, the hindmost corner of the blade with two small terminal joints; it bears the second ray, which is accordingly out of connection as well with the stem as with the pelvis; sometimes it is proximally coalesced with *R*. The third ray has pressed so far forward, that it articulates both with the stem and the pelvis. Most of the other rays are more or less straight, cylindric, distally a little flattened (especially in the foremost ones); the two (less frequently three) hindmost are always somewhat bent, so that the convexity turns dorsally, owing to the fact, that the glandular bag from the dorsal side passes under them to the ventral side of the fin. These two hindmost rays are often more or less united, sometimes almost quite coalesced. The foremost rays (more than half of them) have three joints, then follow some (3) with two joints, and the last (3) are never jointed. The number of rays varies from 12—16 [1]); commonly one fin of the same pair has a ray more than the other, and a rather considerable variation is found in the more special relations of the rays, in their mutual coalescing [2]), their articulation, and distal dichotomy; sometimes an extra ray is inserted, not reaching the stem; such extra rays have not been counted in the numbers given, and they do not occur symmetrically in both fins. Such variations are also known in other Sharks [3]), and I shall not here enter into further details, as they are of no importance for the examination in question.

The stem consists of 1) a large and big principal piece, *Basale metapterygii* (*B*), to which most of the rays are attached; its inner edge is almost straight, only slightly concave, the outer edge is convex; 2) a short piece (b_2) directly continuing the foregoing; 3) generally is on the medial side inserted, as it were intercalated, a little cuneiform piece (b_1). The piece b_2 bears the two hindermost rays, so that the last but one is articulated at its proximal extremity, and here also touches the basale, the last at its distal extremity, where it has also a little articular surface with the proximal end of the stem of the appendage. Finally is found 4) a rather considerable piece (β) placed on the dorsal side of the stem in such a way, that it is proximally connected with the latero-dorsal corner of the basale by a little articular surface, and distally by a longer, obliquely placed articular surface with the latero-dorsal edge of the anterior end of the appendix-stem (fig. 2 at x). This piece β is rather thick, dorso-ventrally somewhat flattened, has a convex medial edge, and a straight lateral edge; posteriorly it is somewhat more pointed than anteriorly; the foremost part of the convex edge is connected with the dorsal side of the piece b_2; it has no articulation at all with any of the rays [4]). Between the lateral corner of b_2, β, and the appendixstem 5) a little piece b_3 is sometimes intercalated.

Then follows 6) the appendixskeleton. Its chief piece (tab. I, fig. 1 *b*, fig. 2, 3) evidently belongs to the stem, and is placed in immediate continuation of the foregoing pieces, with

[1]) In two females I have found the number respectively 15—17 and 16—17 on the two sides.

[2]) In one specimen separate, independent pieces of cartilage have been developed; they are placed across, and near the outer end of the rays they connect two and two of these.

[3]) Comp. Gegenbaur: Ueber das Skelet der Gliedmaassen der Wirbelthiere im Allgemeinen und der Hintergliedmaassen der Selachier insbesondere. Jen. Zeitschr. 5 Bd., 1870, p. 435 seq.

[4]) By the choice of the letter-marks I have intended to point out, that all these parts belong to the stem-skeleton.

which it forms an — to be sure very obtuse — angle. In a fully developed skeleton the chief piece is longer than the basale; in the largest specimens at hand the ratio is: $\frac{B}{b} = c. \frac{3}{4}$; on the medial side it is rounded, in the foremost third part somewhat dorso-ventrally flattened; the lateral surface (*l*) is more or less distinctly bounded from the other surfaces; it is only in the fore part somewhat rounded, posteriorly it is flattened, and the hindmost part is somewhat hollow; on the dorsal side this lateral surface is in the whole length of the piece sharply limited by a thin, elevated, hard calcified ridge (fig. 2, 3, *Rd*), anteriorly beginning as quite low, posteriorly becoming higher and higher, as well as thicker, and bearing in the posterior half an edge, folded to the dorsal side, irregularly indented, and collarlike; on the ventral side (see fig. 3) the lateral surface is in the greater part of its extent much more indistinctly bounded by an evenly rounded eminence, which is not harder than the common surface; in the posterior part, however, rises rather suddenly a short, calcified, strong ridge or plate, which in the shape of a large foliaceous process folds over to the dorsal side, where it approaches rather near to the opposite edge (fig. 2, 3, *Rv*). The free edge of this folded process is thickened, and irregularly rugged. The described elevated ridges or plates in connection with the flatly hollowed hindmost part of the lateral surface forms the place of part of the appendix-slit or the excretory duct of the gland-bag; these hard parts of the skeleton it is, that, as mentioned on p. 7, prevent a distension of the appendix-slit.

Immediately behind the end of these calcified ridges the chief piece continues as a thin, round, finger-shaped elongation, the end-style (fig. 1, 2, 3, *g*); it is soft, or at all events at its base quite devoid of calcification, while farther out a slight surface-calcification may be found. Else the chief piece is everywhere calcified on the surface (being anteriorly somewhat rough for the attachment of the muscles), and more calcified than the basale and the rays, but the above mentioned ridges (*Rd*, *Rv*) are completely calcified and hard. When such a chief piece is dried, these ridges therefore will not shrink, but rise distinctly as independent parts. By a close examination of an undried chief piece the boundary lines of these calcified side-parts may also be distinguished, and thus we shall arrive at the same result: the chief piece is composed of three parts, viz. the appendix-stem (*b*), posteriorly becoming lanceolate, medio-laterally compressed, and ending as a slender, thin, (at the base) uncalcified end-style, and two calcified marginal cartilages, one long, slender, dorsal, the other shorter, broader, ventral (*Rd*, *Rv*).

To this chief piece are attached a number of terminal pieces, more or less movably joined to each other and to the chief piece. Of these pieces two join the posterior borders of the marginal cartilages and the end-style of the stem, and form, as a kind of continuation of the marginal cartilages, the dorsal (dorso-medial), and ventral (ventro-lateral) borders of the hinder part of the appendix-slit; these two pieces are here called respectively the dorsal and the ventral terminal piece (*Td*, *Tv*).

The dorsal piece (fig. 1 *Td*, fig. 4, 5) is the smaller one; it tapers to both ends, most to the posterior; on the exterior (medially) it is somewhat rounded, with a sharp lateral edge, a little denticulated, towards the appendix-slit slightly hollow in the foremost two third parts; the thick medial edge is by means of connective tissue closely connected with the end-style, the anterior end with the dorsal marginal cartilage. It is completely calcified, and the surface, especially towards the terminal end, is rugged and rough.

The ventral terminal piece (fig. 1 *Tv*, fig. 6, 7) is considerably larger; the surface towards the appendix-slit is deeply hollow like a trough, the external, ventral, surface is rounded, and has laterally a winglike, sharp process; it is also completely calcified, and a great part of the surface is irregularly furrowed and rugged. The one anterior edge of the trough articulates with the ventral marginal cartilage, by the inner, ventral, edge it is connected with the style.

Between this piece and the overlapping plate of the ventral marginal cartilage is seen a third terminal piece (fig. 1, T_3), the thorn or spine (fig. 8, 9). It is, like the other pieces, quite hard, and the proximal end is somewhat head-shaped with a smooth surface, almost like an articular surface; else it is for a great part very irregularly rugged and furrowed, but the outermost point is glossy and smooth, dentine-like; the whole thorn is longitudinally somewhat twisted.

Besides these fully developed terminal pieces indications of two more are to be seen, viz. a thin, narrow lamella, only calcified in spots, joins the lateral edge of *Td*, and supports the edge of the dorsal lip of the appendix-slit; anteriorly it reaches somewhat beyond *Td*; this indicated piece is here designated as Td_2 (comp. pl. V, fig. 61, 62); the second piece is a very firm and strong fibrous tissue, joined to the anterior dorsal edge of the piece *Tv*, and without distinct borders merging into the aponeurotic covering, connecting the thorn, the piece *Tv*, and the overlapping plate of the marginal cartilage, and serving for insertion of part of the muscles (see pl. V, fig. 61, 62, Tv_2); in this latter piece a calcification has commenced, indicating perhaps, that it might become a separate terminal piece, which I shall designate as Tv_2 (comp. other Plagiostomes for inst. *Spinax*). As these two last mentioned pieces are, as it were, still developing, I suppose, that even the most developed of the appendices in hand cannot, in a stricter sense, be said to be full grown yet; but as the piece Tv_2 also in some other Sharks (f. inst. *Acanthias*) is found only indicated and uncalcified, even in quite developed appendices, my supposition is not quite reliable.

The whole of this terminal skeleton, composed of the terminal pieces and the end-style of the stem, is movable to a certain degree; as to further details on this point the reader is referred to p. 14.

By examining the appendix-skeleton in the earliest stages of development we find that originally it is composed of only one single piece, being that, which above is termed the appendix-stem. This (in the specimen from Iceland, 2^m 50^{cm} long, and in the specimen from the Zoological Museum, 9 ft. long) is still quite soft, shorter than the basale, anteriorly rounded, posteriorly lanceolate, the edges of the lancet being placed almost dorsally and ventrally, and ends as a thin style (see fig. 2 in the text p. 19); thus mainly rendering the form of the chief piece minus the marginal cartilages. Of these latter as well as of the terminal pieces no trace is found. In somewhat more advanced stages, where the appendix-stem is as long as, or a little longer than the basale, the three terminal pieces and especially the thorn are very well to be distinguished, while the marginal cartilages still are absent, or, at all events, in the fibrous tissues, occupying their place, no calcification or distinct bordering of such cartilages is to be found (not even of the overlapping plate). In still a little more advanced stages also the marginal cartilages are found in the same shape and with the same bordering as in the most developed, but the boundary lines between them and the stem are much more distinctly marked; they are calcified, but are still soft enough to permit of easy cutting;

to the naked eye the section shows a particular fibrous texture (as in sections of the terminal pieces), and a whitish colour, distinguishing it distinctly from a section of the appendix-stem or any other part of the skeleton proper, for inst. a ray or the basale, the surface of which will be hyaline. From these developmental facts it will appear with all desirable distinctness, that the marginal cartilages and the terminal pieces are secondary parts of the skeleton, developed in the tissues surrounding the primary skeleton, properly so called. Thus of the appendix-skeleton only the appendix-stem, the piece *b*, belongs to the primary skeleton.

To resume what is said about the appendix-skeleton in the Greenland Shark:

The appendix-skeleton consists of a chief piece and terminal pieces movably connected with it; the chief piece is formed by the coalescing of the appendix-stem with two secondary calcified cartilages, the marginal cartilages; the appendix-stem belongs to the primordial axial skeleton of the ventral fin, being the terminal joint the extremity of which remains soft; the terminal pieces are all secondary calcified cartilages.

The muscular system (pl. V, fig. 58 to 62) follows the type, which has been described in *Acanthias* by v. Davidoff[1]; this type, however, has been founded on the structure of the ventrals of the female; the rather considerable differences from it are due to the copulatory appendages, for the special use of which special muscles have to be developed. Distinction may be made between: I) The fin muscles proper, and II) the muscles of the appendage; as, however, some of the former spread over part of the appendage, this distinction cannot be made quite distinct.

I. In the fin-muscles proper may be distinguished, as v. Davidoff and the earlier authors do, between the muscles of the ventral and those of the dorsal side; they are antagonistic, the former adducting the fin, and removing it from the abdomen, the latter abducting the fin, and pressing it against the abdomen.

1) The ventral muscles of the fin consist of a) a medial muscular mass, chiefly reaching from the pelvis to the stem-skeleton of the ventral, with laterally and obliquely-posteriorly directed bundles of fibres, and b) a lateral mass, the muscles of the rays, issuing from the stem-skeleton, and following the rays to the fin-membrane.

a) This powerful group of muscles (pl. V, fig. 58—61, *A* and *E*) in so far does not wholly belong to the ventral side, as, besides forming the medial edge of the fin, it is also seen on the dorsal side. Looking first at its ventral side we find its origin covering almost the whole ventral surface of the pelvis: between the fin-muscles of the two sides only a triangular piece of the pelvis is to be seen in the middle anteriorly, from the top of which a narrow uncovered streak runs backward to the end of the above (p. 8) described process; from this issues further backward in the linea alba an aponeurotic streak (fig. 58, *s*), which continues the pelvis, and serves as attachment for part of the same muscular mass. The superficial ventral part is for the greater part composed of distinct bundles of muscles, enveloped in rather firm sheaths of connective tissue, and mostly corresponding in number and direction with the muscles of the rays; but this composition of isolated bundles is effaced anteriorly-laterally and posteriorly-medially.

Anteriorly the fibres running obliquely from the pelvis towards the outer margin of the fin

[1] Beiträge zur vergleichenden Anatomie der hinteren Gliedmasse der Fische. Morphol. Jahrbuch. 5 Bd., 1879, p. 451 seq.

form a rather solid mass spreading from the fore edge of the pelvis over the broad ray *R*. The foremost of the following distinct bundles of muscles cross the ventral surface of the basale reaching as far as to the horny filaments of the fin-membrane, ending here in a tendinous mass; the following bundles only reach to the basale where they are inserted with tendinous ends, from which tendinous part the ray-muscles originate as a prolongation — however, when we look farther backwards, with a distinct interposition of a narrow stripe of the basale. Between the said foremost bundles, continuing immediately in the ray-muscles, and those attached to the basale, a gradual transition is found, a tendinous part in the superficial layer of the bundles being inserted on the place of transition.

The hindmost and medial part of the muscle A is not composed of isolated bundles, but its fibres running rather straightly backwards form a solid mass, inserted on the distal end of the basale, on the pieces b_1, and b_2, and on the proximal end of the chief piece of the appendage (*b*).

The whole muscular mass, as mentioned, is of a considerable thickness; its deeper part which is also seen from the dorsal side, is not divided into separate bundles; this deeper, more dorsal, part originates from the rounded posterior surface of the pelvis, and even reaches to its dorsal surface; it is inserted along the medial side of the basale and the following joints inside the insertion of the described superficial ventral layer.

With this muscle A is closely connected another (pl. V, fig. 59 and 61, *E*), chiefly seen from the dorsal side. It originates on the medial side of the basale, a little before the middle, its fibres crossing those of the muscle A, and spreading over the appendage; as above the knee of the latter the fibres run obliquely across the medial edge of the fin and on to the ventral side, part of the edge of this muscle will consequently be discernible on this side (pl. V, fig. 58 and 60 *E*). It is spread like a cloak over the chief muscle (*D*) of the appendage forming a rather thin plate and growing thinner from the ventro-medial edge laterally (cp. fig. 1 in the text); its fibres are attached, partly along the narrow ridge, formed by the dorsal marginal cartilage along the appendix-slit (fig. 61 *af*) partly, distally, to a thin, firm aponeurosis (fig. 61 *a*), covering the muscle *D*, and attached to the elevated distal part of the dorsal marginal cartilage (*Rd*). In somewhat older animals with well developed appendages this muscle *E* is as well proximally as distally distinctly separate; in young animals, however, with only little developed appendices (fig. 59) the distal part is still very distinctly marked, but the proximal part is less sharply separated from the large muscular mass *A*; numerous bundles coming from the pelvis and the aponeurotic streak *s* unite with those from the basale, and numerous bundles from the basale run over among the former and reach to the proximal end of the appendix-stem.

The above described muscular group consisting of the muscles *A* and *E*, will, according to circumstances, be able to act in two different ways; these muscles will, when the antagonists of the dorsal side are not contracted, move the fin from the abdomen, and at the same time draw its inner edge towards the median line, thus moving the two fins towards each other; and when the dorsal antagonists act on the fin, they will move the appendix only, towards the median line, thus acting as extensors for the appendix; the latter action will be facilitated by the muscle *E* acting rather distally on the appendix (an effect as to the opening of the appendix-slit is of course out of the question). Consequently I design the large chief muscle *A* as *Musculus adductor (et depressor) pinnæ (et appendicis)*, the muscle *E* as *Musc. extensor (appendicis)*[1].

b. The ventral muscular system of the rays (fig. 58, 60, *Ra*) is composed of distinctly separated bundles of fibres, or independent muscles in number corresponding with the rays they follow; only anteriorly the independence of the ray-muscles, as mentioned above, is concealed by coalescence with the lateral bundles of *Musc. adductor*, coming from the pelvis. The ray-muscles originate on the ventral surface of the basale and the piece b_2, and run laterally backwards in an oblique direction, each following its ray, but without reaching the end of it; they only reach the horny filaments (the two layers of which comprise a rather considerable part of the lateral ends of the rays) and here pass into tendinous tissue. The hindmost ray-muscle is rudimentary; it does not originate on the stem-skeleton, but on the last ray but two, and passes to the last but one and on to the fin-membrane.

2) The dorsal muscular system of the fin proper (pl. V, fig. 59) is composed of a) a superficial part originating from the lateral muscles of the body, and b) a deeper-lying part originating from the stem-skeleton.

a) On a part of the body, corresponding in length to the connection between the body and the fin, a system of distinct muscular bundles (*O*) originate in the aponeurosis covering the lateral muscles of the body, and run obliquely outward and backward to the horny filaments, where they pass into tendinous tissue; thus their outward border corresponds to that of the ray-muscles on the ventral side, being considerably distant from the ends of the rays. The hindmost of these bundles are directed straight backwards, corresponding to the direction of the last of the rays. Furthermore from the inner side, the side towards the muscles of the body, of the said system some bundles of fibres (*O'*) originate running obliquely backward and inward, and attached to the hindmost half of the basale and to the dorsal piece β; thus the whole system originating from the lateral muscles, is, as to the hinder half, arranged in a feather-like or fanshaped way.

b. Quite covered by the superficial layer just described the deeper layer of the dorsal ray-muscles (fig. 59, *Ra*) is found. These muscles originate from the dorso-lateral side of the basale and of the piece b_2 as well as from β, and are seen as distinct bundles corresponding in their number and direction to the rays; they pass into tendinous tissue immediately before the lateral ends of the bundles of the superficial layer, so that the latter reach a little way farther on the rays. However, these two layers are not quite sharply separated, bundles of fibres from the superficial layer reaching to the deeper, and connecting with it; on the hindmost fin-rays the bundles of the deeper layer cross those of the superficial one, this latter spreading in a fanshaped way from the attachment to the body.

II. Besides the described separate parts of the fin muscles connected with the appendix

[1] The muscle which in *Acanthias* and other Selachians corresponds to the muscle *A*, is by Petri called: *Flexor pterygopodii*; but there are several objections to this name. Firstly, the muscle does not only act on the appendix, but on the whole fin (it is also found in the female), and next it cannot well be called the flexor of the appendix, as it is more properly to be regarded as the extensor. The flexion of the appendix is, I suppose, effected by means of the *M. compressor sacci*, the muscle of the glandular bag (fig. 58, 61, *S*), of which more hereafter, together with the muscular layer originating on the body itself (fig. 59 and 61, *O*).

other muscles are found, more especially belonging to this organ, it being inside the skin quite surrounded by muscles except the terminal part. In this muscular system may naturally be distinguished between: 1) The muscles of the chief piece, and 2) those of the glandular bag.

1) The first part (pl. V, fig. 58—62, *D*) is composed of one single muscle wrapping in a cloak-like manner the whole of the chief piece from the dorsal marginal cartilage to the ventral one, and to the rounded edge formed by the appendix-stem itself along its lateral surface above this short marginal cartilage; the part of the chief piece situated between these bounds, the lateral surface is for the greater part covered by the muscles of the glandular bag (see fig. 1). The large muscle *D* is thickest along the medial side of the appendix, and is chiefly composed of longitudinal fibres arising from the whole length of the chief piece; from the foremost part of this, below the knee , arise some specially powerful bundles, and consequently this part of the surface of the skeleton is very rugged; also from the lateral edges arise numerous fibres and bundles, and distally several bundles come from the covering aponeurosis *a* (see pl. V, fig. 61). Corresponding to the form of the appendix-stem this muscle tapers distally, and its hindmost fibres reach to the base of the style. It is inserted in the firm aponeurosis covering the marginal cartilages and the whole terminal part, and thus it acts on the style and the two terminal pieces *Td* and *Tv*. In contracting it bends the style medially forward at an obtuse angle to the chief piece, whereby the two terminal pieces are also moved; at the same time the thorn is erected on account of its connection with the other terminal pieces, especially *Tv*, and stands out laterally; as a consequence the distal part of the appendix-slit situated between these movable pieces, is dilated to a rather considerable degree. I therefore (like Petri) design this muscle as *M. dilatator*.

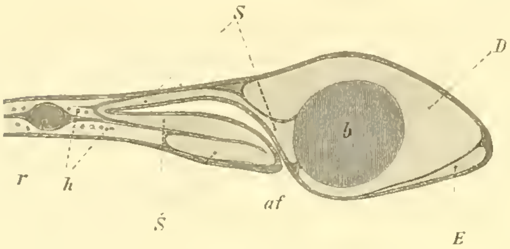

Fig. 1.

Part of a transverse section through the appendage of the Greenland Shark (about 26mm behind the beginning of the appendix-slit). *b* the appendix-stem; *D M. dilatator*; *E M. extensor*; *S M. compressor*; *af* the appendix-slit; *r* a ray; *h* horny filaments.

2) Among the muscles of the glandular bag I do not only class a) the muscles immediately wrapping this organ, but also b) some portions (fig. 61, 62, *S*) arising from the hindmost rays, and forming, in my opinion, with the glandular bag an insolvable whole, only artificially to be detached from it. The glandular bag, as I understand it, has its origin from an invagination of the skin into a muscular mass laterally covering the stem-skeleton in the appendix; by the further growth of this invagination on to the ventral side of the fin part of the muscular mass was brought along as a kind of wrapping of the bag and developing further together with it. Consequently this wrapping cannot be regarded as dermal muscles but belongs to the skeletal muscles; it is also composed of quite the same striated fibres as these; its original relation to the stem-skeleton may, in the fully developed organ, be seen in the still existing attachment along the lateral surface of the appendix-stem (see the transverse section, fig. 1 in the text).

a. The glandular bag (pl. V, fig. 58, 60 *S*) is seen on the ventral side of the fin, where it reaches forward covering a smaller or larger part of the ray-muscles, according to the development of the whole appendage; while in the youngest specimens it only reaches very little beyond the "knee" between the stem and the chief piece of the appendix (cf. fig. 58), in the most developed it reaches almost half way towards the pelvis (cp. fig. 60). As the glandular bag in most of the other Sharks, which I have examined, reaches still further, generally even far beyond the pelvis, there is reason to suppose that in none of the ventrals of the Greenland Shark in hand the whole copulatory organ has reached the greatest development, which was already intimated by the description of the skeleton of the terminal part.

The connective tissue, investing the muscle-sheath of the glandular bag, is continued on all the specimens as a very thin membrane between the skin and the ray-muscles almost to the pelvis; this membrane may easily be separated as well from the skin as from the muscles, but in the specimens in hand it (perhaps as a consequence of the preservation in brine) is very fragile; it contains no striated muscular fibres.

While the dorsal muscular wall of the glandular bag has no intimate connection at all with the part of the fin before the "knee" — only a loose, soft connective tissue here joining the bag to the ray-muscles — it is otherwise at the proximal end of the chief piece, part of the muscles of the bag being inserted on the lateral surface of this part of the skeleton, covering it wholly, and following it quite down to the terminal part; other fibres attach to the last ray along its medial edge; and some fibres arising from this spot and from the ventral surface of the two last rays, pass into the dorsal muscular wall of the glandular bag and continue it to the ventral marginal cartilage, where they attach to the connective tissue of its inner side.

The direction of the fibres of the dorsal muscular wall of the bag otherwise corresponds to that in the ventral wall; as shown in fig. 60, the fibres radiate from the point, where the connection with the skeleton anteriorly ceases; along the medial side they run almost in a parallel direction with the axis of the bag and the appendage, but else on the broader part of the bag they spread in a fanshaped manner to the lateral edge; on the hindmost narrow part they run entirely straight backward, and here a few bundles pass into *M. dilatator*. This arrangement agrees very well with that, which fibres originally directed from before backwards, might be supposed to get by being pressed out of their position by an invagination protruding from the region between × × in fig. 60. A separation of the muscular wall of the bag into two distinct layers is quite out of the question. With regard to *Acanthias* Petri (l. c. p. 316) has stated that the muscular wall of the bag consists of two layers, an outer one of circular muscles, and an inner one of longitudinal muscles; a separation and arrangement of such a kind however, is not found in *Acanthias*, any more than in *Spinax* or the Greenland Shark. Neither can I admit that the words of Petri (l. c. p. 317) are correct: "Die Muskelschicht der Drüse wird nicht mit eingestülpt, sondern sie differenzirt sich allmälich aus der Bindegewebsschicht nach der Einstülpung." (Cp. also l. c. p. 328). In my opinion, as before has been shown, it admits of no doubt that the muscles of the bag are simply borrowed from the original muscular system of the skeleton[1]; in the earliest stages of *Acanthias* — male embryos of a length of 15 m — which I have been able to examine in this respect, the muscles around the rudiment of the glandular bag are already as distinct as those surrounding the stem of the chief piece, and the muscular layer of

[1] This is corroborated with particular plainness by the arrangement in the Holocephales.

the bag has already been pressed towards the ventral side as well as the other surrounding layers of tissue.

b. Intimately connected with the other muscles of the glandular bag is found a powerful muscle (pl. V, fig. 59, 61 and 62, *S*), seen on the dorsal side, where it forms the lateral lip of the long slit (*af*), which is the entrance to the bag. It takes its origin from the two hindmost rays (sometimes also having bundles from the last but two) as also from the lateral surface of the piece β, covered by the superficial layer (*O*) coming from the muscles of the body; it is inserted in the tendinous tissue passing over the head of the thorn (T_3), and firmly connected with the proximal end of the terminal piece *Tv*, especially with its edge; in this tissue is found imbedded several firm, fibrous portions, which partly calcify, and probably — in more developed stages — form a separate piece (Tv_2). In the hindmost part this muscle is completely fused with the distal part of the muscles of the glandular bag, and anteriorly it forms a whole with the above mentioned bundles of the dorsal wall of the bag, which arise from the ventral side of the two hindmost rays; in the interspace a kind of separation is effected by the attaching of the fin-membrane, the connective tissue of which wedges in between the "lip muscle" and the wall of the bag itself. This muscle acts antagonistically to *M. dilatator*, which in a preparation is easily seen by pulling it: thus when *M. dilatator* by contracting has dilated the groove between the terminal pieces, as described above, and the "thorn" stands out, the contraction of this "outer lip-muscle" of the appendix-slit will again straighten the groove by especially acting on the piece *Tv*, and at the same time carry back the "thorn", so that it will lie against the piece *Tv*.

I find the same muscle in all other Plagiostomes, but in very different stages of development (cp. the following). Petri has mentioned it in *Acanthias*, but as *M. levator* of the "thorn" (l. c. fig. 5, *B*, *C*, *F*, *ml*); he says: "Er inserirt sich hinten vermittels eines starken, sehnigen Bandes am vorderen Theil des Spornes (= the thorn) und hat allein die Aufgabe diesen zu heben." This, however, is quite incorrect: it is not inserted on the thorn, even if its tendon of course by looser tissue is connected with the proximal part of the latter, but on the piece *Tv* (*b'''* in the figures of Petri), of which piece Petri's interpretation is quite wrong (cp. the following); and it does not assist the *M. dilatator*, nor raises the thorn, but it counteracts the *M. dilatator*, and thereby becomes a *M. depressor* of the thorn! The carrying back to the position of rest of the terminal pieces is in the Greenland Shark and *Acanthias* not exclusively brought about by an elastic reaction of the tissues between the firm parts of the skeleton, as asserted by Petri (l. c. p. 303), but this reaction, which certainly exists, is also supported by the action of muscles belonging to the glandular bag, or, at all events, forming part of its muscular system. Taking it for granted that the appendix genitalis by the copulation is really introduced into the cloaca of the female, I imagine the following act to take place: the appendix is guided and brought into the cloaca by means of the muscles belonging to and arising from the fin-muscles proper; next the *M. dilatator* will come into function, and, by its dilating the terminal parts, fix the appendix in the cloaca, and then the muscles of the glandular bag will evacuate its contents into the furrowshaped, in the appendix itself situated part, the walls of which at the same moment will contract, at the same time ejecting the secretion and letting go the firm hold of the apppendix. As I think the chief action of the muscular wall of the glandular bag to be the ejection of the secretion, I design it — including the described outer lip-muscle of the appendix-slit — as *Musculus compressor (sacci)*.

II.

The Ventral Appendages in other Selachians.

For comparison with the facts found in the Greenland Shark, I have examined as many other forms of Selachians, as I have been able to get the material for, being soon convinced that the representations, hitherto found in the literature, gave only a rather incomplete insight into the structure of these organs, and only to a small degree were to be used comparatively.

The greater part of my material has consisted of well preserved ventrals, a less part only of skeleton parts, dried or preserved in spirit, which the director of the collection of Vertebrata of the Zoological Museum, Professor Lütken, has been kind enough to place at my disposal. The following description has been divided into three parts of very different extent, of which the first will give a short general account of the copulatory appendages in the Selachians in general, the second a more particular description of the forms, on which this general account has been based, and the third will as a conclusion contain some short remarks as to what for the present may be regarded as tolerably certain concerning the function of these organs. That the particular description will treat more of the skeleton and less of the muscles is occasioned by the relatively small variation of the latter.

1. A General View of the Copulatory Appendages in the Selachians.

As to the **outer form**, the same outline is found in the copulatory appendages of all Selachians: it is always the inner part of the fin which is prolonged, and formed into an appendage, and this appendage may be more or less free of the fin-membrane; it is most separated in the Holocephales, least so in some Sharks; it always consists of a, longer or shorter, proximal part, the shaft, and a, generally shorter, distal part, the terminal part, this latter being always free of the fin-membrane, and (at all events in the Plagiostomes) possessed of a certain mobility.

On the dorsal side of the appendage, sometimes, however, quite laterally, a deep furrow or slit, the appendix-slit runs longitudinally, to the posterior end; the edges or lips of this slit can always be opened, at least in two places, viz. at the foremost beginning of the slit in the shaft, and behind in the terminal part; frequently the slit can be widened in a considerable part of the shaft (*Somniosus, Acanthias, Spinax*, a. o.); there is, however, always a part of the slit, in which widening is prevented by the inner skeleton, or where the lips cannot at all be separated, or sometimes even may be coalesced (the latter in *Scyllium* and *Pristiurus*); the part of the slit situated in the terminal part can (at all events in all Plagiostomes) be widened by muscular action, and again narrowed by elastic reaction, sometimes assisted by muscular action. The appendix-slit is the duct of a glandular bag which is surrounded by muscles, and in all Plagiostomes with its greater part situated on the ventral side of the fin, under the skin, but in the Holocephales, where it has only been little developed, limited to the appendix-shaft.

The skeleton of the appendage belongs always to the axial stem of the fin-skeleton[1]); among the rays (in the Plagiostomes, not in the Holocephales) only the hindmost, most frequently the two hindmost, are of importance as serving as attachment for part of the appendix-muscles (those of the glandular bag); as a consequence these rays have been somewhat bent, with the convexity turned dorsally; the two hindmost are often partly, sometimes quite coalesced.

With the primary skeletal parts, developed from the fin-stem, join, in the Plagiostomes, several very differently shaped, calcified, secondary skeletal pieces, developed in the connective tissue, surrounding the original, primary skeleton. These secondary pieces show, especially in the terminal part, a considerable variation, both as to form and number, and the different genera, or even species, may present rather important differences; but everywhere may be established the same fundamental type that has been pointed out in the Greenland Shark.

In the Plagiostomes the primary skeleton consists of: a large basale (B), and in continuation of this one or more (until a number of four, *Rhinobatus*) shorter pieces (b_1, b_2, etc.), and finally a terminal joint, the appendix-stem (b); this latter is always long, often considerably longer than the other parts of the stem taken together. To these pieces must be reckoned one more, β, placed dorsally, parallel to the short stem-pieces b_1, b_2 etc.; most frequently it connects the basale with the appendix-stem, but sometimes it does not reach the basale anteriorly, and is then connected with b_1; in *Rhina* it is rudimentary, and only connects the last joint with the appendix-stem; in *Narcine* it seems to be wanting.

In quite young males of Plagiostomes (cp. fig. 2 in the text), even in embryos, all these primary skeletal parts are already found; during the growth the terminal joint, the appendix-stem, is prolonged, growing much more than the other parts, and calcifying to some degree in the surface (often to a higher degree than any other part of the primary skeleton of the fin) always, however, with the exception of the distal terminal part, this often wholly, and at all events at its base remaining soft, and consequently flexible; this part of the appendix-stem I (after its form in the Greenland Shark and many other Sharks) name the end-style (g).

Contemporary with the growth and the calcification the secondary skeletal parts develop around the appendix-stem, first as firm, fibrous parts, calcifying by degrees, and finally very hard; some of them belonging to the terminal part are even shining, polished, and dentine-like; they then rise, more or less naked, through the skin; this applies to one piece in *Somniosus*, *Lamna*, *Sclachus*, *Rhinobatus*, *Raja radiata*; to two pieces in *Acanthias*, three (four) in *Spinax* etc.

Two of the secondary skeletal parts are always closely connected with the appendix-stem, and may even quite coalesce with it; these two cartilages form shorter or longer ridges, and are situated, one dorsally, the other ventrally, connected with the appendix-stem in such a way as to form with it the part of the appendix-slit that cannot be widened; they are the two marginal cartilages, the

[1]) When A. Fritsch (Zool. Anzeiger, vol. 13. 1890, p. 318, and Fauna der Gaskohle etc. Böhmens, vol. 3. 1895) restores the ventral appendages of the fossil Xenacanths as lateral structures, developed from rays, I am convinced that he is wrong, and has misinterpreted the fossils.

dorsal one (*Rd*), and the ventral one (*Rv*); posteriorly they always reach to the end-style, anteriorly more or less forward, commonly not to the same length, and at most to the proximal end of the appendix-stem. Together with this they form the "chief piece" of the appendix-skeleton, a name used by several earlier authors, who most frequently have not seen that this "piece" consists of three parts.

The other secondary cartilages, the terminal pieces, together with the end-style form the skeleton of the terminal part, and are more or less movably connected mutually, with the marginal cartilages, and with the end-style. The number of terminal pieces may be different, but in all Plagiostomes two are found, one dorsal (*Td*), and one ventral (*Tv*), placed as a kind of movable continuation of the two marginal cartilages, and with their inner edges joining the end-style of the axial piece, which by being bent (ventro-medially) is moved in connection with them; thereby they dorsally withdraw more from each other, and the slit between them is widened. Only in a few cases (*Trygon violacea*, *Chlamydoselachus*) these two pieces are found alone; in most Sharks a piece Td_2 is joined to the lateral margin of *Td*, and imbedded together with this in the dorsal lip of the appendix-slit; often a piece Tv_2 is in a like manner joined to *Tv*; further is generally found a piece T_3, placed ventrally and laterally, and often rising through the skin as a "spur" or thorn; still more pieces may be developed (especially in *Raja*), but their homologies in the different forms are generally easily pointed out, and are in the special part indicated by the letters used. Finally may to the terminal pieces proper be joined one or more "spurious" pieces or covering pieces, enclosing like a shield the terminal pieces, properly so called, on the dorsal side (*d*) or the ventral side (*v*); they are developed in the aponeurosis of the *M. dilatator* bespoken later on, which otherwise wraps the terminal part, and serve as insertion for part of this muscle. Such covering pieces are found in all Rays and in some Sharks (for inst. *Rhina*). As to the abundantly varied structure of the terminal part the reader is referred to the special part; here I shall only add that the simpler forms are generally found in the Sharks, to which may be joined among the Rays *Torpedo*, *Narcine*, *Rhinobatus* and *Trygon*, while the most complicated structures are found in the species of *Raja*.

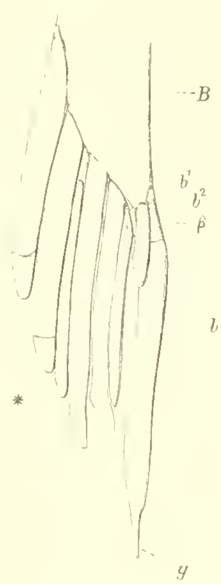

Fig. 2.

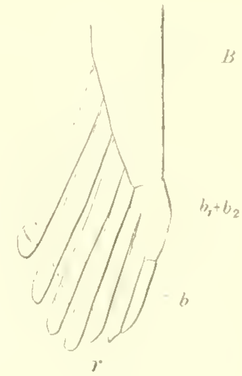

Fig. 3.

Fig. 2. *Somniosus microcephalus*, young ♂ (2^m 50^{cm}). The hindmost part of skeleton of left ventral (considerably diminished). The letters as before. * an intercalated extra-ray.

Fig. 3. *Somn. microcephalus*, ♂. The corresponding part of skeleton of left ventral. $b_1 + b_2$ two coalesced stem-joints; the stippled line indicates the distinction, found between these joints in the right ventral of the same specimen. *b* the terminal joint. Reduction as in fig. 2.

Perhaps it may not be devoid of interest to compare the ventral skeleton of the male with that of the female. In this latter we find the stem composed of a large basale and a different number of shorter joints, among which the terminal one has no ray (typically), but often looks like a ray itself being more or less rodshaped. This latter joint, I suppose, is the one that in the male is prolonged and developed into the appendix-stem, which never bears rays; otherwise, however, the number of intermediate joints between the basale and the terminal joint (the appendix-stem in the male) does not always correspond in the two sexes of the same species, and the part of the stem situated distally of the basale seems upon the whole to be rather varying in females of the same species[1]). In the female, as was to be expected, all the secondary skeletal pieces are wanting, but besides those also the piece β of the primary pieces. It is rather difficult to decide with any degree of certainty, how this piece is to be interpreted; perhaps it might be done by following its development. The smallest embryos (of *Acanthias*) that I have had occasion to examine, however, have had this piece quite independent, in the same position, and with the same relations as in the grown animal. This piece, however, has to be considered as belonging, either to the stem, or to the rays, and in the latter case it is, I think, to be regarded as one ray, there never being any mark of a composition of more parts. In several species, as *Trygon*, *Rhinobatus*, it might, as to its form, remind of a ray, which then was to be considered as displaced to a higher level than the others, and turned parallel to the axial stem; in *Trygon* it must be the last, hindmost ray, while in *Rhinobatus* it could not be the last ray, as more real rays follow farther backward; and so on in the other species: if it was to be considered as a ray, it must, in the different species, be a different ray, displaced and transformed. I think it more probable that the piece β belongs to the stem, and has been separated from this by a longitudinal division, which might possibly be occasioned by the development of special muscles for the appendix.

In the Holocephales (see pl. I) all secondary cartilages are wanting in the fin-skeleton: it is only composed of a large basale bearing all the rays, of a short piece b_1, the appendix-stem b, and the dorsal piece β. The walls of the appendix-slit are produced by a kind of rolling-up of the stem-portions b_1, and b, and thus the terminal part is only formed of the hindmost part of the appendix-stem; this latter is rather differently formed in the two genera *Chimæra* and *Callorhynchus* (see the special part).

The appendix-skeleton of the Holocephales accordingly is of a less compound construction than that of the Plagiostomes, and that, as will be seen hereafter, is also the case with the muscular system. This simpler structure evidently in some degree repeats primitive features, but these, on the other hand, are connected with facts, that by no means are primitive, as for inst. the strongly marked separation of the whole organ from the fin proper, the highly specialized form of the primary skeletal parts — against the simpler form in the Plagiostomes (as the simple, rod-like shape of the terminal joint b etc.) —, the connection with other, particular copulatory organs, etc.; these things, as well as many other facts

[1]) In two specimens of ventrals of female Greenland Sharks I find the structure different in the two sides of the same pair of fins. In the left ventral of one specimen the basale is followed by a long and powerful joint, ($b_1 + b_2$, fig. 3) bearing two rays, and a ray-like little terminal joint b; in the right fin of the same specimen follow after the basale two short joints (the distinction between those is indicated by stippling in fig. 3) b_1, b_2, each bearing one ray, and b_2 also the little ray-like terminal joint b; thus on the left side a coalescing of b_1 and b_2 seems to have taken place. On the left side of the other specimen follows after the basale only one sword-like, compressed piece, taking the place as the terminal joint, and showing in its distal end, which is somewhat flattened, an indication of a longitudiual division; in the right side, on the contrary, the basale is followed by a short joint (b_1) bearing a ray and a compressed terminal joint (b). Consequently, if we suppose a coalescing of b_1 and b on the right side, together with the last ray, we shall arrive at the structure on the left side. As far as I have seen, the female fin-skeleton of *Acanthias* shows similar variations.

in the structure of these animals indicate that the Holacephales by no means occupy a primitive position among the Selachians.

As to the skeleton of the ventral in the female, the basale (in *Chimæra*) has distally only one small, tap-like joint, standing both for the piece b_1, and the appendix-stem (b) in the male[1]).

What has been given in the earlier literature as to the skeleton of the ventral appendages in Selachians, is generally only isolated descriptions without any real understanding; only Gegenbaur[2]) and Petri have compared several forms, but neither of them has been able to recognise a common type. Gegenbaur (l. c. p. 452) has interpreted the terminal pieces as modified rays, but on account of the circumstances in the *Chimæra*, he indicates (p. 456) the possibility that they may be parts separated from the stem-skeleton; he does not know the marginal cartilages, and he has considered several early stages of the skeleton as definitive forms of it. Petri quite correctly has seen that the terminal pieces and marginal cartilages — which latter, however, he has not recognised in all the species he has examined — are secondary structures, and have nothing to do with the rays; the terminal stem-joint itself which I have called the appendix-stem (b), he has interpreted correctly in *Raja*, but wrongly in *Acanthias* and *Scyllium*[3]) — the only Sharks examined by him — as well as in Torpedo[4]) (he has not examined *Chimæra*). Some earlier authors have seen the piece β in some specimens, while it by others has been overlooked, or at all events has not been mentioned. Only Gegenbaur and Petri have sought its origin in a transformation of other skeletal parts of the fin[5]). Gegenbaur does not mention it at all in *Raja*, *Carcharias* and *Scyllium*[6]) but in *Heterodontus* and *Acanthias* (l. c. fig. 16 and fig. 19, b), and in *Chimæra* (fig. 23 r'); in the last named it is interpreted as a ray, but in the two former as belonging to the stem-skeleton[7]); accordingly Gegenbaur has not seen that in *Chimæra* it is the same skeletal piece as in the Plagiostomes. Petri thinks it to be a coalescence of basal parts of rays, being of opinion that it bears rays in *Acanthias* and *Torpedo*; accordingly in his figures he marks it r'. This supposition, however, is wrong[8]); I never found rays

[1]) v. Davidoff (l. c. p. 473, pl. XXIX, fig. 18 b) thinks it only to be corresponding to b_1. Unfortunately I have only had occasion to examine skeletonized ventrals of *Chimæra* ♀, in which this joint was wanting, so that the fin-stem consisted only of the basale.

[2]) Ueber die Modificationen des Skelets der Hintergliedmaassen bei den Männchen der Selachier und Chimären. Jen. Zeitschr. vol. 5, 1870, p. 452.

[3]) In these Sharks Petri supposes the stem to end with a long and a short joint; in *Acanthias* as the short terminal joint he has interpreted one of the terminal pieces (my piece Tv), in *Scyllium* the soft end-style.

[4]) As to *Torpedo* see p. 49.

[5]) Bloch, M. E.: Von den vermeinten doppelten Zeugungsgliedern der Rochen und Haye. Schr. der Berl. Gesellschaft Naturf. Freunde, vol. 6, 1785 (*Raja clavata* [= *radiata*]); and: Von den verm. männlichen Gliedern des Dornhayes, ibid. vol. 8, 1788, does not mention this piece in *Acanthias*, but in *Raja*, where he calls it: „der vierte Knochen des Schenkels", pl. IX, fig. 1, *o*. Cuvier (Duvernoy): Leçons d'anatomie comparée, 2 Éd., 1846, vol 8, p. 306, designates it as „Calcanéum" in *Raja*; the same appellation is used, likewise for *Raja*, by Moreau: Hist. nat. des Poissons de la France, vol. I, 1881, p. 249. I have not found it mentioned by other authors.

[6]) Of these three forms G. has only had quite young specimens, in which the secondary pieces had not yet developed. The fault made here by G. viz. to consider this stage as the full-grown state, and accordingly as an especially simple form in these Plagiostomes, has already been corrected by Petri (l. c. p. 293). It is to be supposed, however, that the piece β had been developed in all three forms, as in embryos of *Acanthias* of a length of only 15^{cm} it is already quite distinct and relatively as large as in the full-grown animal.

[7]) I am quite unable to understand the place in question (l. c. p. 451) in Gegenbaur; there is a regrettable discrepancy between the letters in the text, and those in the figures, and also, I think, a change of pieces, which makes the whole confused; so much, however, is certain that the piece which in the figures 16 and 19 is marked b (my piece β) does not in *Acanthias* bear any ray; it never bears rays at all.

[8]) For further details see under *Acanthias* and *Torpedo*. When Petri, to support his construction of this piece as

attached to this piece, but always found it placed at another level than that of the nearest rays, and I take it to be a specially separated part of the stem-skeleton.

The muscular system (see pl. V and VI) does not show the rich variation found in the skeleton, being upon the whole rather uniform, which is a natural consequence of the fact that the part of the skeleton, particularly multifarious both as to the number and form of the single pieces, viz. the terminal part, has no muscles of its own; the muscles (generally) only acting on the terminal part as a whole.

Only the medial side of the fin-muscles has been specially developed in the male; the muscles spreading over the lateral parts of the fin, i. e. the ray-muscles of the upper and lower side, and the dorsal layer originating from the lateral muscles of the body, are chiefly the same in both sexes, and show in the different forms examined so very few differences that I, also in the special part, pass over them.

In the medial muscular system may be distinguished between a more proximal and a distal part, not however strongly separated, especially not so in many Plagiostomes, while in the Holocephales the separation is more distinct, the appendage of the latter being more independent of the fin.

In the Plagiostomes I generally find the same type, as has been described in the Greenland Shark. The proximal part consists of a *Musc. adductor* (*et depressor*) *pinnæ* (*et appendicis*) (*A*), and a *M. extensor appendicis* (*E*). *Musc. adductor* does not in any of the forms examined by me show any separation into an independent, superficial ventral layer, and a deeper, more dorsal one, but forms a whole[1]); the ventral side, however, appears to a great extent separated into single bundles corresponding to the ray-muscles, while the dorsal side shows nothing of the kind. The fibres arise from the pelvis, as well from the ventral, as, though often to a smaller extent, from the dorsal surface, as also from a tendinous stripe prolonging, as it were, the hindmost edge of the pelvis into the median line; they run obliquely-laterally, and are inserted on the basale, on the following joints (b_1, b_2 etc.), and on the proximal end of the appendix-stem; often, however, the superficial medial fibres run on and mingle with the *M. dilatator*. The fibres forming the medial marginal part, run almost straight from before backward, and form always a solid mass not divided into separate bundles; the foremost, lateral parts (as in the Greenland Shark) are coalesced with the deeper-lying ray-muscles.

M. extensor (*appendicis*) (*E*) is mostly a rather flat muscle, situated on the dorsal side of the previous one; it originates on the medial side of the basale, often moreover on the pieces b_1, b_2, etc., and is inserted on the appendix-stem, usually at the proximal end, but sometimes farther backward, and the hindmost part of this muscle then spreads in a cloak-like manner over part of *M. dilatator* (comp. the Greenland Shark). This muscle generally is very distinct, already in quite young animals with undeveloped appendages; but in *Lamna* I find its fibres woven into those of *M. adductor* to

a coalescing of basal parts of rays, refers to the fact that such a coalescing of rays is frequently seen in other parts of the fin, especially anteriorly, he does not see that the basal joints of the rays always are many times longer than the distal, and that this difference of size is also preserved by such concrescences.

[1]) The type of the arrangement of the ventral muscular system put down by v. Davidoff (l. c. p. 456) for *Heptanchus* ♀, which reminds of the arrangement in *Chimæra*, I have had no occasion to see in any Plagiostome; v. D. asserts to have found it very generally, and refers to *Acanthias* almost as an exception; however, I can with certainty see no other forms mentioned in his text than *Carcharias* as belonging to the same type as *Heptanchus*.

such a degree that it does not appear as an independent muscle, and only artificially is to be separated from the former.

The distal part, the muscular system of the shaft, is typically composed of two muscles: *M. dilatator* (*D*), and *M. compressor* (*sacci*) (*S*).

M. dilatator (*D*) is always very large and powerful; it wraps in a cloak-like manner the appendix-stem until the terminal part, leaving only the lateral surface uncovered, part of which is occupied by *M. compressor*. *M. dilatator* originates forward, either from the appendix-stem only, or frequently also, above the knee of this latter, from the pieces b_1, etc., or from the basale; posteriorly it is attached to the aponeurotic wrapping of the terminal part, or, when covering pieces have been developed from the wrapping, partly to these. Besides fibres of it often go to the skin, and here and there bundles pass into the *M. compressor*. The chief action of this muscle is to bend the terminal pieces together with the soft end-style (ventro-) medially, by which means the terminal part of the appendix-slit is widened; at the same time some of the terminal pieces are often turned from their position of rest in such a manner that they rise through the skin, or are erected so that they stand out free (as the spur or thorn in *Somniosus* and *Lamna*, the claws in *Spinax*, the hook and the spur in *Acanthias*; the large piece T_3 in *Raja*, etc.). When the contraction ceases the appendix-slit will again be narrowed, and the erected skeletal pieces will again be laid, partly mechanically by elastic reaction of the soft connective tissue, but partly also the *M. compressor* will be able to support this latter operation.

Musc. compressor shows in the Plagiostomes so particular a structure, that when it has been examined at all, it has hitherto been misapprehended, the greater part of it being understood as a bag composed of dermal muscles.

This muscle, I suppose, originally occupies in the Plagiostomes a place, similar to that in the Holocephales (see later); i. e. it covers the lateral surface of the appendix-stem, or very frequently only its proximal part, and anteriorly it also reaches on to the piece β and the (two) last rays. Into this muscle, a longitudinal folding of the outer skin penetrates from the dorsal side of the shaft; this folding forms the appendix-slit and the glandular bag, the former leading into the latter. The foremost part of the folding growing on ventrally, carries with it the wrapping muscle, and then both grow on together, and form a singularly thickwalled bag which from the slit-formed opening on the dorsal side grows on between the last ray and the stem skeleton to the ventral side of the fin, where it becomes situated between the outer skin and the ventral ray-muscles. In Sharks the foremost, blind part very often grows much farther forward, not only near to the pelvis, (*Spinax*, *Rhina*, *Somniosus*) but in many, I think in most Sharks it reaches forward of the pelvis (for inst. *Acanthias*, *Scyllium*, *Pristiurus*, *Lamna*, *Selachus*)[1]), and then the bags of the two sides are in contact a long way in the median line (fig. 4). In the Rays the bag is much smaller, (pl. VI, fig. 68), but on the other

[1]) In *Mustelus lævis* the glandular bag reaches as far forward as to the pectorals; i. e. the part before the pelvis is of far more the double length of that behind it. I have myself only had immature males of *Must. lævis* for examination; but this statement I found on a drawing without any text, left by A. Schneider which, together with other drawings, has been published as an appendix to the fragment left by S.: Studien zur Systematik und zur vergl. Anat., Entwickelungsgeschichte und Histologie der Wirbelthiere (Zool. Beiträge, vol. 2, 1890). The figure in question (pl. 25, fig. 11) is explained as *Mustelus lævis*. Brustflossen und Bauchflossen mit Saamenblasen. Die Cutis entfernt. Bauchseite

hand its secreting part is especially developed, and its muscular wall somewhat more complicated. In the part of the *M. compressor* forming the muscular wall of the bag, the direction of the fibres may be rather different, but they chiefly radiate in bent lines towards the periphery, or round this to the dorsal surface; this latter is only by loose connective tissue connected with the ray-muscles. In the part in the shaft the direction is more straight, parallel to the axis; this is the case with the fibres covering the lateral surface of the appendix-stem (or a short proximal part of it), as also with those forming the outer, lateral border of the appendix-slit. This lateral part most frequently appears on the dorsal side as an independent muscle, and might be called the outer lip-muscle, being, as it were, separated from the other part of the wall of the bag by the attachment of the fin-membrane. By a closer examination and by a transverse section through this region (cp. fig. 1 and 14 in the text) I have been convinced of its forming a whole with the other parts of the muscular wall of the bag, with which also the corresponding part in the Holocephales forms a complete union (see later). A large part of this outer lip-muscle originates anteriorly from the piece β and the hindmost ray, or rays; posteriorly it is inserted partly on the inner investment of the ventral marginal cartilage, partly on the aponeurotic covering of the ventral terminal pieces, and acts through this especially on the piece *Tv*. The muscular coat formed by *M. compressor* will by contracting expel the fluid secreted from the epithelium of the bag; but besides its hindmost, lateral part, the outer lip-muscle, when it is long and powerfully developed (as in Sharks with a short ventral marginal cartilage, for inst. *Somniosus*, *Spinax*, *Acanthias*, *Rhina*), will act antagonistically to *M. dilatator*, i. e. narrow the dilated terminal part, and lay the erected terminal pieces.

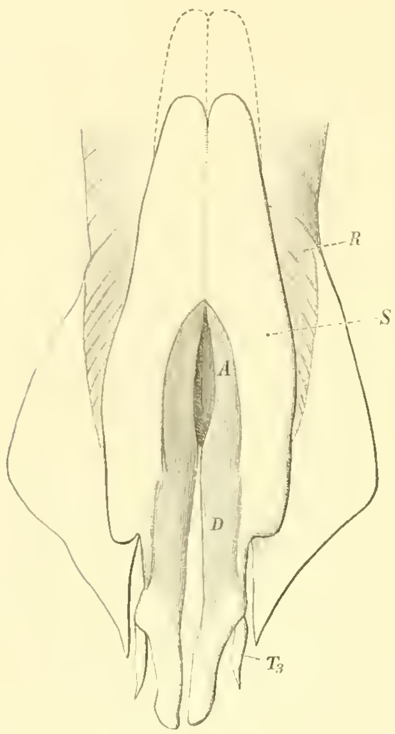

Fig. 4.

Acanthias vulgaris ♂. The ventrals seen from the lower surface. *S M. compressor*, *A M. adductor*, *D M. dilatator*, *R* ray-muscles, T_3 the spur. The stippled contour indicates the anterior extent in another specimen.

The muscular system of the appendix which here has been briefly represented in its typical characteristics, shows in different Plagiostomes special modifications, as to which the reader is referred to the special part. I shall only here state that the part of *M. compressor* which appears as the outer lip-muscle of the appendix-slit, commonly, as to its size and development, is adjusted to the length of the ventral marginal cartilage; therefore it is very small in *Scyllium* (pl. VI, fig. 66, *S*), and in *Pristiurus*, rather small in *Raja* (fig. 67, *S*); longer and more powerful in *Torpedo*, but especially developed in Sharks as *Somniosus*, *Acanthias*, *Spinax*, *Rhina*, a. o. From the part of *M. compressor* wrapping the bag proper, is in the Rays developed a special muscular layer around the voluminous gland found in these latter. In the Sharks (with the exception of *Rhina*) the inner epithelium of the bag does not form real glands, but only contains secreting cells, and is accordingly very simple as secreting apparatus. In the Rays, however, has been developed a bulky gland protruding as a thick, oval body from the dorsal wall of the bag into its inner space, and almost filling it; when the ventral wall of the bag is opened, this body is immediately seen, and in sound animals it is sometimes seen rather distinctly through the skin[1]). Down the middle of the gland runs straight or obliquely (*Trygon*) a longitudinal furrow, in which is seen a great number of rather large holes with raised margins: they are the excretory openings of collective ducts from a solid mass of large, dichotomously divided, tubular glands. This gland is on all sides until the longitudinal furrow enclosed by a muscular layer, originating from the dorsal muscular wall of the bag. By this special muscular layer the secretion may evidently be ejected into the inner space of the bag, and then by contracting of the muscular wall of the bag itself be driven on, partly through the large opening at the base of the shaft, partly posteriorly through the "tube", formed by the marginal cartilages, and on through the terminal part; in full-grown animals these latter ducts are generally found filled with the secretion. Among the Sharks I have only in *Rhina* found a similar bulky gland, but situated only in the shaft (for further particulars see under *Rhina*).

A survey of the medial fin-muscles in the females of the Plagiostomes will show that they are of a considerably simpler structure than those of the male. In the female is found only one single muscle, a *M. adductor pinnæ* (pl. V, fig. 63, 64, *A*) originating in quite the same way as in the male from the pelvis and its aponeurotic prolongation in the ventral median line, and built in a similar manner as to the division of the ventral side in separate bundles, the passing of the foremost lateral part into the ray- muscles, a. s. o.; here, too, the medial marginal portion forms a solid mass, continuing as a posteriorly tapering bundle on to the terminal joint of the fin-stem[2]).

It is then — especially considering the intermingling of fibres that often takes place in the different muscles of the male — an obvious conclusion that an adductor of a similar simple construction as the one, now found in the female, has been the origin of the *M. adductor*, the *M. extensor*, and the *M. dilatator*, perhaps also of the *M. compressor* of the male. When the hindmost joint of the fin-stem developed into the appendix-stem, the distal part of the orginal, simple *M. adductor* might be thought to be brought along at the same time, so that part of the deeper-lying fibres would originate from the stem-skeleton, by which process the *M. dilatator* would arise; while in the proximal part too a group of fibres originating from the stem separated as the *M. extensor* (in *Lamna* this muscle is only part of the *M. adductor*). The *M. compressor* might have the same origin as the *M. dilatator*, but more likely it represents the very hindmost ray-muscles.

In the males of the Holocephales (pl. VI, fig. 69—71) the separation between a proximal muscular group and a distal one, placed on the appendix-shaft, is, as before mentioned, more strongly marked than in the Plagiostomes. The proximal group is formed by a *M. adductor*, corresponding to that of the latter, as to the detailed structure of which I refer to the special part; a separate *M. extensor* is not found. The distal part is also here composed of a *M. dilatator* and a *M. compressor*,

[1]) This gland was already seen long ago. J. Th. Klein (Historiæ piscium naturalis promovendæ missus tertius etc. cum observationibus circa genitales Rajæ maris etc. 1742), as far as I have seen, is the first author, who mentions it. He thinks the gland to be a kind of testis ("forte officina seminis"), but observes that he has not been able to find any connection with the kidneys, nor with "vesiculis seminalibus" ("adesse tamen possunt"). E. Olafsen in his Icelandic voyage [illegible] takes the same view of the gland as Klein.

[2]) The figure of *Acanthias* ♀ given by v. Davidoff, l. c. pl. XXIX, fig. 12, is not correct with regard to the direction of the fibres; so I have given a new figure.

the latter being of special interest with regard to a comparison with the Plagiostomes; it is much thicker than the *M. dilatator*, and covers the lateral surface of the stem-piece b_1, and of the piece b to the terminal part. Into this muscle sinks through the dorsal appendix-slit a continuation of the outer skin as a „glandular-bag", which on account of its simplicity might be called „rudimentary", when compared to that of the Plagiostomes, as it has evidently remained in a similar stage of development as that, with which it begins in those; by a further development forward and ventrally a quite similar glandular bag would arise as the one described as characteristic in the Plagiostomes. The direction of the fibres of the *M. compressor* is rather peculiar in the Holocephales (see the special part); here I shall only mention that part of the fibres seen dorsally (fig. 70), runs along the lateral edge of the appendix-slit rather straight from the piece β backward in quite the same manner as in the corresponding part, the „outer lip-muscle", of the *M. compressor* in the Plagiostomes. The whole structure of this muscle forms, as it seems to me, an incontestable proof as to the correctness of my interpreting the muscular coat of the glandular bag of the Plagiostomes as part of the skeletal muscles proper.

In the female the whole muscular system of the appendix is wanting; according to v. Davidoff the little terminal joint has an attachment for part of the dorsal muscles arising from the wall of the body (l. c. p. 477, pl. XXIX, fig. 18, *ps*), corresponding to the attachment of the same muscle on the piece b_1 in the male; just on account of this v. Davidoff explains the terminal joint to be homologous with this piece.

The fin-muscles of the male have been rather slightly treated in the earlier literature; a comparison between several forms has been almost quite out of the question, only a few forms having been described. Thus among the Sharks *Acanthias* has already been mentioned by Bloch, among the Rays some *Raja*-species by several authors (*Raja radiata* very briefly and incompletely by Bloch, *Raja circularis* [or *clavata*] by Duvernoy, *R. clavata* by Vogt & Pappenheim and later by Moreau), *Chimæra monstrosa* by v. Davidoff. Petri alone has examined several different forms and tried to make a comparison, but he cannot be said always to have been successful or to have found the correct interpretation. While he upon the whole pretty correctly has interpreted the muscle I have called *M. adductor*, — his *M. flexor pinnæ*, or *pterygopodii*, a name rejected by me as presumably not suitable, — and *M. dilatator*, a name introduced by him (at all events in *Scyllium*, *Acanthias* and *Torpedo*), the other muscles have either been misapprehended or not at all mentioned. The *M. extensor* he has only seen in *Scyllium* and *Raja*, where he calls it *M. flexor pterygopodii interior*, and of my *M. compressor* he has only mentioned the part, which I have called the „outer lip-muscle" (of the appendix-slit), in *Acanthias* and *Raja*, and with different appellations, respectively as *M. levator* (of the spur) and as *M. flexor biceps* (which latter name is also given to a quite different muscle in *Scyllium*), and he has assigned to it different, partly misapprehended, functions. It has already been observed that both Petri and all other authors, who have mentioned the glandular bag, have understood the muscular wall to be a separately developed dermal muscular system, and consequently omit it by the mentioning of the fin-muscles proper. In the special part account will be rendered of the earlier literature, and the particular works will be referred to.

2. Special Part.

Selachoidei.

Spinacidae.

Acanthias vulgaris Risso.

(Pl. I, fig. 10, 11.)

The common picked Dog-fish has been so often examined that I think a more particular description of the external features of the copulatory appendages to be superfluous; I may refer to Petri[1]) (with regard to whose description, however, I must remark that the investment with dermal teeth at the places of transition to naked parts does not cease gradually, but is quite sharply bounded; the dorsal side is wholly naked, as is also on the ventral side the hindmost point of the terminal part), as also to the earlier description by Bloch[2]) and Home[3]). In a specimen of the length of 64^{cm} the following measures were found:

Length of the appendix (from the fore-edge of the cloaca) . .	$6{,}5^{cm}$
— - - part free of the fin	$3{,}1^{cm}$
— - - terminal part	$2{,}2^{cm}$
— - - appendix-slit	$4{,}2^{cm}$
Breadth of the appendix	ab. 1^{cm}

The skeleton has not been quite correctly described by any of the earlier authors[4]).

Between the basale and the appendix is found only one short joint (b_1), and besides the dorsal piece (β[5]); this latter articulates anteriorly with the basale, posteriorly with the appendix-stem b, and medially with b_1; its lateral edge is convex, projecting somehwat in the shape of a roof over the two hindmost rays; these rays are borne by the piece b_1, and are often coalesced; they are stronger and longer than the last ray but two, which latter comes from the basale.

The stem of the chief piece of the appendix has a length like $B - b_1$, and proximally towards its articulation with b_1 is found a ridge (at b in fig. 10) projecting in a somewhat keel-like manner; in the hindmost half it has laterally a little trough-like hollow. The soft end-style is short[6]), flatly rounded, and reaches not nearly to the end of the terminal part. The dorsal marginal cartilage[7]) (Rd) can forward be indistinctly traced as a rounded ridge to about the letter x in fig. 11 (it is more

[1]) l. c. p. 300, pl. XVII, fig. 5, *A*.

[2]) l. c. 1788, p. 9, pl. 2, fig. 1.

[3]) On the Mode of breeding of the Ovoviviparous Shark etc. Phil. Trans. 1810, Pt. II, p. 205, pl. IX and X; in the lastmentioned place the ventrals and the appendages have been drawn in a position, which they scarcely naturally would be able to have.

[4]) Drawings are found not only in Bloch, Gegenbaur and Petri, but also in Molin: Sullo scheletro degli Squali, pl. III, fig. 7; Memorie dell' Ist. Veneto, vol. 8, 1859, but without any explanation or description in the text.

[5]) Gegenbaur, fig. 16, *b*; Petri, fig. 5 *D*, *r*.

[6]) Gegenbaur, fig. 17, *i*; it has been quite overlooked by Bloch and Petri.

[7]) Mentioned neither by Gegenbaur nor Petri. The hindmost end of it is the Processus *x* am Schienbein (l. c. fig. 3) of Bloch. Neither of these authors have seen independent marginal cartilages in *Acanthias*.

distinct, when the piece is dried); posteriorly it is distinctly elevated as an edge of the appendix-slit. The ventral marginal cartilage (*Rv*) is shorter, resembles the corresponding one in the Greenland Shark, and has, as in the latter, a plate-like part[1]) folded to the dorsal side; on the concave inner side it has furthermore a strong, elevated process; in the furrow between this process and the folded part the proximal end of the "thorn" is placed.

There are four terminal pieces.

Td[2]) is narrow, with the foremost part of its medial edge closely connected with the end-style, and behind this with the edge of the ventral piece *Tv*; distally it takes the form of a flattened, sharp-edged hook; this hook-shaped part rises uncovered through the skin, is smooth, shining, and dentine-like. *Td* is with part of its lateral edge connected with a quite thin, plate-formed piece[3]), Td_2, also anteriorly connected with the marginal cartilage *Rd*; it is placed in the skin forming the dorsal lip of the appendix-slit of the terminal part, and corresponds to the piece Td_2, indicated in the Greenland Shark.

The ventral terminal piece, *Tv*[4]), is considerably broader and longer than the dorsal one, rounded on the ventral (outer) surface, hollowed like a spoon towards the appendix-slit; except the hindmost part it is firmly calcified; the foremost part of the medial edge is connected with the end-style, and behind this with *Td*, the hook of the latter lying freely in the outermost spoon-like end of the former piece; in the proximal end it has medially an articular process for articulation with the above mentioned process of the concave side of the marginal cartilage *Rv*, and its lateral edge is firmly connected with a strong, thin membrane (fig. 11, Tv_2), serving in the foremost part for attaching the outer lip-muscle of the glandular bag; this membrane then corresponds to the similar, but thicker one in the Greenland Shark, and to the piece Tv_2 in *Spinax*.

The fourth terminal piece, T_3, is the one called the "spur"[5]) by the different authors; with the proximal, somewhat head-shaped end it is attached inside of the folded plate of the marginal cartilage *Rv* to the above mentioned process, and to the proximal and lateral end of the piece *Tv*; it is formed as a triangular thorn or spine, longitudinally somewhat twisted, with two concave surfaces; it is firm, shining, dentine-like, and the greater part of it is uncovered by the skin. It can be moved quite in the same manner as the corresponding spine in the Greenland Shark.

The muscular system. The *M. adductor* shows the general typical relations. The *M. extensor* reminds very much of the same one in the Greenland Shark; as in the latter it has here its origin on the medial side of the basale and b_1, stretches over the "knee" of the appendix-stem as a thin, flat covering over the *M. dilatator*, and inserts itself along the boundary line of the dorsal marginal cartilage.

The *M. dilatator* originates proximally with a dorsal portion at the same place as the *M. extensor* and quite covered by it, that is to say some way up on the basale; on the ventral side its proxi-

[1]) Bloch, Processus *d*; Gegenbaur, fig. 15, 16, *a*; Petri, fig. 5, *D*, *E*, *pr*; regarded by all only as a process on the chief piece.

[2]) Bloch, der Haken, fig. 2, *e*, fig. 6; Gegenbaur fig. 16, 17, *o*; Petri, fig. 5, *hk*.

[3]) Petri, fig. 5, *la*; it is neither mentioned nor drawn by Bloch or Gegenbaur.

[4]) Bloch: der breite Knochen, fig. 2, *d*, fig. 5; Gegenbaur, fig. 15—17, *c*; Petri, fig. 5, *b'''*, he interpreting it as the terminal joint of the stem.

[5]) Bloch, der Sporn, fig. 2, *c*, fig. 4; Gegenbaur, fig. 15, 16, *a'*; Petri, fig. 5, *sp* and *ca*.

mal origin accordingly is much more backward, at the distal end of the *M. adductor*; it is inserted as usual, its aponeurosis being especially attached to *Tv* and *Td*; the latter piece, the hook, is turned (round its medial edge as the axis) out of its position in the spoon-shaped end of the former, when the muscle is contracted during the dilation.

The part of the *M. compressor* wrapping the bag, is much distended, and consequently rather thin, corresponding to the considerable extent of the bag anteriorly (see fig. 4 in the text). The part inserted on the lateral surface of the appendix-stem, is very small, reduced to a few bundles of fibres on the proximal end of this part of the skeleton, which otherwise is almost quite enclosed by the *M. dilatator*. The part, which as outer lip-muscle forms the lateral limit of the appendix-slit, seems to me to receive in its surface some fibres coming from the muscular layer originating from the lateral muscles of the body, but otherwise it originates as usual on the hindmost rays and on β; it is inserted with a kind of tendon in the above-mentioned membrane on *Tv*, and consequently it acts antagonistically against the *M. dilatator*, and at the same time lays the spur T_3[1]).

Spinax niger Bonap.

(Pl. I, fig. 12, 13.)

The very peculiar-looking appendages in this common Shark have singularly enough been very little mentioned by earlier authors, and by many, also among the later, they are not mentioned at all. Gunnerus[2]), in his description of the Sort-Haa, says: they (i. e. the two *Membra genitalia*) were supplied with some sharp bony spines, such as I have seen on the *Membra* of several Rays, when the ends have been turned inside out. Kroyer[3]) says: At the end of the copulatory appendages of the males are found three crooked thorns or horny claws, and a tapering dermal flap, which behind projects a little over these claws. The claws are movable against each other, and form a kind of prehensile organ. In the position of rest they are hidden between a pair of small cartilaginous plates, and the skin covering these plates. This is the most complete, and also, I think, the most correct description I have seen[4]). Duméril[5]) gives a drawing of the appendix, but with no explanation whatever (nor in the text neither); the drawing is rather difficult to understand, neither is it correct; thus the dermal flap mentioned by Kroyer appears in this figure as a thorn, although it is

1) Petri (l. c.) designates this part of my *M. compressor* as *M. levator* (fig. 5, *ml*), and attributes to it a dilating effect, having allein die Aufgabe diesen (den Sporn) zu heben, and thus he in this place speaks of two dilating muscles. The incorrectness of this, however, is easily pointed out. Contrary to Petri, Bloch upon the whole has a correct understanding of the mobility of the spur, speaking (l. c. p. 13) of einen sehr sonderbaren *Mechanismus*. Davon mir wenigstens in der Anatomie kein ähnlicher bekandt ist. Bloch has a chiefly correct description of the muscular system; he distinguishes between three muscular portions, the first of which being the ventral ray-muscles, the second, which he compares to the adductor femoris in man, is my *M. adductor*, the third *M. dilatator* + my *M. extensor*. He describes the glandular bag as a particular organ, to which he does not ascribe any muscular walls, as he supposes that the other (2) muscles expel its klebrigte Feuchtigkeit. Neither has Petri seen my *M. extensor* as a separate muscle in *Acanthias* (see his fig. 5, *B*, and the description p. 302); but it is also to be acknowledged that in this species it is very closely connected with the *M. dilatator*, especially proximally.

2) Throndhjemske Selskabs Skrifter II, 1763, p. 319.

3) Danmarks Fiske vol. III, 1852—53, p. 908.

4) Müller & Henle, System. Beschr. der Plagiostomen, 1841, p. 86, say: Kein Dorn an den männlichen Anhängen, founded, I suppose, on young specimens, in which only the soft dermal flap is seen.

5) Hist. nat. des Poissons, vol. I, 1865, the atlas, pl. IV, fig. 13.

quite soft. Lilljeborg[1]) only says: The copulatory organs of the male are small and pointed, and reach only a little behind the ends of the ventrals; they are until towards the end coalesced with the ventrals. As no thorns are mentioned, L. must have examined only undeveloped appendages.

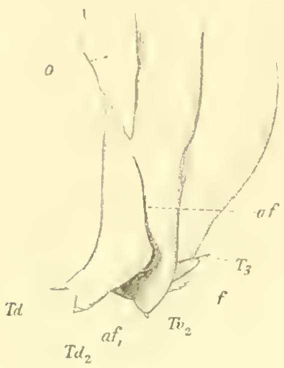

Fig. 5.

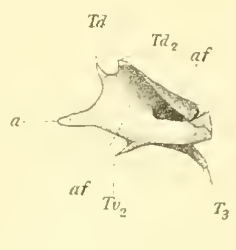

Fig. 6.

Fig. 5. *Spinax niger.* The appendage of the right side with part of the fin-membrane, seen from the dorsal side, somewhat enlarged. The terminal part is dilated. *f* the folded, free end of the fin-membrane; at *o* the fin has been cut from the body. af_1 the dilated part of the appendix-slit.

Fig. 6. The dilated terminal part, seen from behind. *a* the soft terminal flap. *af* the spot where the appendix-slit passes into the dilated, terminal part of the furrow.

The appendix, when fully developed, is short, clumsy, thick, and reaches only a very little farther backward than the end of the fin-membrane, the free part of which is also very short. Dermal teeth are not found, neither on the dorsal, on the medial, nor on the greater part of the ventral side, except on this latter laterally, near the fin-membrane. In the numerous, developed appendices, examined by me, the terminal part was always very much dilated, and such was also the case in the specimens, I have caught alive; in the dilated state the terminal part stands almost at a right angle to the stem, its hinder end with the soft dermal flap (*a*) pointing inward towards the middle line; the dilated part of the furrow then looks like a concave sole of the foot, in whose heel is seen the opening, through which the secretion of the glandular bag is probably ejected. Three polished, hard points protrude like claws through the skin, one at the dorsal lip of the furrow, the second at the ventral lip, and the third, and longest, juts out, ventrally and laterally, from the spot, where the fin-membrane becomes free of the appendix.

In specimens of the length of $35{,}5^{cm}$—$38{,}5^{cm}$ the following measures are found[2]).

Length of appendix (from the fore edge of the cloaca) . .	abt.	$2{,}5^{cm}$—35^{cm}
— - the part, free of the fin	-	$1{,}2^{cm}$
— - the terminal part	-	1^{cm}
— - the appendix-slit	-	$1{,}8^{cm}$
Breadth of the appendix	-	$0{,}6^{cm}$—$0{,}8^{cm}$

The skeleton. Between the basale and the appendix are found two small pieces (b_1 and b_2), each bearing one of the two hindmost rays (accordingly $b_1 + b_2$ in *Spinax* = b_1 in *Acanthias*); nevertheless these rays may be found coalesced, and are, as usually, directed straight backward, parallel to the appendix. The piece β is relatively somewhat longer than in *Acanthias*, but of a similar form.

The axial part of the chief piece of the appendix is somewhat more clumsy than in *Acanthias*, but otherwise of a similar form, and also supplied with a short, soft end-style; including this latter the stem is only a little longer than the basale. The marginal cartilages, too, show chiefly the same relations as in *Acanthias*.

[1]) Sveriges och Norges Fiskar, vol. 3, 1891, p. 677.

[2]) It is somewhat difficult to obtain exact measurings on account of the terminal part being bent.

The terminal pieces are 5.

The dorsal one, *Td*, is somewhat s-shaped, round, and articulates medially with the end-style, while the hindmost part of it projects through the skin as a curved, polished claw; as in *Acanthias*, it is united with a thin lamellar piece, Td_2, which piece, with the exception of the hindmost point, is quite covered by the skin forming the dorsal lip of the furrow.

The ventral piece *Tv* is also somewhat s-shaped, broader than the dorsal one, thick at the base, becoming thinner distally and laterally; it is concave like a spoon on the side towards the furrow, on the other side rounded. At the proximal part of the lateral edge it is firmly united with a hard, dentine-like piece Tv_2, which in *Acanthias* is only represented by an uncalcified membrane. This piece is before (proximally) prolonged to a long, flat end, behind (distally) to a shorter one, projecting through the skin as the before mentioned claw in the ventral lip of the furrow; the piece is rather narrow, ventrally concave, dorsally rounded. In moving it follows the piece *Tv*.

The last piece T_3 corresponds to the thorn in *Acanthias* and *Somniosus*, and is also here formed as an elegant, bent, rounded and completely smooth thorn with the proximal end head-shaped.

It is quite out of the question that these claws , as supposed by Kroyer, should be able to act as a prehensile organ , as they cannot properly be moved against each other; but they will be very able to fix the appendix firmly in a hollow, as by the dilatation of the terminal part their points are turned in three opposite directions, as may be seen from fig. 6 in the text.

The muscular system. From the *M. adductor* has been separated a long, flat bundle as a particular muscle originating before from the medial aponeurotic stripe together with the other fibres of the *M. adductor*, and then on the dorsal side passing obliquely over the *M. extensor* and next over the *M. dilatator*; on the appendix it follows the appendix-slit, and forms together with the *M. dilatator* the medial lip of this slit; partly it is attached in the skin of this lip, but chiefly on the proximal end of the piece Td_2. This muscle evidently is instrumental in increasing the dilation of the terminal part, which dilation, as has already been indicated, seems to be especially great in *Spinax*.

The *M. extensor* is almost as in *Acanthias*, that is, not sharply bounded from the dorsal part of the *M. dilatator*.

This latter, on the contrary, is on the ventral side distinctly bounded from the *M. adductor* by a line running obliquely from the lateral side down towards the medial side. Its aponeurosis, as in *Acanthias*, is especially attached to *Td* and *Tv*.

The glandular bag (the *M. compressor*) does not in any of my numerous specimens reach quite to the pelvis, and accordingly it must be termed proportionally small. Its outer lip-muscle as usual originates from the piece β and the hindmost rays, and is with its principal portion very distinctly inserted on the piece Tv_2, with another portion on the folded part of the ventral marginal cartilage (not on the thorn T_3).

Scymnus lichia Bonap.

A skeleton in the Zoological Museum (from V. Fritč in Prague).

In this specimen the appendix only reaches a trifle farther backward than the fin-membrane, and the condition of the terminal skeleton makes it probable that the organ is not fully developed.

Between the basale and the appendix-stem is found one piece b_1 bearing the two hindmost rays. The piece β is rather large, flattened, with an edge turned towards the dorsal side.

The appendix-stem is as long as $B + b_1$; its proximal part below the knee is somewhat bent, medially convex, otherwise of a similar form as in the Greenland Shark, i. e. distally lanceolate; the end-style is very short. The dorsal marginal cartilage is a very narrow ridge, reaching forward almost to β; the ventral one is much longer than in the Greenland Shark, occupying almost the whole length of the appendix-stem as a rather high, firm, and hard lamella, the distal part of which forms a but small, very narrow, folded plate, properly speaking only an indication of such a one.

Among the terminal pieces the piece *Td* is still quite soft, not separated from the other tissue; *Tv* on the contrary is hard, and reminds, as to its form, of the corresponding piece in the Greenland Shark. T_3 is present, but small, and no doubt not yet quite formed; whether in the developed organ it is hidden by the soft tissue — so that the observation by Müller & Henle: Die männlichen Anhänge ohne Stachel (l. c. p. 91) so far may be justified — I must leave undecided; the observations of these authors concerning the ventral appendages are however, as it turns out, often quite unreliable.

Scylliidæ.

Scyllium canicula (L.).

(Pl. II, fig. 16, 17).

The copulatory organs are mentioned by several authors, generally, however, without any particular description, as these authors especially attach importance to one peculiarity in the ventrals of the male, which (in all stages) forms an easy distinctive mark between *Scyllium canicula* and *Sc. stellare* (*catulus*)[1], viz. that the ventrals are completely coalesced dorsally of the appendages, and in the middle of the hindmost edge of this coalesced part only a small incision is found. By a fold of the fin-membrane, passing over the proximal part of the appendages, these are also partially covered on both sides ventrally, and thus they are placed as tongues in a bell, which is open on the lower side, their hindmost ends reaching to or even farther (abt. 5^{mm}) than the hindmost edge of the bell[2]. The whole dorsal side (i. e. the side towards the body) of the coalesced ventrals is covered with dermal teeth and pigmented (spotted like the skin of the animal in other places), and this covering is continued round the edge to the ventral side, where it is quite sharply limited; the other ventral part of the coalesced fins (the part in contact with the dorsal side of the appendages) is naked, unpigmented, and soft.

The appendix (in two specimens, when measured from the cloaca, abt. 43^{mm} long, abt. 6^{mm} broad at the base of the terminal part, which is of a length of abt. 24^{mm}) is straight, posteriorly some-

[1]) See for inst. Müller & Henle, l. c. p. 7, 10. Kroyer, l. c. p. 824. Duméril, l. c. p. 316, 317. Lilljeborg, l. c. p. 650. Petri, l. c. p. 303, and fig. 6.

[2]) The words of Lilljeborg l. c. p. 650: The male has small copulatory organs, not reaching to the hindmost points of the ventrals, and scarcely of half of the above given length of these fins do not apply to the developed state. Neither can the figure 6 of Petri represent the developed appendages, and it is upon the whole bad; the appendages are in this species never so clumsy; the description at p. 303 is only ill adapted to *Sc. canicula*, and not very well to *Sc. catulus*.

what conically tapering, on the greater part of the surface covered with dermal teeth; only immediately at the cloaca the dorsal side is naked, as is also the outermost point of the appendix, which is soft and papillous; from here a naked, depressed stripe reaches forward on the medial side of the terminal part[1]). On this part the dermal teeth have another shape than elsewhere on the animal, being longer and more pointed, like small thorns with the points turned towards the base of the appendix; accordingly the hinder part of this is rough to the feeling when rubbed backward, contrary to what is the case elsewhere on the animal. The appendix-slit is covered in the terminal part by a thin, soft membrane arising from the dorsal (inner) lip; when this membrane is thrown back, the furrow is found to be open as usual; but above the terminal part it is only represented by a groove in the skin, not very deep; the slit, which in the Sharks, hitherto mentioned, is quite open, is in this animal under the dermal furrow by coalescing formed into a tube reaching to the base of the organ near the cloaca, and first here an opening is again found, an oval aperture through which a sound may be brought into the glandular bag. This latter accordingly has two outlets, one at the base of the appendix, the other between the movable parts of the terminal part[2]).

The skeleton. Between the basale and the appendix is found one very small piece (b_1) bearing no rays; the piece β is also inconspicuous, somewhat triangular, with a broad articulation before with the basale, a narrow one behind with the appendix-stem.

The appendix-stem is of about the same length as the basale; it is calcified to a rather considerable degree; the soft end-style reaches to somewhat more than half the length of the terminal part.

Both marginal cartilages are specially strongly and peculiarly developed, which will be seen from fig. 16 clearer than from a description. The dorsal one (*Rd*) reaches (as is usual) somewhat further forward than the ventral one, but in the dorsal middle line it joins with the latter for a long way by a firm (suture), so that the two cartilages together with the stem form a complete, firm tube, open before where the glandular bag joins it, and behind at the terminal part. Thus the part of the ventral marginal cartilage assisting in the forming of this tube, corresponds to the folded plate of the ventral marginal cartilage in the before mentioned Sharks[3]).

The number of terminal pieces is four[4]), completely corresponding to those in *Acanthias*. *Td* is narrow, somewhat triangular; along the side towards the furrow it is connected with a thin, style-shaped piece, Td_2 which proximally becomes broader, and reaches a little under the dorsal marginal cartilage. *Tv* is broader, lengthened-oval, rounded on the outer side, towards the furrow slightly hollow, thick, and solid. Between its proximal end and the ventral marginal cartilage is inserted a well developed piece, T_3, which is not formed as a thorn, nor can it be erected to such a position, as

1) At *x* in the fig. 6 of Petri.

2) Davy, J.: On the Male Organs of some Cartilaginous Fishes, Phil. Tr. vol. 10, 1839, p. 146. has already mentioned this fact in *Scyllium Edwardsii*; Petri represents it l. c. p. 304.

3) As Petri has not seen the marginal cartilages as such in *Acanthias*, he has in *Scyllium* understood them to be something particular in this genus.

4) When Petri also finds four pieces in *Scyllium* it arises from his counting the end style of the stem (b'' fig. 7, C); he has really overlooked one piece, viz. Td_2.

the corresponding piece in the hitherto mentioned Sharks. All these terminal pieces are hard, white, china-like, but none of them protrudes with any part through the skin.

The muscular system is as in *Sc. stellare*, where it will be more particularly mentioned.

Scyllium stellare (L.)

(Pl. II, fig. 18–19; pl. VI, fig. 65–66.)

As upon the whole the ventrals of the male as to contour and shape are different from those in the preceding species, so it is also the case with the appendices. The ventrals are also here coalesced[1]), but only for a short way (in one specimen of the total length of 90^{cm} the coalesced part has a length of 16^{mm}); the small cut in the posterior edge in *Sc. canicula* has here become a large slit (in the specimen mentioned above about 26^{mm}); the dermal teeth also spread to a greater extent on the ventral side of this part of the fin. As furthermore no lateral fold of the skin is found on the ventral side covering the base of the appendices, and corresponding to the one mentioned in *Sc. canicula*, no »bell« is formed here.

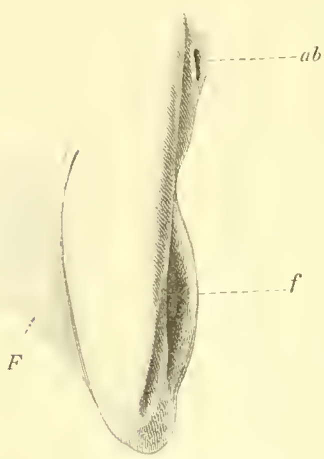

Fig. 7.

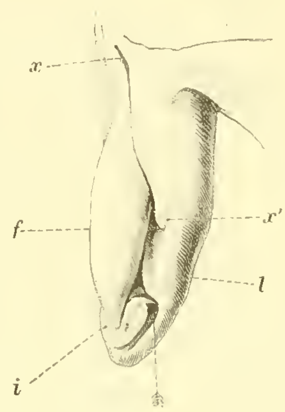

Fig. 8.

Fig. 7. *Scyllium stellare.* The appendage of the right side seen from the ventral side; about the natural size, *ab* abdominal pore. *F* fin-membrane, *f* winglike process.

Fig. 8. The same appendage seen from the dorsal side; the coalesced part of the membrane of the ventral is cut up, and thrown back. The arrow indicates the direction, in which a sound may be brought into the appendix-canal.

The appendix reaches just outside the posterior fin edge; it is far more big and clumsy than in *Sc. canicula*, but still the details remind of the latter, they are only coarser and more conspicuous.

In a specimen of a total length of 90^{cm} the following measures were found:

Length of the appendix from the fore-edge of the cloaca to the hindmost point .	61^{mm}
— - - free part	36^{mm}
— - - terminal part	34^{mm}
Breadth of the appendix above the terminal part	14^{mm}
— - - — across - — -	16^{mm}

The terminal part is relatively larger than in the preceding species, and its peculiar appearance is especially caused by the strongly developed process *f*, which is only indicated in the preceding species. This process is on the ventral side (fig. 7) hollow, and the bottom of this hollow is naked, which nakedness continues on the soft, outermost point. The greater part of the appendix is also

[1]) When Lilljeborg l. c. p. 655 tells that the ventrals in *Sc. stellare* are not coalesced, he is not quite right. Müller & Henle l. c. p. 10 state the fact correctly.

here covered with dermal teeth; besides the parts mentioned only the surroundings of the anterior aperture of the glandular bag are naked. The points of the dermal teeth are also turned towards the base of the appendix; they are longest and most pointed on the dorsal side of *f* and *l*. The appendix-slit is closed (to an extent of abt. 15^{mm}) in advance of the terminal part, as may be seen by throwing back the dermal lip *x—x'* in fig. 8; accordingly we have as in *Sc. canicula* two outlets for the secretion of the glandular bag.

The skeleton in its main features is as in *Sc. canicula*, but the appendix-part of it is much more clumsy and peculiarly twisted. One small b_1 without rays, and a little β with rounded contour are found[1]).

The appendix-stem, from the articulation with b_1 to the end of the style, is of the same length as the basale; it is somewhat bent with medial concavity; the end-style of about half the length of the calcified stempiece; at the distal end of the former the medial edges of both the adjoining terminal pieces form a rather sharp knee.

The marginal cartilages are principally like those in *Sc. canicula*; *Rd* is posteriorly somewhat longer than *Rv*, and is distally and medially a little hollow.

The terminal pieces are four, three of them white and hard. *Td* is formed somewhat like a roof and as broad medially as *Tv* is ventrally; Td_2 is mainly as in *canicula*; *Tv* is rounded on the outer side, somewhat concave towards the slit, T_3 in my specimen is not calcified; but a soft, fibrous cartilage, joining with *Tv* and placed in the lip *l*, in my opinion represents this piece[2]). As in *Sc. canicula* none of the terminal pieces are seen through the skin.

The muscular system. From the medial marginal part of the *M. adductor* have been branched off two separate muscles: fig. 65, fig. 66 a_1 and a_2.

If we look at the ventral side (fig. 65) the fibres of the marginal part are seen as a powerful muscle a_1, anteriorly originating from the medial aponeurotic stripe, and posteriorly inserted on the proximal part of the appendix-stem close to the ventro-lateral edge of the skeletal orifice for the glandular bag; but part of its fibres attaches to the basale, and another part runs into the *M. dilatator*. Looking at the dorsal side (fig. 66) we find the edge formed by another muscle a_2, anteriorly only indistinctly separated from a_1, but posteriorly distinctly enough, as here a foremost portion of the *M. dilatator* originating from the medial side of the basale, wedges in between both. This muscle a_2 distally joins with the *M. extensor* (*E*), and together with this is inserted by a tendon below the "knee" of the appendix-stem.

The *M. dilatator* is enormously thick, and originates with the greater part of its mass from the appendix-stem until the boundary of the marginal cartilages, but, as already mentioned, a portion of it arises from the medial side of the basale; part of this muscle distally joins in the composition of the peculiar process *f* (it is the same in *Sc. canicula*, where this process is much less conspicuous), which by no means, as Petri says, is composed exclusively of "verfilztem Bindegewebe".

[1]) Petri l. c. fig. 7 C has distally of β (r' in Petri) another little piece (r''), which is not found at all in my specimen, and which upon the whole I do not think to be normal (originating from a rupture?); furthermore a piece (*mr*) which he (p. 305) compares to a "knee-cap"; this is, however, scarcely to be regarded as a particular piece, but, I suppose, only a strongly calcified eminence on the stem.

[2]) Petri, fig. 7 C, *x*.

M. compressor. The bag-formed part of this muscle is rather long, and reaches considerably forward of the pelvis. On the contrary, the part forming the «outer lip-muscle» is rather small (smaller than in my figures); as usual it originates from the stem-skeleton (β) and from the hindmost rays, and is inserted on the proximal edge of the ventral marginal cartilage; it will here scarcely be able directly to contract the dilated terminal part[1]).

Pristiurus melanostomus (Bonap.).

(Pl. II, fig. 20, 21.)

The ventrals of the male of this species are also dorsally coalesced in a similar manner as in the preceding two Scylliidæ[2]), but to a still less extent than in *Sc. stellare*, and a deep curve separates the coalesced part into two fin-laps. The appendices reach far behind the fin-membrane[3]), in a specimen of the length of 78^{cm} to 23^{mm} behind the point of the fin-membrane; the whole length, from the hindmost edge of the cloaca, is 50^{mm}; the part quite free of the fin is 35^{mm} long; the largest breadth of the organ is about 7^{mm}; the terminal part has a length of about 25^{mm}. The ventral side is covered with dermal teeth, except the hindmost, soft, as it were, convoluted part (abt. 9^{mm} long), on which still scattered groups of teeth may be seen; the dorsal side is naked, as are also the adjoining parts of the medial side, where they are covered by the fin-membrane; on the free edge of the lip *l* a few scattered rows of dermal teeth are seen. The dermal teeth are generally very fine; as in the foregoing species their points are on the terminal part turned towards the base of the appendix. The dentition on the coalesced fin-parts is as in *Sc. stellare*.

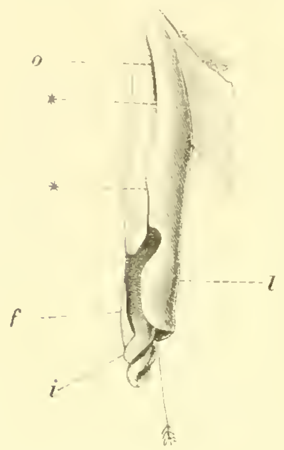

Fig. 9.

Pristiurus melanostomus. The right appendage seen from the dorsal side; about the natural size. The fin-membrane is cut through, and thrown back. *o* the larger basal opening of the appendix-slit; between the asterisks it is closed by coalescing. The other signs as in fig. 8.

The peculiar appearance of the appendix will be seen with sufficient distinctness from fig. 9. The furrow anteriorly is opened by a large, easily distended slit of a length of $8-10^{mm}$; behind this slit it is closed for an equal length, and again open in the terminal part. In spite of the great dissimilarity in general when compared with the appendix of the preceding Scylliidæ, a closer examination will show a rather considerable similarity with these, especially with *Sc. stellare*: corresponding to the peculiar process *f* of the Scyllia is found a thin, soft dermal process, which may be folded towards the furrow (as in fig. 9), or spread in a wing-like

[1]) This part of the *M. compressor* has been quite overlooked by Petri, who has seen and drawn the other muscles, and given them the following names (see l. c. pl. XVII, fig. 7, A and B):

The muscle here marked *A* (the chief portion of the *M. adductor*) = *fl. m. p.* i. e. *flexor major pinnæ.*
- — - — a_1 = *fl. p. b.* i. e. *flexor pterygopodii biceps.*
- — - — a_2 = *fl. p. ex.* i. e. *flexor pterygopodii exterior.*
The *M. extensor* here marked *E* = *fl. p. i.* i. e. *flexor pterygopodii interior.*

What Petri calls «flexion» must, I think, rather be regarded as an adduction connected with an extension of the appendix.

[2]) The expression used by Lilljeborg l. c. p. 660 «their inner edges are not coalesced» is accordingly not quite correct. The appendices are shortly described at p. 662.

[3]) Comp. Gunnerus: Om Haae-Gælen, pl. I, *f.* (Trondhjemske Selsk. Skr., II.)

shape to the medial side; to the lip *l* which in the Scyllia is turned into the furrow, corresponds the part in *Pristiurus* marked with the same letter, to the naked dermal fold *i* in one corresponds the naked dermal fold *i* in the other, etc.

Also the skeleton shows the near relation to the other Scylliidæ. Between the basale and the appendix is found (ventrally) a very small, quite rudimentary piece b_1 which of course bears no ray; dorsally is found an also very small piece β.

The appendix-stem and the marginal cartilages are much like those in the Scyllia. The stem is twisted longitudinally in a similar manner as in *Sc. stellare*, but is not bent medially. The dorsal connection of the marginal cartilages, however, is not so close as in the Scyllia; the two pieces may here be forced a little from each other.

The number of terminal pieces is five, if to the terminal pieces we will count a piece, Rd_2, which has not been found in any of the Sharks, mentioned in the foregoing; it is joined movably to the hindmost edge of the dorsal marginal cartilage, and is situated in the dermal fold below the asterisk in fig. 9.

Td and *Tv* are long and narrow, and form at the end of the style a similar kneeshaped curve as in *Scyllium stellare* (in *Sc. canicula* it is only indicated); a slightly calcified or almost quite soft piece Td_2 is found, projecting forward under the edge of *Rd*; *Tv* proximally forms a rather broad plate, to the dorsal edge of which is attached a leaf-shaped, somewhat bent piece T_3. All the pieces are completely hidden in the skin.

The muscular system is substantially quite the same as in the Scyllia, the only difference being that the outer lip-muscle seems to be still less developed in *Pristiurus*.

Lamnidæ.

Lamna cornubica (Gmelin).

(Pl. II, fig. 22, 23.)

In a specimen of the length of 2^{m} 5^{cm}, which in the beginning of November 1897 was driven on shore on the western coast of Jutland, the appendix has a length of 21^{cm}[1]) and a largest breadth of 4^{cm}; the terminal part is $7{,}5^{cm}$ long. The whole ventral surface is densely covered with dermal teeth quite to the end; this investment ceases with a strongly marked boundary line on the medial surface, which is quite naked to the terminal part; this latter being almost quite covered with teeth until the margins of the appendix-slit, also on the dorsal side; the other parts of the flat dorsal side of the shaft are naked, and these naked parts are laterally marked off from those covered with teeth by a rather deep longitudinal dermal fold. Apparently the appendix-slit from before the terminal part and to a larger foremost opening at the base of the appendix is closed as in the *Scylliidæ*; but in reality it is open, and for the whole way it is possible, though with difficulty, to press a sufficiently thin sound in between the margins of the marginal cartilages. On the medial side, immediately be-

[1] Lilljeborg l. c. p. 625 gives for a specimen of the length of $2{,}4^{m}$ a length of 25^{cm} for the appendix.

fore the terminal part, is seen a small opening (*l* in the fig. 10 in the text) of a length of $1^1/_2{}^{cm}$; this opening leads into a deep, pocketlike invagination of the skin, lined with a soft continuation of this, similar to a mucous membrane. On the dorsal side of the terminal part, at the lateral base, a polished skeletal piece projects uncovered by the skin and like a thorn (T_3). The terminal part is easily bent ventrally; if bent in that way, the thorn, as in many other Sharks, will rise mechanically, and stand out horizontally; it will immediately lie down again, when the terminal part is let loose. A dermal fold supported by the skeletal piece Td_2 is prolonged forward into the tube formed by the marginal cartilages in such a manner, that this tube gets two outlets, one on each side of the lamella concerned; but the appendix-slit proper is situated laterally of this piece (*af* in fig. 10).

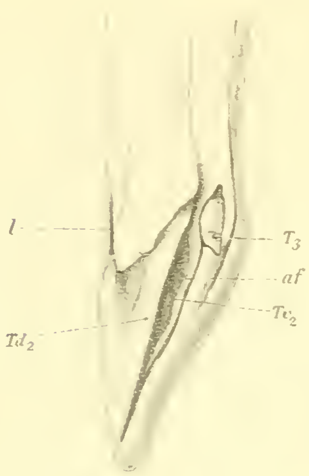

Fig. 10.

Lamna cornubica. The hindmost part of the right appendix seen from the dorsal side; considerably reduced. *l* the opening of a pocketlike invagination of the skin. Tv_2 a dermal fold containing no skeletal piece.

The skeleton. Between the basale and the skeleton of the appendix is found (almost as in the Scylliidæ) one very small piece b_1, highest on the medial surface, and otherwise quite low, that is to say, wedge-shaped; in connection with the distal end of the basale and the proximal end of the appendix-stem it bears the hindmost ray, which at the base is rather broad. The piece β is pretty well developed, and, as is usual in Sharks, connects the basale with the appendix-stem.

The appendix-stem is very long, twice as long as the basale $+ b_1$; proximally it is only a little calcified (comp. *Selachus*), but else it is firmly calcified in the surface until the terminal part, where it forms a very long style, reaching to the hindmost end of the terminal part; this style for the hindmost two third parts is calcified in the surface; its soft basal part is situated immediately under the above mentioned pocket; the distal end of the *Musculus dilatator* passes into the firm, fibrous ventral wall of this pocket, in such a manner that its aponeurosis is firmly inserted in the perichondrium above the calcified part of the style, as well as in the corresponding places of the two adjoining calcified terminal pieces *Td* and *Tv*; the soft part of the style and the joints between the marginal cartilages and the two skeletal parts *Td* and *Tv* will then act as a kind of articulation [1]).

The marginal cartilages are very long, hard, and thick; forward they reach almost to the beginning of the appendix-stem; the dorsal one reaches somewhat longer forward and also somewhat further backward than the ventral one. In the greater part of their length the two cartilages are in contact with their margins; proximally the dorsal one is covered a little by the ventral one, the margin of the former being bent somewhat into the tube enclosed by both; behind, a little before the terminal part, they separate, and leave between them a slit broadening distally.

The number of terminal pieces is four.

Td and *Tv* are long, almost equally developed; their distal ends are not calcified, and do not reach quite to the end of the style. To the inner dorsal edge of *Td* is attached a piece Td_2, which

[1]) If we should suppose a skeletal part to be developed in the ventral wall of this pocket, it would in all respects be corresponding to the (covering-piece) *v* found in *Rhina*.

is a rather thick lamella only partly calcified. Also a piece Tv_2 is indicated as a pretty long, thin lamella, which does not calcify or only calcifies to a very small degree (see fig. 10 in the text); it is connected with the proximal end of Tv, stretches forward inside the "thorn", and is with the anterior end firmly united with the aponeurosis, on which the "outer lip-muscle", bespoken afterwards, acts; by the pulling of this muscle at Tv_2 and Tv the dilated terminal part is brought back, and the thorn T_3 situated between the two said pieces is laid. T_3 has more particularly the form of a claw, whose proximal part is head-shaped and rather soft, wrapped in the soft tissue connecting it with the adjoining pieces.

The muscular system. The *M. adductor* is distally not sharply separated from the *M. dilatator*, as part of the fibres of the former passes into the superficial medial layer of the latter. The former muscle is quite woven together with the *M. extensor*, so that it is only by preparing from the dorsal side far into the large, proximal muscular mass that a considerable portion of fibres is found, originating from the basale, and having a direction common in the *M. extensor*.

The bag-shaped part of the *M. compressor* is very long and rather thick; in the specimen examined by me, it is about 40^{cm} long, of which 23^{cm} are situated under the ventral skin before the pelvis[1]. The "outer lip-muscle" shows the peculiarity that in spite of the long ventral marginal cartilage it is prolonged covering the dorsal surface of the said cartilage until the terminal part, where it acts on Tv by means of the above mentioned lamellar indication of a Tv_2 in a similar manner, as this muscle acts in Sharks with a short ventral marginal cartilage.

The *M. dilatator* only covers a very small part of the dorsal side of the appendix-shaft, by far the greater part of the dorsal marginal cartilage being covered only by the skin.

Selachus maximus (Gunnerus).

The appendix has been briefly mentioned by Sir Everard Home[2], somewhat more detailed by Blainville[3], but not originally by Pavesi[4], whose specimen, however, was a male; only in his second paper[5] does Pavesi briefly describe and draw (p. 353) the (undeveloped) appendix, and collects the whole literature treating of these organs, giving also in a table (l. c. p. 406) the dimensions that may be put together according to the obtained facts. The image of the appendix that is to be got from the literature, is upon the whole only imperfect. I have not found any particular mentioning

[1] The glandular bag contained only a little mucus, while the tube of the appendix, and the above mentioned pocket as well as the inside of the terminal part were all filled with an extremely viscid, milk-white mucus, which made the fingers exceedingly slippery and was difficult to get washed off; it contained numerous cells of different size and shape, with oval or round nuclei staining very readily.

[2] 1) An anatomical Account of the Squalus maximus etc. Phil. Trans., 1809, S. 207. 2) Additions to an Account etc. Phil. Tr., 1813, S. 230. Among other things the glandular bag is here mentioned as "a cavity between the skin and muscles of the abdomen, eleven feet long and two wide. The inner surface of this cavity is smooth, almost polished, and of a beautiful white colour; it contained a white mucus, extremely viscid and tenacious."

[3] Mémoire sur le Squale Pèlerin. Ann. du Muséum d'Hist. Nat., T. 18, 1811.

[4] Contribuzione alla storia naturale del Genere Selache. Ann. del Mus. Civico di Genova, vol. 6, 1874.

[5] Seconda Contribuzione alla Morfologia e Sistematica dei Selachi. Ann. del Mus. Civico, vol. 12, 1878. Besides the drawings quoted here one more drawing is found, only, however, a sketched outline, of evidently undeveloped appendices of a "Squalus maximus", in Carus und Otto: Erläuterungstafeln zur vergl. Anatomie. Part 5, pl V, fig. VIII, 1840.

of the skeleton, but the following will, nothwithstanding it defectiveness, show, that the structure of the skeleton is like that of *Lamna*.

In the museum of Copenhagen is found a pair of dried skeletons of these organs that have been got from a stuffed specimen (from California) of the length of 9^{m} 15^{cm} ($27^{1}/_{2}$ Danish feet). By long soaking the dried softer cartilaginous parts swelled so much that upon the whole they might be thought to approach to the shape of the fresh skeleton. Of the parts of the fin skeleton proper is only found a little, somewhat triangular piece, situated proximally at the dorsal end of the appendix-stem; it must be the piece β, which is accordingly (as presumably also the piece b_1) quite small as in *Lamna* (and the Scylliidæ)[1]).

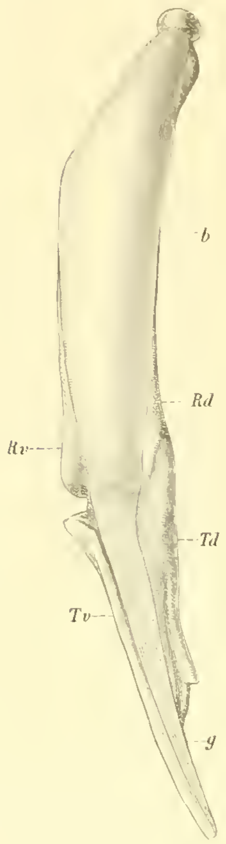

Fig. 11.

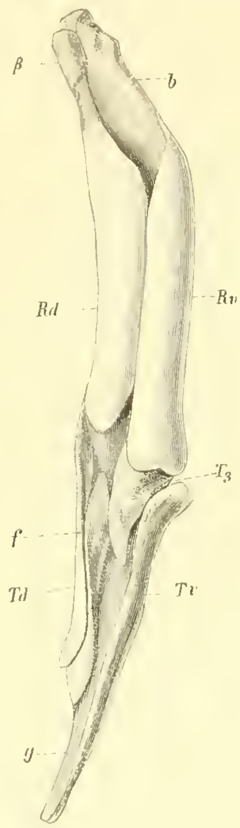

Fig. 12.

Fig. 11. *Selachus maximus.* The skeleton of the right appendage seen from the ventral side; much reduced.

Fig. 12. The same from the dorsal side. *f* furrow in the dorsal terminal piece. Both figures have been drawn after a dried skeleton. The position of T_3 is scarcely quite correct, and *Tv* is separated from its connection with the marginal cartilage *Rv*.

The appendix-skeleton has a length of about 1^{m}[2]); it may be doubted if all the terminal pieces have been preserved, but the principal features may be seen distinctly enough. The appendix-stem is calcified (the proximal end, however, not very much); the soft style is very long and rather broad, and reaches to the outermost end of the terminal part (comp. *Lamna*). The marginal cartilages are developed almost as in *Lamna*, that is to say, they join dorsally without forming a firm suture, the edge of the ventral one overlapping that of the dorsal one[3]). The number of terminal pieces (in the specimen in hand) is 3.

Td is short, not reaching to the end of the style; it is calcified for the greater part of its length, and has on the dorsal surface a furrow or groove *f*, wide before, where it passes into the large appendix-slit, while behind it becomes a narrow slit following the piece to the end[4]).

Tv is only calcified anteriorly, otherwise it is a soft cartilage following the style just to the end. T_3

1) Pavesi (1878, p. 378, fig. 12) draws the ventral skeleton of a young male; here is only seen the basale, and a very little developed stem-part of the appendix. As, however, in other Sharks the pieces, which I have here called b_1 etc. and β, are distinctly present in young ones, even in embryos, it is to be supposed that they have been overlooked here; in *Scyllium* and *Lamna* they are so small, that they are easily overlooked, if the skeletal parts are not cleaned of the soft parts with especial care.

2) In the specimen of Blainville it was 3 feet long (the free part); the length of the animal was 29 ft. 4 inch.

3) The words of Blainville l. c. p. 125 are: »ils offroient en outre une fente ou sillon étendu dans toute leur longueur, mais dont la moitié antérieure, d'à peu près 14 pouces, étoit étroitement fermé par le rebord de deux cartilages très-serrés et qu'on ne pouvoit écarter qu'avec une très grande difficulté.»

4) It may possibly be this (?) slit, which is mentioned by Blainville l. c. p. 126 as a »sillon . . . . . beaucoup plus petit et plus étroit« . . . . . etc.

is claw-shaped and of a considerable size (in the specimen before me 16^{cm} long, and the broadest part $5{,}6^{cm}$ broad); with the exception of the proximal part it is completely calcified; according to the statement of several authors[1]) the point of it (in the developed organ) projects through the skin.

Besides the three terminal pieces seen in my figures, I think it probable that one more has been found, a Td_2 as in *Lamna*. I found this opinion in the first place on the words of Blainville (l. c. p. 126) that besides the claw there is un autre cartilage, un peu aplati, occupant le milieu du tiers antérieur de cette gouttière (i. e. the furrow of the terminal part); celui-ci étoit mobile presqu'en tous sens, mais entièrement renfermé dans un repli de la membrane interne qui se prolongeoit, libre et flottante, jusqu'à l'extrémité posterieure du sillon . Next I found the above stated opinion on the description (1878, p. 352) and drawing in woodcut (fig. 3) of the (undeveloped) appendix given by Pavesi: nella metà apicale offrono un pezzo mediano lanceolato, rialzato e piano, con fenditure laterali. Questo superficie non ha traccia di sperone corneo . Later (p. 405) it is said of this piece that it is only a thickened dermal fold, not to be confounded with the spur [2]). The dermal fold mentioned by these authors, no doubt corresponds with that one which in *Lamna* contains the piece Td_2. But what is the fenditure laterale of Pavesi? According to the figure it must be situated on the medial side of the organ, that is to say, it is presumably the sillon .... beaucoup plus petit et plus étroit of Blainville; and thus it must be supposed to be the one seen in the skeleton, fig. 12 *f*, and not a pocket like the one described above in *Lamna*, because this latter is situated before the terminal part, and accordingly would be seen on the part called by Pavesi la meta basale .

Rhinidæ.

Rhina squatina (L.).

(Pl. II, fig. 24—27.)

In a specimen of the length of 1^{m} and a breadth across the pectorals of $0{,}59^{m}$, the part of the appendix free of the fin is $8\frac{1}{2}^{cm}$ in length; from the foremost beginning of the slit the length is

[1]) Shaw: General Zoology V, pt. II, Pisces, 1804, tab. 149 (in the text nothing is found about it); the figure is certainly bad, and the appendices can scarcely ever have that appearance, but are, to use the words of Pavesi (1878, p. 404), trasformate in sorta di gambe dall'imaginoso disegnatore . Blainville gives it to be 7 inches long, but covered by soft tissues except $\frac{1}{2}$ inch, which m'a paru comme cornée et libre au bord supérieur et extérieur de l'appendice . Home speaks of it as a strong, flat, sharp, bony process, five inches long, which moves on a joint, and the bone projects an inch and a half beyond the skin, like a spur (1809, p. 207); in the later addition is only said: the spur bears a striking resemblance to that of the male ornithorynchus paradoxus. Lesueur: Description of a Squalus etc.; Journ. Acad. Nat. Hist. Philad. II, part II. 1822, p. 349; Mitchill in Dekay: Natural History of New York, Zoology, part IV, Fishes, 1842, p. 358: From and between the anal fins, two legs project five feet in length, and are terminated by a claw tipped with horn . Van Beneden: Un mot sur le Selache (Hannovera) aurata du crag d'Anvers; Bull. Acad. Roy. de Belgique, 2 Série, vol. 42, 1876, draws a sketch of the appendices with the spur from a stuffed specimen in British Museum, and shows that these spurs are (as well as the gill-rakers) found as fossils in tertiary strata. Before I knew this fact and the paper by van Beneden, I have expressed, in a lecture given in the Society for Natural History in Copenhagen (March 1897), the conjecture that the very hard, dentine-like terminal pieces of the appendices of Selachii might exist as fossils, and indicated that perhaps some of the ichtyodorulites were not dermal teeth (spines) but such skeletal parts; by turning over the work by Agassiz on fossil fishes I have, however, not been able to find any drawing, to which this conjecture might be applied.

[2]) Pavesi himself thinks the presence or absence of this latter to be dependent on the age of the animal, and not to indicate a difference of species, and it is now beyond all doubt that this opinion is quite correct. All other species of Sharks that are provided with a similar spur (as *Acanthias, Spinax, Somniosus* a. o.) show that this piece is formed hidden in the skin, and is not uncovered until it has reached a considerable degree of development, contemporary with the organ as a whole having altered its shape and dimensions.

11,5[cm] (from the foremost edge of the pelvis to the hindmost point of the appendix the length is 24[cm])[1]); the largest breadth is found somewhat above the hindmost point of the fin-membrane, and is about 3,5[cm]. The ventral side is flat, covered with dermal teeth till the naked terminal part (4,3[cm] long, 2,1[cm] at the broadest spot, at the base); these dermal teeth are flat, and form a complete mosaic, only a little rough to the feeling, when rubbed with the finger towards the base, and it is of quite the same nature as that covering the ventral side of the rest of the fin[2]); the whole surrounding of the cloaca as well as the space from there to the foremost lateral corner of the fin is naked (with a few scattered groups of teeth); furthermore a naked stripe stretches from the hindmost inner edge of the fin-membrane, where the fin is laid against the appendix, some way on the ventral side of the fin. Both edges as well as the whole dorsal side of the appendix are naked.

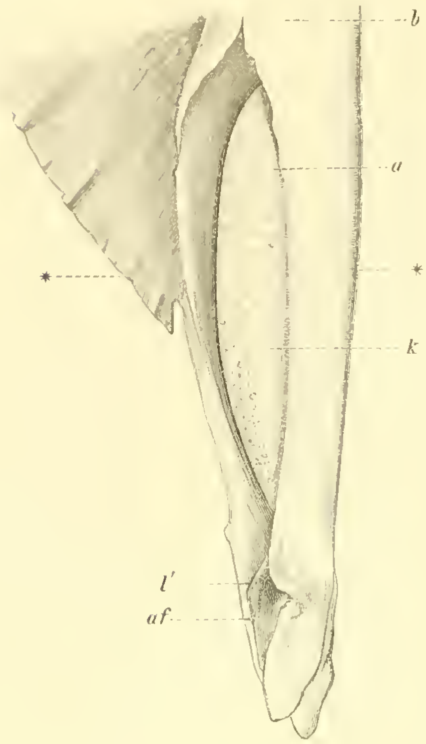

Fig. 13.

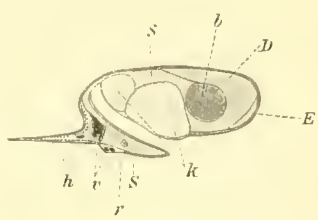

Fig. 14.

Fig. 13. *Rhina squatina.* The left appendage from the dorsal side, reduced. The part from *a* to *b* has been cut up in prolongation of the appendix-slit to open this latter so much as to get a view of the gland *k*. *l'* is part of the entrance to the pocket between *Tv* and *v*.

Fig. 14. A transverse section through the same appendage after the line, marked with * * in fig. 13. *b* the transverse section of the appendix-stem. *D Musculus dilatator. E Musculus extensor. S Musculus compressor. k* the gland. *v* blood-vessels. *h* horny filaments. *r* the end of the last ray.

The somewhat triangularly pointed terminal part shows, when seen from the dorsal side, the appendix-slit (*af*) situated near the lateral edge; a rather large, foliaceous fold of the skin, which includes the skeletal piece Td_2, originates from the dorsal lip of the slit; the proximal end of this fold stretches into the (half-) tube formed by the distal ends of the marginal cartilages. Accordingly there will, on both sides of this plate, be an outlet from the canal of the glandular bag in the broad part of the appendix; the real continuation, however, of this canal is here, as everywhere, situated in the terminal part laterally of the said fold (at *af*). If the fold is thrown back, there will in the lateral margin of the appendix-slit proper be seen a rather large

[1]) Müller & Henle l. c. p. 99 state in characterising the genus: „Die Anhänge des Männchen klein und weich", which, as we have seen, does not apply to adult animals, and consequently is of no value as a characteristic of the genus.

[2]) This dental mosaic on the ventral side is quite different from that of the dorsal side, where the dermal teeth project as small thorns from the thicker skin. The words of Müller & Henle in characterising the genus: „Schuppen konisch in eine Spitze endigend, zerstreut" are then only to be applied to the dorsal side. I have not upon the whole found any mention made of the dermal teeth of the ventral side, only expressions to the effect that the abdomen is more or less smooth.

aperture (at l') leading into a pocket between the ventral terminal piece (Tv) and the ventral covering piece v.

If the lateral lip of the appendix-slit above the terminal part is lifted, a thick glandular body is seen protruding from the medial side of the canal, in which feature this species differs from all other Sharks I have had the occasion to examine. This gland will be more particularly mentioned afterwards.

The skeleton. Between the basale and the appendix-stem three short pieces (b_1, b_2, and b_3) are found, each bearing one of the three hindmost rays (the two hindmost of these rays are terminally quite coalesced for a long way). At a first glance the piece β seems to be wanting, but a closer examination shows it to be present, represented by a little cartilage, arising from the lateral hind corner of b_3, and joined by a particular articulation to the proximal end of the appendix-stem b. Contrary to what commonly is the case in the Sharks, the piece β does not here articulate proximally with the basale.

The appendix-stem (b) is long, considerably longer than the basale (the ratio is $^5/_2$), round (with the exception of the proximal part where it dorso-ventrally is somewhat flattened); the style is long, not, however, reaching to the hindmost point of the terminal part. The marginal cartilages are short, and are only found at the distal part of b; contrary to what commonly is the case in the Sharks, the ventral marginal cartilage is the one reaching most forward. The general shape of these cartilages, I think, may be seen with sufficient clearness from the figures. The ventral marginal cartilage bends towards the dorsal one with a plate similar to that found in many other Sharks, but does not quite reach it. But this plate is here in a peculiar way hollow, being behind split into two lamellæ receiving between themselves the proximal end of the piece Tv; this piece, then, projects into the ventral cartilage, quite covered, until the point marked * in fig. 25[1]. The hindmost end of the inner one of these two lamellæ protruding very much, the appendix-slit is by its transition to the terminal part straightened to an extraordinarily narrow passage.

The number of terminal pieces must in reality be taken to be four; but to these four is added a good-sized, ventrally situated piece, v, rounded in a scutiform manner, and partly covering the terminal part (see fig. 24) behind the ventral marginal cartilage. This piece has developed in the aponeurosis which, in the Sharks hitherto mentioned, encloses the terminal part, and it serves like this aponeurosis for inserting the large *Musc. dilatator*. If this piece v is removed, the ordinary terminal pieces are easily recognized: Td which is rather broad, flat, with a thickened edge medially (which edge follows the style closely, but reaches a little further backward), and a sharp and thin edge laterally; Td_2 proximally joined to the foregoing piece, is a broad, but thin, and but slightly calcified lamella. Tv is of a very peculiar shape, thick and solid, ventrally rounded, dorsally, towards the slit, deeply hollowed in a spoon-like shape; its proximal end, as already mentioned, passes its articulation with Rv, and enters between the two lamellæ of the overlapping plate; with the proximal end articulates, completely hidden, a little calcified piece representing the "thorn" or "spur" (T_3); this latter piece (see fig. 27) is proximally irregularly head-shaped, and from this thick part a thinner one

[1] If in *Acanthias* or *Spinax* the projection of the ventral marginal cartilage, mentioned at p. 28, was more developed, and proximally prolonged, a similar state of matters might be the result.

projects, bent at its rise, but otherwise straight, cylindrical, and rounded posteriorly. It is necessary in order to get a view of this piece T_3, and to isolate it together with *Tv*, to cut away part of the outer lamella of the ventral marginal cartilage.

The muscular system. The *M. adductor* shows no deviations from the common type; the *M. extensor*, on the contrary, shows the peculiarity of being divided into two independent muscles (comp. *Torpedo*), an inner (medial) one, and an outer (lateral) one, bordering on each other, and both originating from the basale; the inner or foremost one arises rather far forward on the basale alone, runs, like the *M. extensor* in the Greenland Shark, across the appendix-knee, covering as a thin plate part of the dorsal side of the *M. dilatator*, and ends quite posteriorly, at the terminal part. The outer or hindmost extensor arises behind the foregoing one, not from the basale only, but also from the pieces b_1, b_2, b_3, and it is attached to the appendix-stem immediately behind the »knee».

The *M. dilatator*, as is commonly the case, encompasses the appendix-stem from the dorsal marginal cartilage to the ventral one; the lateral part of it arises forward on the ventral side of the basale and the short pieces following this latter (comp. the Rays); behind its chief portion is attached to the ventral covering piece *v*.

Of the *M. compressor* the bagshaped part is rather short, and does not nearly reach to the pelvis, but otherwise it agrees with the one found in other Sharks. The »outer lip-muscle» is very powerful as in the other Sharks with a short *Rv*, and is attached posteriorly chiefly in the aponeurotic covering of the piece *Tv*.

The secreting part of the glandular bag shows in its foremost part the same relations as in the other Sharks; but in the part which is situated in the shaft itself, a large glandular body (see fig. 13 and 14) has been developed on the ventral side. The presence of this gland may already be guessed by the peculiar exterior of the appendix-shaft; its proximal part shows, when seen from the ventral side, a peculiar convexity, by which the organ gets a contour not unlike that of a human leg with a large calf. The glandular body reaches before quite to the beginning of the bagshaped part, that is to say, much farther than the appendix-slit itself, so that it is necessary to cut up some way (see fig. 13) in order to get a view of the foremost end; it is a little tapering behind, and reaches to the terminal part. A slight, longitudinal furrow is found on the free (dorsal) surface about the middle, and on the edges of this furrow are situated two series of large glandular outlets; a great number of similar outlets are also found laterally of the furrow, in pretty irregular groups; to the medial side of the furrow are also some such openings, but apparently in much smaller number. When the gland is pressed an abundance of mucus will appear as stoppers in the said outlets. The glandular body is composed of dichotomously branched tubes, quite similar to those found in the Rays, and with quite similar large secreting cells; but they are here grouped in a somewhat different manner as a consequence of the outlets of the gathering ducts being spread on a much greater space. The glandular body in *Rhina* furthermore deviates from that of the Rays by its ventral position in the shaft [1]), and by not having the special muscular coat developed as in those; the part of the *M. compressor* situated at the gland will very likely be able to act in a similar way, possibly only with less force, in *Rhina*.

[1]) In *Torpedo, Narcine, Rhinobatus* and *Trygon* the dorsal glandular body of the bag is continued throughout the shaft with the same structure as in the bag, but reduced in bulk, and situated along the ventral marginal cartilage. If in one of those Ray-forms the part of the gland situated in the bag be supposed absent, and the part in the shaft displaced

The peculiar mixture of Shark-like and Ray-like characters that, as it is well known, is found in *Rhina*, is accordingly increased by several features in the appendages of the male, which features by the ventral covering piece and the pocket, situated below it, with entrance from a side-slit, and partly also by the glandular bag, recall those in the Rays (*Torpedo*, *Narcine*, *Rhinobatus* and *Trygon*), while most of the other features are those common in other Sharks.

Cestraciontidæ.

Heterodontus (Cestracion) Phillipi (Cuv.).

The skeleton has been described by Gegenbaur[1]). Between the basale and the appendix are found two pieces (b_1, b_2 = $_{,}\beta$, $_{,}\beta'$, l. c. fig. 18, 19) that bear no rays; the piece $_{,}\beta$ is well developed (l. c. *b* fig. 19). The chief piece of the appendix is provided with two (rather long?) marginal cartilages (the boundary lines of which cannot be seen in the figures of Gegenbaur, as he has not understood the marginal cartilages to be particular pieces), of which the ventral one has a dorsally bent plate (l. c. fig. 19, *a*); the stem is prolonged into a long style reaching almost to the end of the terminal part (l. c. fig. 19, 20, *i*). The number of terminal pieces is four: *Td* (= l. c. fig. 19, 20, *o*), Td_2 (= l. c. *u*), which, as is often the case, is proximally prolonged into the appendix-slit; *Tv* (= l. c. *e*), as commonly, stronger and thicker than the others, and finally T_3 forming a short thorn. Gegenbaur has correctly seen the homologies of these pieces with those in *Acanthias*, where, however, he has not seen the piece Td_2 (= *u* in *Heterodontus*). Of these terminal pieces the piece T_3 is said (l. c. S. 452) to be hard, while the others, though fully developed, are still cartilaginous.

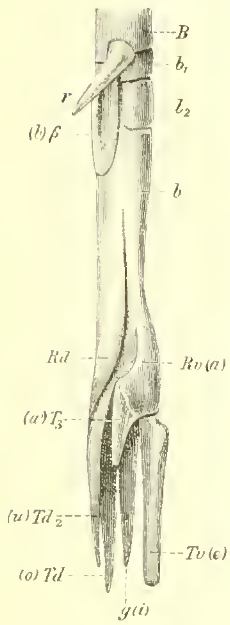

Fig. 15. *Heterodontus Phillipi.* The skeleton of the right appendage. After Gegenbaur (l.c. fig. 19), somewhat reduced. The letters placed in parentheses are those used by Gegenbaur. *r* the last ray.

Notidanidæ.[2])

Chlamydoselachus anguineus Garman.

Günther[3]) has briefly described the appendages and their skeleton, and given figures of them. Only a third part of the length of the appendages is free of the fin, „as is the case in the *Notidanidæ* generally", and there is no notch in the hindmost fin-edge, between the membrane and the appendage. Between the basale and the appendix-stem there are „three rudimentary and one larger intermediate cartilages" (b_1, b_2, b_3, b_4?), none of which bears any ray. To judge by the figure, there is no piece $_{,}\beta$;

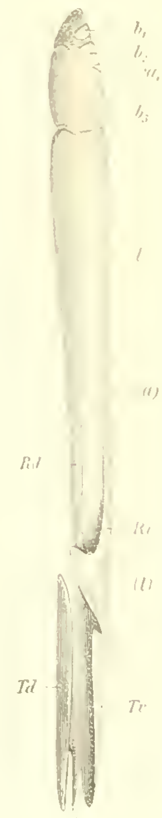

Fig. 16. *Chlamydoselachus anguineus.* The skeleton of the right appendage. After Günther, somewhat reduced. The letters in the parentheses are the original ones.

along the ventral marginal cartilage to the lateral surface of the appendix-stem, we should have a similar state of matters as in *Rhina*. There can scarcely be any doubt that the gland in this Shark and in the Rays — in spite of the difference of position — are in reality homologous. Furthermore the glandular bag in younger stages of the Rays seems to pass through a stage of development, in which there is, also as to the exterior, a conspicuous similarity with that of the *Rhina*, without any conspicuous longitudinal furrow etc. (see later under *Raja batis*).

[1]) Über die Modificationen etc. 1870, p. 450, Taf. XVI, fig. 18—20.

[2]) I regret very much that my efforts to get ventral fins with developed appendages of *Hexanchus* or *Heptanchus* have been in vain. The figure of the skeleton of *Heptanchus cinereus* Ag. given by Fritsch in Fauna der Gaskohle etc. Böhmens, vol. 3, 1895, p. 43 is quite useless. From this figure appears only that at least the two terminal pieces *Td* and *Tv* are found; what Fritsch calls the „sporn" is the last ray (or rather the two last, coalesced ones). The „i" of the figure, I suppose to be the piece $_{,}\beta$, and it is certainly not the „Letztes Glied des Hauptstrahles". The figures of the structure of the appendages in the extinct *Xenacanthidæ*, given by Fritsch as well in his chief work as in several articles in the „Zool. Anzeiger" 1888—91, I think to be justified in designating as unreliable; but by means of the published figures alone the real structure cannot be determined.

[3]) Voyage of H. M. S. Challenger, Zool., Vol. XXII, 1887, S. 2, Tab. LXIV, fig. *C, D, E*.

as, however, no figure is given of the part in question, seen from other sides, I cannot regard this absence as quite certain. The long appendix-stem is prolonged to a style reaching to the end of the terminal part. The marginal cartilages (not understood by Günther to be particular pieces) appear to have mainly the same structure as in the Spinacidæ: the ventral one has the usual overlapping plate (l. c. T. LXIV, fig. *D, D', t*). The number of the terminal pieces is only two (if not a piece T_3 has been overlooked or removed by the preparation?) viz. *Td* and *Tv*, both hard and calcified, *Tv* being as usual largest and broadest.

Carchariidæ.

Mustelus antarcticus Gthr.

A pair of dried skeletons of ventral fins with appendages in the Zoological Museum at Copenhagen.

Between the basale and the appendix-stem one rather small piece b_1 bearing the last ray, which is partly coalesced with the last but one; a distinct, well developed β that seems to have been triangular. The appendix-stem is prolonged to a long, soft style reaching almost to the hindmost end of the terminal part. The marginal cartilages stretch over the hindmost two third parts of the chief piece, the dorsal one reaching farther forward than the ventral one; the edges of their folded parts join dorsally, leaving between them only a narrow slit. To the distal end of the dorsal marginal cartilage is added a foliaceous, slightly calcified piece, homologous with the piece Rd_2 mentioned in *Pristiurus.*

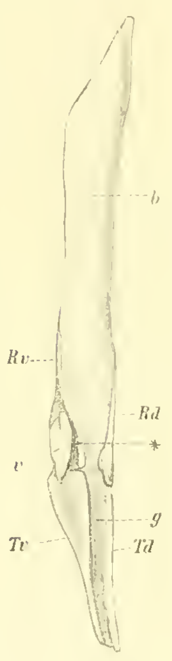

Fig. 17.

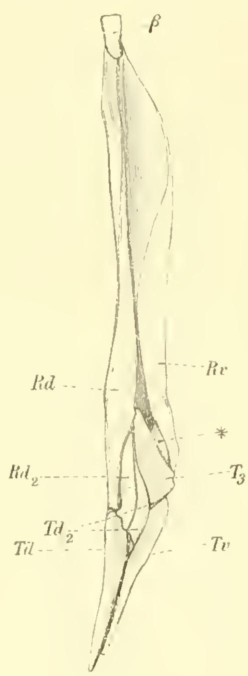

Fig. 18.

Fig. 17. *Mustelus antarcticus.* Skeleton of the right appendage, seen from the ventral side; about the natural size. *v* the ventral covering piece; * a spoon-like hollow in the ventral marginal cartilage.

Fig. 18. The same preparation from the dorsal side; * the bottom of the hollow in the ventral marginal cartilage, protruding into the appendix-slit. Both figures have been drawn after the dried skeleton.

The number of terminal pieces is 4 (+ 1).

The two of these pieces that as usual follow the style, and together with it form the walls of the hindmost part of the appendix-slit, *Td* and *Tv*, are well calcified, lengthened, pointed, and *Td* a little longer than *Tv*. To the lateral edge of *Td* is proximally added a foliaceous, slightly calcified piece Td_2, forward stretching under the piece Rd_2 into the appendix-slit as in several other Sharks. Finally there is a rather large, flat, triangular, posteriorly taplike piece T_3 that, however, does not not appear to have projected through the skin as a »spur«.

Besides these real, typical, terminal pieces still a special piece, *v*, is found, which I take to be corresponding to the one marked with the same letter in *Rhina*, and accordingly to have arisen from the aponeurosis of the *Musc. dilatator*; here in *Mustelus antarcticus* it covers a peculiar, rather deep, spoonlike hollow on the ventral side of the end of the marginal cartilage *Rv* (on the dorsal side the corresponding spot is seen protruding into the appendix-slit, at * in fig. 18).

The descriptions of different Sharks given in the preceding section will have shown that the common type in the skeleton is clearly conspicuous; the single secondary skeletal pieces may vary pretty much, as to their form, but their homologies are easily and surely demonstrated. Although the mentioned species of Sharks cannot be said completely to represent the Sharks upon the whole, yet they belong to so many different families that we may be justified in coming to the conclusion that the skeletal structure of the appendix is in the Sharks rather simple and easily explained. This, however, can in no way be said of the Rays in general; here, especially in the genus *Raja*, may be found particularly complicated structures varying to a high degree even from species to species; and as the *Raja*-species are those that have been especially examined by earlier authors, it will easily be understood that so few general results have hitherto been obtained. If, however, by means of the Sharks we have got a clear understanding of the characteristic common features, it will not be so very difficult to point out these features also in the *Rajæ*. It is, however, an obvious supposition that other forms of Rays than *Raja* will approach more nearly to the Sharks, and such forms will most likely have to be sought among the shark-like Rays, as *Pristis*, *Rhinobatus*, *Torpedo*, etc. Through the kindness of Professor Lütken I have from our museum obtained the material of the two last-named genera, and of *Torpedo* I have also got some pairs of ventrals from Napoli.

Batoidei.

Torpedinidæ.

Torpedo marmorata Risso.

(Pl. III, fig. 28—31.)

The appendix, like the whole fish, is naked, flattened, with tolerably parallel sides, the terminal part oval, distinctly marked off from the shaft by a slight constriction. The appendix-slit runs on the dorsal side quite straight, nearest to the lateral edge until the hindmost half of the terminal part where it suddenly bends to the medial side, and with a curve reaches to the end. On either edge of the terminal part is seen a lengthened slit, posteriorly widening somewhat like a buttonhole; either slit leads into a blind, pocket-like bag, inside the later mentioned covering piece *v*[1]. None of the enclosed skeletal pieces are naked.

In a specimen of the length of 29^{cm}, a breadth of 17^{cm} the following measures are found for the appendix:

[1] Petri l. c. pl. XVI, fig. 4 gives a — neither good nor exact — figure of the appendix, seen from the dorsal side.

Length from the foremost end of the slit to the extremity . .	40^{mm}
— of the free part	17^{mm}
The greatest breadth	ca. 10^{mm}
The length of the terminal part	15^{mm}

In another specimen of the same length and a breadth of 19^{cm} the appendages were a little shorter and broader, but otherwise as fully developed.

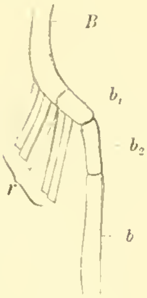

Fig. 19.

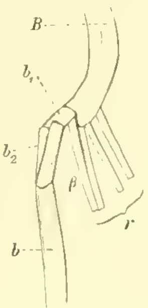

Fig. 20.

Fig. 19. *Torpedo marmorata.* Part of the skeleton of the right ventral, from the ventral side. *r* the hindmost rays partly cut off. Natural size.

Fig. 20. The same preparation from the dorsal side.

The skeleton. Between the basale and the appendix-stem are found two pieces b_1, b_2, of which the former is the shorter one (seen dorsally it is much shorter), and bears the two hindmost rays (the last but one is partly borne by the basale also). The piece β is long, longer than b_2, flat; proximally it articulates with b_1, runs along b_2 without touching it, and articulates distally by an oblique articulation with the appendix-stem [1].

The appendix-stem is rather straight, calcified in the surface until the terminal part, where the mosaic of the surface suddenly ceases, and the outermost part of the stem is soft, which soft part, chiefly of the same breadth as the harder one, thus corresponds to the style, and reaches to the end of the terminal part, ending with a broadly rounded, convex edge.

The marginal cartilages are both calcified, but very unequally developed, by which the whole appendix gets a peculiar asymmetric appearance; the ventral one [2]) reaches a trifle longer forward than the dorsal one, but backward it ceases far before this latter; the dorsal cartilage is by a longitudinal furrow apparently divided into two pieces of which the lateral one begins forward about the middle of the ventral cartilage, and stretches backward about as far past the hinder end of this latter (see fig. 30, 31); this part of the dorsal marginal cartilage is on the ventral side hollowed in a trough- or groove-like manner; the medial part of this cartilage, especially the foremost part of it, is slightly calcified, membranous, and is placed like a cover over the appendix-slit, so that a narrow slit is left between its outer edge and the ventral marginal cartilage.

[1]) Petri has quite misunderstood the relations of these skeletal pieces, and has upon the whole been very unlucky in his explanation of the skeletal pieces in *Torpedo.* Already his beginning: «Das Skelet von Torpedo besitzt nur sehr geringe Ähnlichkeit mit dem der vorher beschriebenen Arten», promises nothing good; and his description of the terminal parts shows that he has not understood them at all. He has correctly seen that between the basale and the appendix are situated two pieces: fig. 4 D, b', b'', but their length and position is given less correctly in the figure, which is, like all his figures, rather bad; but then he has completely overlooked the piece β as a separate skeletal part taking it to be a process on the appendix-stem: «Nach vorne entsendet dasselbe (i. e. the appendix-stem) an der medialen (i. e. the dorsal) Seite neben dem zweiten und dritten Glied des Basale entlang einen Processus, welcher mit dem ersten Basale am hinteren Ende noch in Verbindung steht». As a homologon to the piece β in *Acanthias* (Petri's fig. 5 r') he takes a little piece (fig. 4 D, r'), which is said to bear the two last rays and to have originated from a coalescing of the proximal joints of those: «es ist dieselbe Concrescenz, wie ich sie bei *Acanthias* beschrieben habe». In *Acanthias*, however, the piece β (r' in Petri) bears no rays, as, after all, it never does. The little piece which Petri has seen in *Torpedo* (and in the figure marked r'), is only an uncalcified corner of the basale itself, projecting over the two last rays, but it does not bear the rays.

[2]) The marginal cartilages are partly correctly seen and determined by Petri as «Rinnenknorpel»: Fig. 4 D and E, *c* and *l*; F, *l*; (and pl. XVII, fig. 4 B, *l*): the skeletal piece, however, interpreted by Petri as a dorsal marginal cartilage and marked *l*, is only the firm lateral part of the dorsal marginal cartilage; the thin, cover-shaped part seems to be removed, except on fig. 4 B, representing the muscles.

The number of the terminal pieces is three; but to be able to see these pieces, and correctly to understand their relations to the marginal cartilages, it is necessary to remove a large ventral covering piece, homologous with that mentioned in *Rhina*, and marked *v*, because the whole ventral side of the terminal part is hidden as by the half of a thimble (the contour of which may often be distinguished through the skin). The foremost edge of this covering piece is incised in an irregularly heart-shaped manner, the one — lateral — corner being produced much farther than the other; it is strongly rounded from side to side, and the surface is dotted with small holes. The edges of this piece have on each side a peculiar bend, and immediately behind this the covering piece is firmly joined to the specially thickened hinder edges of the two terminal pieces *Td* and *Tv*; by the said bends and the ventral concavities of the covered terminal pieces, the peculiar side-slits and the walls of the before mentioned pockets are formed. The *M. dilatator* is attached to the fore edge of the covering piece, and by the firm connection between the covering piece and the outermost point of the terminal pieces the action of the muscle is transmitted to that point.

The dorsal terminal piece, *Td*, is quite short, somewhat convex towards the appendix-slit; the ventral side on the contrary is deeply concave; together with the corresponding marginal cartilage which, as we have seen, is also hollow, it forms a complete trough, in which the medial pocket is situated. The ventral terminal piece, *Tv*, has the double length, is likewise rounded on the dorsal side, hollow on the ventral one, and forms with the covering piece the lateral pocket. Finally a piece T_3 is added to the hindmost end of the ventral marginal cartilage, and to the proximal part of *Tv*; it is shaped as a slightly bent, round thorn, almost hidden inside of the lateral edge of the covering piece [1]).

The muscular system. The *M. extensor* is divided into two parts reminding of the state in *Rhina*. The foremost one originates from the foremost half of the basale, runs over the knee, and is attached immediately below this to the *M. dilatator*, and partly to the distal end of β and of the appendix-stem; the hindmost one originates from the other, hindmost, half of the basale and from the following pieces (also from β), passes with its distal part under (i. e. ventrally of) the foregoing one, and is continued rather directly in the medial part of the *M. dilatator*.

M. compressor. The bag-shaped part of this muscle, situated on the ventral side, is very small; properly speaking it is confined to a ventrally rounded swelling between the two hindmost rays and the parts of the stem-skeleton, b_1 and b_2; accordingly there is no part projecting across the ray muscles, the foremost contour of the bag being bordered by the skeleton (the pieces b_1 and b_2), the outermost one by the hindmost ray muscles. The ventral fibres of this little bag run obliquely backward towards the hindmost ray, almost in continuation of the hindmost fibres of the *M. adductor*. The part forming the outer lip-muscle, is rather powerful and long, originates forward from the piece β (foremost

1) Petri, as already mentioned, is quite wrong as to the terminal part; he takes the dorsal terminal piece *Td* to be the terminal joint of the appendix-stem (l. c. p. 308, fig. 4 F, *bIV*); the ventral terminal piece and the thorn T_3 become zwei kleine verkalkte Spangen, borne by the hindmost part of the ventral marginal cartilage to which they are added radienartig (fig. 4 E and D, *sp''* [= *Tv*], *sp'* [= T_3]). Only the piece *v* (fig. 4 E, F, D *sch*) has been tolerably correctly described and interpreted by Petri. Thus he has had no idea of the homologies of the terminal pieces with those in *Acanthias* and *Scyllium*, not to speak of *Raja*.

also from b_1), and the fibres pass obliquely backward towards the last ray and the ventral marginal cartilage. On the inside of this latter the muscle continues somewhat farther back, tapering, and with the fibres running straight backward. The whole muscular wall may pretty easily be separated from the two hindmost rays to which its fibres are not really attached; when thus separated from the rays the whole muscular bag shows a rather strong resemblance to *M. compressor* in *Chimæra*.

The *M. dilatator* is with the whole of its hindmost end attached to the covering piece *v*, and thus, by means of the firm connections of this piece with the distal end of the terminal part, it acts on the movable portions of the terminal part[1]).

The glandular body is pigmented, and its longitudinal furrow runs a little obliquely; it has before been briefly described by Leydig[2]) and by Petri (l. c. p. 22), but none of these authors mention the peculiar fact, in comparison with the *Raja*-species (and accordingly it is to be supposed that it has not before been seen), that the glandular body, continually tapering posteriorly, stretches throughout the shaft quite down to the terminal part. In the shaft it follows the ventral marginal cartilage, and is here for some way along this skeletal piece surrounded by the outer lip-muscle , the latter appearing as the continuation of the dorsal muscular wall of the bag . The longitudinal furrow, and the openings in it follow the glandular body quite to its hindmost end.

Torpedo oculata Bélon.

In this species the features are principally as in *T. marmorata*.

In a specimen of a length of 30^{cm}, a breadth of 19^{cm}, the following measures were found:

Length of the appendix		43^{mm}
— - - slit		36^{mm}
— - - part free of the fin		17^{mm}
— - - terminal part	abt.	14^{mm}
Breadth of the appendix		$7—8^{mm}$

Narcine sp.

(Pl. III, fig. 32, 34.)

A badly preserved specimen, the species of which is difficult to determine, measures in length $24{,}5^{cm}$, in breadth 12^{cm}:

The appendix from the beginning of the slit to the hindmost point is	27^{mm}
- free part	14^{mm}
- length of the terminal part	10^{mm}
- breadth of the — -	5^{mm}

[1]) Petri has given a very imperfect description of the muscles of which he only mentions *M. dilatator*. (Comp. l. c. fig. 4 B and C.)

[2]) Beiträge zur mikroskopischen Anatomie und Entwickelungsgeschichte der Rochen und Haie, 1852, p. 86.

The exterior of the appendix is chiefly as in *Torpedo*; we find here the same marginal slits (and pockets), but the medial one is with the buttonhole shaped, distal part situated quite on the dorsal side, and the lateral one is turned a little ventrally; next it is to be remarked that the appendix-slit in the whole of the free part of the organ is lying quite laterally, the dorsal lip overlapping it quite to the outer edge like a cover, much broader than in *Torpedo*; corresponding to this the portion of the terminal part containing the piece *Td* is folded quite over the hindmost part of the appendix-slit. The glandular bag and its inner gland are relatively more strongly developed than in *Torpedo*.

Fig. 21.

Narcine sp. The right appendage from the dorsal side. Natural size. *l* the opening of the medial pocket. *Rd*, *Td* skeletal parts covered by the skin.

In the skeleton, notwithstanding the principal conformity with *Torpedo*, several peculiar features are found. Between the basale and the appendix-stem also here two pieces, b_1 and b_2, are found, the former short, the latter longer; b_1 bears the last ray at the connection with the basale; the last ray but one seems to me only to articulate with the basale. The piece β is totally wanting. The appendix-stem is long, considerably longer than the basale + b_1 and b_2; it is calcified in the surface excepting the short end-style, which distally becomes broad, flat, with rounded hindmost contour. The marginal cartilages are thin, rather short, and occupy only the hindmost half of the stem; the ventral one shows the same features as in *Torpedo*; also here it reaches a little farther forward; the dorsal one, when seen from the dorsal side, forms a broad, ovate leaf tapering proximally, and continuing as an uncalcified band quite to the articulation of the appendix-stem with b_2; its lateral edge reaches to the free edge of the ventral marginal cartilage; seen from the ventral side it is hollowed in a trough-like manner as in *Torpedo*; but distally it does not nearly reach so far as in the latter, and consequently the two marginal cartilages do not end so obliquely of each other distally (this fact seems also to imply a greater mobility of the terminal part in *Narcine* than in *Torpedo*).

The number of terminal pieces is three, to which is to be counted a quite similar ventral covering piece *v* as that in *Torpedo*. As already mentioned, *Td* is folded to the dorsal side, and has apparently a shape deviating considerably from that found in *Torpedo*; a closer examination shows however that this deviation to some degree is due to the position; on the medial-dorsal side the piece is hollowed in a groove-like manner (for the medial marginal slit); otherwise it is flatly rounded on the outer surface, concave towards the appendix-slit, with a sharp lateral, convex edge.

Tv is short, oval, rounded towards the appendix-slit (as in *Torpedo*) concave on its outer surface, by which, together with the covering piece *v*, it forms the hollow for the lateral pocket. T_3 is somewhat s-shaped, tapering to both ends, little and slender. The covering piece is chiefly as in *Torpedo*; also here we find on both its margins curvatures destined (especially on the lateral margin) to form the button-hole shaped opening of the pocket together with the terminal pieces *Td* and *Tv*. The foremost lateral corner appears independent as a very small *v'*.

The muscular system is as in *Torpedo* with the exception that the part of the *M. compressor* that may be seen on the ventral side, is relatively larger, and laterally spreads somewhat more, and that the *M. extensor* is single. The glandular body is prolonged into the shaft quite as in *Torpedo.*

Rhinobatidæ.

Rhinobatus columnæ Bonap.

(Pl. III, fig. 35—37.)

In a specimen of the total length of $85{,}5^{cm}$ and a breadth of 26^{cm} across the pectorals the appendix had a length of $11{,}5^{cm}$.

The other measures were:

from the fore end of the slit to the hindmost point of the appendix	$7{,}4^{cm}$
the part free of the fin	$6{,}2^{cm}$
Length of the terminal part	$1{,}9^{cm}$
Breadth - - — -	$0{,}8^{cm}$

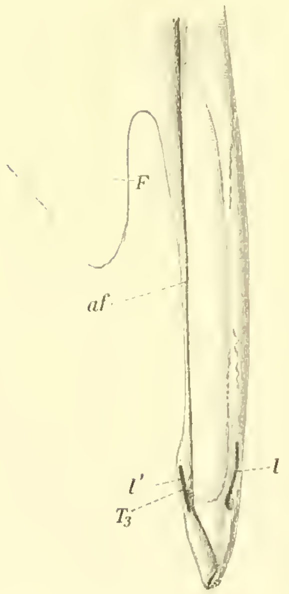

Fig. 22.

Rhinobatus columnæ. The left appendage from the dorsal side. Natural size. *F* the fin-membrane. *l'* the opening of the lateral pocket, *l* of the medial one.

The appendix reminds of that in *Torpedo*, being flat, and having (on the ventral side) the terminal part marked off by a slight constriction; but it is considerably longer, with a long free portion, and a relatively short terminal part, and so it has a rather slender, elegant appearance. The ventral side is all covered with the same dense mosaic of fine, flat dermal teeth as the other parts of the belly; only the very outmost point (1^{mm}) is naked and soft. On the dorsal side the region around the foremost part of the appendix-slit is naked as well as the whole part before the slit, which is normally in contact with the belly, this having also a corresponding naked spot; furthermore the naked part stretches as a small stripe backward close to the medial edge until the terminal part, the dorsal side of which is quite naked; otherwise the dorsal side is covered with teeth, and has the darker colour of the back of the animal. The appendix-slit is situated quite close to the lateral edge, only in the terminal part it bends towards the middle. On the dorsal side of the terminal part are seen two marginal-slits leading into pockets, quite corresponding to those in *Torpedo* and *Narcine*; the medial one is the longer; in the lateral one the outermost part of the piece T_3 is seen freely protruding from the skin as a shining thorn.

The skeleton. Between the basale and the appendix-slit are found four pieces: b_1, b_2, b_3, b_4; the last one being the longest, next to that follows b_1 which is also the broadest, but they are all more long than broad; b_3 and b_4 bear no rays, b_2 bears the last ray, b_1 the last but one (and, in connection with the basale, also the last but two). The piece β is exceedingly long; anteriorly it articulates with the dorsal side of b_1 close to the basale, then it stretches along the other pieces, b_2 b_3 b_4, and next articulates with the appendix-stem b in a long joint, reaching as far past the articulation of b_4, as the length of this piece b_4 itself; it reaches quite to the dorsal marginal cartilage. It is narrow and flat, distally a little bent. The appendix-skeleton is of a length about equal to the basale + b_1 . . . b_4, the stem is rather slender, and ends in a style of a similar shape and nature as in *Torpedo*, only it is here relatively very short. The marginal cartilages are very long; both of them begin almost at the same point forward, the ventral one, however, a little before the dorsal one, and they end at the style in an inverse ratio, that is to say, the dorsal one reaching a little farther backward. On the greater part of their external surface they are very closely connected with the teeth-covered skin, so that they only with difficulty can be separated from it. The distal part of the dorsal marginal cartilage is, quite as in *Torpedo*, ventrally hollowed in a trough-like manner; this part is hard and firm, shining, while the other part is more soft, lamellar, lying like a cover over the appendix-slit, and forward reaching to β. The terminal part on the ventral side is covered by a piece v, quite corresponding to that in *Torpedo* and *Narcine*; the margins, however, are without folds.

The number of real terminal pieces is three.

Td is very small, a little concave on its ventral side; *Tv* is larger, and bears on its lateral edge a process directed forward; it is externally flatly rounded, internally towards the appendix-slit it has a trough-like concavity. T_3 articulates with the hindmost lateral edge of *Rv*, and with the fore end of *Tv*; proximally it is broadly ovate, and distally it tapers to a shining conical point, which, as already mentioned, is uncovered by the skin.

The muscular system is principally as in *Torpedo*; the *Musc. extensor*, however, is single, as in *Narcine*. The glandular bag occupies here, as in those two genera, the space between the distal end of the basale and the proximal end of the appendix-stem, but laterally it spreads over the hindmost rays in a similar manner as in *Raja*.

The glandular body is very narrow, and does not anteriorly reach the end of the bag; accordingly it fills the inner space of the bag to a far less extent than in the other Rays; it is prolonged as a thin, raised stripe, provided with a furrow and gland-pores as in *Torpedo* and *Narcine*, throughout the length of the shaft till the terminal part.

Trygonidæ.

Trygon violacea Bonap.

(Pl. III, fig. 38—40.)

A specimen of a length of 1^{m}, a breadth of 44^{cm} shows the following measures:

The length of the whole appendix	9^{cm}
- — - - free part	$6{,}5^{cm}$
from the fore end of the slit to the hindmost point of the appendix	8^{cm}
The length of the terminal part	4^{cm}
The largest breadth at the base of the terminal part.	$1{,}5^{cm}$

The whole appendix, as the ventral itself, is naked, somewhat latero-ventrally compressed, almost triangular, when cut through, but with rounded edges; the broadest surface looks inward, and is in contact with the base of the tail; the appendix-slit follows the more narrow dorsal side till the terminal part, where apparently it separates into two slits, surrounding a lengthened-oval, firm, and hard part, covered by the skin (*Tv*); in reality, however, only the inner one of these slits is a continuation of the appendix-slit (*af*); the outer one (*l'*) leads into a deep pocket ending far forward, and limited by the terminal skeleton proper and the covering pieces to be mentioned later. Immediately before the passing of the slit into the terminal part its inner (dorsal) lip forms a rather large, soft, pigmented dermal fold, which, however, is not seen externally, being placed under the overlapping firm edge of the outer lip, supported by the covering piece *v*.

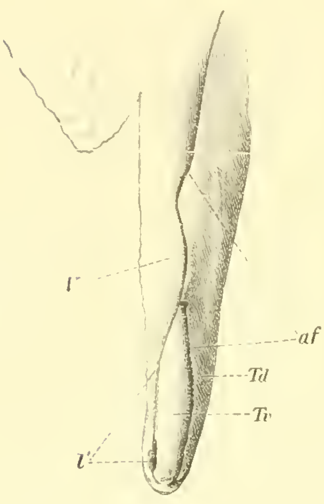

Fig. 23.

Trygon violacea.
The left appendage from the dorsal side; reduced. *l'* the opening of the lateral pocket. *l'*, *Td*, *Tv* the parts of the skin, in which the skeletal parts, indicated with the corresponding letters, are inclosed.

None of the skeletal parts protrude through the skin.

The skeleton. Between the short basale and the appendix-stem are found two pieces, b_1 and b_2, of about equal length, but b_1 is much the broader, especially proximally, where it is of the same breadth as the basale, and where on its dorsal edge it articulates with a very long piece β, which, without touching b_2, reaches to the appendix-stem, and articulates with the dorsal side of this almost quite to the fore end of the dorsal marginal cartilage. b_1 bears the last ray, which proximally for a long way is coalesced with the last but one which articulates with the end of the basale; these two are by ligaments firmly connected with the ventral marginal cartilage. The appendix-stem is long and powerful, more than twice as long as the basale $+ b_1 + b_2$; its hindmost part (a little less than half the whole length) is uncalcified as a strong, broad style reaching to or only a little past the end of the terminal pieces. The marginal cartilages are both calcified, the dorsal one most solidly; they reach about equally far forward, and occupy almost the distal half of the stem above the style; behind the dorsal marginal cartilage reaches a little farther than the ventral one; the latter is concave on its outer surface, while the former is partly rounded.

The number of terminal pieces is two, only *Td* and *Tv* being found.

Td is a large, externally rounded plate of pointed-ovate contour, thickest at the medial edge along the style, and laterally quite thin; the lateral edge is finely indented. *Tv* likewise is large, but the inner surface, towards the appendix-slit, is rounded, while the outer surface is deeply hollow as a trough, both edges of which are somewhat bent towards the concavity. The whole ventral side of the terminal skeleton, as well as great part of the ventral marginal cartilage, is covered by two hard, calcified, firmly connected covering pieces v and v_1, to which the *M. dilatator* is attached, and which correspond to the single v in the preceding genera of Rays (in *Narcine*, as we have seen, the proximal-lateral corner of v had already been partly separated as an independent piece, to which in *Trygon* the larger piece v_1 must be taken to correspond). The larger lateral piece v_1 shows distally a rather deep hollow on the outer, otherwise rounded surface, by which means a strong ridge is produced on the opposite, concave inner surface, and this ridge is firmly connected with the raised medial edge of the piece *Tv*; the above mentioned deep lateral pocket is then situated between the last-mentioned pieces.

The muscular system is peculiar by the little marked bounding between the single groups of muscles. Thus on the ventral side the fibres of the *M. adductor* are seen behind and medially to continue, without any bounding whatever, directly into the *M. dilatator*, and laterally to pass over on the *M. compressor* in such a way, that the contour of the glandular bag before and medially is quite effaced; the fibres of the ventral wall of the glandular bag — as in *Torpedo* — have the same direction as those of the *M. adductor*, and they are here, until close to the lateral edge, quite woven together with the latter. On the dorsal side the marginal portion of the *M. adductor* is seen as a powerful mass arising partly from the pelvis, partly from the aponeurotic covering of the muscles of the abdominal wall, and laterally overlapping part of the *M. extensor*. This latter arises from the whole extent of the basale, as well as from the following pieces, and is distally, without any bounding, woven together with the *M. adductor* and the continuation of this, the *M. dilatator*, which latter also with a considerable mass wraps the whole of the appendix-stem and both the marginal cartilages quite to their margins at the appendix-slit. Behind it is attached to the proximal edge of the ventral covering pieces (v, v_1). The part of the *M. compressor*, appearing as the outer lip-muscle, is only sligthly developed; more developed is the part of the dorsal muscular wall of the glandular bag, running more transversely, and wrapping the glandular body, which it follows throughout the shaft to its hindmost end at the terminal part.

The glandular body stretches here — as in the preceding genera of Rays — through the whole length of the shaft along the ventral marginal cartilage, constantly tapering backward, and the furrow which in the part of the body, situated in the bag, runs from before obliquely to the medial side (separating a pigmented and an unpigmented surface), continues with its pores quite to the terminal part. The part of the appendix-slit situated in the terminal part, has quite smooth walls.

The above described features of the glandular body, and several other characteristics — as for inst. the presence of ventral covering pieces, enclosing a pocket with an opening through an outer side-slit, and furthermore the hollowing of the ventral side of the piece *Tv* — very much recall those in *Torpedo* and *Rhinobatus*[1]), and it is evident that *Trygon* is more closely allied to those than to *Raja*, at all events with regard to the structure of the appendices.

Rajidæ.

In this family the appendices reach to quite a considerable size, and consequently they, naturally enough, have attracted the attention, and have in some species several times been the subject of examination. As a rule, however, this examination has not been very thorough, nor has it been ex-

[1]) Partly even those in *Rhina*.

tended to more species of the genus, and therefore the result as to comparison has only been slight. The species show great differences that may easily be used diagnostically. The corresponding structures in the different species are easily pointed out; more difficult it is to work out the comparison with the other Plagiostomes in a sure way. I hope, however, to have succeeded in this in the following description of the species I have examined.

Raja batis L.

(Pl. IV, fig. 45—48.)

The appendices of the Skate are mentioned by several authors, who, however, have restricted themselves to brief remarks of the outer shape and the size. This latter may in old males be so considerable that the appendices may convey a notion of "Skates with three tails", or "Skate-Kings" (Pontoppidan)[1]; Lilljeborg[2]) gives, in old males, the length to be between $^1/_4$ and $^1/_5$ of the total length of the animal, and says that the appendages reach far behind the middle of the tail. I know, however, no thorough representation of these organs or their skeleton[3]).

In a specimen of a length of 1^m 26^{cm} (2 ell Danish) the appendix has a length of $27{,}5^{cm}$[4]). The other measures were:

From the fore edge of the slit to the end of the appendix	25—26^{cm}
The part free of the ventral	18^{cm}
The terminal part	13^{cm}
The largest breadth (across the basis of the terminal part)	4^{cm}

The shape of the appendix is flattened, the contour clavate, the breadth increasing towards, and culminating in, the big, ovate terminal part. The skin is naked in every place. The appendix-slit in the free part of the organ is situated quite close to the lateral edge; in the part united with the fin more towards the middle of the dorsal side; in front the slit is easily dilated, and a little-finger may here be brought into the ventral glandular bag, the powerful gland of which may be partly discerned through the skin; the rest of the slit until the terminal part is certainly open, but on account of the stiffness of the marginal cartilages it can only be very little dilated; in the terminal part, however, dilation may easily take place, especially if the end of the appendix is bent ventromedially. In the terminal part the skin forms on the ventral side a large, soft lip, closing together with the dorsal lip, which is supported by skeletal parts. If the soft lip is thrown back, its inner, bluish-red mucous membrane is seen, as also a large skeletal piece (T_3) with sharp, indented outer edge; it is, however, quite covered by the mucous membrane, which on the dorsal side of the piece

1) See Kroyer, l. c. p. 993.

2) l. c. p. 590.

3) The Ray mentioned by Joannes Battarra in Atti dell' Acc. delle scienze di Siena, Tomo IV, 1771, p. 553, the appendix-skeleton of which he draws in fig. I, must be the Skate, or at all events a nearly allied species (according to Giglioli [teste Lilljeborg] the Skate is not found on the coasts of Italy (?)). Davy l. c. p. 145 mentions the glandular bag and its large glandular body, its secretion etc.

4) In two skeletons of ventrals belonging to the Zoological Museum the appendices have a respective length of 41^{cm} and 38^{cm}.

forms a great many transverse, soft, vascular folds (see fig. 24 in the text, *bl*). If the terminal part is more opened, the walls of the appendix-slit are seen; they are very curiously formed, covered with a mucous membrane, and their folds and pockets supported by different skeletal pieces. Besides what has been mentioned, we find on the ventral side a firm fold with a porous edge, *da*, reaching into the proximal part of the slit, and a process (Tv_2), with a loose, soft covering, and supported by skeleton; laterally of this process is found behind a deep recess or pocket, *Lv*. On the dorsal side are seen two recesses, the foremost one (*Ld*) very deep, and separated from the appendix-slit by a lamella supported by skeleton; the hindmost one (*Ld'*) is less deep; finally is seen a process (*Tv*), enclosed in a soft membrane, which process is laid against the above mentioned one on the ventral side of the slit. The real continuation of the appendix-slit runs between these two processes, as indicated by the sound in fig. 24[1]).

The skeleton. Between the basale and the appendix-stem are found two pieces, b_1, b_2, the latter longer than the former; b_1 bears the six hindmost rays, b_2, as usual, none; with the dorsal and lateral edge of b_1 is connected a long, plate-shaped β, distally articulating with the appendix-stem *b* almost beside the articulation between this latter and b_2.

The appendix-stem is long, about twice as long as the basale + b_1 + b_2; behind it becomes by and by dorso-ventrally flattened, especially in the terminal part, where its outer end is quite flattened, thin, and rounded. As is usually the case, the calcification ceases in the terminal part; in the long part corresponding to the style is however found on the medial edge a strongly calcified region projecting in a somewhat bump-like manner (*x* in fig. 45, 47). The marginal cartilages are long and hard, and are for a long way rather closely joined with their edges; distally they separate; the dorsal one begins before close by the articular surface between β and *b*, but distally it does not reach as far out on the stem as the ventral one, which in return does not reach so far proximally as the dorsal one; thus an open space is found proximally, where the glandular bag joins in, and where its foremost, dilatable outlet is situated. The dorsal marginal cartilage sends forth distally a

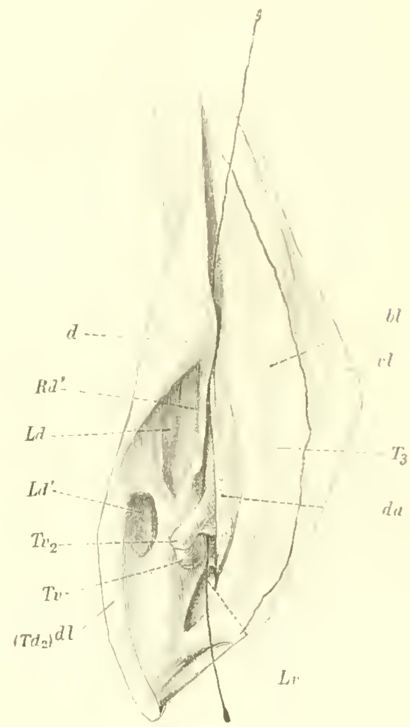

Fig. 24. *Raja batis*. The terminal part of the right appendage, from the dorsal side, strongly dilated (much reduced). A sound goes through the bottom of the appendix-slit. *vl* the soft, ventral dermal lip; T_3 the terminal piece T_3 covered by mucous membrane with the dermal leaves *bl*; *da* a firm dermal fold, dotted with small holes on the edge. *Lv* the ventral pocket, *Ld*, *Ld'* the two dorsal pockets; *d*, *dl* the dorsal lip with the enclosed skeletal parts *d* and Td_2; *Rd* a dermal fold, supported by a plate-shaped prolongation of the dorsal marginal cartilage; *Tv*, Tv_2 dermal projections supported by the skeletal parts marked with the same letters.

[1]) In specimens with quite short, undeveloped appendices, shorter than, or of an equal length with, the fin-membrane (the free part from 2,5–3,5cm in length), we, as might be expected, do not find much of these elaborate structures; in such young appendices with all parts still soft the appendix-slit is easily opened and quite spread, and then the walls of the slit are seen to be smooth and simple, upon the whole without recesses or folds, also in the terminal part; one strongly pronounced dermal fold is however seen along the ventral lip; the inner, already plate-shaped edge of this fold represents the spongy-porous dermal fold (*da*) in the adult, and in the lateral part of it the large skeletal part T_3 will develop.

long, triangular, plate-shaped prolongation, *Rd*, fig. 45, running into the terminal part, and supporting the above-mentioned dermal fold.

The number of terminal pieces is five, and to these is to be counted a «covering piece» belonging to the aponeurosis of the *Musc. dilatator.* This covering piece[1]) (fig. 48) is chiefly situated on the dorsal side, has a fairly triangular contour, flatly rounded, with part of the medial edge bent in such a manner that it catches round the medial edge of the end-style (fig. 46, *d*). This piece quite evidently belongs to the same kind of structures as those, described as «covering pieces» in the before mentioned forms (*Rhina*, *Mustelus antarcticus*, *Torpedo*, *Narcine*, *Trygon*), only the development having here taken place in the dorsal side of the aponeurosis; and so I here (and in other *Raja*-species) mark it with a *d*.

With the distal end of the dorsal marginal cartilage is only connected one piece, proximally also touching the style; I regard it to be corresponding to the *Td* of the other Plagiostomes, as it is situated in the same manner as that in the dorsal lip of the appendix-slit, and shows the same relations to the marginal cartilage and the stem; it is rather thick, somewhat bent in a crescent-shaped manner with the concavity towards the stem; distally it is firmly connected with the style of the stem by means of an uncalcified (or slightly calcified) cartilaginous prolongation[2]). With the hinder half of the lateral edge of this piece *Td* is connected a long, narrow piece, attached by a band to the terminal end of the style; it is situated in the edge of the dorsal lip, and I think it to be corresponding to the piece, which in several other Plagiostomes I have called Td_2. With the ventral marginal cartilage are terminally and laterally connected two pieces of a peculiar shape. Only the medial one of these is also connected with the style of the stem, passing closely along it until the above mentioned calcified bulb x; this piece then must be corresponding to *Tv*; it is rather thin, rounded on the outer side, and prolonged to a slender, bent, obliquely-posteriorly and laterally directed part, ending in a hook (it is this hook, which is seen covered by a loose, mucous membrane in the fig. 24 of the text at *Tv*). The other piece consists of a crescent-shaped, large part, the concave side of which is for a long way connected with the terminal and lateral edge of the ventral marginal cartilage; most anteriorly the long horn of the crescent reaches into the appendix-slit; behind and laterally the piece is prolonged to a long, rather slender process, tapering to a somewhat bent, flat part with a slightly notched end (it is this process, which is seen covered by loose, soft membrane in the fig. 24 of the text at Tv_2). I take this piece to be homologous with the fully developed piece Tv_2 in *Spinax* (in *Acanthias* and *Somniosus* it is only indicated), and its situation seems to me to settle this homology beyond doubt. Finally is found, belonging to the ventral structures, a very large piece, rather crescent-shaped when viewed from the ventral side, which must be corresponding to the piece T_3 (the «thorn» or «spur» in different Sharks); proximally it reaches far into the appendix-slit, is on its medial side broad, flatly rounded, and sends forth laterally a high, sharply winglike ridge with undulating, finely indented edge; somewhat above the middle it sends forth a tap-like process, ventrally overlapping Tv_2; distally it ends with a plate resembling the blade of an axe, and ventrally reaching over the

[1]) It is mentioned by the way by Moreau l. c. p. 251 under *Raja clavata* by the name of «Cartilage interne»; the presence of Td_2 is also noted here, but this piece gets no special name, as it is not found in *R. clavata*.

[2]) This connection-piece I take to be not independent.

style[1]) (to judge by the pieces before me this part seems to be a little varying with regard to the details of the processes).

As to the muscular system the reader is referred to *Raja clavata* with which the other *Raja*-species agree exactly in most respects. The *M. dilatator*, however, is here somewhat more distinctly than in the thorn-back separated into two, a large dorsal one, and a smaller ventral one.

The glandular body, as in all *Raja*-species, is limited to the dorsal side of the ventral bag proper, and accordingly does not continue into the shaft. In young specimens of the Skate with undeveloped appendages not yet reaching the end of the ventral, the appearance of the gland is rather deviating from that of the developed one; it is more flattened, and the gland-pores are spread in more (four or more) rows over the greater part of the surface; in other words, it shows a rather striking resemblance to the glandular body in *Rhina*. By a continued growth of the marginal portions of the gland, and by a strong rounding of these portions, the surface that in younger animals is provided with pores, will be hollowed, and thus apparently become more narrow, and in this way the characteristic deep longitudinal furrow will arise.

Raja nidarosiensis Collett.

Of this species I have had only one pair of dried ventral skeletons, the appendix-part of which had a length of abt. 33cm. The principal features agree exactly with those of the Skate; the resemblance includes the common habit of the single skeletal pieces, but a closer examination of these will show some minor peculiarities in the details; for inst. it will especially easily be seen that the piece T_3 is bent in a somewhat different way, and has a relatively larger lateral wing, a larger forward directed tap, and its distal end has not the peculiar shape like the blade of an axe; on its medial surface it is deeply concave, spoon-like, etc. I shall however omit to give a detailed account of the deviations of all the pieces from those in the Skate, and leave to others, who may have more material at their disposal, to work out this subject more thoroughly; no doubt the deviations will make good specific characters. According to the existing descriptions of the species the appendages are very large, and are said to reach behind to the beginning of the first dorsal fin.

Raja clavata L.

(Pl. IV, fig. 49—52; pl. VI, fig. 67—68.)

This Selachian I think to be the one whose appendices have most frequently been examined and described. Duvernoy[2]) has briefly mentioned them, their glandular bag with its glandular body and their skeleton, the nomenclature of which he has formed in accordance with the appellations of the parts of the hind limb and the foot of a mammal. Later they have been described by Vogt and Pappenheim[3]), whose description it is rather difficult to use on account of the want of references

[1]) In my figure it has been displaced a little, so as to reach too far up on the other terminal part.

[2]) Cuvier: Leçons de l'anatomie comparée, 2d ed., vol. 8, 1846, p. 305 (perhaps the description applies to *R. circularis*).

[3]) Rech. sur l'anat. comp. des organes de la génération chez les animaux vertebrés. Ann. d. sc. nat. (Zool.), vol. XII 1859, p. 111—117, pl. 3.

to the accompanying figures, and in these the total want of letters indicating the single parts; still later they have been described by Petri[1]) and Moreau[2]). Besides short remarks on these organs are found in several writers of mostly systematic works. None of these descriptions seem to me to be quite serviceable.

In a specimen of the total length of 76^{cm} the whole length of the appendix is 18^{cm}. The other measures are:

Length of the free part	13^{cm}
from the fore end of the slit to the extremity of the appendix	15^{cm}
from the fore end of the terminal part	10^{cm}
Largest breadth (across the base of the terminal part) . .	2,7^{cm}

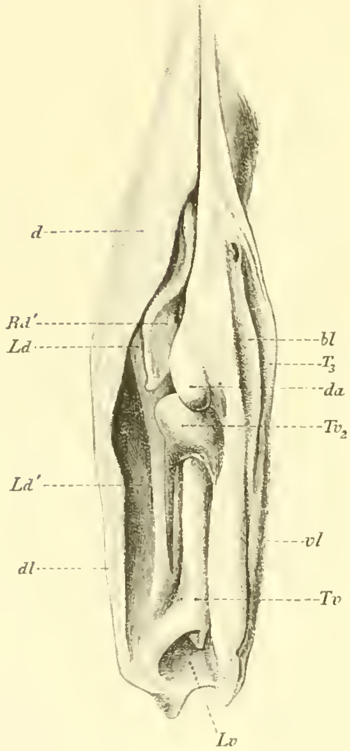

Fig. 25.

Raja clavata. The terminal part of the right ventral appendage, much dilated; reduced. The letters as in fig. 24.

The whole appendix is naked (but on the abdominal side of the glandular bag are found some scattered thorns); the shape is lengthened-clavate with a short shaft; the terminal part forms the club, and is relatively very long, broadest at the base, and tapering from thence towards the point. Only the foremost dilatable part of the appendix-slit, the part forming the foremost outlet from the glandular bag, is situated dorsally; from here the slit goes laterally, almost even passing to the ventral side; from this side it can be seen, but not at all from the dorsal side (contrary to the situation in the Skate). This is brought about by the fact that the dorsal lip, which only proximally is supported by skeletal parts, at the base of the terminal part overlaps the slit to such a high degree; the ventral soft lip is, when compared to that of the Skate, only very narrow. If the terminal part is opened so much, that the interior is seen[3]), this latter will present an appearance, apparently quite different from that in the Skate; it will, however, be possible to point out quite corresponding projections and hollows: on the ventral side of the slit is seen, relatively only little conspicuous, the membrane-covered terminal piece T_3[4]) which shows before a sharp, cutting edge, and on closer examination also is seen, as in *Raja batis*, to bear on its upper surface a row of transverse, soft, but less developed dermal leaves *bl*; a bayonet-like, hard, and sharp-edged blade[5]) (on which one may easily cut oneself, although it is covered by membrane) projects strongly, corresponding to Tv_2 in the Skate; to the piece *Tv* in this latter corresponds a

[1]) l. c. p. 310.

[2]) Hist. nat. des Poissons de la France, vol. I, 1881, p. 248—259.

[3]) Petri, l. c. pl. XVI, fig. 1 D, has given a drawing of the dilated terminal part, which is quite unsatisfactory, especially with regard to the ventral side.

[4]) Petri, l. c. fig. 1 D, *hk*.

[5]) Petri, *bj*.

long cylindrical process, reaching with the point into the ventral recess[1]), which is here situated far backward, almost terminally (*Lv*); on the dorsal side are seen the two same recesses[2]) as in the Skate, but of different size and extent, as well as the projecting lamella *Rd'*[3]) borne by the skeleton; the only new thing that does not seem to be represented in the Skate, is a strongly projecting part supported by the skeleton, *da*[4]), which part belongs to the ventral side; it corresponds to the porous, spongy, firm dermal fold in the Skate, where, however, no skeleton is found.

The Skeleton. Between the basale and the appendix-stem (Metatarsien Moreau [Cuv., Duvernoy]) there is a b_1 bearing the last six rays, a b_2 without rays, a flat β with s-shaped edges, proximally connected with b_1, and distally by means of a joint with the appendix-stem[5]). This latter is about (scarcely) twice as long as $B + b_1 + b_2$, and closely behind the two proximal articular surfaces for b_2 and β it becomes flattened, and ends with a quite flat, thin-edged, hindmost rounded part; corresponding to the great length of the terminal part, the uncalcified style (une sorte de phalange Moreau [etc.]) forms the greater part (about two thirds; in my figure it is a little too short); also here is found, about at the middle of the medial edge, a thickened and somewhat calcified part. The marginal cartilages are large, plate-shaped; the dorsal one reaches farthest forward, but behind it ceases much before the ventral one; the dorsal cartilage sends forth into the interspace between the terminal pieces a long, firmly calcified, s-shaped and pointed, blade-like process, bent in an undulating way, and with sharp edges (*Rd'*, fig. 50).

The terminal pieces are 5 (6), to which is still to be counted a covering piece[6]). This (*d*) is situated dorsally, is flatly rounded on the outer side, concave towards the terminal part, whose proximal portion it covers; anteriorly it is curved in an oblique, half-moon-shaped manner, having the lateral fore corner far drawn out; from this corner it shows an elevation running towards the medial edge, and indicating the place of attachment of the *M. dilatator*; consequently the whole part before this line is covered by the muscle. *Td*[7]) has a broad line of attachment with the distal edge of the dorsal marginal cartilage, but only touches the appendix-stem; outward it is somewhat flat, inward concave; its lateral edge is convex, and somewhat indented; its distal end is attached to the appendix-style by soft tissue, representing the cartilaginous bridge in the Skate. The piece Td_2 found in *R. batis* is wanting here. *Tv* is a long, slightly bent piece[8]), provided with a short, hook-like point, and having before a short articulation with the distal end of the ventral marginal cartilage, medially a long connection with the appendix-style, reaching until the thickened and calcified place in this latter; laterally it is for a rather long way connected with a bayonet-like Tv_2[9]); this latter is connected with the hindmost lateral edge of the ventral marginal cartilage by an oblique articulation, and distally it

[1]) Petri *ctc.*
[2]) Petri *ala, alp.*
[3]) Petri *pr.*
[4]) Petri *da.*
[5]) Petri, fig. 1 C, b_1, b_2, *r'*; Moreau (= Cuvier-Duvernoy): Tibia, astragale, calcanéum; basale = femur.
[6]) Petri: *sch'* schuppenförmiger Knorpel , grössere Schuppenlamelle ; Moreau: Cartilage interne, no. 3, fig. 27. l. c. p. 250.
[7]) Petri: *sch*, likewise schuppenf. Knorpel , kleinere Schuppenlamelle (p. 312); Moreau: Cartilage externe, no. 2.
[8]) Petri: *st*; Moreau: Cartilage no. 6 bis, cartilage en cuilleron.
[9]) Petri: *bj*; ein bajonettähnliches, gedrehtes Knorpelstück (p. 313); Moreau: Cartilage en hallebarde (Duvernoy), no. 6.

runs out in an elegantly shaped, longitudinally somewhat twisted blade with a peculiar sharp lateral edge. Ventrally of this, and attached to the same edge of the ventral marginal cartilage, is found a piece *da*[1]) which I do not find in the Skate, or in any of the other Plagiostomes I have examined, but, according to Petri and Moreau, it evidently appears in several other *Raja*-species; it has a thick, lateral edge, and a rounded contour; it is movable and seems to be composed of two pieces, a little, proximal, lamellar *da'*, and the larger distal *da*. Finally is found the large piece T_3[2]). It consists of a more narrow foremost part, the proximal end of which is attached to the lateral edge of the ventral marginal cartilage, and which laterally sends forth a sharp, winglike ridge (corresponding to that in the Skate, but much lower), and next of a broader, hindmost part whose medial edge (corresponding to the axe-blade in the Skate) folds round the appendix-style[3]).

The muscular system, with regard to the proximal part, shows the typical relations, as will be sufficiently clear from the figures 67 and 68 on pl. VI.

The *M. dilatator* is on the dorsal side behind split into two parts, but this cleaving has not been carried through to the proximal part of the muscle, and so the *M. dilatator* seems to me to form one muscular mass here as well as in most of the other Plagiostomes I have examined. The whole of the large dorsal part of this muscle is with its hinder end attached to the dorsal covering piece, i. e. not to the edge of this piece, but some way in on its surface till a plainly indicated line of insertion (see fig. 49 on pl. IV). In *Raja batis* the division of the *M. dilatator* indicated in *R. clavata* seems to be more strongly pronounced, and in other *Raja*-species[4]) it even seems to lead to a separation into two independent muscles, one larger situated dorsally, and another smaller, ventral, which

[1]) Petri: *da* »ein spatelförmiger Knorpelstück« (p. 313); Moreau, who has correctly seen that it is composed of two pieces, calls the little proximal one: Cartilage intermédiaire, no. 4, the larger one: Cart. accessoire, no. 3.

[2]) Petri: *hk* »hakenförmiger Knorpel«; Moreau: (Duvernoy) Cartilage en soc de charrue, no. 7 (in the principal figure, however, indicated by 1).

[3]) Vogt & Pappenheim's appellations have to be with difficulty found out from the description, this, as mentioned, having no references at all to the figures, and in these no letters are found. I give below the appellations of these authors corresponding to my names. It seems that they have not clearly seen that the chief piece — la pièce principale — is composed of three parts; they use the names »la lèvre interne« partly of the marginal cartilages, but without establishing the independence of these pieces; the prolongation of the dorsal marginal cartilage is described (p. 114) as »une feuille mince en forme de spatule«. The other names are:

The covering piece d = pièce externe, la plus superficielle (p. 115).

Td = pièce externe; seconde pièce.

Td = pièce alongée, courbée en S; it is interpreted as coalesced of two pieces, the terminal part wrapping the appendix-stem being called »une petite pièce cartilagineuse formant une gouttière« etc. (this part in young animals is possibly soft).

da = petite pièce cartilagineuse .... presque carrée et couverte .... par un coussin gélatineux.

Tv_2 = pièce .... plus allongée, sa forme est semblable a celle d'une équerre très large.

Tv = une dernière pièce cylindrique etc. (p. 116).

[4]) For inst. in *R. Schultzii*, according to Petri (l. c. p. 314; pl. XVII, fig. 2 B and C). Petri calls the greater, medio-dorsal part *M. levator*, and thinks this part to be composed of two kinds of muscles, viz. the greater part of »red« fibres in which is found a wedge-shaped »white« part (fig. 2 B, *al*) the fibres of which, however, are said to run — only with altered colour — into the red mass (a difference of this nature I never saw in any Plagiostome); the smaller, dorsal muscle is called *M. rotator* with regard to its action on the »hakenförmige Knorpel« (my piece T_3). In *Raja clavata* Vogt & Pappenheim (l. c. p. 116), as it would seem, (the description is not quite clear to me) have also found two muscles where I only find one; they speak of a »Muscle écarteur dorsal«, »originating« on the large dorsal covering piece (where the fibres of their »M. releveur« are said to be attached; according to their description this »releveur« for one thing is composed of the dorsal layer coming from the body (i. e. the tail), and is rather incomprehensible to me); and next of a »muscle écarteur ventral« which by means of »rather long tendons« is attached to the outer side of the »s-shaped piece« (T_3). Duvernoy also says (l. c. p. 308) that his »Muscle grand abducteur« (*M. dilatator*) in »la raie ronce« is divided in a similar manner, and attached in the same way.

latter during the dilation acts especially on the terminal piece T_3, by which means this piece is turned (revolving as the radius round the ulna in a human fore arm).

The *M. compressor* (*S*) forms the bag situated on the ventral side; the direction of its fibres, as far as seen on the ventral side, is exactly given on pl. VI, fig. 68; on the dorsal side (fig. 67) the part forming the outer lip-muscle, which part is rather small, is seen anteriorly arising from the piece β, and posteriorly attaching itself in the inner investment of the ventral marginal cartilage; when the connective tissue laterally uniting it with the hindmost ray, is prepared away, it is here very distinctly seen to be continuously connected with the dorsal muscular wall of the bag[1].

The glandular body has by earlier authors been sufficiently described as well in this species as in other *Raja*-species; when developed it seems in all species to show principally the same appearance.

Raja radiata Donovan.

(Pl. IV, fig. 53—57.)

Brief remarks on the appendices of this species are found in several authors, as usually mostly concerning the size[2]) and the like facts. Lilljeborg[3]), however, not only says that they are very large and in old individuals sometimes reach past the middle of the tail (in a specimen of the length of 53^{cm} they were 14^{cm} long and $3{,}2^{cm}$ broad on the middle), but he also gives a rather thorough description of their outer contour and whole shape; of the inner configuration of the appendix-slit he only says that it is „divided into parts or separate hollows". He does not enter upon an examination of the parts of the skeleton; he mentions only, that a piece in the dorsal lip has a free, backward directed point. We find, however, in the older literature a representation of the skeletal parts of these organs, as well as of their structure upon the whole, viz. by M. E. Bloch[4]). His specimen had a length of 16 inch. (about 42^{cm}), and the appendices (from the pelvis) were $5^1/_2$ inch. (abt 15^{cm}) long, $1^1/_8$ inch. (abt $3{,}5^{cm}$) broad across the terminal part.

1) Petri has called this part of my *M. compressor* „*M. flexor pterygopodii biceps*" (l. c. fig. 2 B, *flb*), and thereby indicated that he thinks it to be corresponding to the muscle in *Scyllium* marked with the same name, which latter, however, shows quite other relations (see my fig. 65 and 66 of *Sc. stellare*); he describes it as inserting itself on the dorsal marginal cartilage instead of on the ventral one (this, perhaps, is only a miswriting). In the proximal part the *Flexor pterygopodii exterior* of Petri corresponds to my *M. adductor* (*A*), his *Flexor pt. interior* to my *M. extensor* (*E*). The muscles mentioned by Duvernoy (in Cuvier's Leçons 2d ed. vol. 8, p. 307) are: 1) Le muscle abaisseur = my *M. adductor*; 3) L'abducteur de l'appendice = *M. extensor*; 5) Le grand abducteur ou extenseur des pièces mobiles et terminales = *M. dilatator*; his no. 2 („le releveur de la nageoire") is the muscular layer coming from the body (pl. VI, fig. 67), and his no. 4 (Moreau's „court extenseur") I am unable to unravel. The same names have mostly been used by Moreau (l. c. p. 255): his Muscle long extenseur = *M. extensor*, his M. fléchisseur = the part of *M compressor* forming the outer lip-muscle. Moreau, in correspondence with my opinion, describes his M. grand abducteur (*M. dilatator*) as separating into two bundles. Vogt & Pappenheim, besides the already mentioned „écarteurs" (*M. dilatator*) only mention the *M. adductor* as „l'abaisseur de l'appareil copulateur", and as the antagonist of this a „releveur" partly formed by the dorsal muscular layer coming from the body. Bloch only mentions two muscles in *Raja radiata* (l. c. vol. 6, 1785) both together representing my *M. dilatator*.

2) Kroyer l. c. p. 943 gives the measures: a specimen $17^1/_2$ inch. long with appendices of the length of $1^{1}/_{2}$ inch., and thinks (p. 954) that the appendages are very strongly developed in the adult males.

3) l. c. p. 552.

4) Von den vermeinten doppelten Zeugungsgliedern der Rochen und Haie. Schr. d. Berl. Ges. naturf. Freunde, vol. 6, 1785, p. 377. Bloch calls his Ray-species *Raja clavata* L., and in his faunal works he has drawn and described it as *Raja clavata*. The figures, l. c. pl. IX, however, show with perfect certainty that the species in question is *R. radiata*. (Both this plate and the one concerning *Acanthias* are, without any explanation, affixed to the edition by Schneider of Bloch's Ichthyology.) Petri has not perceived that in Bloch the question is not of the real *R. clavata*.

Two pairs of ventrals with fully developed appendices, now before me (unfortunately I cannot give the total length of the animals) show the following measures:

Length of the appendix	10^{cm}
— - - part free of the fin	$6{,}2^{cm}$
— - - terminal part	$4{,}6$—5^{cm}
Breadth of the — —	$2{,}7^{cm}$ at the broadest spot
— - - basal part	$1{,}6^{cm}$

A dried specimen of a length of 39^{cm}, a breadth of 24^{cm} shows fully developed appendices, 8^{cm} long, and $2{,}2^{cm}$ broad across the terminal parts; in another specimen (in spirit) 43^{cm} long, and 29^{cm} broad the appendices are only $6{,}5^{cm}$ long, the terminal part abt. 4^{cm} long, $2{,}1^{cm}$ broad; here they are not yet fully developed though it was to be expected judging from the size of the animal. Facts as these, that rather grown individuals have rather undeveloped appendices, I have oftener seen, for inst. in *Acanthias*.

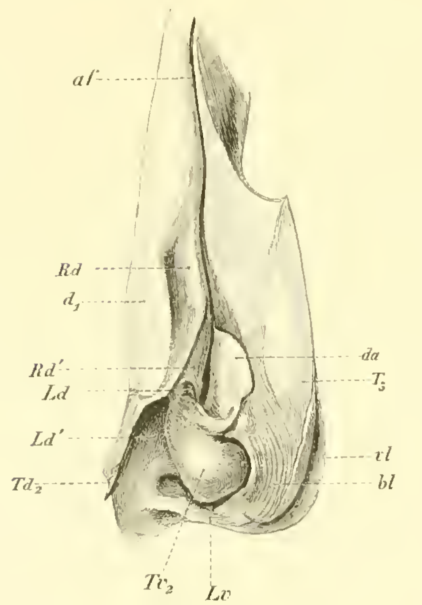

Fig. 26.

Raja radiata. The terminal part of the right ventral, much dilated; reduced. Td_2 the naked spine of this same skeletal piece. The letters as in fig. 24 and 25.

The appendix is naked, much more clumsy than in the preceding species, flattened, somewhat rounded on the dorsal side, the contour is clumsily clubshaped; the club is formed by the terminal part constituting more than half the length of the part to be seen from the back. The appendix-slit runs from the foremost dorsal opening laterally, so that it cannot be seen from the dorsal side except in the hindmost end of the terminal part, where the dorsal lip, as it were, retires; the dorsal lip, throughout the terminal part, is supported by inner skeletal parts reaching to its edge, while the soft membrane of the ventral lip as a broad wall stretches past its skeletal part (T_3), and is laid — in a similar manner as in the Skate — dorsally against the upper lip; from the hinder, lateral edge of this latter a naked spine projects. If the soft, ventral dermal lip *vl* is thrown back, an elevated, long, bowshaped, cutting edge of the skeletal piece T_3 is laid bare (fig. 26 in the text, to the right of *bl*). If the terminal parts are opened still more (which here is easily done), we shall, although with altered shapes and relations, see corresponding projections and hollows as those described in *R. batis* and *clavata*. The upper side of the piece T_3 does not here show (or shows at most weak traces of) the transverse folds *bl*, peculiar in those two species; a broadly tongue-shaped, rather soft and movable lamella with porous edge and spongy lateral surface represents *da* in the Skate and the Thorn-back; a large, ovate, hard swelling corresponds to the process Tv_2; behind and laterally of this the ventral recess *Lv* is found, large and deep; the foremost recess *Ld* is smaller and more hidden, situated before the ovate swelling, and also the lamella *Rd'* supporting its lateral wall, is only little conspicuous.

The skeleton. Between the basale[1]) and the appendix-stem, as in all *Raja*-species, are found a b_1, a b_2, and a β[2]); b_1 also here bears the last six rays. The appendix-stem is about twice as long as $B + b_1 + b_2$, flattened especially distally; its terminal part, being as usual uncalcified, here forms an s-shaped, quite thin, flat "style" broadening towards the end. As in the other *Raja*-species the dorsal marginal cartilage stretches forward almost to the beginning of the stem, but backward not so far as the ventral one; this latter, especially distally, is a good deal broader. To the inner side of the dorsal marginal cartilage, at its distal edge, is articulated a triangular cartilage *Rd'* (fig. 56); it is quite corresponding to the one marked *Rd'* in the two other *Raja*-species, in which, however, it is only a direct prolongation, a process, from the marginal cartilage itself.

The number of terminal pieces is five, exclusive of the covering pieces. Three covering pieces d_1, d_2, d_3 are found on the dorsal side. The lateral one, d_1, is a good-sized, externally rounded plate, with a bow-shaped, convex lateral edge folding round to the ventral side. Its medial edge is rather straight and firmly connected with d_2, which latter as a narrow band runs obliquely across the terminal part, and tapers towards the medial end that is bent round to the ventral side, and by a ligament attached to the point of the piece T_3 (see fig. 55). The third covering piece, d_3, is connected with the lateral end of the preceding one; it is of a triangular, externally somewhat rounded shape, and by a ligament attached to the hindmost end of the appendix-style; with its inner surface is is connected with the dorsal side of the piece Td_2. The three mentioned covering pieces have all arisen from the same aponeurosis of the *M. dilatator*, and accordingly they together represent the single covering piece *d* in the Skate and the Thorn-back.

Of real terminal pieces two are found in the dorsal lip: *Td* and Td_2 (see fig. 54, 55). *Td* is short; it is with its whole fore edge attached to the dorsal marginal cartilage, with its foremost medial corner also to the appendix-stem; from its medial-distal corner it sends forth a soft, cartilaginous part which farther backward is coalesced with the style (comp. the Skate); else its distal edge is connected with Td_2, a proximally broad, distally narrow and tapering, very hard, somewhat s-shaped cartilage; it is outwardly rounded, inwardly concave, and ends in the above mentioned thorn projecting naked from under the edge of the dorsal lip.

To the ventral side belong three terminal pieces: *Tv*, Tv_2, and T_3. The two first of these are very peculiar, and can only be rightly seen when the skeletal parts are disunited (see fig. 57).

Tv consists of two parts, a "body" and a long process; the "body" is proximally attached to the edge of the ventral marginal cartilage, with one edge to the medial edge of the style (see fig. 51), and with the opposite one to the piece Tv_2; from the ventral surface of the "body" the process arises, and forms together with the "body" a kind of T; this process is bent in an irregularly s-shaped manner, ends in a fine, hook-shaped thorn, and is situated in the deep, spoonlike hollow formed by the piece Tv_2.

Tv_2 is still more peculiar; its chief part forms an oval spoon, outwardly strongly rounded, inwardly very deeply hollowed, from the foremost part of which a large, half-moon-shaped part arises joining the inside of the ventral marginal cartilage of the appendix-stem; the lateral edge of the "spoon" is prolonged into a not quite calcified, winglike process; between this process, the half-moon-shaped

[1]) Bloch l. c.: "der erste Knochen des Schenkels", fig. 1, *l*.

[2]) b_1 = "der zweite", b_2 = "der dritte", β = "der vierte Knochen des Schenkels" (fig. 1, *m*, *n*, *o*) in Bloch.

part, and the firm body of the "spoon" part of the terminal piece T_3 is intercalated as a kind of articular head (see fig. 55).

This latter, T_3, is large, forms a half-moon-shaped plate (fig. 55), the distal "horn" of which is bent in a somewhat hook-shaped manner; the proximal horn stretches in between the marginal cartilages, far forward in the appendix-slit; on the concave edge of the half-moon the mentioned "articular head"[1]) projects bearing a large, transverse-oblong "articular surface"; the upper or inner surface (the surface towards the appendix-slit) bears at the lateral, convex edge a thin, bent, sharp ridge which in some individuals is undulating or finely indented; it is the above mentioned edge seen on the undamaged organ[2]).

Still has to be mentioned a peculiarly elevated, round, narrow cartilaginous ridge x, running across the dorsal surface of the appendix-style; this ridge seems to me only to be a special swelling of the style, and to correspond to the calcified and thickened bump x in *R. batis* and *clavata*.

Raja fyllæ Ltk.

In a specimen[3]) of a total length of 55^{cm}, a breadth of $30{,}5^{cm}$, the fully developed appendices are 11^{cm} long, i. e. exactly $^1/_5$ of the total length.

The other measures were:

From the beginning of the slit to the end of the appendix	9^{cm}
The part free of the fin	$7{,}6^{cm}$
The length of the terminal part	$5{,}5^{cm}$
The breadth across the shaft	$1{,}5^{cm}$
— — — the terminal part	$1{,}75^{cm}$

As in the other *Rajæ* the appendix is naked. The outer form as well as the inner configuration of the appendix-slit in the terminal part is very much like that of the Skate. The contour consequently is of a more slender club-shape than in *R. clavata* or *radiata* with a longer shaft and a pointed-ovate, somewhat broader club constituting the larger, hinder portion of the terminal part. As in the Skate the appendix-slit can be seen for its whole length from the dorsal side, but runs close

1) This evidently corresponds to the tap on the piece T_3 in the Skate, which overlaps the piece Tv_2.

2) Bloch l. c. pl. IX has drawn most of these terminal pieces in a very recognizable manner, some of them even excellently (as fig. 4 and fig. 5). He distinguishes between an upper part (the chief piece of the appendix), and a nether part (the terminal part); the first he interprets as a tibia with its fibula (?) ("ein Röhrenknochen, und sitzet letzterer oberwärts, wie bey anderen Thieren, an dem Schienbein fest"); this latter is = my dorsal marginal cartilage; l. c. fig. 1 and 3, q; the tibia again consists of: a piece (= my ventral marginal cartilage), l. c. fig. 1 and 3, r, r, "welcher unter gewissen Umständen die Rinne verschliest", and of an "unterer Knorpel" (= my appendix-stem), fig. 3, s; it ends hooklike; this is brought about by the fact that Bloch has not separated the covering piece d_3 from its connection with the style. Bloch makes the nether part consist of five pieces, which number arises from the fact that twice he makes two pieces one. These five pieces have the following relations to my appellations:

T_3 = fig. 4, "der Sichel".
Tv_2 = - 5, "der Helm".
Tv = - 6, "der wurmförmige Knochen".
$Td + Td_2$ = - 7, "der Winkelhaken".
$d_1 + d_2$ = - 8, "die Schaufel".

3) Station 25, at a depth of 582 fathoms; the Davis Strait.

to the lateral edge; the dorsal lip of the terminal part, also like that of the Skate, is along the whole lateral edge supported by skeletal parts, while the ventral lip has a broad, soft edge covering the skeletal parts (T_3), and passing round to the dorsal side; if this dermal lip is thrown back, we shall see, quite as in *R. batis*, a naked, cutting edge of a raised, winglike ridge on T_3, running almost throughout the terminal part. If this latter is opened still more, an almost complete conformity with the features in the Skate will be seen; and thus it will be sufficient to point out the deviations. These deviations are confined to the ventral side, and are chiefly as follows: 1) the membrane covering the inner, dorsal surface of the piece T_3 medially of the cutting edge, has very few and long, obliquely situated, low dermal folds (that may easily be overlooked); 2) the fold *da* is shorter (shortened distally), softer, in the middle of its distal part it projects in a more tongue-shaped manner, upon the whole most like that in *R. radiata*; it is as in this and in *batis* without any inner skeletal support; 3) the two projections corresponding to the skeletal parts *Tv* and Tv_2, are somewhat longer, so that they stretch distally over the opening of the ventral recess which thereby gets a somewhat other appearance than in *R. batis*.

Raja circularis Couch.

(Pl. III, fig. 41—44.)

In old males the appendices are said to be somewhat more than $^1/_5$ of the total length; in a male of a length of $79{,}2^{cm}$, a breadth of $48{,}5^{cm}$ they were $16{,}5^{cm}$ long[1]).

I have only had the occasion to examine a dried skeleton in the Zoological Museum; this skeleton measures from the snout to the point of the tail 40^{cm}, across the pectorals c. 20^{cm}; the appendix-stem has a length of $6{,}5^{cm}$, the terminal part of $3{,}7^{cm}$, and a breadth of 1^{cm} on the broadest spot. Between the basale and the appendix two pieces are found: b_1 bearing the 8 (7) hindmost rays, and a longer b_2, without rays, as well as a long, plate-shaped β, broadest in the fore part.

The ratio between the length of the appendix-stem and $B + b_1 + b_2$ is $3/2$; the rather narrow, flat, soft terminal part is shorter than the calcified one. The dorsal marginal cartilage reaches forward almost to the beginning of the stem, and ceases behind with a concave, oblique edge, the lateral corner of which is situated much farther forward than the hindmost end of the ventral marginal cartilage, which, as usual, does not reach so far forward. As in *Raja batis* and *clavata*, the dorsal marginal cartilage sends forth a long, thin, pointed, lamellar (calcified) prolongation passing in between the terminal pieces (it is not seen in any of my figures).

The number of terminal pieces is five, besides two dorsal covering pieces. One of these latter, d_2, I suppose to be corresponding to the piece that in *R. radiata* has been marked in the same way; it is long and narrow, spreads distally in a spoonlike manner, and the medial edge of the broader part folds round the appendix-style towards the ventral side, where it is attached to the distal end of the piece T_3 (see fig. 43). The other covering piece, d_3, is firmly connected with the dorsal surface of the terminal piece Td_2 (as is also the corresponding one in *R. radiata*) and is (as in this) distally closely connected with the end of the appendix-style; it is rather thin and flat.

[1]) Malm, A. V: Göteborgs och Bohusläns Fauna, 1877, p. 606.

On the dorsal side are found two real terminal pieces (see fig. 41, 42), *Td* and Td_2. The former is for a long way connected with the dorsal marginal cartilage and with the appendix-stem; from the hinder end it sends forth a long, round, somewhat finger-shaped, bent process with rounded end, and running obliquely towards the ventral side; on the dorsal side only a little of the basal part of this process is seen, while a larger part may be seen from the ventral side (comp. fig. 44 *Td*). With the outer hindmost corner of *Td* a piece Td_2 articulates, dividing behind into two branches, an inner one, short and soft, attaching to the appendix-style, and an outer one, hard, compressed, produced to a fine point (corresponding to the free thorn on the corresponding piece in *R. radiata*); this latter branch is best seen from the ventral side (fig. 44, Td_2), as it is dorsally hidden by the covering piece d_3.

The ventral lip shows three pieces: *Tv*, Tv_2, and T_3.

Tv (fig. 42) is slender, anteriorly connected with the terminal end of the ventral marginal cartilage, which is folded round to the dorsal side; next it follows for a long way the appendix-style, then folds ventrally round this as a rather thin prolongation (fig. 44), and ends finally with two small, diverging points at the opposite edge of the style (comp. *R. batis*). This piece *Tv* is in its foremost part laterally connected with the very large Tv_2. This latter is somewhat half-moon-shaped, and is attached with its foremost concave edge to the ventral marginal cartilage; it sends forth two processes; a short, truncate one close to the medial edge, and laterally of this a long one, bent in the free end like a hook (comp. *R. batis*), the point of which is turned into the appendix-slit (dorsally); the piece Tv_2, on its inner side, towards the slit, is of a flat, spoonlike shape.

T_3 (fig. 43) is narrow, falcate, and its foremost end is situated under the lateral edge of Tv_2 in the appendix-slit, between Tv_2 and *Td*; in its hindmost third part it bears on its medial, concave edge a process corresponding to the articular head on T_3 in *R. radiata*, but in the present species it passes into a sharp, winglike edge stretching to the distal end of the piece; the lateral, convex edge of T_3 is sharp and cutting.

Holocephala.

In the males of the Holocephales, as is well known, three particular organs are found that are supposed to subserve the copulation, viz.: 1) the peculiar cephalic organ[1]) provided with dermal teeth, 2) the pelvic appendages, i. e. the two organs placed in a ventrally open pouch on each side before the ventrals, and whose skeleton is connected with the pelvis by an articulation; and 3) the ventral appendages. Only the two last-mentioned sets of organs, and especially the ventral appendages, which correspond to those of the Plagiostomes, will be mentioned more thoroughly.

[1]) This, however, is wanting in the genus *Harriotta* Goode & Bean, the appendices of which are also said to be small and simple (; of its pelvic appendages nothing is said (Oceanic Ichthyology: Mem. Mus. Comp. Zool. Harvard Coll. vol. XXII, 1896, p. 32).

Chimæra monstrosa L.

(Pl. I, fig. 14, 15; pl. VI, fig. 69—71.)

The larger part of the appendix[1]) is free of the fin, and the appearance consequently differs rather much from that of the other Plagiostomes; this free part is almost as long as the ventral fin itself in its largest extent (from the point where the foremost part of the fin arises from the body, to the end of the much produced lateral corner). The appendix may also here be divided in a shaft and a terminal part; the shaft is thick, short, only about half the length of the terminal part; its inner contour is straight, the outer one very convex, whereby the appendix gets some resemblance to the part of the human leg below the knee, with a very prominent calf. On the dorsal side the appendix-slit runs throughout the free part of the length of the shaft; anteriorly it begins already at the connection with the ventral side of the body as a little roundish opening, the circumference of which is partly supported by the inner skeleton, and consequently it is only anteriorly a little dilatable; from this opening the slit, bent about in the same manner as the lateral contour of the shaft, runs to the base of the terminal part, where it reaches close to the medial edge, and from here it passes on into the terminal part along this edge. In front, behind the described hole, and posteriorly, where the slit passes into the terminal part, its lips can only with difficulty, or not at all, be opened on account of the stiff inner skeleton, but in the rather long interspace it is easily opened, as the lips are composed of soft parts (muscles); in a specimen before me the two concerning, normally tight spots of the slit are closed by the coalescing of the skin; in another specimen the case is the same, only to a less extent, with the right appendix. The skin of the shaft is naked, smooth, thin, and slightly pigmented, so that the muscles and their arrangement can be distinguished rather distinctly through it.

The long terminal part is composed of three branches[2]) a medial one (b^{*}) in immediate continuation of the straight medial edge of the stem; a dorsal one (b^{**}), lying quite close to the lateral edge of the foregoing, commonly only separated from it by the very narrow continuation of the appendix-slit; in one single instance, however, I find the skin coalesced for a considerable part of this slit, so that these two pieces only towards the point can be separated; finally a lateral branch (b^{***}), rather free of the other two. These three branches are generally of almost equal length; sometimes the medial one is a trifle longer than the others; they are stiff, and in their whole length supported by skeleton; the medial one is covered with a fine, but firm, thin skin, through which the skeleton is seen very distinctly; it is rounded on its inner, medial surface, and ends in a little, swollen knob; the lateral side is flat, and pressed into a furrow in the skin of the dorsal branch. This latter branch and the lateral one are more or less completely wrapped by a soft, loose, and tooth-covered skin, by which they are

[1]) The copulatory appendages have been described, more or less completely, by a rather large number of authors, of whom I shall only mention: Gunnerus: Om Hav-Katten, Det Throndhj. Selsk. Skr., 2. 1763, p. 269, pl. V—VI; Krøyer, l. c. p. 798 seq. Lilljeborg, l. c. p. 518; Duméril, l. c. p. 681; Moreau, l. c. p. 163; the descriptions in Gegenbaur l. c. p. 453, and v. Davidoff l. c. p. 453 are very complete. None of these authors mention the glandular bag.

[2]) In *Chim. colliei* Benn. living in the Pacific Ocean (at the coast of California), the terminal part is said to have only two branches (Duméril l. c. p. 681, Goode & Bean l. c. p. 32); Bashford Dean (Fishes living and fossil, 1895) gives however, p. 107, fig. 116, a drawing showing three branches, the medial one of which is invested at the point with dermal teeth, and besides by an articulation separated from the other part; this latter fact may perhaps be caused by an accidental damage.

made thicker and, towards the end, enlarged in a clavate manner, when compared with the medial one; the lateral branch in particular is often distally much swollen. The dermal teeth are fine, a little bent thorns, all with the points forward, towards the base of the organ. The lateral branch does not contribute to the bordering of the appendix-slit of the terminal part, this slit running only between the medial and the dorsal branch[1]).

In three specimens of the respective length of 78^{cm}, 77^{cm}, and 70^{cm}, the measures were:

The length of the appendix from the fore edge of the cloaca	$7{,}5^{cm}$,	$10{,}5^{cm}$,	$6{,}5^{cm}$
The free part of the shaft	$2{,}3^{cm}$,	$2{,}6^{cm}$,	$2{,}3^{cm}$
The terminal part	$4{,}5^{cm}$,	6^{cm},	$4{,}1^{cm}$
The breadth (on the broadest part of the shaft)	$1{,}1^{cm}$,	$1{,}6^{cm}$,	$1{,}1^{cm}$
The breadth (on the middle) of the terminal part	$0{,}7^{cm}$,	$1{,}1^{cm}$,	$0{,}7^{cm}$

The pelvic copulatory appendage has in all three specimens a length of . $2{,}1^{cm}$
— — — — — — — a breadth of $0{,}6^{cm}$.

In one pair of ventrals, kept in spirit, and skeletonized until the terminal part, belonging to a specimen the total length of which I am not able to give, the appendix has had a length of more than 9^{cm}, the terminal part of almost 6^{cm} by a breadth on the middle of 1^{cm}, at the end of $1{,}5^{cm}$; the skeletonized pelvic appendage is 2^{cm} long, and 1^{cm} broad.

The skeleton. The pelvic arch is divided in the middle line, so that it is composed of a right and a left piece; behind, dorsally above the articulation with the ventral, each of these pieces is prolonged to a considerable process; on the foremost convex edge the peculiar, movable, foremost copulatory appendage, the Sägeplatte (Gbr.), is articulated; the skeleton of this appendage is composed of one piece, the medial edge of which bears a row of (5—7) large, crooked, finely pointed dermal teeth; when in rest this piece is turned against the ventral surface of the pelvis which is hollowed like a spoon, and then only the toothless edge laterally of the row of teeth is seen in the opening of the pouch.

The fin-stem consists of a short, flat basale B bearing all the rays (the foremost broad marginal ray (R) is coalesced with it), a b_1, a good-sized β, and the appendix-stem b[2]).

b_1 is not much shorter than the basale, with which it is connected in a rather movable joint; on its medial side it is flat and broad, on the lateral side longitudinally concave; dorsally it forms a narrow edge, forward produced into a large process x, which by a lateral incision is made to form the inner bordering of the above mentioned opening, with which the appendix-slit begins; the other part of the dorsal edge of b_1 is somewhat laterally bent, and bears a rather firm margin of connective tissue; the ventral edge is straight and rounded.

The piece β is tolerably triangular, but with curved sides; it is much curved, and situated in

[1]) In *Chimæra affinis* Cap. the appendices, according to Goode & Bean (l. c. pl. X, fig. 34, 35), are three-branched as in *Ch. monstrosa*, but else they seem to differ rather much from those of this latter. The figures, however, are not distinct enough to get a clear notion of the facts.

[2]) In the figures of Gegenbaur l. c. pl. XVI, fig. 22, 23, and of v. Davidoff, l. c. pl. XXIX, fig. 19, pl. XXVIII, fig. 3, 4, these skeletal pieces are marked in such a way that: $b_1 = \begin{cases} b & \text{Gbr.} \\ c' & \text{D.} \end{cases}$, $\beta = \begin{cases} r' & \text{Gbr.} \\ c_3 & \text{D.} \end{cases}$, $b = \begin{cases} b_1 & \text{Gbr.} \\ c_2 & \text{D.} \end{cases}$

such a way, that its concave side like a roof covers the lateral edge of the piece b_1; with its hindmost corner it is by means of tight connective tissue attached to the lateral surface of this piece; its medial edge is free, and forms the limit of the tight foremost part of the appendix-slit, as it also, together with the process x of the piece b_1, contributes to the bordering of the aperture, in which the slit opens anteriorly. We find thus between *Chimæra* and most likely all the Holocephales (*Callorhynchus* shows the same relations) on one side and the Plagiostomes on the other the great difference that the appendix-slit anteriorly stretches over the piece β, and on the dorsal side separates this piece from the other parts of the stem skeleton.

The appendix-stem b is joined to b_1 by an only slightly movable articulation, and forms the whole terminal skeleton; no secondary cartilages are found, and consequently the terminal part cannot be directly homologized with that in the Plagiostomes. The part of the appendix-stem lying in the shaft, is short, medially flattened; its medial surface is continued directly in the prolongation forming the medial branch of the terminal part; in the lateral surface is found a furrow-shaped hollow continuing the furrow in b_1; both edges of this furrow are elevated and bent towards the concavity, what especially applies to the ventral edge, which rises very much, bends quite over on the dorsal side, folding over the edge of this latter, and lying close to the medial continuation, following this latter quite to the end as the skeleton of the dorsal branch of the terminal part; laterally it forms the cartilaginous prolongation supporting the lateral branch of the terminal part.

That the cartilage of the medial branch of the terminal part is homologous with that part of the appendix-stem, which in the Plagiostomes I have called the end-style, is an obvious conclusion, and admits of no doubt. At a first glance it seems also obvious that the plate-shaped, folded ventral edge with the two other branches must be corresponding to the ventral marginal cartilage in the Plagiostomes, which latter frequently in Sharks recalls it by the plate that is bent in a similar manner; it might even be tempting to continue, and take the two branches, the dorsal one and the lateral one, to represent two terminal pieces (resp. Td and T_3) coalesced with the ventral marginal cartilage; or it might be supposed that this part of the skeleton in *Chimæra* was representing a stage where the terminal pieces had not yet been articulated off as independent parts[1]). But a closer examination shows that the idea of these homologies must be dismissed; the folded ventral edge with its two prolongations is in *Chimæra* absolutely one with the other appendix-stem, consists like this of the same kind of hyaline cartilage, which is corroborated by a transverse section; as a homologon of this structure in *Chimæra* the question can only be of the more or less distinct ventral bordering ridge on the appendix-stem in the Plagiostomes, bearing and continuing the ventral marginal cartilage (see for inst. the Greenland Shark). In the firm, liplike edge of connective tissue, which in *Chimæra* follows the dorsal cartilaginous edge of the appendix-slit, an indication is found that may possibly be regarded as homologous with the dorsal marginal cartilage in the Plagiostomes.

The muscular system. I shall only here describe the muscles that are of importance with

[1]) This has also been intimated by Gegenbaur l. c. p. 455; at the same place he intimates that his supposition that the terminal pieces in the Sharks are transformed rays may possibly be wrong, since in *Chimæra* the branches are in continuous connection with part of the stem-skeleton.

regard to a comparison with those mentioned in the Plagiostomes as belonging to the appendix; as to the other muscles I may refer to the thorough description by v. Davidoff (l. c. p. 473 seq.).

Between the two halves of the pelvis a broad band (fig. 69—71, *s*) is stretched, which, as it were, supplements the hinder surface of the pelvis; anteriorly this band is attached along the whole concave posterior edge of the pelvic arch, and laterally it reaches almost to the articulation between the pelvis and the basale; in the median line it is somewhat thickened as a firmer tendinous stripe. From the whole ventral surface of this band as well as from the ventral surface of the pelvis arises the ventral layer[1]) of the group of muscles representing the *M. adductor (et depressor) pinnæ* in the Plagiostomes; in the middle line a stripe broadening somewhat backward, is left uncovered (see fig. 70). This muscular layer is composed of bundles that are distinctly seen distally. Of the medial and hindmost fibres of this layer only the deepest-lying are attached to the ventral side of the basale, to the thickened medial edge of this piece, from which edge the ventral ray-muscles (*Ra*, fig. 70) arise; otherwise the greater portion of the medial fibres of this muscular layer is attached to these ray-muscles until a line of insertion, distinctly seen in fig. 70. The foremost and lateral parts of this muscular layer pass, without any bordering — neither in the depth —, into the ventral ray-muscles, as is also the case in the Plagiostomes[2]). The other muscular mass[3]) which together with the foregoing one forms the *M. adductor* in the Plagiostomes (fig. 69, 71, *A*), arises from the dorsal side of the above mentioned tendinous band, as well as from part of the dorsal surface of the pelvis (viz. until the slight crest that separates it from the muscle *m* of the pelvic appendage); this layer is thicker than the ventral one, and attaches to the thickened medial edge of the basale and to the piece b_1, especially with a powerful portion of fibres to the large process x of this latter piece; on the ventral side it reaches to the muscle *D*, which corresponds to the *M. dilatator*, and will be more particularly mentioned hereafter. A special *M. extensor* has not been separated.

A far as I am able to see, only two[4]) muscles are found on the appendix-shaft, one corresponding to the *M. dilatator (D)* in the Plagiostomes, the other to the muscular investment of the glandular bag (inclusive of the »outer lip-muscle«), *M. compressor sacci (S)*.

The *M. dilatator* arises anteriorly with its ventral portion from the hinder end of the basale, but with its other parts only from the piece b_1, at some distance from the articulation between this piece and the basale. Almost all the fibres run straight from before backward; only on the ventral side some of them bend laterally; they are attached on *b* close to the base of the lateral and medial branches of the terminal part, and a few fibres go to the skin covering the skeleton; on the

[1]) Oberflächliche ventrale Schicht, *ssv*, fig. 16, 17, pl. XXIX, v. Davidoff.

[2]) I find upon the whole that the difference as to the arrangement of the ventral part of the *M. adductor* in *Chimæra* and in the Plagiostomes is only in degree; in many of these latter (*Scyllium*, *Pristiurus*, the Rays), the superficial part of the ventral layer of the *M. adductor* stretches quite over the ventral side of the basale and more or less out on the ray-muscles. v. Davidoff describes this ventral muscular layer in *Chimæra* as stretching considerably farther laterally on the fin than is really the case; and his words (l. c. p. 474): »Zum Basale hat er gar keine Beziehung« etc., are not correct.

[3]) The »pelvico-basale Fasern« of v. Davidoff, fig. 15, 17, *Pb*; they do not, however, as he thinks, arise exclusively from the pelvis.

[4]) v. Davidoff, l. c. p. 480, counts three, which he moreover calls »vollkommen gesondert«, viz. a »*Flexor*«, an »*Adductor*«, and an »*Abductor*«; in three specimens of *Chimæra* that I have examined, I have not been able to find a real separation between the two first-named; but even if such a separation might appear, it will be of only slight importance with regard to a comparison with the Plagiostomes (as surely also with regard to its functions); at all events, »*Flexor* + *Adductor*« v. D. is = *M. dilatator*; the »*Abductor*« of v. Davidoff is the muscle of the glandular bag.

dorsal side (fig. 69) the muscle stretches considerably farther backward than on the ventral side, reaching to the spot, where the appendix-slit passes to the medial side.

The muscle of the glandular bag, *M. compressor*, arises from the lateral edge of the piece β (see fig. 69), and is inserted on the lateral surface of the piece b_1, and on the appendix-stem, as also on the folded ventral edge of this latter. The fibres seen on the ventral side (fig. 71), pass from the edge of β round the „calf", running obliquely or transversely, so that part of them is inserted perpendicularly on the appendix-stem; those seen from the dorsal side, on the contrary, run straight from before backward, and they form the lateral limit of the appendix-slit, and are attached where the edge folded from the ventral side, is prolonged as the dorsal terminal branch (fig. 69). The opposite, medial, lip of the appendix-slit is formed by the *M. dilatator*.

Into the described, very voluminous muscle the dermal fold representing the glandular bag in the Plagiostomes, sinks from the dorsal side through the appendix-slit. This structure has here evidently remained in a state of development as that, with which it begins in the Plagiostomes; by a transverse section we see that the bag may in reality be called rudimentary, as it only fills very little in comparison with the powerful wrapping muscular mass. If we imagine this invagination to grow very much forward and ventrally, we may get a structure resembling that in the Plagiostomes; part of the bag will then be situated on the ventral surface of the fin itself, and the muscular coating will, as it were, be extended to a thinner wrapping layer, while the part keeping its position along the outer edge of the slit, will retain its original appearance and become the „lip-muscle". This dermal bag, which in *Chimæra* is so small, and whose inner surface is quite smooth and shows no special gland, can nevertheless give plenty of secretion; this fact is proved by the abundance of fluid, partly filling the bag, partly adhering to the branches of the terminal part, and also filling the corners between the base of the fin and the body; on the last-mentioned place it may be supposed to have flown from the foremost, larger, roundish opening of the appendix-slit.

I have not a quite clear understanding of the influence of the muscles of the appendix-shaft on the terminal part; however, I think it likely that by a contemporaneous action of both the said muscles a — probably rather slight — distension of the three terminal branches may be brought about, the *M. dilatator* acting on the medial branch, the *M. compressor* on the two others; by this action the continuation of the appendix-slit between the medial and the dorsal branch would be opened. That also here the *M. compressor* will serve for the pressing out of the secretion of the „glandular bag", seems to me to admit of no doubt.

As to the pelvic appendage (fig. 70, 71, p), to which nothing corresponding is found in the Plagiostomes, it is in *Chimæra* rather simple; its contour is tolerably spoon-shaped, and it bears on the surface that in the position of rest is turned ventrally (but which will accordingly be turned dorsally, when the organ is directed forward), a soft, loose, unpigmented or slightly pigmented dermal cushion, while the membranous skin of the opposite surface fits tightly to the skeleton. For moving this organ has only one muscle (fig. 69, m), by which it can be raised in such a way as to come out of its pouch[1]), when it is able to take hold with the toothed edge. This muscle is very powerful;

[1]) Comp. also Garman: On the Pelvis and External Sexual Organs of Selachians etc. Proc. Boston Soc. Nat. Hist. Vol. 19, 1876—78, p. 199.

as it has no antagonist, the resistance of the surrounding skin, and, I think, also the pressure of the abdominal muscles over the base of the pouch, must be regarded as the cause why the organ folds back and is hidden in the pouch, when the muscle *m* is relaxed. The way in which this muscle is attached, has been described more in detail by v. Davidoff (l. c. p. 479).

Callorhynchus antarcticus Lacép.

The appendices have been briefly mentioned by Duméril (l. c. p. 681) as follows: Ceux des Callorhynques .... consistent en des prolongements cutanés, enroulés de manière à former une paire de cylindres creux et irréguliers que soutiennent des cartilages flexibles ; the foremost pair of organs, which are enclosed in the pouch, and have here a far more complicated structure than in *Chimæra*, have been more particularly described. The same organs have later been mentioned, though still rather briefly, by T. Jeffery Parker, in a kind of preliminary note[1]), in which is found the rather bold hypothesis, that these anterior appendages in *Callorhynchus* are representing a middle pair of limbs , they being understood as serially homologous with the real appendices; thus *Callorhynchus* (and the *Chimæræ* in general) should (but to be sure only in the males!) show the remains of a hexapod stage . The real appendices (posterior claspers) are only mentioned with a few words to the effect that they correspond to those in the Plagiostomes, as they occur in the same position, have the form of a plate rolled longitudinally into a tube, and are supported by a prolongation of the basipterygium .

In a specimen (in the museum in Copenhagen) of a length of abt 70^{cm} I find the following measures:

The length of the (real) appendix from the fore edge of the cloaca	$8{,}5^{cm}$
The length of the terminal part	5^{cm}
The breadth across the base of the shaft	$1{,}7^{cm}$
- — — - middle of the terminal part	$0{,}8$—$0{,}9^{cm}$.

As to the habitus the appendix at a first glance reminds more of that in the Sharks than of that in *Chimæra*; but a closer examination shows a very near relation to the latter; it is only the terminal part not being split into branches, that causes the apparent resemblance to the Sharks; the shaft corresponds in shape quite to that in *Chimæra*, and is, as in this latter, covered with a thin, naked skin, through which the extension and form of the muscles may be distinctly discerned; on the terminal part there are, as in *Chimæra*, no muscles at all; but here the skin is everywhere thin, and is lying immediately over the skeleton, so that a reliable view may be got of the structure of this skeleton — unfortunately I could not skeletonize the only male specimen of the museum. The terminal part is somewhat dorso-ventrally flattened with rather parallel sides, only a little tapering towards the rounded end.

On the dorsal side the appendix-slit runs as a narrow slit, beginning, as in *Chimæra*, with a rather large opening at the base, close to the abdomen; this hole is supported by skeleton to the same extent as in *Chimæra*; from here the slit runs in a curve through the shaft into the terminal

[1]) Notes from the Otago University Museum, VIII On the Claspers of Callorhynchus. Nature, vol. 33, 1886, p. 635.

part, where it passes over the medial edge on the ventral side, and here it ends in the shape of an *S*; thus the whole slit is formed like a cork-screw. Immediately behind the hole the edges can only with difficulty be separated on account of the stiffness of the skeleton; but in the terminal part the slit is easily opened on account of the thinness of the skeleton, which is here like a thin, convoluted shaving, which may to a certain degree be unrolled. The inner, tubular hollow of the terminal part, as well as its opening at the point is completely stuffed with secretion, which also fills the hole at the base as well as the nooks between the appendix, the base of the fin, and the body.

Fig. 27.

Fig. 28.

Fig. 27. *Callorhynchus antarcticus.* The right ventral appendage from the ventral side; a little reduced. *ab* abdominal pore.

Fig. 28. The same from the dorsal side.

As to the skeleton, I think it pretty sure that in the shaft it is as in *Chimæra*; as we find a rather movable joint before the hole , the surroundings of which seem to be quite as in *Chimæra*, we may be justified in supposing the basale to end here; somewhat out on the shaft we find another, little movable joint; accordingly the piece b_1 is found between these two points; on the ventral side the distal border of this piece is distinctly marked by the cessation of the inmost part of the muscular mass of the glandular bag (the calf); the other part of the skeleton then must be the appendix-stem; this seems here to be formed like a convoluted leaf, in which no separation into branches is found; such branches, no doubt, would be discernible through the membranous skin, if lines of separation really existed (the only place where such a line of separation might perhaps be found, is along the lateral edge of the ventral side, where a longitudinal furrow in the skin is found in both appendices, but I can find no mobility along it, and take it therefore to be due only to the skin). If we imagine deep incisions in this cartilaginous leaf, the three-branched form in *Chimæra* might arise; on the other hand we may from the three branches in *Chimæra* (see pl. I, fig. 14, 15) easily reach the structure in *Callorhynchus* by imagining a coalescing on the dorsal side (fig. 14) of b^{**} and b^{***}, on the ventral side of b^{***} and b^{*} (fig. 15).

The muscular system, with regard to the appendix-shaft, is evidently as in *Chimæra*; *M. dilatator (D)* is easily recognised; its chief portion is situated dorsally (*M. adductor* v. David.), and originates on b_1 while the inner and ventral portion (*M. flexor* v. D.) also here arises farther forward on the basale, and does not reach so far backward; further the large muscle (*S*) of the glandular bag, which in no respects shows other relations than in *Chimæra*, with the only exception that is is a little shortened ventrally.

The foremost copulatory organs, the pelvic appendages, are very remarkably formed, and much larger than in *Chimæra*. The pouch in which they are hidden, is therefore also much larger; the entrance of this pouch forms, when closed, a longitudinal slit (abt. 2,5cm long), and is situated laterally, immediately before the ventral fin. The chief part of the organ enclosed in the pouch, corresponds to the »Sägeplatte«[1]) of the *Chimæra*; it is here more lengthened, with a longer »shaft« broadening in the free end to an obliquely cut off, rather thick plate; this plate is on its (when in the position of rest) ventral surface towards the edge invested with numerous, flat, sharp, comb-shaped dermal teeth, of which those nearest the edge are the largest. Each tooth is almost fan-shaped with the edge divided into 5—7 pointed comb-teeth, of which the middle one is the largest (comp. Duméril l. c. pl. 14, fig. 2, 2 a). The teeth continue, somewhat smaller, along the whole (dorso-) medial edge of the »Sägeplatte«; they are placed on a dermal lip, which is unsupported by skeleton (and borders the afterwards mentioned canal, into which a sound can be introduced). As far as I can see the teeth continue all the way to the attached base of the organ. The points of all these teeth are turned forward.

On the opposite surface (the dorsal one when in the position of rest) this »Sägeplatte« is provided with a rather curiously elaborate system of large dermal folds partly supported by an inner cartilaginous skeleton[2]). From the dorsal edge of the organ a large, folded dermal plate projects on either side. 1) The lateral one of these plates somewhat recalls a human ear, and is with its free edge folded towards the dorsal side of the »serrated plate«; the proximal part of this membrane is supported by a particular cartilage, while the distal part which is very much folded, has no inner skeleton. 2) Next another dermal leaf arises from the dorsal and lateral surface of the »serrated plate«, opposite to the former; it is folded the other way, and situated between the »serrated plate« and the first leaf; it has no skeleton. 3) The second dermal leaf projecting from the »serrated plate« towards the medial side, is anteriorly grown fast to the inner wall of the pouch; its free edge is folded in such a manner, that it forms a kind of bag; it contains no skeleton, but where it posteriorly is united with the lateral leaf (1) at the dorsal edge of the »serrated plate«, these two leaves, by a rolling of their common hindmost part, form a tube supported by a stiff cartilaginous skeleton; the free end of this skeleton projects some way past the end of the »serrated plate« (cp. the figure of Duméril). A sound inserted into this tube, can be brought far into a deep, dorsally open canal along the dorsal edge of the »serrated plate«; on the medial side the bordering of this canal is formed by the above mentioned teeth-covered dermal lip. 4) Finally a big, white, ovate body projecting from the medial wall of the pouch, is found outside the bag formed by the inner dermal leaf (3). This evidently is a glandular body[3]), the opening (or rather openings) of which seem to be inside the bag formed by the inner leaf (3), in the foremost, inner corner of this bag. From this gland proceeds the very abundant secretion filling the space between the »serrated plate« and the described elaborate dermal folds, as also the peculiar tube, evidently the excretory duct for this secretion. As

[1]) As far as I have been able to determine without dissection, this part in the specimen in hand has a length of ca. 3,5^{cm}, a breadth of ca. 2^{cm} across the broad terminal part.

[2]) Only the cartilaginous skeleton has been rendered — and scarcely quite completely — in the mentioned figure by Duméril, as also this skeleton only is mentioned in the text (l. c. p. 682); this work, therefore, gives only a very incomplete idea of the whole organ; the same may also be said of the short communication by Parker in »Nature«; upon the whole it is very difficult, without drawings and dissection, to give a tolerably clear survey of these complicated structures.

[3]) Parker evidently has also seen this glandular body: »In connection with the sac is a gland secreting a lubricating fluid, and closely resembling the well-known gland of the Elasmobranch claspers« (which gland, however, is not found in all Elasmobranchii). To this is added the interesting observation: »In the female, although the clasper itself is absent, a small glandular sac occurs in the corresponding position«. Garman (l. c. p. 200) has, earlier than Parker, seen the gland, and given a very short and incomplete description of the pelvic appendages. He thinks that the above described cartilaginous tube serves for conducting the secretion into »the groove of the penis« (i. e. the appendix-slit), »when it is turned forwards, and through the latter the fluid is conveyed to the oviducts of the female«. The supposed turning forward of the appendix,

to the signification of this secretion as well as to the use of the whole organ we can only form rather vague conjectures.

Of the mobility and muscular system of the pelvic appendage Parker gives the following information, showing that the same muscle is found here as in *Chimæra*: The Clasper is exserted by the action of a strong muscle arising from the inner face of the pubic cartilage and passing over its anterior border to be inserted into the principal cartilage (the serrated plate) of the clasper. The plane of movement of the organ is nearly horizontal .

3. Which is the Function of the Appendices Genitales?

That the ventral appendages are peculiar to the males of the Chondropterygians is an old and widely known fact — they have already been mentioned by Aristotle[1]), and at the present day most fishermen distinguishes the male from the female by means of them[2]). Everybody then agrees that these organs in some way or other subserves the copulation; but till recently we have had no real observation of the copulation of Chondropterygians[3]), and we have therefore been obliged to form our opinion of the use of these organs from their structure. Many authors — Rondelet[4]), I think, as the first — have thought the appendices only to be organs for clasping the female during copulation, and therefore names as Holders , Claspers , Haftorgane , Halteorgane , Klammern , and the like have been generally used; as a consequence of this idea they have always, I think, been considered to act as a kind of prehensile organ, which might cling to some part of the body of the female outside, and thus hold it fast[5]). Others, on the contrary, have supposed that these organs have to be introduced into the sexual organs of the female; but their action there has been interpreted in several ways. Almost all the earlier authors, as Linné, Artedi, Willughby (Ray), Klein, Battarra, Gunnerus have thought that they convey the sperm, and called them *Penes*, *Mentulæ*, or *Membra genitalia*, and with regard to their existing in pairs, some of those authors refer to the Snakes, which analogon also seems to be rather obvious. After the appearance of the works by Bloch, the first-mentioned idea of the appendages as mere external clasping organs gained many

however, cannot take place, and so the whole supposition has to be dropped. Garman does not mention the structure of the appendix itself.

1) Ἱστορίαι περὶ ζῴων. Ed. by Aubert and Wimmer. Leipzic 1868, vol. I, p. 455, Chap. V, 5, § 15.

2) Lorenzini (Osservazione intorno alle Torpedine, 1678), who, it would seem, has only known the appendages in the Rays, declares that they may be found in both sexes. He says nothing of their function. This misconception — that they are also to be found in the females — recurs oftener. I think the assertion by A. Fritsch, that in the Xenacanths the old females are also provided with appendages, to be not better founded. (In Bashford Dean: Fishes living and fossil [Columbia Univ. Biol. Series, III] 1895, a figure is found on p. 73, representing General Anatomy of shark ( ) , and this is provided with claspers !).

3) The lively description by La Cépède (Histoire naturelle des Poissons, T. I, p. 254—55) of a copulation between two Sharks, is evidently not founded on observation. His description and construction of the appendices (l. c. p. CXLIII, p. 70, p. 273) are based on the essays of Bloch.

4) Libri de piscibus marinis, 1554, Lib. IIII, p. 89: Mares cartilaginei fere omnes circa podice appendices duas habent quibus coire creduntur. At ego illas sæpe multumque contemplatus, non video quo pacto his coire illi possint: potius igitur ad retinendas foeminas factas esse arbitror .

5) This is decidedly said by Bloch (Schr. Berl. Ges. vol. 6, pp. 379, 384), whose excellent representation seems to have influenced very many authors; further by Home (Phil. Tr. 1809, p. 207, and 1810, p. 206), by Cuvier & Valenciennes (Hist. nat. des Poissons P. I, p. 536), by Treviranus (Tiedemann u. Treviranus Zeitschr. für Physiologie vol 2, 1828, p. 9 [in the explanation of the figures]), by Duméril (l. c. p. 241), and others.

adherents, but the notion that they are real penes, i. e. organs conveying the semen, seems never to have been fully superseded by it; Blainville advocates this opinion[1]), and later we find it in Mayer[2]), in Leydig[3]), Stannius[4]), Steenstrup[5]), L. Agassiz[6]), Davy[7]), and (partly) Günther[8]); this opinion, after all, is perhaps to this day the most widely spread; it is also rather obvious, and analogies from other groups of animals present themselves, as it were, spontaneously[9]). This interpretation of the appendages as the direct conveyers of the semen, however, meets with difficulties, which partly have been correctly seen by several authors; some of those then have adhered to the opinion that they are introduced into the cloaca of the female, but only to be more indirectly subserving the copulation. Thus Geoffroy St. Hilaire[10]) characterizes them as clitores, and Petri[11]) thinks their chief

[1]) l. c. p. 126. Blainville promises a treatise on „la structure et les usages de ces appendices dans les raies et les squales", in which he even thinks to have found a connection with the sexual organs proper, what he had not been able to do in „le Squale pélérin".

[2]) Über die Bedeutung der fussförmigen Anhänge bei Rochen und Hayen, und ihr Wiedervorkommen bei niederen Thieren. Frorieps Notizen aus dem Geb. der Natur- und Heilkunde, vol. 40, 1834, p. 273. Mayer supposes that these „limbs" by the *Musculi adductores* are brought to the cloaca, receive the semen into the appendix-slit, and convey it on to the terminal part, the opened leaves of which „wie ein Blumenkelch" embrace the cloaca of the female; further he imagines that the copulating animals „wahrscheinlich von einander abgewendet sich befinden" (Petri l. c. p. 291 renders the description by M., but in more respects incorrectly).

[3]) l. c. p. 86. „Die sogenannten Haftorgane erinnern in ihrer gewundenen, rinnenförmigen Gestalt sehr an die äusseren Begattungsorgane mancher Krebse und ich glaube, dass sie ebenso wie diese zum Überpflanzen des Samens nach den weiblichen Geschlechtstheilen dienen, wobei dann das Sekret der oben beschriebenen Drüse eine vielleicht die Samenmasse einhüllende oder schützende Rolle spielt".

[4]) Handbuch der Anatomie der Wirbelthiere, 2 Aufl., 1854, I, p. 278, note 5.

[5]) Hectocotyldannelsen hos Octopodslægterne Argonauta og Tremoctopus. Kgl. D. Vid. Selsk. Skrifter, 1856, p. 26. „I think, however, ... the analogon to be as obvious, which is found in so many males among the decapod Crustacea, in which a pair of the abdominal limbs are formed as more or less complete tubes, or the analogon, seen in the male Rays and Sharks, where the ventrals, that is to say, active organs of motion, have one side transformed into large ducts of the semen."

[6]) 1) Proceedings of the Boston Society of Nat. Hist. Vol. VI, 1856—59, p. 377. 2) Ibid. Vol. XIV, 1871, p. 339. In the first-mentioned place is only found a report of some observations by Agassiz occasioned by a lecture on the egg-development in Rays; he thinks the „claspers" of the Rays to be real copulatory organs, supposing them to be turned forward and upward, by which turning „an opening in them" (the larger basal opening of the appendix-slit?) is brought up to the spermatic ducts; it is supposed that they may easily be introduced into the oviduct even to the shell-gland. In the later communication (2) this is more particularly worked out: One ray of each posterior fin is capable of erection and rotation, and is covered with erectile tissue, far too delicate to allow it to be used as a clasper around a body covered with sharp rough spines. In the act these two organs are rotated inward and forward, bringing the furrows on their inner surface into parallel contact, and in apposition with the testes. Being then introduced into the body of the female, their extremities diverge in the two oviducts, and the *glans* being uncovered exposes a sharp cutting instrument, which would injure the organs of the female if she resisted; the male has her, therefore, in complete subjection, and has been observed to strike and wound her with this spine. What was formerly supposed to be the penis is too small, and of insufficient length to accomplish fecundation (viz. the urogenital papilla). The penis consists of the two long flexible finger-like fins, furnished with two projectile spinous appendages as in vipers. (In *Chimæra* the surfaces of the organs are also spinous, as in snakes). The two spines found in cartilaginous fishes are homologous with the *os penis* of mammals. In men this bony part has disappeared, and we have only the soft spongy portions of the organ remaining; the quivering of the legs during connection seems the echo, as it were, of the sensitiveness of the flexible posterior limbs of the skates (!). — As the thought of a comparison with the Snakes cannot be said to have been exactly new at that time, so it is also the case with the „homology" with the „*os penis*"; it is already found in Ray (Willughby: De Hist. Pisc. etc. 1686, p. 77). Garman, l. c. p. 199—200, subscribes the opinion of Agassiz.

[7]) Already l. c. 1839, p. 149; more decidedly in: Fragmentary Notes on the Generative Organs of some Cartilaginous Fishes (Trans. Roy. Soc. Edinb. 1861; vol. 22, p. 500).

[8]) Introduction etc. p. 167. Günther also supposes that the two appendices by being put together may form one canal; he thinks it to be possible that the appendix-slit leads as well the secretion of the glandular bag as the sperm.

[9]) Besides to the palps of the Araneina, the thought will easily be led to the limbs that in the Crustacea, especially the Decapoda, have been developed for serving the copulation; not only Leydig and Steenstrup, as has been shown by the above quotations, but also Mayer have thought of these; several other analogies indicated by Mayer are rather distant (even if they be not all so distant as those, attributed to M. by Petri: the thumb-swellings in the frogs, the spur of the Ornithorhynchus — which analogies I have not at all been able to find mentioned in M.).

[10]) According to Petri; I have not been able to find the essay in question.

[11]) l. c. p. 330. The secondary function, which Petri (in accordance with Bloch) ascribes to them: to serve as an organ of motion making the males more mobile than the females — especially in the Rays — may surely, to say the least of it, be characterized as problematic.

employment to be to act as a kind of "dilators" of the sexual organs of the female; he imagines them to be introduced until the mouth of the oviduct, whereupon the *M. dilatator* dilates the terminal part, so that the bore of the oviduct is enlarged, and the male also is enabled to draw the female nearer to itself, in such a manner that he can with his urogenital papilla reach into the cloaca of the female, and there discharge the sperm, which from there more easily may penetrate into the mouths of the oviducts that have been dilated by the appendices.

None of the mentioned authors have been able to found their opinions on any observation of the copulation[1]. Only of late we have one, as it would seem, reliable observation, communicated by Bolau[2], by which at all events it may be regarded as an established fact that the appendix is really introduced into the genitals of the female. This observation applies to *Scyllium stellare (catulus)*, and is made in the aquarium of the zoological garden in Hamburgh. Before the copulation the male for about a day kept near the female, and pursued her, but it was not observed in what manner he seized her. During the copulation the female is encircled by the male, the latter, as it were, twisting round her cross-wise; only one appendix, it would seem, is introduced at each copulation, and this appendix, judging by the very incomplete sketch given by Bolau, (l. c. p. 322, fig. 2) must also after the act be somewhat dilated. The copulation itself lasted in two observed cases 20 minutes. Bolau follows Petri with regard to the interpretation of the part played by the appendix on this occasion; but he adds that he is not able to decide, whether the appendix-slit[3] plays a part by the conveying of the semen.

This observation, as far as I know, stands hitherto quite alone; it seems to me to be of no small interest, although it decides nothing with regard to the most important question, whether the appendix really conveys the semen or not. As to this question we are still reduced to draw our inferences from the structure of the organ. This structure seems to me to show with complete certainty that at all events the appendix-slit cannot be the duct of the semen; it is situated in such a way, that it is impossible to understand how the sperm should get into it and follow it, as it, as we have seen, is situated dorsally and laterally, sometimes (for inst. in the Skate) quite laterally; the ventrals are not able to perform a movement of such a nature as to make the foremost opening

[1]) Davy and Agassiz, however, — as also several of the earlier authors (for inst. Rondelet) — have known the following remark in Aristotle, which might be indicative of some observations really having been made in antiquity: εἰσὶ δέ τινες οἵ ἑωρακέναι φασὶ καὶ συνεχόμενα τῶν σελαχῶν ἔνια ὄπισθεν ὥσπερ τοὺς κύνας (l. c. 5, chap. 5, § 1). In his last communication (1861, p. 500) where Davy rather decidedly declares in favour of construing the appendix as a "penis", he mentions some circumstances supporting the notion of an "intromission", derived from *Centrina*, as for inst. that the cloaca of the female is large enough to receive the appendix, that it appeared "slightly lacerated at its superior commissure", and that the mouths of the uteri protruded, and were red and blood-filled. Garman (On the Skates (*Rajæ*) of the Eastern Coast of the United States. Proc. Boston Soc. Nat. Hist. Vol. XVII, 1874, p. 171), who, as mentioned, subscribes the opinion of Agassiz, to whom he attributes "the credit of the discovery of the functions of the claspers", has observed "a fact that adds a little emphasis to his (A.'s) discovery" viz: that in virginal Sharks the hindmost end of the oviduct is closed as by a kind of hymen (comp. also Semper: Das Urogenitalsyst. der Plagiost. Arb. Zool.-Zoot. Inst. Würzb. vol. 2, 1875, p. 279), or provided with a very small pore; this pore is round in the species of which the male has tapering "claspers", and forms a short, horizontal slit in those where the claspers are flat with rounded ends; in the species where the appendix has sharp edges and hooks, the hindmost part of the oviduct and the cloaca is very thick and leathery. In virginal *Mustelus* the oviducts were furthermore found stretching along the dorsal side of the cloaca to a point at the middle of the anus; in grown, impregnated specimens they are open, as if an inch or more had been cut off of the end, and the rectum opens in the cloaca between their openings and the outer one.

[2]) Über die Paarung und Fortpflanzung der *Scyllium*-Arten. Zeitschr. f. wiss. Zool. vol. 35. (1881, p. 321.

[3]) He wrongly places the appendix-slit on the inner side of the organ, and its partly closed state in *Scyllium* seems unknown to him.

of the slit approach the cloaca of the animal itself (as supposed by Agassiz [and Garman]); neither can a turning round the longitudinal axis be effected (least of all a turning of 180°, as would be required in the Skate), and thus any thought of a putting together of the slits of the two sides to form a tube (Agassiz, Günther) has to be dismissed (quite apart from the fact that in some forms — *Scyllium, Pristiurus* — the appendix-slit is closed for a long way by coalescing). A putting together of the medial sides of the two appendages may however easily be effected by the *Musc. adductores*, but by this no convenient way for the sperm would be formed; and the observation of Bolau shows moreover that in *Scyllium* only one appendix is used at a time; for the present it may, however, be disputed, whether this is a universal law in all cases and in all other Selachians. Thus it seems that the tubular, or rather semi-tubular form of the appendix cannot directly have anything to do with the transferring of the semen; the most immediate purpose of this form evidently is the transportation of the gland-secretion.

On the other hand the structure of the appendix shows with still greater certainty — quite apart from the observation by Bolau — that the appendix cannot be used for externally clasping the female. For a great part, I think, it is the hooks, claws, or thorns, so often projecting through the skin of the terminal part that have caused or supported this supposition. But an attentive observation of the position and way of moving of these firm parts, as also of the whole constitution of the terminal part, might, as it seems to me, rather easily have persuaded the many adherents of the theory of these organs as "claspers", or "Klammerorgane", that they are only ill adapted for such a purpose. The skin of the whole terminal part is, as we have seen, often quite naked and soft (the point itself is always so), and the appendix would therefore — as has been correctly pointed out by Agassiz — be badly off with regard to the rough surfaces, with which in most cases it would have to do, and against which it would only be slightly protected by the secretion (Bloch; this secretion would rather be a hindrance for the clasping, as is also remarked by Davy). In the *Raja*-species the hard skeletal parts whose business would be to hold fast the female, only appear within the dilated terminal part, and are wrapped by a specially vulnerable skin, very much like a mucous membrane; consequently, if these parts were to hook on — for which their special shape is in no way adapted — for inst. to the thorny tail of the female Ray (Cuvier & Valenciennes, Duméril), their most immediate surroundings would be much exposed to injury; and if we choose to regard such appendages as those in *Acanthias*, *Somniosus*, or above all *Spinax*, which, by the hooks, thorns, or claws projecting freely through the outer skin, may for a superficial examination convey the impression of being plain prehensile organs (the dilated terminal part of *Spinax* reminds not a little of a bird's foot!), then any closer examining will show that they cannot be such: the position of these claws is always so, that they cannot catch an object, or clutch it. Besides their movement inward, against each other, when the terminal part is closed, always takes place with small force, by elastic reaction of the connecting soft parts, only to a small degree (and not in all cases) somewhat assisted by muscular action. The erection of these parts on the contrary, when the terminal part is opened by means of the always powerful *M. dilatator*, can take place with great force, and they may with force be kept spread out. I think therefore that there can be no doubt, but that Davy has had an eye for the correct fact (although the Rays especially examined by him, do not present the fact so clearly by far, as do *Acanthias* or *Spinax*), when he supposes the appendices to be organs for intromission and retention like the Penis of the Dog; only in a hollow these spurs, thorns etc., can be of importance as retentive organs; it is quite evident that they are barbs that are kept stiff, as long as the dilation of the terminal part lasts. Viewed in this way the dermal teeth on the terminal part in *Scyllium*, *Pristiurus* (and *Chimæra*) will also get importance, they being placed with their points towards the base of the fin and raised by the dilation; they will also — although to a less degree — act as barbs. When the dilation ceases, all these barbs — large and small — are laid, and thus they present as small resistance as possible by the extraction from, as well as by the introduction into a hollow. That the object is that they may be introduced and extracted without resistance, is very finely shown in some instances; this, above all, applies to the hook (*Td*) in *Acanthias*; in the position of rest it fits so elegantly into the spoonlike ventral terminal piece (*Tv*) as to remind of a surgical instrument[1]). All the appendices are moreover adapted for being thickly smeared with the viscid secretion of the glandular bag, and accordingly being made smooth, by which an introduction into a relatively narrow hollow may be highly facilitated.

I think then that the structure of the appendix shows quite indisputably: 1) that this organ is intended for being introduced into a hollow, and 2) that it is able to fix itself in this hollow by the dilation of the terminal part. In this way — but only in this way — the appendix becomes an organ of retention during copulation. It would a priori be the only reasonable supposition, that the hollow of which the question here can be, must be the genitals of the female; by the observation of Bolan this supposition has been made a certainty, and this gives to his observation its special importance. My opinion then is, that at all events it may be put down as certain that the ventral appendages during copulation serve as retentive organs in the genitals of the female[2]). But this can scarcely be their only function. My opinion is that they must have several functions, among others to awaken the sensuality, and furthermore to open (or at all events to widen) the mouths of the oviducts in virginal females, and thus secure impregnation and facilitate the parturition; and though I cannot imagine that the appendix-slit should form a duct for the sperm, I still think it probable that the appendages in some way or other subserve the conveying of the semen, so that it is not conveyed by means of the urogenital papilla of the male alone. And I also suppose that the secretion of the glandular bag subserves this object. As we have seen, the secretion is in all appendices not only evacuated through the hind end of the organ, in the terminal part, but also in all instances through the opening at the base of the organ, and thus not only the genitals of the female and the appendix itself, but most likely the whole immediate surrounding of the cloaca in both the copulating animals will be lubricated by the secretion. The consequence of this will be that the sperm will easily be mixed with the secretion, and it may readily be supposed that this mixing may have a stimulating influence on the spermatozoids, or act as gathering and conveying

[1]) Gegenbaur, who does not at all mention the function of the appendix, says of these parts in *Acanthias* (l. c. p. 452): "Das Verhalten beider Stücke ähnelt den verdeckten Haken, wie sie als chirurgische Instrumente gebraucht werden".

[2]) The old, before quoted observation in Aristotle gains by this view very much in trustworthiness: "There are those who assert that they have observed that some of the Selachians hang together behind like the Dogs"; and it lies near to suppose that it is this kind of "hanging together", that is suggested by Pennant (Brit. Zoology New. Ed. 1812, Vol. III, p. 112) of the Skate: "....several of the males pursuing one female; and adhere so fast during coition, that the fishermen frequently draw up both together, though only one has taken the bait".

the semen, preventing it from flowing off in the water. Then the part played by the secretion, would not be restricted to facilitating the introduction of the appendix — which part I regard as quite incontestable —, and to protect the different parts partaking in the copulation (eventually also the outer skin) against a severe friction; but the secretion would also be of direct importance for the impregnation by yielding a means, as it were, of keeping together the semen and leading it along the appendix into the oviduct.

It must be possible to some degree to test this supposition by examining the way in which the spermatozoids act in relation to the fresh secretion; but unfortunately I have had no opportunity for that[1]. For the present I must leave the value of this and my other suppositions to the testing of others, and own that I have only been able to advance the understanding of the functions of the ventral appendages very little; most of the questions raised by the different, rather complicated structures, especially in the terminal part, must still be left quite unanswered, as also such facts as the large extent of the glandular bag in most Sharks must still appear mysterious[2]. With regard to some of these questions it may be dubious, whether they ever will be solved; but with regard to others, especially the question of the appendages as means of the conveying of the semen, it would seem that they might be solved by observations. It is to be hoped that the future will bring such observations.

Addenda.

I have been unwilling in this translation to make any essential alterations of the original Danish text. This latter was ready printed in August 1898. I regret to say that shortly after I saw that I had quite overlooked a short, but rather essential contribution by A. Schneider to the question of the function of these organs; it is only little more than half a page, and is printed in »Zool. Beiträge» vol. I, 1885, p. 61[3]. In this contribution he says of the glandular bag: »Dieser Sack hat jedoch noch eine andere bisher ganz übersehene Function. Er ist ein Receptaculum seminis, Ich habe bei *Spinax Acanthias* Samen darin gefunden. Die Begattung dürfte deshalb bei den *Plagiostomen* in der Weise stattfinden, dass zuerst das Receptaculum seminis mit Samen gefüllt wird und von da aus mit Hülfe des in den Uterus eingeführten Pterygopodium die Immissio seminis stattfindet. Bei

[1] Hitherto only very little is known of the chemical relations of this secretion. Davy (l. c. 1839, p. 145) says it is neither acid nor alkaline, and that it has a very indistinctly acrid after taste. Moreau, on the contrary, declares it to be acid (l. c. p. 258); this, however, can scarcely be correct, as in this case it would have a bad influence on the spermatozoids with which it will scarcely avoid to come into contact.

[2] For those, who are of opinion that Agassiz has solved the question of the function of the appendages correctly, these bags, perhaps, will not appear quite so mysterious; Garman, for inst. says (Proc. Bost. Soc. 1874, p. 173): «That the cavity upon the ventrals, containing the muscular gland, fills so readily with the sperm when the claspers are erected, and that its contents are expelled, upon contraction of the muscles around it, with such certainty to their ends, when restored to their normal position, are evidences that it acts as a forcing or squirting apparatus». I must, however, object against this 1) that I cannot see that the sperm upon the whole can be filled into the bag, still less, that it can be done easily; and 2) that spermatozoids never have been found in the glandular bag, although its contents have several times been subjected to microscopical examination, also with the object of seeking spermatozoids in them.

[3] As it is reported in »Biol. Centralbl.» vol. III, 1883, no. 7, p. 224, this contribution to the »Beiträge» must have appeared two years before the completing of the said volume.

den *Holocephali*, *Callorhynchus* und *Chimæra* besitzt das Männchen vor dem Pterygopodium jederseits einen sehr verwickelt gebauten Apparat. Derselbe besteht aus einer Tasche, in welcher mehrere, Knorpel enthaltende, mit Widerhaken versehene Stücke hervorgestreckt werden können. Ich fand diese Tasche bei *Callorhynchus* mit Samen gefüllt. Auch bei dieser Gruppe der Elasmobranchier wird demnach der Samen vor der Begattung nach aussen gebracht. Wie freilich hier die Begattung stattfinden wird, lässt sich vorläufig nicht angeben. The essential thing is that Schneider declares to have found sperm in the bag in *Acanthias* and in the pouch of the pelvic appendages in *Callorhynchus*; certainly no proof is given, but we shall have to suppose that Schneider has really found the spermatozoids. Whether these have been numerous, that is to say, whether the bags in question really can be said to have been filled with the semen, of this we know nothing with certainty, and we can — in my opinion — not yet in any way put it down as an indubitable fact that the glandular bag of the Plagiostomes is a reservoir that has to be filled with the semen and by the copulation to eject it. Nothing is said of the way, in which the filling of the bags in question should take place.

I have unfortunately not been able to get a paper by Haswell (Notes on the claspers of Heptanchus. Proc. Linn. Soc. N. South Wales. vol. 9, P. 2, p. 381).

During the time between the appearing of the present essay in Danish and this translation I have received a paper by H. C. Redeke (Onderzoekingen betreffende het Urogenitaalsystem der Selachiers en Holocephalen. Acad. Proefschrift etc. Helder 1898) in which (p. 77) after a representation of what till then was known regarding the appendages and their function, the author declares that he has himself found numerous spermatozoa in the mixipterygoid bag [1]) in one single specimen among many examined specimens of *Mustelus vulgaris*. He calls, however, attention to the fact that the bag was not filled, which fact he explains by supposing, either that the animal during its agony might have emptied the bag, or rather that these animals will copulate, as soon as the bag is filled. An observation by another observer, respecting a male *Raja clavata* that had ejected an abundance of semen through the dilated appendices, can scarcely be regarded to be of any value, as there is no proof to the effect that the ejected fluid in reality was semen and not the secretion from the gland. Finally is quoted an observation by Professor M. Weber, which observation the author thinks may be used to explain, in what manner the filling of the glandular bag might be brought about. I shall give the proper words of the author, and else abstain from advancing my strong doubt of the fact: Deze (Prof. Weber) nam waar, hoe een groote Rog (*Raja clavata*) rondzwemmende in een der bassins, plotseling een groote wolk, vermoedelijk sperma, loosde en vervolgens, misschien reflectorisch, heftig met zijn mixipterygien begon te zwaaien, die daarbij een pompende beweging schenen uit te voeren. Het is niet onmogelijk, dat ook in de natuur, al is de omweg een allerzonderlingste, het sperma eerst in een groote hoeveelheid geloosd en gelijktijdig door de mixipterygien in den zak opgezogen wordt.

[1]) The appellation of Mixipterygium, which has of late often been used in stead of the objectionable Pterygopodium of Petri, is due to Gegenbaur (Das Flossenskelet der Crossopterygier etc. Morph. Jahrb. vol. 22, 1895. p. 136, note 1).

EXPLANATION OF THE FIGURES.

A: *Musculus adductor.*
af: The appendix-slit.
B: The basale metapterygii.
b: The appendix-stem.
b_1, b_2, b_3, b_4: The stem-joints between the appendix-stem and the basale.
β: The dorsal stem-piece.
D: *Musculus dilatator.*
d, d_1, d_2, d_3: Dorsal covering pieces.
da_1, da: Terminal pieces belonging to the ventral side (in some *Raja*-species).
E: *Musculus extensor.*
g: The end-style, the uncalcified end of the appendix-stem.
h: Horny filaments.
O, O': Fin-muscles arising from the body.
P: The pelvis.
R: Marginal ray.
r: Rays.
Ra: Ray-muscles.
Rd: The dorsal marginal cartilage.
Rd': Process from the dorsal marginal cartilage (in *Raja*-species).
Rd_2: A special terminal piece, added to the dorsal marginal cartilage.
Rv: The ventral marginal cartilage.
S: *Musculus compressor.*
s: A ligamentous septum, serving for attaching part of the *Musc. adductor.*
Td, Td_2: Dorsal terminal pieces.
Tv, Tv_2, T_3: Ventral terminal pieces.
v, v': Ventral covering pieces.

Plate I.

Fig. 1—9. *Somniosus microcephalus.*

Fig. 1: The skeleton of the right ventral, viewed from the dorsal side; considerably reduced.
— 2: The chief piece of the right appendage, viewed from the dorsal side; reduced. l the lateral surface; x articular surface for attaching the piece β.
— 3: The same skeletal part, from the ventral side.
— 4: The dorsal terminal piece, Td, from the dorsal side.
— 5: The same piece, from the ventral side.
— 6: The ventral terminal piece, Tv, from the dorsal side.
— 7: The same piece from the ventral side.
— 8: The "thorn" or "spur", T_3, from the dorsal side.
— 9: The same, from the ventral side.

Fig. 10—11. *Acanthias vulgaris.*

Fig. 10: The skeleton of the right appendage, from the dorsal side; natural size.
— 11: The same skeletal part, from the ventral side.

Fig. 12—13. *Spinax niger.*

Fig. 12: The skeleton of the right appendage, from the dorsal side; a little enlarged.
— 13: The same, from the ventral side.

Fig. 14—15. *Chimæra monstrosa.*

Fig. 14: The skeleton of the right ventral, from the dorsal side; natural size. x process on the piece b_1; b^*, b^{**}, b^{***} the medial, dorsal, and lateral branches af the appendix-stem.
— 15: The same skeletal parts, from the ventral side.

Plate II.

All the figures represent the skeleton of the appendage of the right ventral fin (or parts of it).

Fig. 16—17. *Scyllium canicula.*

Fig. 16: The skeleton of the appendage, from the dorsal side; natural size.
— 17: The same, from the ventral side.

Fig. 18—19. *Scyllium stellare.*

Fig. 18: The appendage, from the dorsal side; natural size.
— 19: The same, from the ventral side.

Fig. 20—21. *Pristiurus melanostomus.*

Fig. 20: The appendage, from the dorsal side; natural size.
— 21: The same, from the ventral side.

Fig. 22—23. *Lamna cornubica.*

Fig. 22: The appendage, from the dorsal side; much reduced.
— 23: The same, from the ventral side.

Fig. 24—27. *Rhina squatina.*

Fig. 24: The appendage, from the ventral side; reduced.
— 25: The distal end of the same, from the dorsal side; * indicates the place where the terminal piece T_3 ends, hidden in the ventral marginal cartilage *Rv*.
— 26: The same part, from the ventral side; the covering piece *v* removed.
— 27: The terminal pieces *Tv* and T_3 figured separately.

Plate III.

All the figures represent the skeleton of the appendage of the right ventral fin (or parts of this skeleton).

Fig. 28—31. *Torpedo marmorata.*

Fig. 28: The distal end of the appendix-skeleton, from the dorsal side; about natural size.
— 29: The same; the covering piece *v* removed.
— 30: The same, from the ventral side.
— 31: The same, from the ventral side; the covering piece *v* removed.

Fig. 32—34: *Narcine sp.*

Fig. 32: The appendage, from the dorsal side; somewhat enlarged; the covering piece *v* removed.
— 33: The same, from the ventral side.
— 34: The covering pieces *v* and *v'*, from the dorsal side.

Fig. 35—37. *Rhinobatus columnæ.*

Fig. 35: The appendage etc., from the dorsal side; about natural size; the covering piece *v* removed.
— 36: The same, from the ventral side.
— 37: The terminal point of the appendage, with the covering piece *v*, from the ventral side.

Fig. 38—40. *Trygon violacea.*

Fig. 38: The appendage etc., from the dorsal side; about natural size; the covering pieces *v* and *v'* removed.
— 39: The terminal part of the same, from the ventral side, with the covering pieces *v* and *v'*.
— 40: The appendage from the ventral side; the covering pieces removed.

Fig. 41—44. *Raja circularis.*

Fig. 41: The terminal part of the appendix-skeleton, from the dorsal side; natural size.
— 42: The appendage from the dorsal side; the covering piece d_3 and the terminal piece T_3 removed.
— 43: The terminal part of the same, from the ventral side.
— 44: The appendage, from the ventral side; the covering piece and the terminal piece T_3 removed.

Plate IV.

All the figures represent the skeleton of the appendage of the left ventral fin (or parts of this skeleton).

Fig. 45—48. *Raja batis.*

Fig. 45: The terminal part of the skeleton of the appendage, from the dorsal side; considerably reduced; the covering piece *d* and the terminal piece T_3 removed; *x* a calcified part of the end-style *g*.
— 46: The same, from the ventral side; all the pieces present.
— 47: The same, from the ventral side; the covering piece and the terminal piece T_3 removed.
— 48: The dorsal covering piece, *d*, seen from the dorsal side.

Fig. 49—52. *Raja clavata.*

Fig. 49: The appendage with all its pieces, viewed from the dorsal side; considerably reduced.
— 50: The same, from the dorsal side; the covering piece *d* removed.
— 51: The same, from the ventral side, with all the pieces present.
— 52: The same, from the ventral side; the covering piece *d* and the terminal piece T_3 removed.

Fig. 53—57. *Raja radiata.*

Fig. 53: The skeleton of the appendage with all its parts, from the dorsal side; reduced; *x* thickened and calcified part of the end-style *g*.
— 54: The same, from the dorsal side; the covering pieces d_1—d_3 removed.
— 55: The same, from the ventral side; all parts present.
— 56: Part of the dorsal wall of the appendix-slit, viewed from the ventral side; the ventral marginal cartilage and all the terminal pieces of the ventral side, as well as the covering pieces removed. *Rd'* is here an independent piece.
— 57: The terminal part of the ventral marginal cartilage with the terminal pieces *Tv* and Tv_2, separated from the other skeletal parts, and viewed from the dorsal side (i. e. part of the internal side of the ventral wall of the appendix-slit).

Plate V.

All the figures represent the right ventral fin.

Fig. 58—62. *Somniosus microcephalus.*

Fig. 58: Ventral fin, viewed from the ventral side, of a young specimen, 2^m 50^{cm} long; considerably reduced.
— 59: Part of the same ventral fin, viewed from the dorsal side and a little turned.
— 60: Part of the ventral of a large specimen, seen from the ventral side; considerably reduced. The terminal parts, with the exception of part of the spur T_s, covered by aponeurosis.
— 61: The same, from the dorsal side; part of the dorsal ray-muscles, *Ra*, removed, as well as part of the muscular portion *O* arising from the body; *a* aponeurosis of the *Musc. extensor E.*
— 62: Part of the same, showing the muscles of the appendix, after removing the *Musc. extensor E.* the muscular portions *O* and *O'* (comp. fig. 59), as also part of the glandular bag (comp. fig. 61).

Fig. 63—64. *Acanthias vulgaris* ♀.

Fig. 63: Ventral fin from the ventral side; natural size.
— 64: The same from the dorsal side; most of the muscles arising from the body removed.

Plate VI.

The figures, except fig. 67—68, represent the right ventral fin.

Fig. 65—66. *Scyllium stellare.*

Fig. 65: The ventral fin from the ventral side; somewhat reduced; the greater part of the glandular bag *S* removed; a_1, a_2 special muscles of the appendix; *f* the winglike process.
— 66: The same, from the dorsal side; *af* the basal opening of the appendix-slit.

Fig. 67—68. *Raja clavata.*

Fig. 67: The left ventral fin, from the dorsal side; considerably reduced; the terminal parts covered by the aponeurosis.
— 68: The same, from the ventral side.

Fig. 69—71. *Chimæra monstrosa.*

Fig. 69: The right ventral fin, from the ventral side; a little reduced; the skin on the branches of the terminal part not removed; b^* the medial terminal branch, b^{**} the dorsal one, b^{***} the lateral one; *p* the »serrated plate» covered with its skin.
— 70: The same, from the dorsal side; *m* the muscle of the »serrated plate»; *x* process on the piece b_1.
— 71: Part of the same, from the ventral side; the ventral portion of the *Musc. adductor*, *A* in fig. 70, removed.

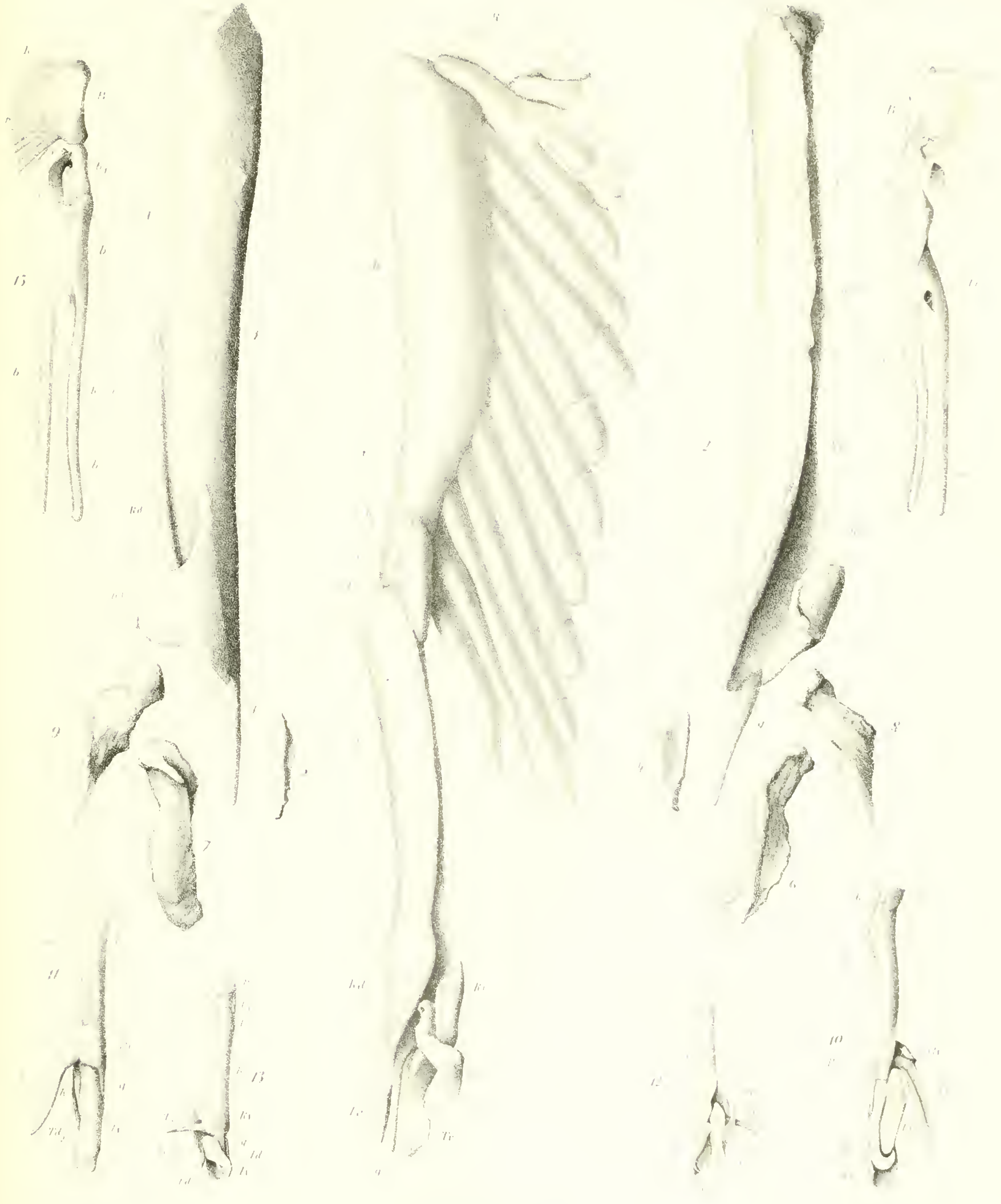

Fig 1–9 Somniosus microcephalus. Fig 10–11 Acanthias vulgaris. Fig 12–13 Spinax niger.
Fig 14–15 Chimaera monstrosa.

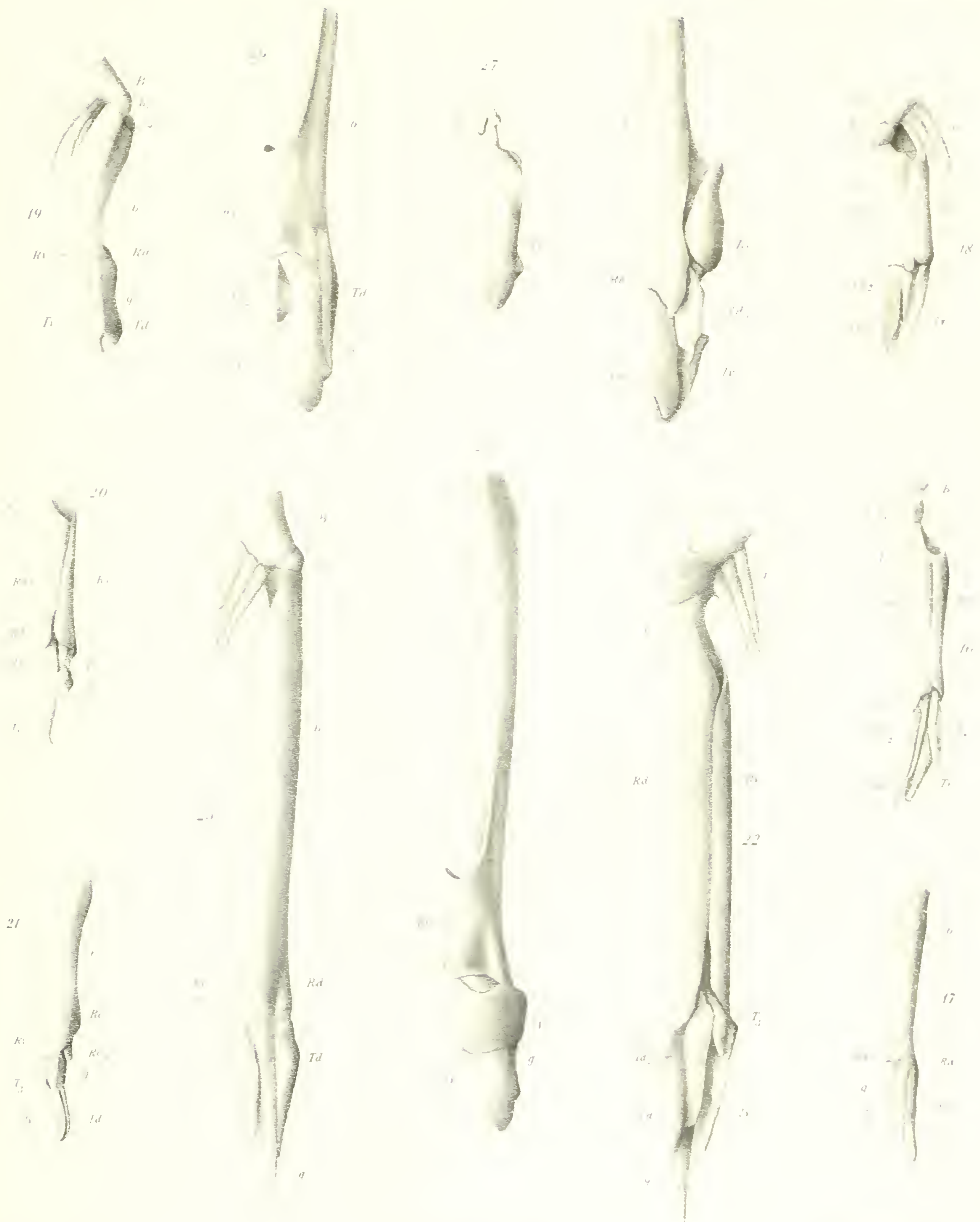

Fig. 16. 17 Scyllium canicula. Fig. 18. 19 Scyllium stellare. Fig. 20. 21 Pristiurus melanostomus.
Fig. 22. 23 Lamna cornubica. Fig. 24. 25 [illegible]

Fig 28–31 Torpedo marmorata, Fig 32–34 Narcine sp. Fig 35–37 Rhinobatus columnae
Fig 38–40 Trygon violacea Fig 41–44 Raja circularis

Fig 45–48 Raja batis. Fig 49–52 Raja lintea. Fig 53–56 Raja radiata.

Hector Jungersen del.

Winkel & Magnussen

Fig. 58-62 *Somniosus microcephalus*; Fig. 63-64 *Acanthias vulgaris* ♀.

Hector Jungersen del.

Winkel & Magnussen lith.

Fig 65-66 Scyllium stellare. Fig 67-68 Raja clavata; Fig 69-71. Chimæra monstrosa

THE DANISH INGOLF-EXPEDITION.

SECOND VOLUME.

3.

NUDIBRANCHIATE GASTEROPODA.

BY

R. BERGH.

WITH 5 PLATES.

COPENHAGEN.

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Nudibranchiate Gasteropoda.

Nudibranchiate Gasteropoda.

By

R. Bergh.

Upon the whole and according to the experiences of deep-sea explorations, we can scarcely expect any considerable result as to nudibranchiate gasteropoda, nor has such a result been obtained by the Ingolf-Expedition, but it has as a compensation brought to light several very remarkable and partly quite new forms.

The complete result was the following forms:

Nudibranchiata holohepatica.

1. Lamellidoris muricata (O. F. Müller).
2. Cadlina repanda (A. et H.).
3. Aldisa zetlandica (A. et H.).
4. Bathydoris Ingolfiana, Bgh. n. sp.
5. Doridoxa Ingolfiana, Bgh. n. sp.

Nudibranchiata cladohepatica.

6. Candiella Ingolfiana, Bgh. n. sp.
7. Atthila Ingolfiana, Bgh. n. sp.
8. Dendronotus robustus, Verrill.
9. D. arborescens (O. F. Müller).
10. Coryphella sp.
11. Cor. sp.
12. C. salmonacea (Couth.).
13. Goniëolis intermedia, Bgh. n. sp.
14. Gon. atypica, Bgh. n. sp.
15. Amphorina Alberti, Quatrefages.
16. Galvina sp.

The nudibranchiate gasteropoda form two large groups: the holohepatic and the cladohepatic nudibranchiata. They are chiefly and most generally distinguished by the structure of the liver, the blood-gland, and the seminal vesicle.

All the holohepatic forms have a liver without side-branches, but a gall-bladder; they have a special blood-gland and two seminal vesicles (spermatheca and spermatocyst). In the large cladohepatic group, which is very rich in forms, the liver is branched, no blood gland is found, and only one seminal vesicle (spermatocyst).

Nudibranchiata holohepatica.

R. Bergh, System der nudibranchiaten Gasteropoden[1]).

This family comprises only the Dorididae together with the Doriopsidae and the Phyllidiadae as well as the dubious and somewhat deviating Corambidae. Common to all of them — with the single exception of the Phyllidiadae — is the gill which is formed of more or less, single or compound, leaves or tufts, is retractile or not retractile, and is placed in the median line of the back, as well as the position of the anal aperture, which, in consequence of the position of the gill, is found behind in the arch or ring formed by the gill-leaves.

The Dorididae have a strong bulbus pharyngeus, often provided with labial plates, but almost always (with the exception of the Bathydoridae) wanting real mandibles.

Dorididae phanerobranchiatae.

Fam. Goniodorididae.

Lamellidoris, Ald. et Hanc.

R. Bergh, System der nudibranch. Gasteropoden. l. c. 1892. p. 1152—1154.

This genus, which belongs to the sucking phanerobranchiate Dorididae (the Goniodorididae) is distinguished from the Adalariae, which it resembles very much in outer structure, by the presence of two prominent chitinous lists below in the inner mouth, and by the narrow radula that has only one outer plate.

The Lamellidoridae belong almost exclusively to the colder seas.

Lamellidoris muricata (O. F. Müller).

R. Bergh, on the nudibr. gaster. moll. of the north pacific ocean (Scientific res. of the explor. of Alaska. Vol. I. art. V—VI), second part. 1880. p. 221—224. Pl. IX, fig. 18; Pl. XI, fig. 10—12.
Pl. V, fig. 31—32.

Of this species two specimens were taken on the 10th of May 1895 at Trangisvaag between Laminariæ and red algæ.

The smaller individual was only 6·5mm long, the larger one, which was examined more closely, measured 9mm. The colour was whitish with a yellow tinge, the rhinophores were yellow.

The outer form was the common one; the tubercles on the back were powerful, most of them rather truncate; the rhinophores and tentacles had the common form; the number of gill-leaves was ten, as far as they were to be discerned.

[1]) Malacolog. Untersuchungen (Semper, Reisen im Archipel der Philippinen. II, 11). XVIII Heft. 1892. p. 1070—1160.

Of the intestines only the bulbus pharyngeus was examined. It had a length of 1mm by a breadth of 1·25mm, and it measured in height with its beautiful large sucking crop that resembles a double kettle-drum (fig. 32), also 1·25mm; the sheath of the radula projected strongly from the posterior end. The tongue had thirteen rows of teeth, in the sheath of the radula were 21 rows, of which the three hindmost ones had not yet been fully developed; thus the total number of rows of teeth was 34[1]. The lateral teeth were slightly yellowish, the others colourless; the length of the median false tooth-plates (fig. 31 a) was 0·05mm; the height of the lateral teeth (fig. 31 b) was 0·10mm, and of the outermost teeth (fig. 31 c) about 0·06mm. The lateral teeth had the common form, very finely denticulated, but not quite to the point, the number of the denticles appeared to be 15—20. The outermost teeth were of the common form.

This species is, especially by the structure of its radula (by the denticulated lateral teeth), easily distinguished from the typical *Lam. bilamellata* (L.); on the other hand I think it questionable whether *Lam. varians* and *hystricina* which I have established (l. c.), are not mere varieties of *Lam. muricata*.

Dorididae cryptobranchiatae.

Fam. Cadlinidae.

R. Bergh, System d. nudibranchiaten Gasteropoden. l. c. 1892. p. 1100.

Beside the Bathydoridae and a few Chromodoridae[2] the Cadlinidae are the only cryptobranchiate Dorididae with rhachidian tooth plates. The family comprises the genera *Cadlina* and *Tyrinna*[3]; the latter is distinguished from the former by a peculiar form of tentacles and by the penis having no thorny armature.

Cadlina, Bgh.

R. Bergh, Rep. on the Nudibranchiata (Explor. of Alaska) I. 1879. p. 114 (170) — 125 (181).
— malakolog. Unters. Heft XVIII. 1892. p. 1100.
— die Opisthobranchier (Report — Albatross). 1894. p. 168.

The Cadlinae are of an elongated-oval, somewhat depressed form. The back is covered with fine, a little pointed papillæ, not very densely set; the gill is composed of a few bi- and tripinnate leaves; the tentacles are short, lobelike; the foot is rather powerful, with a rounded fore end with marginal furrow.

1) The (2) specimens (from the neighbourhood of Bergen) which I have examined before, showed 32 and 44 rows of teeth.

2) While in several Chromodoridae rhachidian thickenings are found in the radula that may simulate median tooth-plates, those thickenings are in a few forms, in *Chromod. punctilucens* and *scabriuscula* (R. Bergh, rep. on the Nudibranchiata (Blake-Exped.). Bull. Mus. of compar. zoöl. Harvard college. XIX, 3. 1890. p. 164. Pl. 1, fig. 7 a — p. 162. Pl. 1, fig. 13 a, 14), and in *Chrom. juvenca* (Zool. Jahrb., Supplem. Fauna chilensis. 1898. p. 532. Taf. 31, fig. 7 a) developed into real median tooth-plates.

3) l. c. Fauna chilensis. 1898. p. 523—526. Taf. 30, fig. 21—29; Taf. 32, fig. 21—24.

The oral aperture bears a strong, almost ringshaped labial plate, composed of densely set, rather high, a little hooked elements with cleft points. The radula has small median tooth-plates and a row of erect lateral plates with denticulated margins. — Glans penis is provided with rows of small thorns.

Of the genus only a few species are known, chiefly from the cold seas, and their specificness is not beyond all doubt, possibly these forms belong to one and the same species.

1. *C. repanda* (A. et H.).
   M. atlant. or. et occ.
2. *C. glabra* (Friele et Arm. Hansen).
   M. atl. or. septentr.
3. *C. Clarae*, Jher.
   M. mediterr.
4. *C. pacifica*, Bgh.
   M. pacific. septentr.

Cadlina repanda (Ald. et Hanc.).

R. Bergh, l. c. 1879. p. 115 (171) — 120 (176). Pl. V, fig. 15; Pl. VI, fig. 21 — 22; Pl. VII, fig. 9 — 18; Pl. VIII, fig. 3—6.
— l. c. 1894. p. 169 — 171. Taf. VII, fig. 4 — 11.
Pl. II, fig. 16 — 19.

At station 27 i. e. on 64° 54' Lat. N. and 55° 10' Long. W. a single specimen of this species was taken at a depth of 393 faths (temp. + 3°8).

The specimen that had been preserved in alcohol of 70% showed a chiefly whitish colour, and was of a somewhat stiff and frangible consistency. The length was 13^{mm} by a breadth of 7^{mm} and a height of 5^{mm}; the breadth of the foot was 3^{mm}, the length 10^{mm}; the breadth of the mantle-edge was $1{\cdot}5^{mm}$; the height of the almost outstretched rinophoria 2^{mm}, and of the retracted gill likewise 2^{mm}.

The outer form was as usual in this species. The club of the rhinophoria strongly perfoliate; there appeared only to be seven gill-leaves; the genital papilla as usual.

The skin was densely stuffed with very long, slightly yellowish, cylindrical spicules, sometimes slightly and sparsely rugged on the surface, strongly calcified, and measuring $0{\cdot}025^{mm}$ in diameter.

The bulbus pharyngeus was strong, of a length of $2{\cdot}75^{mm}$ with the radula-sheath strongly conspicuous on the under part of the posterior end; the elements of the broad, yellow, ring-shaped labial plate reached a height of $0{\cdot}075^{mm}$ (fig. 16). The tongue was broad and flat; the almost colourless radula contained 36 rows, and further backward appeared still 50 rows, the four hindmost of which were not yet quite consolidated; thus the total number of rows was 86. The number of tooth-plates in each row was in the hindmost part of the tongue 44[1]). The tooth-plates were almost quite colourless; the length of the median teeth rose to $0{\cdot}04^{mm}$, and the height of the lateral teeth rose to

[1]) The number of the series of teeth in the (6) before examined individuals was 51—70 and 96; the number of tooth-plates in each row was 22-29 and 31. In *Cadlina pacifica* the number of the series of teeth was 67—85, and of the plates in the rows 27—33.

0·10^{mm}. The median plates showed on the hooked part outward to each side 2(—3) denticles (fig. 17a); the lateral plates (fig. 17, 18) were quite as before described.

Also the salivary glands, the intestinal canal, and the yellow liver were as before described.

The anterior genital mass was large; the ampulla of the hermaphrodite duct, the seminal vesicles, the two parts of the seminal duct, and the penis-sac were as usual; the armature belonging to the glans penis and part of the seminal duct (fig. 19) showed the thorns in great numbers and of a length of up to 0·030^{mm}. The mucous gland was milk-white.

Fam. Diaululidae.

R. Bergh, System d. nudibranch. Gasteropoden. 1892. p. 1097—1100.

This (provisional) family includes forms with a somewhat flattened body and most frequently with a finely villous back. The tentacles are of a tubercle- or finger-like shape; the branchial cleft is roundish and most frequently crenate, with tripinnate gill-leaves. The labial disk is unarmed. The narrow rhachis of the radula is nakked; its pleurae bear many tooth-plates, and these, at least the greater part of them, are hook-shaped. The penis is mostly unarmed.

The family contains several rather distinctly marked generic forms. Of the nearly related genera *Diaulula* and *Gargamella* the latter is distinguished by a strong armature of the penis (of the same kind as in *Platydoris* and *Hoplodoris*). *Thordisa* and *Aldisa* have small tubercle-like tentacles; but in the former the outermost tooth-plates are comb-shaped, while the tooth-plates in *Aldisa* are erect, staff-shaped, and the penis armed with rows of thorns. The genus *Trippa* has the back covered with villous tubercles, and particular salivary glands of the oral tube (*gland. ptyalinae*). *Halgerda* has a smooth back, a narrower foot, and the outermost tooth-plates are serrated. The teeth of the genus *Baptodoris* are somewhat like those of *Halgerda*, but the penis is here armed with series of thorns (as in the Phyllidiadae and the Doriopsidae). The body of *Peltodoris* is more stiff, and the back finely granulated. The genus *Phialodoris* agrees as to the outer form with the last-mentioned genus, but its penis is of a very deviating shape.

Aldisa, Bgh.

R. Bergh, l. c. 1892. p. 1098.

Aldisa zetlandica (Ald. et Hanc.).

Tab. V, fig. 17—23.

One specimen of this species was taken at station 27 i. e. on 66 33' Lat. N. 20 05' Long. W., at a depth of 44 fathoms (temp. 5 6).

Preserved in alcohol it measured in length 11^{mm} by a breadth of 6^{mm} and a height of 4^{mm}; the length of the foot was 9·5^{mm} by a breadth of 4·5^{mm}; the diameter of the branchial cleft was 2^{mm}, and the gill-leaves reached to a height of 1^{mm}. The colour of the back was a light lemon-colour, but the tubercles were whitish; the rhinophoria and the gill-leaves were yellow; the lower side of the whole body was yellowish white.

The form was oblong-oval, the lateral edges however rather parallel, the rounded anterior and posterior end of the same breadth. The back was everywhere covered with small; a little pointed tubercles showing under the magnifying glass, as well as the whole back, fine spicules; the margin of the rhinophore-openings is covered with quite small tubercles, which is also the case with the margin of the round branchial cleft. The strong club of the rhinophoria appeared to contain 15—20 pairs of leaves. There were 8 gill-leaves, tripinnate; almost in the middle of the circle the but little conspicuous anal papilla was found. The lower side of the not very broad mantle-edge showed oblique bundles of spicules distinctly to be seen from without. The genital papilla had two openings. The mouth was round, and on each side of it was found the short, truncate tentacle. The foot was anteriorly rounded, with a marginal furrow, the foot-brim narrow; the tail rather short, rounded at the end.

The central nervous system (fig. 17) showed the cerebral and pleural ganglia to be distinctly discerned, almost of the same size, roundish; the pleural ones situated (fig. 17 bb) outside the cerebral ones. The pedal ganglia (fig. 17 cc) were lying behind the former pair, also of a roundish shape, about as large as the cerebral ones, and connected by a rather short commissure. The bulb-shaped proximal olfactory ganglia were almost sessile (fig. 17); the roundish buccal ganglia were connected with each other by a not quite short commissure.

The black eyes (fig. 17) were quite short-stalked. The otocysts (fig. 17, 18) were lying on the uppermost edge of the pedal ganglia, measured in diameter $0{\cdot}10^{mm}$, and contained a rather great number of round and oval, firm otoconia of a diameter of $0{\cdot}007$—$0{\cdot}013^{mm}$ (Fig. 18). The leaves of the club of the rhinophore, as well as its axis and the stalk contained numerous spicules exactly of the same kind as those found everywhere in the skin, especially in large numbers in the back with its tubercles and in the lower side of the mantle-brim. These spicules are long, staff-shaped, cylindrical, or here and there also a little rugged, straight or slightly bent, strongly calcified, clear as glass, and of a diameter of up to $0{\cdot}03^{mm}$; they are, as is usual with this kind of spicules upon the whole, easily broken, and were often found broken into many pieces.

The short and powerful bulbus pharyngeus together with the thick, strongly projecting radula-sheath measured in length 2^{mm}; the labial disk was covered with a simple, colourless cuticle. The tongue was broad and flat, and appeared to contain 25 rows of teeth, of which the foremost were very incomplete, and the tooth-plates to a great extent broken; farther back in the radula-sheath still 26 rows seemed to be found, of which the hindmost were not yet completely developed; thus the total number of the rows seemed to be 51. The odontogenous cells of the radula-pulp were arranged in long columns forming the long tooth-plates. The number of tooth-plates in the series was considerable, but could not be made out. The tooth-plates were completely colourless; the outermost were only $0{\cdot}08^{mm}$ long, while the largest were at least $0{\cdot}35^{mm}$. The tooth-plates were of the peculiar, before described shape, very long, flattened, and thin, at the point a little broader (measuring $0{\cdot}013^{mm}$), formed like a spoon, in the point and in part of one edge provided with quite fine and pointed denticles (fig. 19); the outermost tooth-plates were less long and denticulated for a longer way (fig. 20).

The whitish salivary glands were seen as a small mass on each side of the fore end of the stomach.

The oesophagus was short; the stomach oblong, of about the same length as the bulbus pharyngeus.

The anterior genital mass was a little oblong, rather large. The glans penis (fig. 21) projected in a length of 0·16mm and with a diameter of 0·08mm from the anterior genital aperture; it was on the foremost part of the outside and inwardly covered with apparently irregularly arranged (fig. 22) colourless, straight, and a little bent thorns of a height of 0·007—0·016mm, rising from a little flat base (fig. 23)[1]. The thorny armature is continued for a (short) way into the seminal duct.

Fam. Bathydorididae.

R. Bergh, System l. c. 1892. p. 1090.

Bathydoris, Bgh.

Report on the Nudibranchiata. Challenger-Exped. Zool. Vol. X. 1884. p. 109.

Corpus fere semiglobosum, sat molle; dorsum papillis conicis parvis ubique sparsis praeditum, margine palliali vix ullo; rhinophoria retractilia clavo perfoliato; tentacula sat magna, nonnihil applanata, acuminata; branchia e fasciculis discretis compluribus (6—10) fruticulosis non retractilibus formata; podarium sat latum.

Bulbus pharyngeus permagnus; armatura labialis nulla; mandibulae magnae, sat applanatae, margine masticatorio laevi, processu masticatorio nullo; series radulae multidentatae, dente mediano et dentibus lateralibus hamo forti obliquo instructis praeditae.

Penis fortis, inermis, fissura laterali coeca, apertura apicali.

This genus was established on a specimen taken during the Challenger Expedition almost in the middle of the Pacific from a depth of 2425 fathoms where the temperature was 1° C.

By the semiglobular form of the body, the separate branchial tufts, and the papillæ spread over the back, the Bathydoridae remind not a little of the, otherwise far different, genus Kalinga belonging to the Polyceradae, as also, by the position of its branchial tufts, of the Hexabranchidae[2]. The gigantic bulbus pharyngeus differs essentially from that in all other Dorididae; it is provided with powerful lateral mandibles as those in *Bornella* and *Scyllaea*, and as in these genera they are on the fore side covered by a thick muscular plate. The armature of the tongue resembles that in the Tritoniadae. As in *Bornella* and *Scyllaea* the hermaphrodite gland is quite separated from the liver.

The Bathydoridae appear to form a remarkable connecting link between the Dorididae and the Tritoniadae, showing also a certain resemblance to the Bornellae and Scyllaeae; but they have also, as other Dorididae, a blood-gland close to the central nervous system.

The Ingolf-Expedition has from the sea-bottom in the Davis Strait brought, as it would seem, a new form of this genus, which accordingly now comprises

1. *B. abyssorum*, Bgh.
l. c. 1884. p. 109—116. Pl. XII, fig. 14—20; pl. XIII, fig. 1—26; pl. XIV, fig. 15.
M. pacific.

2. *B. Ingolfiana*, Bgh.
M. atlant. arctic.

[1]) I have formerly overlooked this armature, which is only to be discovered with great difficulty.

[2]) The number of gills seems in the Bathydoridæ to be much varying; as the tufts, of which the gills are composed, may be more or less independent, as is also the case in the Hexabranchidae. Comp. my malacolog. Unters. Heft. XIII. 1878. p. 561; Heft. XVI. 1889. p. 929.

Bathydoris Ingolfiana, Bgh. n. sp.

Corpus quasi subgelatinosum, dorsum subpellucidum. Rhinophoria et tentacula brunnea, branchia et genitalia externa aurantiaca, podarium e nigro purpureum.

Hab. M. atlant. arctic.

Pl. I; Pl. II, fig. 1—2.

The only specimen of this remarkable form was taken on 59° 12′ Lat. N., 51° 08′ Long. W. (the broad part of the Davis Strait, about West of Cape Farewell) from a depth of 1870 fathoms, by a bottom temperature of 1·3° C. According to the kind communication by Prof. Jungersen, the trawl here brought up a whole cart-load of large, firm blocks of clay, the substance of which reminded of potter's clay, and seemed to contain no organisms, and also a fluid, yellowish mud, in which were only found some Rhizopoda, small Crustacea (Isopoda, Tanaidae, Amphipoda, Ostracoda), and a few dead shells of Yoldia-like small bivalves, of Dentalia, and of a form of Buccinida. The swabs were empty, and accordingly the bottom must certainly have been poor. Of larger animals the same trawling only brought the common little deep-sea fish *Cyclothone microdon*, a pair of curious Actinia, and a longstalked, cupshaped silicious sponge, as well as a characteristic red Planaria swimming edgewise, and furthermore a Nemertine. Moreover was found in the meshes of the trawl an immense number of colourless lumps of jelly, warty on the surface, and about the size of a hazel-nut.

The nature of the mentioned lumps of clay caused this animal to come up in a partly somewhat rubbed condition. It gave no sign of life at all, and did not contract when touched. It was immediately put into 70°/₀ alcohol, and is said to have neither contracted much therein, nor altered its form.

The animal in its fresh state is stated to have been of an, as it were, somewhat gelatinous consistency, and the somewhat scraped dorsal side quite transparent, so that the intestines might be seen through it. With the exception of the almost colourless back the animal was of a dark-brown-violet colour, but much darker on the foot.

The animal, which is rather well preserved in the alcohol, showed on the back a light greenish white ground-colour, crossed through by a network with wide meshes of branched and anastomotic blackbrown stripes, in the crossings of which were often seen small black rings with whitish centra (partly from broken-off papillæ?), similar very small and small rings were moreover found spread in the meshes. Towards the foot the colour became velvet-black, and of this colour was also the back of the neck and the upper side of the foot. The rhinophoria were yellowish, the fore part of the head black brown, the tentacles brownish yellow; the exterior genitalia were yellowish; the gills were dirty brown, as was also the sole of the foot. The length of the animal was $9·3^{cm}$ by a height of $6·5^{cm}$ and a breadth of 6^{cm}; the foot was 6^{cm} long by a largest breadth of $5·5^{mm}$; the footbrim was $13—15^{mm}$ broad, the tail 6^{mm} long; the fore end of the head was about $2·6^{cm}$ broad, each tentacle besides projecting $2·5^{cm}$, the club of the rhinophore 1^{cm} high; the diameter of the flat gills was $1—1·5^{cm}$ the height of the anal papilla 7^{mm}; the præputium projected 6^{mm}. The colossal folds of the vulva were $1·5^{cm}$ high, and when spread from each other they had a breadth of 3^{cm} by a length from above downwards of $2·5^{cm}$.

The form of the animal is almost spherical (fig. 1, 2), a little flattened on the lower side (the foot), strongly reminding of a gigantic Ochidiopsis. Below the region of the rhinophoria a little forward and a little behind is found a trace of a dorsal brim (fig. 1), otherwise the back bends smoothly and without any distinct margin downwards and inwards towards the foot, so that the body has no sides properly speaking; anteriorly the body passes without any distinct border into the head (fig. 1). To each side of the back of the neck the short-stalked club of the rhinophore (fig. 1) was seen projecting from its hole the edge of which was smooth; the club contained about 80 rather narrow leaves. The fore-end of the head was large, roundish, rather flat (fig. 1) with vertical-oval aperture, in which the light bluish-white labial disk appeared; from the sides of the head the strong, somewhat compressed, tapering (fig. 1) tentacle projected freely; the narrow chin below the head was smooth (fig. 1). — The evenly and strongly convex back (fig. 1, 2) was everywhere covered with small, disk-like depressed or slightly elevated figures of a diameter of 0·5—2^{mm}, the centra of which were either further depressed or rose to a cone of a height of at most 1^{mm}; the depression would seem to have been caused by a strong retraction or a rubbing off of the little cone. Towards the fore end of the back was seen on each side the projecting margin of the round holes of the rhinophoria, and farther forward the but little conspicuous smooth dorsal edge behind the back of the neck (fig. 2). On the hinder part of the back are seen the rather large, flat branchial tufts (fig. 1), placed in a large circle, which is completed in the median line behind by the short and powerful anal papilla. The number of the branchial tufts were 10; on the left side the three hindmost were drawn closer together, and above these was one more isolated; on the right side three and three were closer together. Each tuft showed a short, black-coloured stalk, from which 3—5 tri- and quadripennate leaves spread flatly. The anal papilla was a little depressed, truncate, with a slightly crenate aperture directed backward and downward (fig. 1). The rather large space circumscribed by the branchial circle, showed a number of smaller and larger small diks like those on the other parts of the back; forward and a little to the right, close to the hindmost branchial tuft of the foremost right group, was seen the renal pore (fig. 1) a little projecting. — The sides of the body are quite low. Anteriorly, on the right side, behind the region of the rhinophore, the outer genitals were seen, foremost the opening of the præputium with a little projecting fold, and behind it the adjoining vulva with its two colossal, indented sidelobes (fig. 2). — The foot is powerful, broad; the fore margin with a deep transversal furrow (fig. 2), the side margins not very conspicuous, the tail rather short (fig. 1).

The intestines were nowhere to be seen from without; the coverings of the back were thin, mostly only 0·3^{mm} thick; the thickness of the foot in the middle about 3^{mm}. The intestines were by short, cobweblike connective tissue attached to the foot and the sides of the back as well as to each other.

The broad and flat central nervous system resting on the hinder part of the bulbus pharyngeus, was of a slightly yellowish white colour; its breadth was 16^{mm} by a length of the cerebral ganglia of up to 5·5^{mm} and a thickness of up to 1·5^{mm}. It was wrapped in a very thin, but adhering capsule, which was prolonged out on the larger nerves. The cerebral ganglia (pl. II, fig. 2 aa) are the largest, and anteriorly considerably broader[1]), the commissure between them short

[1]) On the before examined specimen (comp. l. c. p. 111, pl. XIV, fig. 4) the hindmost part of the supraoesophagal ganglion was thin, and was by me wrongly interpreted as belonging to the pleural ganglion

and not broad; neither the upper nor the lower surface themselves seemed to send off nerves, but from the fore margin and the outer end, on the contrary, at least 7 nerves arose, from the indentation on the outer margin three, and from the hindmost part of the lower side of the commissure arose a quite thin nerve running backward. The pleural ganglia were almost but half the size of the cerebral ones, of a short-oval contour (fig. 2 bb); they sent off four thicker and a pair of quite thin nerves. The pyriform pedal ganglia (fig. 2 cc) that were connected, as it were, by a stalk with the cerebral ones, were larger than the pleural; they sent off four strong nerves, one from the lower side. The large common commissure (ca. 25^{mm} long), as usual double (fig. 2 d). The cerebro-buccal connective is almost as long as the large commissure; the buccal ganglia (fig. 2 ee) were of an ovally roundish shape with a diameter of $2{\cdot}5^{mm}$, and sent off five nerves; the rather strong buccal commissure (fig. 2 f) was 20^{mm} long. — The nerve cells (of the pleural ganglia) were of a diameter of at least $0{\cdot}30^{mm}$; the nerves were in their proximal part often a little reddish. In the skin was seen a rather rich network of nerves and small ganglia, sending off branches to the small papillæ of the skin[1]).

In spite of a careful examination I did no more in this individual than in the earlier examined one succeed in finding eyes and otocysts, which nevertheless surely are not wanting[2]). The strongly developed rhinophores showed along the fore and hinder surface a strong median (transversely folded) rhachis, downwards broad and upwards tapering, from which arise lamellæ without spicules; the point of the club is formed by a little final papilla. Through a special cavity two strong nerves ascended, and besides strong and anastomosing muscular strings stretched through these organs. The small, round disks of the skin were slightly depressed, with a projecting edge, and in the middle was often found a more or less contracted papula (pl. I, fig. 3). No spicules or calcified elements were found in the skin at all.

The mouth-tube of this individual was quite short, the bulbus pharyngeus being projected, so that the bluish labial disk was lying in the outer mouth; the labial disk was short-oval, longer in the direction from above downwards, its diameter was 12^{mm}, in the middle was seen the narrow, perpendicular aperture of the inner mouth (pl. I, fig. 2). The exceedingly powerful bulbus pharyngeus itself (pl. I, fig. 4; pl. II, fig. 1 b) was of a whitish colour; only in the region of the pharynx the underlying colour shone through with a bluish tint; the bulb was $3{\cdot}4^{cm}$ long by a breadth of $3{\cdot}2^{cm}$ and a height of 3^{cm}; the radula sheath projecting in a semiglobular form posteriorly on the lower surface (fig. 4 c) had at its base a diameter of 13^{mm}. The rather strong Mm. bulbo-tubales (Protrusores bulbi) were as has been shown before[3]). The bulbus pharyngeus (fig. 4) is by a rather sharp crest (the margin of the mandibles), only interrupted on the lower surface, divided into a smaller and narrower former part, and a rather larger hinder part; on the sides behind the mentioned crest the latter has an even hollow, posteriorly passing evenly into the common prominences produced by the tongue-muscles to the sides of the pharynx. The upper side of the bulbus pharyngeus (fig. 1) is strongly

1) Comp. l. c. p. 112. pl. XIV, fig. 5.

2) Eyes are found in a species of *Pleurotoma*, obtained at a depth of 2090 faths. in a *Fusus* from a depth of 1207 faths (Wyv. Thomson, the Depths of the Sea. 1873. p. 465) and in other mollusks; the presence of eyes in animals from these depths will, according to (the abyssal theory of light), not be incomprehensible. On the other hand a rather large number of blind deep-sea fishes and a still greater number of abyssal Crustacea without eyes have been found. (Comp. Semper, Die nat. Existenzbed. d. Thiere. I. 1880. pp. 103, 262).

3) Comp. l. c. p. 113, pl. XIII, fig. 2.

convex; the anterior half between the projecting hinder edges of the mandibles is flattened and a little hollowed; the posterior half is evenly convex, and from its middle arises the æsophagus, on either side of which is seen a slight hollow with the apertures of the ducts of the salivary glands. The sides of the bulbus pharyngeus are evenly convex with a hollow behind the margins of the mandibles (fig. 4). The lower side is anteriorly slightly convex with a hollow behind the margins of the mandibles, and behind this rises the strong radula-sheath (fig. 4 c). As in the Pleurophyllidiae and the Pleuroleuridae, in *Hero* and *Bornella*, and even in *Scyllaea* a thick muscular plate (fig. 4,r) covering the greater part of the anterior surface of the mandibles, is found behind and around the little labial disk; this plate showed a little below the middle of the fore side a transverse, rather broad furrow; the thickness of the plate was about the region of the upper end of the labial disk up to 9^{mm}, decreasing upwards and downwards as well as towards the margins. From the inner margin of the labial disk its coating continues as a thick dark blue or almost black blue covering over the whole inside of (i. e. the opening of) the muscular plate, and attaches near the free margin of the mandible[1]), in the middle at a distance of 6^{mm} from it, but upwards and downwards approaching it, until the attachment in the uppermost and nethermost places almost reaches quite to the edge. Above and below the same coating continues through the upper and lower end of the slit between the margins of the mandibles to the backside of these, where it is attached in quite a similar manner as on the foreside, the naked margin of the mandibles being, however, here only 4^{mm} broad in the middle. The covering is continued into the coating of the buccal cavity. When this muscular plate is removed the mandibles are naked; the right one covered (pl. I, fig. 6) with its marginal portion the margin of the left one (in the same manner as in the before examined form). The mandibles are strong and large, 29^{mm} long by a breadth of up to 17^{mm}; resting on the outer margin the mandible rose to a height of 18^{mm}; in the marginal part the thickness rose to almost 2^{mm}. They were of a fine horn-yellow colour, almost the whole of the inner half being brown yellow. Their form (fig. 6) is oval, a little more rounded below than above (fig. 6 a); the inner edge is a little more projecting than the outer one, and tapers a little more towards the middle. The mandibles are evenly bent from above downward; they are thickest where the blue coating is attached, decreasing in thickness towards the edge, especially towards the outer one, which is still somewhat soft; they are quite smooth on the surfaces, very finely concentrically and radially striated; the masticatory edge was almost smooth. The mandibles join, and are immediately connected with each other at the upper end, below they are a little apart (fig. 6). — The mandibles being removed the anterior end of the muscular masses of the mandibles are uncovered, the colour of the inside of these muscles (the cheeks) is dark blue, as is also that of the other parts of the buccal cavity, as well as the tongue and the tectum radulæ, to which the brown radula forms a rather strong contract. — The tongue (pl. I, fig. 5) is very powerful, of the usual form, with a deep slit; in the buccal cavity it projected 7^{mm}, and measured above from the base of the tectum radulæ 15^{mm} in length; its height (from above downward) was 19^{mm}, and its breadth also 19^{mm}; the tectum radulæ had a length of 7.5^{mm}, anteriorly it reached to the middle of the height of the tongue-slit. The radula itself was reddish brown, somewhat glistening, its marginal part of a purple brown; its continuation into the sheath

[1]) Comp. l. c. p. 113. pl. XIII, fig. 4.

was lighter, yellowish. After being separated from the tongue it measured with its continuation 28^{mm} in length, and when spread out 32^{mm} in breadth. On the radula was found 35 rows of teeth (measured along the outer margin), and farther back 24 rows, about six of which were not yet fully developed; thus the total number was 59. About the twenty foremost rows were more or less incomplete, and the tooth-plates often injured. In the rows were found up to 116 tooth-plates on each side of the median tooth[1]). The length of the median tooth was about 0·5^{mm} by a breadth of 0·22^{mm}; the lateral teeth measured along the backside up to 0·95^{mm}; the lengths of the 6 outermost teeth were: 0·40—0·43—0·45—0·48—0·5—0·6^{mm}. The median tooth is flat, rather thin, somewhat lengthened (fig. 7a, 8) with an excavated fore end, and a straight hinder margin over which projects a little truncate, median cone; the fore part rises obliquely in a short rounded hook (and the hooks on all the median teeth were of the some form). The lateral teeth (fig. 9—13) are longer, and have a much more powerful base, from which the tapering hook rises obliquely and rather slantingly; the margins of the hook, especially the inner one, project freely anteriorly; otherwise the length and breadth of the hook is somewhat varying. Towards the margin of the rasp the lateral teeth decreased (fig. 12—14) considerably in strength and were narrower. In the 6—8 outer ones, especially the very outermost, the hook was considerably reduced (fig. 12a). Double teeth, so frequent in the nudibranchiata, were not wanting (fig. 15).

The salivary glands are strongly developed, and cover (pl. II, fig. 1 cc) the sides and partly the lower side of the stomach, where they join almost in the median line. They are somewhat flattened especially above, of a thickness of 1—9^{mm}, yellowish white, somewhat lobed in the margin, especially the left one; this latter was larger than the right one, its length was 22^{mm} by a breadth of also 22^{mm}; the rigth one was 32^{mm} long and 14^{mm} broad. At the fore margin of the gland the salivary duct was seen widening at its fore end into a little ampulla (fig. 1; 4c); the length of the duct with the ampulla was almost 10^{mm}.

The oesophagus (pl. II, fig. 1) was of a dark bluish-gray, about 11^{mm} long with a diameter of 9^{mm}; the longitudinal folds shone through indistinctly. The oesophagus passes by degrees into a first stomach, also dark bluish-gray, bag-shaped, of a length of 3·5^{cm} with a diameter of 1·7^{cm}. This stomach appears rather thickwalled on account of the not very numerous (ca. 12), but thick and projecting, wrinkled longitudinal folds, which were slightly to be seen from without, and which partly continue anteriorly into the folds of the æsophagus, become lower posteriorly, but for the greater part continue into the folds of the second stomach. The inside of this first stomach is quite dark blue. Through a slight constriction also indicated exteriorly (pl. II, fig. 1) this stomach passes into the second stomach, situated to the left, 3·6^{cm} long with a diameter of 1·4^{cm}, and exteriorly of a yellowish white colour. It is also rather thickwalled, its yellowish inside that is finely dotted with red, beariig a small number (ca. 12) of highly undulated folds stopping short at the aperture of the biliary duct. Here the yellowish white intestine begins which all the way from the pylorus is rather thinwalled. It (pl. II, fig. 1 dddd) stretches backward along the left margin of the liver, bends behind the middle of the length of the liver over the upper side of it, and runs to the right and forward

[1]) In the before examined form the number of rows on the tongue was 55, and the total number 75; the number of the lateral teeth was 130 on each side.

to the middle of the right margin of the first stomach, forms here a knee, and stretches backward along the right margin of the liver continuing over its hinder end up to the anal papilla (pl. I, fig. 1). The whole length of the intestine is 25^{cm} by a diameter varying between 10—15^{mm}. The inside of the intestine shows on the middle of the under side particularly fine transverse folds while the rest of the wall chiefly has very fine netforming folds; through the middle of the above mentioned finely transversely-folded part a prominent longitudinal fold stretched for a great part of the hindmost part of the intestine. The wall of the hindmost part of the intestine was more smooth. The alimentary canal showed through almost its whole length from the cardia to the rectum abundant, as it were, clayey, dark yellowish gray contents, partly quite loose and incoherent, partly forming soft lumps of a length of almost up to 2^{cm} and a diameter of 1^{cm}. These contents consisted of the above mentioned clayey mass with grains of sand, mingled with half disorganized animal substance, with Polythalamia, Diatoms, and pointed silicious spicules; also a piece of a wormlike animal, full 2^{cm} long, and almost disorganized, was found.

The very large, dirtily dark brownish gray liver was $7{\cdot}2^{cm}$ long by a breadth of up to $4{\cdot}2^{cm}$ and a height (behind) of $3{\cdot}7^{cm}$; its contour was roundish, the fore end a little more pointed than the rounded hinder end (pl. II, fig. 1). On the upper side of the fore end was found an impression of the first and especially of the second stomach, along the greater part of the left margin was seen a furrow for the intestine, which at the beginning of the hindmost third part of the liver bent inward over its upper side, and on its way forward was situated in a broad and deep furrow continuing in a more superficial one along the right margin of the liver. The surface of the liver was smooth, with only superficial furrows, partly from vessels. Below on the left margin was found the short and thick biliary duct of a light dirty yellowish colour (9^{mm} long by a diameter of 6^{mm}); it opened at the pylorus of the second stomach, and led into a not very great cavity, on the walls of which 3—4 large openings were seen. The biliary duct and the cavity of the liver were filled with masses like those in the alimentary canal. No gall-bladder was found.

The large pericardium, $3{\cdot}7^{cm}$ long, and 4^{cm} broad, covered the middle of the liver; folds before on its under side (the pericardial gill) were very distinct. The yellowish ventricle of the heart was 23^{mm} long by a hindmost breadth of 10^{mm}. — The large, whitish, flaccid blood gland was resting on the pharynx, partly attached to the salivary glands, of a length of $2{\cdot}3^{cm}$ by a breadth of (before) 1^{cm}, (behind) $1{\cdot}5^{cm}$; before it was rounded, behind straightly curtailed; its thickness was 5^{mm}; it appeared to contain a cavity with folds on the thin walls, but was torn on the under side by the preparing out of the central nervous system; a strong artery ran to the lower side of the organ.

The fine, large, brown-yellow kidney (pl. II, fig. 1) covered the whole hermaphrodite gland and large part of the upper right side of the liver; with its branches it stretched partly under, partly here and there over the intestine; it was rather firmly attached to its underlayer. It was composed of very strongly branched principal stems, some foremost and more hindmost; the stems as well as their branches were in a most varying manner set with leaves, folds, and ampullæ often forming, as it were, greater and smaller grapes. All these growths on stems and branches were as usual composed of closely crowded small cells. About the middle of the kidney (fig. 1) the stems appeared to lead into a urinal chamber continuing in an ureter running backward along the inner margin of the intestine, and ending in the renal pore inside the branchial circle to the right (pl. I, fig. 1). The inside, at least of the last part of the ureter, is covered with strong, compound, and foliaceous folds and papillæ. The pericardio-renal organ (the renal syrinx) was powerful, pyriform, almost 1^{cm} long, with strong folds on the inside.

The hermaphrodite gland (Glandula hermaphrodisiaca) rested on the foremost right part of the upper side of the liver, its upper surface completely covered and hidden by the foremost part of the kidney. It was (fig. 16) meniscus-shaped, of roundish-oval contour, with a convex upper surface, and the under surface a little concave; its diameter was about $2{\cdot}6^{cm}$ by a thickness on the middle of 1^{cm}; from this middle it sloped evenly towards the not very thick, rounded, almost smooth margin; the surfaces were finely knotty, the colour was gray. The surface of this gland showed everywhere, especially distinct on its upper side (fig. 16), a mass of small clear, semiglobular, prominent papulæ, which, when slightly magnified (fig. 17) were seen to be composed of densely crowded balls of a diameter of $0{\cdot}5$—$1{\cdot}5^{mm}$, and were attached to a central mass; between and below these balls stretched a system of highly ramifying and anastomotic tubes (fig. 17), the efferent ducts. The deeper parts of the gland contained similar balls and tubes. The balls were ovarial follicles with eggs in different stages of development, attached to a central testicular mass containing bundles of zoosperms. About medianly from the foremost part of the under side of the gland the hermaphrodite duct arose stretching to the anterior genital mass.

This large anterior genital mass (fig. 18) was situated on the right side of the bulbus pharyngeus before the liver. Anteriorly and on the under side it was grayish, otherwise of a light yellowish white colour; the length was 5^{cm} by a breadth of $4{\cdot}1^{cm}$ and a height of $3{\cdot}8^{cm}$; its lower surface was slightly convex, the upper one strongly convex, posteriorly more abruptly shelving, anteriorly more gradually sloping; the fore end was a little pointed, the hinder end broader and rounded. Its chief part was formed by the large mucous gland (fig. 18a); on the hinder end lay the spermatheca (fig. 18b) with its rather short duct; before and partly upon this (fig. 18) the large bag of the penis. The hermaphrodite duct (fig. 19a) stretches under the spermatheca and the bag of the penis and forms a flattened coil, quite covered by the latter; this coil is composed of rather thinwalled windings, which, when loosened from each other, had a length of about 15^{cm} by a diameter generally of $1{\cdot}5$—2^{mm}; foremost under the neck of the bag the duct was somewhat thinner, and divided in the usual way (fig. 19b) into the short oviduct and the spermatic duct which is only thin near the beginning (fig. 19c). The spermatic duct was powerful, thickwalled, and stretched in a curved way with a length of 3^{cm} and a diameter of 2^{mm} to the hinder end of the bag of the penis (fig. 19d) continuing into the penis. The bag of the penis (the præputium) (figs 18, 19dd) was large, 3^{cm} long by a breadth of $2{\cdot}1^{cm}$ and a thickness of $1{\cdot}3^{cm}$; it opened with a narrower neck foremost in the outer genital region (pl. I, fig. 2); its walls were not thick, but tough; its inside was smooth, only in the neck were seen longitudinal folds, of which a more strongly marked one was seen in the outer aperture (fig. 2). In the præputium was the whitish penis, quite bent double (figs. 19, 20); when straightened it measured 4^{cm} by a diameter varying between 9—14^{mm}; its contour was round or a little compressed, only the end of the organ was more flat; on one side was found (quite as in the earlier examined Bathydoris) a rather narrow, not superficial, rather long furrow without any discoverable aperture in the bottom; on the point was seen a quite fine round pore (fig. 19f). The spermatic duct entering at the base of the organ (fig. 20a), became by and by a little thinner forward, and with its close windings it was to be traced throughout to the pore on the point of the penis (figs 20, 19f). The short oviduct (fig. 19b) opened into the uppermost part of the duct of the mucous gland. The spermatheca (fig. 18b) was formed like a short bag, of a length of 2^{cm}, it was partly covered by the præputium; its vaginal duct was a little shorter than the seminal vesicle, by its short uterine duct hung by a short stalk the flat spermatocyst, covered by the spermatheca, empty like this, and about half as large. — The mucous gland formed the chief portion of the whole anterior genital mass; hindmost on its under side was seen a more separated, roundish, more whitish, flat part, of a diameter of ca. 2^{cm}, the foremost part of which might without tearing be loosened from the rest of the mass. In the foremost and undermost part of the mucous gland was found the long and high, compressed cavity of the organ, the foremost wall of which was only thin, while the hindmost one was formed by the chief mass of the mucous gland, the inside of which was yellowish, and showed several communicating cavities. The duct of the mucous gland was short, only $0{\cdot}5^{cm}$ long, with strong folds on the inside; the cleftlike outer aperture was bordered by the two above described genital folds, which below were only connected with each other by a narrow commissure, and above by a very broad one (pl. I, fig. 2, 18c).

In itself is was scarcely probable that this deep-sea form from the Davis Strait could be specifically identical with the earlier described form from the large depths in the middle of the Pacific. We have also, in spite of considerable correspondences between the two forms, found not a few and rather great differences. Among these differences were especially prominent the different colour of the cavity of the mouth, another form of the mandibles, and a great difference in the structure of the radula, the tooth-plates of which upon the whole were feebler and longer in this species, and the median teeth especially had quite another form.

Fam. Doridoxidae. Nov. fam.

Forma corporis ut in Doridibus; sed branchia (dorsalis) nulla, et anus lateralis (non dorsalis). Rhinophoria ut in Doridibus.

Bulbus pharyngeus fortis, mandibulis anticis fortissimis armatus. Radula dente mediano forti, pleuris multidentatis.

We know cladohepatic nudibranchiata in which the whole branchial apparatus with its hepatic lobes has disappeared; such is the case in the Phylliroidae, Pleuroleuridae and Hedylidae[1]). And others are found, the Tritoniadae, in which the branchial apparatus has remained without the hepatic lobes. It was almost to be expected that also among the holohepatic nudibranchiata forms without gills were to be found. And such a form we find in the below described new animal, which is also distinguished from all other holohepatica by the anus not being situated dorsally, but

1) R. Bergh, Die Hedyliden, eine Familie der kladohepat. Nudibranchien. Verh. d. k. k. zool. bot. Ges. in Wien. XLV. 1895. p. 1—12. Taf. I—II.

having moved down on the (right) side. The Doridoxidae form a transition to the Tritoniadae, a connective link between the holohepatic and the cladohepatic nudibranchiata.

The habitus of these animals is from the dorsal side quite like that of the Dorididae, in which latter the branchial cleft was especially strongly contracted; but this cleft and the gill itself are completely wanting, and the anus has moved from the dorsal side down on (the right) side of the body. Already this characteristic gives them a resemblance to the Tritoniadae, which form the outermost link of the Cladohepatica. And this resemblance is still greater by the fact that the strong bulbus pharyngeus is provided with powerful mandibles situated on its fore side as in the Tritoniadae. By the presence of these mandibles[1] the Doridoxidae are otherwise nearly related to the Bathydoridae, with which they also correspond with regard to the structure of the radula, this also showing median tooth-plates, a feature otherwise rather rare in the Dorididae.

Hitherto the family contains only the genus

Doridoxa, Bgh. N. gen.

and this genus contains only the one species, described below.

Doridoxa Ingolfiana, Bgh. n. sp.

Pl. II, figs. 3—15; Pl. III, figs. 1—3.

One specimen of this species was taken in 1895 at a depth of 55 fathoms, at station 34, i. e. on 65° 17' Lat. N. 54° 17' Long. W.

It was generally of a yellowish white colour, the back more whitish. The length was 12^{mm} by a breadth of 7^{mm} and a height of 5^{mm}; the length of the foot was $10{\cdot}5^{mm}$ by a breadth of 4^{mm}; the breadth of the head was 5^{mm}, of which breadth $1{\cdot}5^{mm}$ belongs to each tentacle; the height of the rhinophores was 1^{mm}, the breadth of the mantle-brim $0{\cdot}75^{mm}$. The consistency of the animal was rather soft.

The intestines were nowhere to be seen from without.

The form was oval, the hinder end a little more pointed (pl. II, fig. 3). The back was evenly convex, anteriorly between the rhinophores it joined the somewhat projecting hinder margin of the head; it was everywhere rather densely covered with small and quite small, semiglobular, and more flattened papulæ. The margin of the hollows of the rhinophores was slightly projecting, everted and crenate; the (slightly projecting) club of the rhinophores was perfoliate; the dorsal brim was only a little projecting, the margin rather sharp, the lower side smooth. The head was rather large, somewhat flattened, with a rather projecting hinder edge, a little produced on either side; with rather large, roundish-lobelike tentacles; the outer mouth was round (pl. II, fig. 3). The sides of the body are only low before and behind, otherwise rather high, quite smooth; anteriorly to the right is seen the large genital papilla with the prominent little penis, and behind this the vulva (fig. 3); at the beginning of about the last fourth part of the length of the body was the projecting anal papilla, and a little before this the smaller renal papilla (fig. 3). The foot was powerful, but narrower than

[1] In several families of the cladohepatic group quite similar mandibles are seen, in Bornella, Scyllaea, Phylliroidae, Pleurophyllidiadae and Pleuroleuridae.

the back, and projected only slightly from the hinder end of this; the rounded fore end was slightly broader than the other part, with a marginal furrow; the foot-brim was narrow; the hinder end only a little pointed (fig. 3).

The central nervous system (fig. 4) was rather flattened, white, chiefly as in the Doridae. The round cerebro-pleural ganglia (fig. 4a) were a little larger than the likewise round pedal ones (fig. 4b), the distinction between their two parts was not conspicuous; the chief commissures were rather short; the globular buccal ganglia (fig. 4c) joined each other immediately.

The eyes at the base of the rhinophores had a diameter of $0{\cdot}10^{mm}$. The otocysts appeared to contain a not great mass of pale otoconia, no spicules at all were seen in the dorsal skin, or its papulæ, nor in the leaves of the rhinophores.

The mouth-tube was short. The strong bulbus pharyngeus (figs. 5,6) reminded as to its form somewhat of that in the Pleurophyllidiae. It was $3{\cdot}25^{mm}$ long by a breadth of 3^{mm} and a height of $2{\cdot}75^{mm}$. Its strongly convex fore side was covered by the large mandibles; from about the middle of the somewhat convex hinder side the œsophagus originated; the radula-sheath did not project externally. The fore side of the large and strong mandibles were (as in the Pleurophyllidiae) for the greater part covered by a muscular plate which was, however, rather thin. The mandibles (fig. 7) were amber coloured, only the masticatory edge was black brown; they were $2{\cdot}5^{mm}$ long, and their breadth taken together was $3{\cdot}5^{mm}$; they were rather bent, so that their height reached almost $1{\cdot}5^{mm}$; along the middle of their length they showed a smooth, not deep excavation. The hinge-part was rather short, as was also the masticatory process (fig 7a); the masticatory edge was not narrow; it showed through its whole extent just to the hinge-part small roundish or angular facets (fig. 8) of a diameter of $0{\cdot}0055$—$0{\cdot}01^{mm}$. The tongue (figs. 9,10) was broad and flat, and projected only a little in the buccal cavity; the little, forward and downward tapering radula was strongly and shining yellow. The radula contained 15 rows of tooth-plates; further back, in the somewhat bent radula-sheath, which was not to be seen from without, were 24 more rows, of which the three hindmost were not yet quite consolidated; the total number of the rows of teeth were thus 39. The eight foremost rows were very incomplete and the teeth worn; the foremost one contained only 6 and 7 toothplates on each side of the median one. The middle of the radula with the median tooth and two side-teeth were sunk a little under the level of the side parts. On each side of the median one appeared up to 36 lateral tooth-plates. With the exception of the two innermost ones and the very outermost ones they were of a strong yellow colour. The breadth of the clumsy median plates was 0.075^{mm} by a height of 0.10^{mm}; the height of the two outermost lateral ones was $0{\cdot}035$—$0{\cdot}04^{mm}$; then it rose quickly to $0{\cdot}10$, and continued thus towards the rhachis, the two innermost lateral teeth were much lower (pl. III, fig. 1). The median tooth plates (pl. II, fig. 11 a; pl. III, figs. 1 a, 2 a) were short and clumsy, rather erect, with a strong, broad base, hollowed in the fore edge, and with a short, strong, a little pointed hooked part. The two first (inmost) lateral plates (fig. 11 b; figs. 1 b, 2 b) were of a deviating form with a quite short and pointed hook. The other lateral plates (figs. 12; 1,2) reminded as to their form more of the median plate, but the base was much smaller and the hook was longer. The 2—3 outermost lateral plates (pl. III, fig. 3 a) were feebler, and the hook more pointed.

The salivary glands were white, 3^{mm} long by a breadth of 0.75^{mm}, reaching to the foremost part of the stomach; the excretory duct was more than a third of the length of the gland.

The æsophagus (fig 6 a, 13 a) was rather short. The stomach (fig. 13 b) formed a longish bag (4^{mm} long), the numerous longitudinal folds of which were distinctly to be seen from without. It contained an abundance of whitish food of indeterminable animal nature with a few imbedded larger calcareous bodies resembling those in the Alcyonia. From the hinder end of the stomach the intestine arose to the right, crossed the fore end of the liver, bent backwards, and ran a little sinuous to the anal papilla (fig. 13 cc). Its inner side showed fine longitudinal folds, its cavity was empty.

The liver, the outside and inside of which was yellow, was a little hollowed to the left of the hinder end of the stomach, its hinder end that was a little narrower, was rounded; it was 5^{mm} long by a breadth of 3^{mm}; it opened by a round opening into the stomach. The yellowish biliary bladder (fig. 13 d), of a length of 2^{mm}, was on the left side of the stomach.

The heart was situated behind the basal part of the intestine. The blood gland was large, lying behind the central nervous system, partly covering the stomach, yellowish, 3^{mm} long by a breadth of 4^{mm} and a thickness of 0.5^{mm}.

The pericardio-renal organ (the renal syrinx) was situated under the rectum, a little more inwardly than the renal papilla, was melon-shaped, and showed the usual groups of longitudinal folds.

The hermaphrodite gland was whitish, and covered with its rather large lobes the uppermost and right side of the liver, especially in front; its large follicles contained large egg-cells and bundles of zoosperms. The anterior genital mass was large, 4.5^{mm} long by a height of 3.5^{mm}, and a thickness of 2.5^{mm}, it was situated under and to the right of the intestine. The last part of the spermatic duct (fig. 14 b) was thick, and passed into the short, cylindrical (glans) penis (fig. 14 c); this latter, as well as the spermatic duct, was without armature. The spermatheca appeared to be globular, its relation to the spermatocyst (fig. 15), which was filled with sperm, somewhat bent together, and about 1.5^{mm} long, was not to be determined. The mucous gland was lime-white, at the base of its duct was seen a larger, yellowhish gray part (the albuminous gland?).

D. Ingolfiana var.?

Pl. V, figs. 29—30.

The bulbus pharyngeus, of a length of 2.25^{mm}, was completely like that in the other specimen, only the end of the radula-sheath projected a little, and the muscular plate on the fore side of the mandibles was a little thicker. The mandibles were a little lighter, and the masticatory edge was only dark yellow; the secondary oral cavities were not small, and their opening rather wide; the masticatory edge as above. On the broad and flat tongue the sligthly yellowish radula was seen containing 11 rows of teeth, in the radula-sheath 20 were found, of which the three hindmost were not fully formed; thus the total number of tooth-plates was 31. On each side of the median tooth up to 18 lateral tooth-plates were found. The median teeth were yellow, the lateral teeth almost colourless; the height of the median teeth rose to 0.075^{mm}. The median teeth were essentially of the same form as above described, but had at the base of the hook a series of fine denticles (fig. 29). The lateral teeth were upon the whole somewhat more slender (fig. 30).

Future examinations must decide, whether we have here a new species, or only a variety.

Nudibranchiata cladohepatica.

R. Bergh, System der nudibranchiaten Gasteropoden. 1892. p. 999—1070.

Fam. Tritoniadae.

R. Bergh, System. 1892. p. 1066—1070.

Among the cladohepatic nudibranchiata this family appears to be the one most closely related to the holohepatic forms; the ramification of the liver otherwise peculiar to the cladohepatic forms, has disappeared, while the Tritoniadae in other respects have retained the essential exterior and interior characters of this group.

The representatives of this family are already easily distinguished exteriorly by their large frontal veil provided with appendages, and the spoon-shaped tentacles attached to it, further by their peculiar rhinophoria, and the branchial tufts on the dorsal edge. In the interior structure the always colossal bulbus pharyngeus especially shows peculiarities; the strong mandibles on its fore end are closely resembling those in the Pleurophyllidiae, and like those they are coated with a strong muscular plate on the fore side; the strong radula with many rows and many teeth in the rows has broad, somewhat depressed median teeth with a clumsy denticle on either side of the short and clumsy hook, and the innermost lateral tooth is essentially different from all the others.

Hitherto the Tritoniadae include only two chief types, the real Tritoniae without, and the Marioniae with masticatory plates in the stomach.

A sub-group under the Tritoniae is formed by

Candiella, Gray.

R. Bergh, l. c. 1892. p. 1069.

In this form the frontal veil has on the margin rather long fingers (not short papillæ).

The hitherto known forms of this group have been of smaller size than the typical Tritoniae; in this respect the form described below, differs from the others.

Candiella Ingolfiana, Bgh. n. sp.

Pl. II, figs. 20—22; Pl. III, figs. 4—9.

On 61 44' Lat. N., 27 00 Long. W. (station 81) one single specimen was taken at a depth of 485 faths. (bottom temp. 6 1). It was rather well preserved, only somewhat contracted and hardened, and behind on the left side was found a rupture with a prolapsus of the entrails.

The colour of the sole of the foot, the genital papilla, and the region of the mouth was somewhat yellowish; the other parts of the body were grayish blue, but the rhinophoria yellow. The length was 5^{cm} by a height of up to $1{\cdot}4^{cm}$, and a breadth of up to $1{\cdot}6^{cm}$; the breadth of the frontal veil was 8^{mm}, its length 5^{mm}, half of which belonged to the fingers; the height of the sheaths of the rhinophoria was 2^{mm}, of the branchial tufts up to 3^{mm}; the breadth of the sole of the foot was up to 12^{mm}, of the foot-brim up to $0{\cdot}75^{mm}$. — The animal seemed to have imparted a peculiar odour to the alcohol in which it was kept.

The form was as in other Candiellae. The animal was longish, highest in the middle, and sloping from there forward and especially backward where the back ultimately passed into the foot. The fore edge of the frontal veil was a little notched in the middle, and had on each side of the notch 6 fingers, and outermost the only little conspicuous tentacle with its furrow. At the base of the veil were seen the somewhat projecting sheaths of the rhinophoria; the strongly retracted club was $2{\cdot}5^{mm}$ high, and of the shape common in the Tritoniae, resembling a sword-knot, and the rhachis of the hindmost leaf was prolonged in the usual way. The back was smooth: the edge of the back that only projected a little, had on each side 12—14 small and short-branched branchial tufts, of which the foremost one projected outside the sheath of the rhinophore. The sides of the body were rather high, a little convex, and a little sloping inward towards the foot; the genital papilla was situated about under the the fifth (right) branchial tuft, the anus under the eighth, and close above it the renal pore. Anteriorly the foot was rounded, with a strong marginal furrow: the foot-brim was narrow.

The peritoneum was bluish black, and continuations of its connective tissue penetrated everywhere between and wrapped the entrails.

The yellowish white central nervous system showed a rather closely adherent, dense, and finely black punctuated wrapping; as in other Tritoniadae it was rather flat, 4^{mm} broad. The cerebro-pleural ganglia were of oval shape, 2^{mm} long, a little broader anteriorly, the separation between their two parts was only little conspicuous; the roundish pedal ganglia were almost as large as the cerebral ones; the large commissures were half as long again as the breadth of the central nervous system. The buccal ganglia were oblong, $0{\cdot}6^{mm}$ long, connected by a short commissure; the long-stalked gastro-œsophagal ones quite small, roundish.

The otocyst is situated closely before the quite short cerebro-pedal connective, containing a not large number of otoconia.

The large bulbus pharyngeus was 13^{mm} long by a breadth of 9^{mm} and a height of 7^{mm}, being thus one fifth of the whole length of the body; it was lying in a rather loosely attached veil-like wrapping. Its form and structure in all respects as in other Tritoniae. The mandibles covered with the common thick muscular plate, were greenish yellow, only the hindmost part of the hinge, and the portion nearest to the masticatory edge were brownish; the length of the mandibles was 13^{mm}, by a breadth (behind) of $4{\cdot}4^{mm}$, and a height (of the convexity) of $3{\cdot}5^{mm}$, the length of the masticatory prolongation was 3^{mm}. The masticatory edge was slightly convex, even, of a breadth of up to $0{\cdot}4^{mm}$, under the magnifying glass, as it were, finely transversely striated; it had 8—11 series of short, roundish-edged columns, of a height of up to $0{\cdot}10^{mm}$, and a diameter of up to $0{\cdot}08^{mm}$ (fig. 4), the series being somewhat displaced among each other; in the outermost series many of the columns were torn out, and many were worn away and upset more inwardly. — The pharynx was black, the buccal cavity grayish white. — The strong and broad tongue had at the base the powerful tectum radulæ measuring in length (from before backward) 2^{mm}; behind this was seen the short radula-sheath with its flat hinder end[1]); it was $3{\cdot}5^{mm}$ long, $3{\cdot}25^{mm}$ broad, and was to be seen on the outside of the bulbus pharyngeus where it shone through with a reddish tint. The light yellow radula contained 35 series of tooth-plates, the radula-sheath 32, of which the three hindmost were not yet developed, the whole number of plates was thus 67. The length of the radula, when prepared off, was 9^{mm}, and the breadth up to 7^{mm}. The foremost 11 series on the tongue were more or less defect, and the tooth-plates more or less worn and broken; in the 6—7 foremost series only the median tooth and a few lateral teeth were left. The number of tooth-plates in a series rose in the back part of the radula to 85. The tooth-plates were of a very light yellow. The breadth of the oldest median tooth was $1{\cdot}28^{mm}$, that of the youngest ones about the same. The height of the innermost lateral tooth was $0{\cdot}16^{mm}$, that of the next one $0{\cdot}20^{mm}$, and of the third $0{\cdot}24^{mm}$; the height of the lateral teeth rose to $0{\cdot}30^{mm}$, decreased towards the edge of the radula, and of the three outermost teeth it was 0.12—$0{\cdot}10$—$0{\cdot}08^{mm}$. The median teeth (fig. 5 a) were of the broad and short form common in the Tritoniae, with a clumsy median tooth, and a still more clumsy denticle on each side of this. The clumsy and rather low first lateral tooth (fig. 20; 5) was very finely denticulated along one edge of the hook; the hook of the second lateral tooth was a little longer (fig. 21; 5), but, as all the others, without any trace of denticulation; they had all (fig. 22; 6) the form common in the Tritoniae, the hook decreased in height through the outer teeth (fig. 7).

The whitish salivary glands, parallel to the œsophagus, were longish (7—8^{mm} long by a breadth of 2^{mm}), flat, highly lobed; the left one was lying on the black peritoneum, the right one under and behind the bulbus pharyngeus, between this and the anterior genital mass. The efferent duct was almost as long as the gland itself.

The œsophagus was externally and internally black, 17^{mm} long, in its greatest length sack-like widened (to a diameter of $5{\cdot}5^{mm}$), with deep folds on the inside, empty; it opened into the hind part of the stomach, close to the short biliary duct. The stomach, likewise black on the outside, but gray on the inside, was almost globular, of a diameter of 7^{mm}, and for half its length situated in a hollow in the liver: in the hindmost part of the stomach before the opening of the biliary duct was seen a circle of strong, yellowish, longitudinal folds; the cavity of the stomach was empty. From the fore end of the stomach arose the intestine, externally black, internally gray, of a whole length of 18^{mm} by a diameter of 4—2^{mm}, stretched over the anterior genital mass where it formed its curve, and continued somewhat thinner to the anal papilla; throughout almost the whole length of the intestine was seen, besides the fine longitudinal folds, the strong fold, rising to a height of up to 2^{mm}, that had already begun in the hind part of the stomach; also the cavity of the intestine was empty.

The hindmost visceral mass (the liver) was short-conical, broader in the hollowed fore end, with rounded hinder end, of a length of 15^{mm} by an anterior breadth of 12^{mm}, yellowish white, with a rugged surface, wrapped in a very abundant, black, loose, but rather adhesive connective tissue. From the liver itself a longish lobe, 10^{mm} long, stretched over the cardia between the œsophagus and the stomach, with the beginning of the intestine[2]).

[1]) Comp. Malakolog. Unters. Heft XV. 1884. Taf. LXXII, Fig. 5 (Tritonia Hombergi).

[2]) In the black wrapping round the hindmost visceral mass a Gordius-like worm was found of a length of fully 10^{mm} by a diameter of $0{\cdot}065^{mm}$.

The hermaphrodite gland was only of a little lighter colour than the liver, which latter it covered with a thin coating; in its lobes were found ripe oogene cells and spermatozoids. The duct of the hermaphrodite gland projected freely from under the stomach, and ran along the inside of the anterior genital mass. This latter is also provided with a strong, strongly adhesive, black wrapping, penetrating deeply between its single parts; it is large, longish, 14^{mm} long by a breadth of $7{\cdot}5^{mm}$, and a height of 7^{mm}. On the inside was seen farthest back the ampulla of the duct of the hermaphrodite gland which ampulla formed a couple of short windings; and before it was lying the black seminal vesicle with its long, big duct, and on its fore end the large bundle of the seminal duct. When stretched out the ampulla measured 8^{mm} by a diameter of 2^{mm}. The windings of the seminal duct that were closely attached to each other by the black, cobweb-like connective tissue, measured, when separated from each other and stretched out, 6^{mm} in length by a diameter almost everywhere of $0{\cdot}6^{mm}$. The seminal duct (fig. 9 a) opened in the top of the black, sacklike penis (praeputium) which was fully 6^{mm} long by a diameter of $2{\cdot}5^{mm}$ (fig. 9 b.); the walls of the cavity were gray, and in the cavity was lying the white, tapering glans (fig. 9), measuring, when stretched out, 15^{mm}, and to the very point pierced by the powerful seminal duct. The seminal vesicle (fig. 8 a) is, on account of its wrapping, black, as is also its duct; it is bag-shaped, 6^{mm} long by a diameter of $2{\cdot}3^{mm}$, completely filled with sperm; the powerful efferent duct (fig. 8 b) is somewhat curved; when stretched out it is 14^{mm} long by a diameter of $1—1{\cdot}5^{mm}$. The albuminous-mucous gland formed far the greater part of the anterior genital mass; it was higher and thicker behind than before, showed chiefly longitudinal windings, and was, when free of its black veil, of a yellowish white colour. The vulva and the end of the penis-bag were especially strongly pigmented, and wrapped in black connective tissue.

This Candiella, the largest one hitherto known, must certainly be a new species, what is also indicated by details in the outer and inner structure.

Fam. **Atthilidae,** Bgh. N. fam.

Forma corporis fere ut in Tritoniadis, subelongata, subquadrilateralis. Velum orale non parvum, margine laevi, utrinque tentaculatim prominens; rhinophoria vagina margine bilobata retractilia, clavo simpliciter perfoliato. Dorsum appendicibus paucis simplicibus (?) triseriatis praeditum; margine prominulo serie simplici branchiarum arbusculiformium (?) instructo. Anus et porus renalis laterales. Podarium sat latum, antice rotundatum.

Bulbus pharyngeus magnus. Mandibulae facie anteriori bulbi impositae, massa musculari forti tectae, sat elongatae, processu masticatorio nullo, margine masticatorio laevi. Lingva lata, radula multiseriata; rhachis dente angusto hamo elongato; pleurae multidentatae, dente intimo hamo denticulato, reliquis hamiformibus edentulis.

Hepar non ramificatum. Penis inermis.

The Atthilidae[1]) resemble, as to their common structure, the Tritoniae, but are, however, already in the exterior sufficiently marked off from those. The frontal veil is quite different from that of

[1]) *Ἀτθίς*, one of Sappho's female friends.

the Tritoniae, and does not show the tentacles, peculiar to those. The rhinophores are of a quite different structure. The back is not, as in the Tritoniae, without appendages, but has several series of such; the somewhat projecting dorsal edge appears to have a series of low branchial tufts, resembling those in the Tritoniae. The anus, the renal pore, and the foot are as in the Tritoniae.

The bulbus pharyngeus is very strong as in the Tritoniae, and as in those the mandibles are lying on the fore end of the bulbus, and are covered by a thick muscular plate; but they have no masticatory continuation, and the masticatory edge is smooth. The tongue is broad, and the radula bears a rather large number of series of teeth, and these series contain many tooth-plates. The median teeth are quite different from those in the Tritoniae, longish, with a protracted denticulated hook; also the lateral teeth are of a somewhat other shape, the innermost one with a denticulated hook. — Also with regard to the liver, and the relation between this and the hermaphrodite gland, there seems to be essential differences between the Atthilidae and the Tritoniadae, while both families otherwise seem to agree with regard to the genitalia.

The Atthilidae seem (as the Tritoniadae) to be rather voracious beasts of prey.

Hitherto the family comprises only the one genus

Atthila, Bgh. N. gen.

with the one species

Atthila Ingolfiana, Bgh. n. sp.

Pl. III, figs. 10—26.

At station 40 i. e. on 62° 00 Lat. N., 21° 36' Long. W. one single specimen was fished from a depth of 845 faths, where the temperature was 3°3.

It is stated to have been, when living, pink or of a pale flesh-colour. Preserved in 70 % alcohol it was upon the whole of a whitish or slightly yellowish white colour. Its length was $3{\cdot}2^{cm}$ by a breadth of up to $1{\cdot}7^{cm}$; the breadth of the frontal veil was 10^{mm}, the height of the sheaths of the rhinophores 3^{mm}; the length of the foot was 27^{mm} by a breadth of up to 10^{mm}, the breadth of the foot-brim was 3^{mm}. — The specimen was somewhat curved and contracted, the back with its edges somewhat rubbed.

The form was somewhat longish, broader before, evenly narrowing and sloping backward, upon the whole rather like the form in the Tritoniae. The frontal veil (fig. 10) was broad with smooth edges, and its rounded, somewhat tentacle-like lateral ends projected $2{\cdot}5^{mm}$, while its free upper margin was 3^{mm} broad. Behind the frontal veil, adjoining the fore end of the dorsal margin, the rhinophores were seen; their sheath stood out with a two-lipped edge (fig. 11), the hinder lip low and convex, the former one seen as a somewhat tapering lobe, $2{\cdot}5^{mm}$ long; in the depth between both the point of the club was distinguished; this latter was reddish gray, (highly contracted) $2{\cdot}5^{mm}$ high, rather short-stalked, with about 30 broad leaves (on either side), containing a number of highly refractive bag-glands, of a length of up to $0{\cdot}04^{mm}$. The back evenly convex, covered with small, whitish papillæ; as far as I was able to discern, 3 series of such papillæ were found, a median one with 5, and on either side a lateral one with 4—5 papillæ; only a single one was quite preserved, and was seen to be longish-conical (fig. 3 b) and of a height of 3^{mm}. The dorsal margin projected, about in the same way as in Tritonia, and appeared to have been covered with branchial tufts, resembling those seen in that family, only a few (— 4^{mm} high) remnants of these tufts were left. The sides of the body were as in Tritonia, rather high, and, on account of the projecting dorsal margin, a little hollowed and sloping inward; in front the genital papilla was found in the common place as in Tritonia, here with the glans penis stretched forth; a little before the beginning of the last third of the length of the body, and somewhat upward the anal papilla was seen projecting $1{\cdot}5^{mm}$; about midway between this and the genital papilla the minute renal aperture was seen. The foot is powerful; its fore end (fig. 10) rounded, with a slight marginal furrow; the foot-brim of a breadth of up to 3^{mm}; the back and foot were coalesced quite to the point.

The visceral cavity reached to the beginning of the last fourth of the length of the body.

The white (4—5^{mm} broad) central nervous system (fig. 12) showed the cerebro-pleural ganglia to be roundish, connected with a quite short commissure, with no distinct bordering between the two parts; the pedal ganglia scarcely smaller than the former, of an oval contour; the lower commissures rather long (fig. 12 d). The buccal ganglia were of an oval contour, connected by a commissure, almost six times the length of the ganglion (fig. 12 e).

The otocysts were situated behind the pleuro-pedal connective (figs. 12, 13) between the ganglia; they had a diameter of $0{\cdot}14^{mm}$, and contained a few (ca. 10) clear, round, and oval otoconia of a diameter of $0{\cdot}035$—$0{\cdot}04^{mm}$. The skin had no larger spicules.

The bulbus pharyngeus was large and powerful, somewhat resembling that in Tritonia, but shorter, 6^{mm} long by a height and breadth of 5^{mm}. In front it is (fig. 14) somewhat narrower, and foremost on the upper side it is higher (on account of the hinge-part of the mandibles); behind this projecting part the wide pharynx is found, and behind this the short and broad radula sheath (fig. 14); the margin of the upper side corresponds to the outer margin of the mandible, and below this (above on the side of the bulbus pharyngeus) a hollowing was seen. The labial disk is narrow; behind and outside of it is found, quite as in Tritonia, the powerful muscular plate resting on the fore side of the mandibles. These latter (figs. 14—17) are of a light amber-colour, $5{\cdot}5^{mm}$ long by a breadth of $1{\cdot}25^{mm}$, at the hinder end of $2{\cdot}25^{mm}$; the height of the convexity about 2^{mm}; they were rather thin, nor was the hinge-part thick, thinner as well as lighter in the outer hinder half (fig 17). The somewhat upwardly directed hinge-part is more narrow, the hinder end broader and emarginate in the middle (fig. 16); a masticatory continuation was completely wanting, and the masticatory edge was quite smooth throughout its whole length (fig. 17). The cheeks join the inside of the mandibles in their whole length; only foremost in the little mouth-cavity a short stretch (fig. 14) of the hinge-part of the mandibles is uncovered. The mouth cavity is almost quite filled out by the (highly contracted) large, high, and broad tongue (figs 14, 18), the middle part of which is through its whole length (fig. 18) covered by the light yellowish, rather broad radula, which farthest back continues in the short and broad radula-sheath ($2{\cdot}5^{mm}$ long, $4{\cdot}5^{mm}$ broad) (fig. 14). The tongue has 21 series of teeth, further back 12 series were seen, two of which were not yet fully developed. Thus the total number of series of teeth was 33. The number of tooth-plates on either side of the median tooth rose to 120. They were of a very light yellowish colour. The length of the median tooth-plates (on the hind part of the tongue) was almost 0.12^{mm} by a breadth of 0.065^{mm} and a height of 0.06 ; the heights of the three innermost lateral plates were $0.12—0.13—0.14^{mm}$, the 10^{th} measured already a height of 0.20 , and the height rose to 0.22^{mm}, whereupon it again decreased outward, the height of the three outermost being 0.08^{mm}, 0.06^{mm}, $0.035—0.04^{mm}$. The median tooth-plates (figs. 19, 22 a) showed a base, narrow anteriorly, broader posteriorly, from which rose a tapering hook, denticulated through the greater part of its length. The first lateral tooth (figs. 20, 21, 22 b) was denticulated on the inside of the hook. All the other tooth-plates showed no denticulation on the somewhat bent and tapering hook (figs. 23, 24); the outermost one was quite low (fig. 25 a).

The whole visceral mass, 23^{mm} long, up to 13^{mm} broad, was at the hinder end short-conical, and showed, when viewed from above, foremost the large, light grayish yellow liver, prolonged along the left side of the mass just to the hinder end; this prolongation has on the right side the hermaphrodite gland, and along part of the right edge the rectum.

The salivary glands were seen as a large and flat, yellowish mass on either side of the hinder part of the bulbus pharyngeus.

The oesophagus was short, and opened into the stomach that was completely covered by the liver. This stomach was 11^{mm} long by a breadth of 6^{mm}, with rather thin walls; to the right it was attached to the anterior genital mass with the exception of the region of the cardia, otherwise it was everywhere enclosed by the firmly adhering liver; its inside showed strong longitudinal folds; on the left side was seen a rather wide biliary opening, and on the right side more downwards a smaller one. To the right from the hinder end of the stomach rises the intestine, which is in its foremost, transverse course completely enclosed by the liver, then proceeds freely, and runs down towards the foot along the right side and the lower side of the hermaphrodite gland, running between this and the liver up towards the anal papilla, closely attached to both of those; the length of the intestine was 22^{mm}, its diameter at the base 5^{mm}, else $4—3.5^{mm}$; in the first part of it a long, beautiful, feather-shaped fold was seen. — The stomach and especially the intestine were distended by strongly brown-red, animal contents, whose colour was due to enormous masses of long finely-thorny and -rugged, reddish spicules, perhaps originating from a form of Alcyonidae; further was found in the stomach a canary-coloured, globular body, on one side a little hollowed in an umbilicate manner, of a diameter of 4^{mm}, the nature of which could not be made out.

The large, light grayish yellow liver covered with a layer, before somewhat thicker, behind thinner, the oesophagus, the stomach, the anterior genital mass, and part of the intestine; its foremost part was on either side attached to the wall of the body. The liver continues along the left side and the lower side of the hermaphrodite gland just to its point; in this part it rose to the largest thickness, up to 3.5^{mm}.

The pericardio-renal organ, of a length of 2^{mm}, was situated near the anus.

The yellowish white hermaphrodite gland was large, 16^{mm} long by a breadth of 6 and a thickness of 5^{mm}; before and behind a little narrower than in the middle; a little curved longitudinally; somewhat convex on the upper surface, concave on the lower one; with superficial furrows; finely gritty; of the common structure. In the endlobes were large oogene cells and zoosperms. — The anterior genital mass was from above hidden by the liver, situated before the intestine, attached to the right side of the stomach; it was of an oval roundish shape, 8^{mm} long by a breadth of 6^{mm} and a height of $5 \cdot 50^{mm}$, whitish and yellowish white. In a hollow on the hinder end of the mucous gland the intertwined, opaquely yellowish gray ampulla of the duct of the hermaphrodite gland was lying, measuring, when stretched out, 12^{mm} in length by a diameter of up to 2^{mm}; on the fore end were seen the windings of the spermatic duct forming a little coil; the glans that projected from the penis-bag, was almost cylindrical, 4^{mm} long by a diameter of $1 \cdot 75^{mm}$. Behind the spermatic duct and partly covered by it was the spermatocyst, bent double in the middle, 4^{mm} long when stretched out, its duct being of about the same length. The mucous-albuminiparous gland was whitish and yellowish white.

Fam. **Dendronotidae.**

R. Bergh, System d. nudibranchiaten Gasteropoden. 1892. p. 1048—1051.

The Dendronotidae form a group, rather well marked off by its peculiar forms; in this respect, however, but still more by the inner structure, and especially by the structure of the pharyngeal bulb, it proves to be related to the Aeolidiadae.

The animals belonging to this group, have hitherto only been found in the northern temperate, and especially in the cold seas.

The rather strongly limited family includes only two genera, the real Dendronotus and Campaspe, which latter seemed to be distinguished from the former by a simpler structure of the frontal appendages, of the rhinophoria, and of the dorsal papillæ. It is, however, still to be doubted, whether the two generic groups will not prove to be passing into each other, and the examination of the following form seems already to imply such a result.

Dendronotus, Ald. et Hanc.

R. Bergh, die Nudibranchien gesammelt während der Fahrten des „Willem Barents" in das nördliche Eismeer. 1885. p. 19—33 (Bijdragen tot de Dierkunde. Aflevering XIII. Amsterdam. Onderzoekingstochten van de „Willem Barents" Expeditie. Gedeelte IV (1886) 1888).

A little series of species has been referred to this genus, but they are likely to be, for the greater part, reduced to varieties of the typical species. The form examined below, seems, however, to be distinctly specifically different from the typical one.

1. **D. robustus,** Verrill.

D. robustus, Verrill. Americ. Journ. I. 1870. p. 405. Fig. 1.

— , V. Catal. of marine moll. added to fauna of New Engl. Trans. Conn. Ac. V, 2. 1882. p. 550.

D. velifer; G. O. Sars. Bidr. til Kundsk. om Norges arktiske Fauna. I. Moll. reg. arct. Norv. 1878. p. 315—316. Tab. 28, Fig. 2; Tab. XV, Fig. 15.

D. robustus, V. R. Bergh, die Opisthobranchien. Rep. on the dredging oper. off the West Coast of Central-Amer. ... by ... „Albatross". (Bull. of the Mus. of compar. zoöl. at Harvard college. XXV, 10). 1894. p. 141—144. Taf. II, Fig. 6—9; Taf. III, Fig. 1.

Pl. III, figs. 27—29; Pl. IV, figs. 1—5.

This species, which, like the typical one, is distributed over the northern parts of both the Atlantic and the Pacific ocean, is already sufficiently marked by its large and broad frontal veil, and by its simply fingered sheaths of the rhinophores (and the want of appendages at the outside of these). Constant differences in the inner structure between this and the typical species have hardly been pointed out.

On the 5th of August 1895 a single specimen was fished on Dyrafiord (on the west coast of Iceland), which was killed by means of anhydrous acetic acid, and preserved in 70% alcohol.

The well preserved specimen that was scarcely contracted to any appreciable degree, was 4^{cm} long, by a height of the body of $1{\cdot}2^{cm}$, and a breadth likewise of $1{\cdot}2^{cm}$; the breadth of the frontal veil from one point to the other $2{\cdot}5^{cm}$, the breadth of the head proper under the veil 10^{mm}; the height of the sheath of the rhinophores with their snips 6^{mm}, the height of the branchial tufts up to 7^{mm}; the length of the foot almost $3{\cdot}5^{cm}$ by a breadth of up to $1{\cdot}1^{cm}$; the breadth of the foot-brim $3{\cdot}5^{mm}$, the length of the tail 10^{mm}[1]. — The colour was whitish; but a few of the fingers of the frontal veil, the club of the rhinophores, the stem of some branchial tufts, and the genital papilla still showed remnants of an earlier red colour[2].

The form was as before described by me. The head proper, which was strongly convex, somewhat half-moonshaped, showed below the vertical mouth-slit, while the frontal margin had a series of sessile or quite shortstalked papulæ (fig. 1). Behind the head the enormous (from before backwards almost 5^{mm} broad) frontal veil was seen projecting strongly on the sides with its cleft ends; it bears a series of tentacle-like, unequally large appendages of a length of up to 4—5^{mm}, and set with small knots or short branches (fig. 1). Also between the frontal veil and the frontal margin of the head small papulæ are seen here and there. The sheath of the rhinophores as usually high (fig. 27), at the top running into 4—5 unequally large, fingershaped continuations; the club as usual; no appendage at the base of the sheath. On the right margin of the back were seen four branchial tufts, and on the left margin six more irregular ones; the foremost were bipartite, the stems at the base separated or nearly united, and outside of these still a satellite like a branchial tuft was seen, in a few instances coalesced with the branchial tuft proper; this satellite was wanting in the hindmost branchial tufts. On the tail were seen medianly three unpaired gill-like appendages, but only the foremost one showed any trace of leaves (fig. 2). Closely in front of the right second branchial tuft the anal papilla and the renal pore were seen. The back was quite smooth, without any papulæ or small appendages. The genital papilla as usual strong, with conically projecting praeputial papilla in front, and behind this a bent, strong fold covering the vulva.

The intestines were nowhere distinctly seen from without, only on the sides they shone through with a grayish tint.

The visceral cavity reached to the base of the tail.

The central nervous system was milk-white. In the cerebro-pleural ganglia the two

1) Harrington, in the biological section of New York Acad. of sc. (9th of Novbr. 1896), pointed out that the large, pale specimens of Dendronotus from Puget sound could reach a length of full 25^{cm}. Comp. Anatom. Anz. XIII., 1897. p. 95.

2) According to Sars (l. c. p. 315) the living animal is said to be light red (laete rufescens) with numerous scattered white dots.

divisions were strongly marked off from each other, almost globular; the cerebral ones were a little larger than the pleural ones. The pedal ganglia proceeding downward and inward from the mass of the cerebro-pleural ganglia, were of a short-ovate form, a little larger than the cerebral ones, connected by a double commissure, which was shorter than the diameter of the ganglia. The buccal and gastro-oesophagal ganglia as in the typical species.

The eyes of a diameter of $0{\cdot}11^{mm}$, with a black pigment, and dark yellow lens of a diameter of $0{\cdot}03^{mm}$.

The bulbus pharyngeus was 6^{mm} long, by a breadth of $5{\cdot}5^{mm}$, and a height before of 4^{mm}, behind of 3^{mm}; its form was as in the typical species. On each side of the round labial disk was seen inwardly a narrow, irregular, dirtily yellow stripe, which was formed of straight or irregularly bent, only little stiff, unequally long, unequally thick, colourless or slightly dirtily yellowish staves (fig. 3) of a length of at least $0{\cdot}16^{mm}$ by a breadth of $0{\cdot}007^{mm}$ [1]). The mandibles were about as long and high as the bulbus pharyngeus, lemon-coloured, only in the hinge-part of a black-brown colour. The projecting portion in front and above together with its prolongation as in the typical species; the masticatory process short with a not large number (at most ca. 50) of denticles which only reached to a height of $0{\cdot}04^{mm}$, and were rather worn and blunt. The secondary (supplementary) oral cavities were rather large, and their opening not narrow. The tongue as usual short, powerful, and keelshaped, with a long foremost, and short upper edge (fig. 28). In the radula, which on account of the median teeth is yellow, were counted on the fore edge of the tongue 11 series of tooth-plates, and marks after several that had fallen off, and on the short upper edge three series; the continuation of the radula in its sheath in the greatest length light red, and containing 16 series of tooth-plates, of which the two hindmost ones were not yet developed; the total number of series was thus 30. The foremost series were very incomplete, and most of the teeth on the tongue were much worn. The breadth of the oldest median teeth was $0{\cdot}18^{mm}$, in the hinder part of the tongue it rose to $0{\cdot}22^{mm}$, and upon the whole it rose to $0{\cdot}29^{mm}$. The strongly coloured median tooth-plates had a strongly projecting hook, on this and to both sides of it was found a not very large number (most frequently about 25) of not very strong denticles (fig. 4). The number of the almost colourless lateral tooth-plates varied from 13 to 15; the innermost plate was a little smaller than the following one, they decreased in size outward, and the two outermost ones, especially the very outermost one, were small; none of them showed (through the whole length of the radula) any trace of denticulation (fig. 5) [2]).

The salivary glands were as in the typical species.

The oesophagus in the first (3^{mm} long) part is rather narrow, then widening and with numerous longitudinal folds that shine through on the exterior, running on and between the two anterior livers, altogether about 14^{mm} long. The thinwalled stomach, which is also provided with numerous longitudinal folds, is almost globular, of a diameter of 5^{mm}, and situated before the principal

[1]) In the two specimens of *D. robustus* that I have examined earlier, no traces of such a prehensile ring were seen, and only in 4 out of 12 examined individuals of *D. arborescens*; in a specimen of *Dendr. Dalli* the prehensile ring was not wanting, nor in a single specimen of *D. purpureus*.

[2]) Verrill as well as G. O. Sars state the lateral teeth also to be quite or almost quite without denticulation; on the contrary the specimen earlier examined by me, showed a slight and irregular denticulation. The denticulation of the lateral teeth in the Dendronotidae is upon the whole always much varying.

liver, between and on the two anterior livers; near the pylorus it receives in front and below two short and wide biliary ducts from the anterior livers, and behind a similar duct from the principal liver. To the right and upward the stomach opens into the intestine; this was in the first part much distended (wider than the stomach), passes over the hindmost part of the right anterior liver, bends downward along, and is attached to, the anterior genital mass, forms a large curve on the right side of the principal liver, and then rises to the anal papilla; the whole length of the intestine was 2·75^{cm} by a diameter generally of 0·75—1·5^{mm}; the inside of the intestine showed numerous longitudinal folds, of which one was higher than the other. The stomach and the foremost (distended) portion of the intestine was filled with abundant, white and gray, black-dotted contents consisting of animal substance, the greater part of wich could not be determined, mingled with pieces of Copepoda, bristles of Annelida, cnidæ, and grains of sand.

Two anterior livers and a principal liver were found as usual, but separated from each other to a smaller degree than is otherwise the case in the Dendronotidae. They were all of a dirty yellow colour, very strongly lobed, and the lobes loosely connected; I did not succeed in substantiating the existence of liver-branches going into the interior of the branchial tufts. The two anterior livers were somewhat depressed, joining each other on the lower side of the stomach; from as well the right as the left one a conical continuation, 4—5^{mm} long, runs up towards the base of the first branchial tuft. The principal liver, together with the hermaphrodite gland which rested on and was loosely attached to it, formed a conical mass, 18^{mm} long, and, in front, 9^{mm} broad, the fore end of which showed deep impressions of the stomach and the anterior genital mass. It is possible that the fore end of the liver passed directly into the two anterior livers.

The large, flaccid ventricle of the heart was 4·5^{mm} long. The whitish pericardio-renal organ 2^{mm} long, of the usual structure[1]).

The large, yellowish white hermaphrodite gland rises with its fore end a little over the liver, along which it runs to its hinder end; it is composed of small, mostly roundish finely gritty lobes, and in the lobules (the grits) there are ripe oogene cells and spermatozoids. The anterior genital mass was large, a little compressed, 8^{mm} long, by a height of 8^{mm}, and a thickness of 4^{mm}; on the upper edge was seen in front a bundle formed by the windings of the spermatic duct; partly covered by this on the right side of the mass was the smaller bundle of the windings of the prostate gland, and the spermatic vesicle; and behind those the closely set, corkscrew-like windings of the ampulla[2]) of the duct of the hermaphrodite gland. The male branch of this passes directly into the prostate gland formed by the numerous windings of the spermatic duct; it was a little compressed-globular, of a diameter of 2^{mm}. The freely projecting spermatic duct forms a larger bundle of loosely connected windings measuring, when stretched out, about 4^{cm}. The retracted, thinwalled praeputium had a length of 6^{mm}; the strongly contracted (glans) penis was 4^{mm} long, conical (fig. 29). The pear-shaped spermatotheca (2^{mm} long) and the long vaginal duct as in the typical species. The greater part of the anterior genital mass is formed by the powerful, limewhite and white mucous gland, on its right side of a more gray portion (the albuminous gland).

[1]) Comp. R. Bergh, Nudibranch. .... des Willem Barents. 1885. Taf. II, Fig. 24b.
[2]) Comp. l. c. 1885. Taf. II, Fig. 26.

In 1896 were further taken, on 66°35′ Lat. N., 23°47′ Long. W. (station 129), from a depth of 117 faths (temp. 6°5), 2 specimens, which were strongly distorted by being preserved in alcohol. — They showed here and there strong traces of a purple colour, and had a respective length of $3{\cdot}5^{cm}$ and $2{\cdot}3^{cm}$. The common appendages of the frontal veil were reduced to two not very distinctly separated rows of knots or low papillæ, and only the lateral ends of the veil projected strongly and in a cleft manner; there was no tuft at the base of the simply fingered sheaths of the rhinophores; the larger individual had 6, the smaller one 3 pairs of branchial tufts.

2. **Dendron. arborescens** (O. Fr. Müller).

Sml. R. Bergh, die Nudibranchien ...... des Willem Barents ». l. c. 1885. p. 25—33. Taf. II, Figs. 12—28.

As well in 1895 as in 1896 several specimens were fished of this species, that is distributed both in the eastern and western parts of the Atlantic, from the Polar sea to the bay of Biscay, and also is found in the Pacific.

On 66°35′ Lat. N., 55°54′ Long. W. (station 31) 2 specimens were obtained from a depth of 88 faths. (temp. 1°6), one of wich had a length of 4^{cm}, by a height of $1{\cdot}3^{cm}$, and a breadth of $0{\cdot}7^{cm}$; in the other specimen the corresponding measures were $2—0{\cdot}5—0{\cdot}45^{cm}$. The frontal veil had in the former specimen 12 appendages, in the latter 8; the former had 8, the latter 5 pairs of branchiæ.

On 65°17′ Lat. N., 54°17′ Long. W. (station 34) three individuals were taken from a depth of 55 faths. measuring in length $2{\cdot}4—2{\cdot}2—1{\cdot}3^{cm}$; they had all six pairs of branchial tufts.

On 65°34′ Lat. N., 54°31′ Long. W. (station 34), on a depth of 68 faths. (temp. 0°2) was finally taken two specimens. One of them was 2^{cm} long; the other (the frontal veil of which was quite bitten away, and the bulbus pharyngeus laid bare and projecting) measured only $1{\cdot}4^{cm}$; the former had 8 appendages on the frontal veil and 7 pairs of branchial tufts, the other only 6.

All these (7) individuals were of a yellowish white colour. By my earlier examinations I have found, in 13 out of 28 individuals, 8 appendages on the frontal veil, and I never found more than 10 appendages; one of the 7 here examined had 12 such. The number of branchial tufts in the earlier examined specimens was generally 6, and did not exceed 7; in one of those here examined, 8 tufts were found on each side. The anal papilla was in these, as in the earlier examined specimens, always situated between the first and the second branchial tuft.

Fam. Aeolidiadae.

Subfam. **Coryphellidae.**

R. Bergh, System d. nudibranch. Gasteropoden. 1892. p. 1027—1029.

The Coryphellidae have long, simple (not perfoliated) rhinophores (*Himatella* only forming an exception in this respect). The radula has three series of tooth-plates, and the lateral teeth are denticulated. The penis is without armature.

The family comprises the genera *Coryphella* with lengthened, slender body, and a masticatory edge of the mandibles bearing several rows of denticles; *Gonieolis*, which is more clumsy with a broad head with strong rhinophores; and the nearly related *Chlamylla* with its projecting dorsal brim, its scarcely denticulated masticatory edge, its scarcely denticulated lateral teeth, and a developed prostate gland; the genus *Himatella*, finally is separated from the others by its perfoliated rhinophores.

Coryphella, Gray.

R. Bergh, l. c. 1892. p. 1027—1029.

A series of species of this genus have been described, but great part of these, surely, will disappear as being synonymous.

They belong for the greater part to the more cold and temperate parts of the sea.

Coryphella sp. (anonyma).

Pl. V, figs. 14—16.

In 1895 two specimens were taken on 66°35' Lat. N., 55 54' Long. W. (station 31) at a depth of 88 faths (temp. 1·6), one 2^{cm}, the other $1·5^{cm}$ long; preserved in alcohol they were quite yellowish white.

In the larger specimen the body was 4^{mm} high, 7^{mm} broad; the highly contracted tentacles and rhinophores had a length of only $3·5^{mm}$, the papillæ rose to a length of $4·5^{mm}$; the foot was $4·5^{mm}$ broad, of which $1·5^{mm}$ belonged to the footbrim, moreover the corners of the foot projected $1·5^{mm}$; the length of the tail was also $1·5^{mm}$. — In the back of the neck the central nervous system with the black eyes shone through, on the right side of the body the white anterior genital mass did so.

The form was as usual. The papillæ closely set on the lateral parts of the back, were indistinctly arranged in transverse rows, and these rows, perhaps, were gathered into three chief groups, the rows containing scarcely upwards of 4—6 papillæ; the papillæ were firmly attached, lengthened-conical. The projecting anal papilla was situated under the middle of the length of the dorsal edge, the fine renal pore midway between this and the genital papilla.

The cerebro-pleural ganglia were angular-oval, with a distinct transverse furrow; the roundish pedal ones were a little larger than the pleural ones, the commissures between them rather short. The nerve-cells, especially those of the pleural ganglia, were very large, and rose to a diameter of $0·26^{mm}$. — The almost sessile eyes had a diameter of $0·12^{mm}$ with a large yellowish lens; the otocysts were only a little larger than the eyes, with many clear otoconia.

The bulbus pharyngeus was 3^{mm} long, by a height of $1·75^{mm}$, and a breadth of 2^{mm}; of the common form, the radula-sheath only slightly projecting. The light yellow mandibles were of the same length as the bulbus; the hinge-part was not strong; the masticatory process short; the masticatory edge with 4—5 rows of rounded teeth (fig. 14) rising only to a height of $0·009^{mm}$. The secondary oral cavities were rather wide, but their opening rather narrow. The tongue of the common form, the radula colourless. The median tooth-plates were yellowish in the basal part, otherwise the tooth-plates were almost colourless. The height of the median teeth on the hinder part of the tongue was $0{\cdot}08^{mm}$, the length $0{\cdot}24^{mm}$; the length of the lateral teeth $0{\cdot}26^{mm}$ (the oldest only measured 0.20^{mm}), and their height $0{\cdot}09^{mm}$. On the tongue were seen 12 series of tooth-plates, and in the radula sheath 11 series, two of which were not fully developed; thus the whole number of series was 23. The median tooth-plates (fig. 15) had 6—7 denticles on either side of the only slightly projecting point. The lateral plates had 9—12 denticles on one edge (fig. 16).

The oesophagus was of the same length as the bulbus pharyngeus.

I am not able to decide whether this form is new, or is to be referred to one of the species already described.

Coryphella sp.

Pl. IV, fig. 20; V, figs. 11—13.

Of this form one specimen was taken on Isafjord on the 7th of June 1895, and preserved in 70% alcohol.

This individual was 9^{mm} long, by a breadth of $2{\cdot}5^{mm}$ and a height of 3^{mm}; the length of the rhinophores and the tentacles was $1{\cdot}5^{mm}$, of the dorsal papillæ $2{\cdot}5^{mm}$; the breadth of the fore end of the foot with its corners projecting in a fingerlike manner, was $2{\cdot}25^{mm}$. — The colour was now only whitish with strong remnants of a dark brown pigment, especially on the back and sides.

The form was as in other Coryphellae. The head was large; the papillæ (which had for a great part fallen off) appeared to be gathered into four groups that only seemed to contain few series, and few papillæ in each series. The anal opening was at the hind end of the second group of papillæ, in the dorsal edge.

The bulbus pharyngeus was 2^{mm} long, of the common form; the secondary mouth cavities were rather large, their hind wall black-brown, their opening wide. The mandibles were yellowish, with a darker hinge-part, the masticatory edge had a series of (about 40) denticles mostly truncate (fig. 11), and inside of these several irregular series of low tubercles (fig. 11). The tongue was of the common form, with 5 series of tooth-plates, further back 9 series were found, two of which were not yet consolidated; thus the total number of series was 14. The median tooth-plates were yellow, the lateral ones almost colourless. The length of the median plates was $0{\cdot}20^{mm}$, by a breadth of $0{\cdot}10^{mm}$, and a height of $0{\cdot}08^{mm}$; the length of the lateral ones was almost $0{\cdot}14^{mm}$. The median tooth-plates (figs. 12a, 13; 20a) were of the common form, with 5—6 powerful denticles on each side of the short, a little bent point. The lateral tooth-plates (figs. 12b; 20b) had the common form, with a less deep notch in the fore end, and commonly with 12—13 denticles.

This Coryphella seems scarcely to be identical with the preceding one, the lateral teeth especially being too different for that.

Cor. salmonacea (Couth.).

Coryphella salmonacea (Couth.). R. Bergh, anatom. Bidr. til Kundsk. om Aeolidierne. Kgl. D. Vidensk. Selsk. Skr. 5. R., naturv. og mathem. Afdel. VII. 1864. p. 227—237. Tab. IV.

Pl. IV, figs. 18—19; Pl. V, figs. 2—8.

To this species may with rather great certainty be referred 3 specimens, taken on 65°34' Lat. N., 54°31' Long. W. (station 29) at a depth of 68 faths (temp. 0°2). — One large individual was quite eviscerated, of the other the bulbus pharyngeus was taken.

According to an accompanying note the living animals were white with brown dorsal papillæ[1]). The specimens that had been preserved in alcohol, were as a rule of a yellowish white colour.

The length of the two large individuals was now 2·5^{cm}, while the little one only measured 1·5^{cm}; the breadth of the body was in the two former 8^{mm}, in the latter 3·5^{mm}, the height of the body respectively 7^{mm} and 3^{mm}. In the large specimens the tentacles had a length of 5^{mm}, the rhinophores of 6^{mm}, and the dorsal papillæ of up to 3·5^{mm}; the foot rose to a length of 6·5^{mm} and a breadth of 5·5^{mm}, the corners of the fore edge were only little produced, the foot-brim was narrow, the tail short.

The form was as usual. The head was as before (l. c. pl. IV, figs. 34, 40) described. The not broad, papillose lateral parts of the back showed close-set, indistinctly separated, and often displaced transverse and oblique series of papillæ, the series mostly containing 4—6 papillæ. The papillæ were lengthened-conical, and did not easily fall off. — From the region of the strong genital papilla the intestine was seen very distinctly shining through in its direct course to the anal papillæ, projecting at the dorsal edge a little behind the middle of the length of the body; the fine renal pore was seen (above the intestine) midway between the genital and the anal papilla. — The foot was powerful, rather broad.

The white central nervous system was as before (l. c. fig. 41) described by me; the right pleural ganglion sent forth a rather long N. genitalis forming a rather large ganglion (of a diameter of 0·24^{mm}) with one large cell (diam. 0·16^{mm}) and several smaller cells.

The almost sessile eye situated in front of the cerebro-pedal connective, is globular, of a diameter of 0·12^{mm}. Close behind the eye the otocyst is seen of a diameter of 0·14^{mm} with a not great number of clear otoconia.

The bulbus pharyngeus is large and powerful, in the two large individuals of a length of 5·5—6^{mm}, by a breadth of 4—4·5^{mm} and a height of 3·25^{mm}. Its form was as has earlier been described (l. c. figs. 1—3); the labial disk large, the radula sheath projecting in a knoblike manner; in situ the mandibles were seen of a light grayish brown colour. They were of the earlier (l. c. figs. 4—6) described form, greenish yellow with a not strong hinge-part, short and powerful masticatory process; the masticatory edge rather broad with mostly 8—9 series of obtuse or, on the edge itself, pointed denticles (fig. 2). The secondary oral cavities were not small, but their opening narrow (comp. l. c. figs. 4, 10); their hinder wall is, for the greater part, covered with a strong, yellow cuticle, crossed

[1]) According to the MSS of the Greenland investigator Møller (comp. l. c. 1864. p. 228) the animals are said to be semitransparent, pink, with gray-brown or red papillæ with white point.

by parallel, curved lines. The tongue is as earlier described (comp. l. c. figs. 14—17); the shining, greenish yellow radula contained in one specimen 13 series of teeth, in the other 16 series; further back were seen in the radula sheath in one specimen 17 series, in the other 14 series, of which the two hindmost ones were not yet fully developed; thus the whole number of series was 30[1]). Of the series on the tongue the 9—10 foremost ones showed more or less worn tooth-plates, especially the lateral plates were sometimes broken or torn out. The median teeth were yellow, the thin lateral teeth colourless. The height of the median teeth behind the middle of the tongue was $0{\cdot}28^{mm}$, hindmost in the radula-sheath it was $0{\cdot}37^{mm}$; the length of the lateral teeth rose to $0{\cdot}29^{mm}$ by a breadth of the base of $0{\cdot}12^{mm}$. The median teeth (fig. 3a) showed a short bifurcation of the side parts of the base; the hook had commonly down the sides 8—9 denticles, of which all the outer ones were small. The lateral teeth were flat, thin, tapering, with a rather broad base, finely and closely denticulated along the greater part of their inner edge (fig. 3b, 4).

The salivary glands (Gland. salivales) were white, lengthened, attached to the stomach, composed of lengthened, ramifying lobes (fig. 5). Partly interwoven with this another gland (Gl. ptyalina?) seemed to be, the lobes of which were longer, thinner, and of a quite different appearance (fig. 6); its long excretory duct was rather abundantly set with small glandular lobes (fig. 6), and perhaps it opened into the mouth tube[2]).

The oesophagus had a length of $1{\cdot}5^{mm}$; the inside showed strong longitudinal folds. The stomach was large, bagshaped, 9^{mm} long by a diameter of 4^{mm}; from its cardia fine folds radiated continuing through the whole length of the stomach and farther down through the blind bag of the stomach, and out through the intestine. The intestine originating from the hinder end of the stomach, runs to the right a little forward, and then with a bend backward. — The stomach and the fore part of the intestine had ample whitish and gray contents, which were for the greater part of an indeterminable animal nature, but in which were found portions of small crustacea and hydroidea, as well as diatoms, cnidæ, and grains of sand.

The large, light yellowish white hermaphrodite gland reached behind only to the last third of the length of the body; it rested on the blind bag of the stomach (the principal biliary duct), which continued backward to the beginning of the tail; the length was 8^{mm} by a breadth (behind) of up to $3{\cdot}5^{mm}$ and a thickness of up to 2^{mm}; it was composed of 4 large lobes; in the small endlobes were ripe oogene cells and spermatozoids. — The whitish anterior genital mass was 5^{mm} long and broad. In front was lying the large (fig. 7b), 5^{mm} long bag of the penis, which was rather thick-walled; the white glans was only 1^{mm} long, a little curtailed, compressed-conical (fig. 8). The seminal duct (figs. 7a, 8a) was very long, and formed a large bundle. I did not succeed in finding the seminal vesicle.

Coryph. salmonacea (C.), var.

Pl. V, figs. 9—10.

A specimen of this species that has come to hand after the finishing of the preceding examination, was taken on 65° 17′ Lat. N., 54° 17′ Long. W., at a depth of 55 faths, and preserved in 70 % alcohol.

[1]) The number of series in 7 earlier (l. c.) examined specimens was 29—32, in one it even rose to 36.

[2]) Comp. l. c. p. 236.

The specimen, which had lost great part of its dorsal papillæ (they were lying loose in the glass), was of a whitish colour, only the papillæ being slightly brownish. The length was 18^{mm} by a height of the body of up to 4^{mm} and a breadth of 6^{mm}; the length of the rhinophores and the tentacles was $2{\cdot}5^{mm}$, of the papillæ — $3{\cdot}5^{mm}$; the breadth of the foot in front was 4^{mm}, the length of the tail only 1^{mm}.

The form was as in the other specimens. The number of the papillæ in the series (numbering perhaps 60) seemed to be 6 7. Also in this specimen the rectum shone whitish through in its course to the anal papilla.

The powerful bulbus pharyngeus together with its conical radula sheath, was 5^{mm} long by a breadth of $3{\cdot}6^{mm}$, and a height of $2{\cdot}4^{mm}$. The mandibles were yellowish with black-brown hinge-part; the masticatory edge as above described. The hinder wall of the secondary oral cavities was seen as black-brown towards the narrow entrance. The tongue had twelve series of teeth; farther back 16 series were seen, the two hindmost of which not yet consolidated; thus the total number of series was 28. The median teeth were yellow, the lateral ones almost colourless; the former rose to a height of $0{\cdot}26^{mm}$, the latter had a length of $0{\cdot}25^{mm}$. The median teeth as above, but the denticles (8—12) most frequently a little more numerous (fig. 10) as also the denticulation on the lateral teeth (fig. 9) oftenest a little more marked.

Goniëolis, M. Sars.

M. Sars, Beretn. om en i Sommeren 1859 foretagen zool. Reise ved Kysten af Romsdals Amt. 1860. p. 4.

G. O. Sars, on some remarkable forms of animal life from the great deeps of the Norwegian coast. I. 1872. p. 39—40.

R. Bergh, die Nudibranchien . . . . des Willem Barents . 1885. p. 13—18 (Bijdragen tot de Dierkunde. Aflevering XIII. Amsterdam. Onderzoekings-tochten van de Willem Barents Expeditie. Gedeelte IV (1886). 1888).

— , l. c. 1892. p. 1029.

Corpus oblongum, subdepressum, subpalliatum; caput sat latum tentaculis fortibus productum; rhinophoria fortia, simplicia, elongata; podarium dorso paullo latius, antice vix angulatum.

Margo masticatorius seriebus denticulorum minutissimorum armatus. Dentes laterales radulae fere ut in Coryphellis.

This genus, which belongs to the family of the Coryphellidae, has the characters common in this family; the long, simple rhinophores and a lateral tooth on each side of the median teeth of the radula. It is most nearly related to the genus *Chlamylla*, and it will perhaps, by further examinations, be impossible to maintain the generic separation of these two generic forms.

Goniëolis has a somewhat peculiar and depressed clumsy form with projecting dorsal edges, and colossal rhinophores and tentacles; the masticatory edge of the mandibles has several series of quite small irregular knobs.

Hitherto the genus only comprised the species found by Sars and examined by me. The Ingolf expedition has brought home two specimens of Goniëolis, mutually different, and one of them especially so deviating from the typical species, that I have thought it better, at least for the present, not to identify these new individuals with the typical species.

1. **Gon. typica**, M. Sars.

R. Bergh, l. c. 1885. p. 14—18. Taf. III, Fig. 1—26.

This species seems to be marked off from the two others by a different form of the mandibles, by a stronger denticulation of the lateral teeth (and perhaps by the want of a specially developed prostate gland).

2. **Gon. intermedia**, Bgh. n. sp.

Pl. IV, figs. 16—17.

Together with the following species one individual of the present species was taken on June 11th, at 9·30 a. m. on 66° 43′ Lat. N., 55° 57′ Long. W. with the trawl from a depth of 88 faths (temp. 2·6—2°).

The specimen that was rather well preserved in alcohol, was of a whitish colour; its length was 2·7cm, the other measures relatively as in the following species.

The form was as in the typical species, the dorsal lateral edges more projecting than in the following species; the corners and the fore edge of the foot distinctly projecting, more so than in both the other species; the flaccid, dorsal papillæ, many of which had fallen off, rose to a length of 6mm; the genital openings were quite as in the typical species, and so was the anal papilla.

The central nervous system together with eyes and otocysts were as in the species described below.

The bulbus pharyngeus was to a remarkable degree like that in *Chlamylla borealis*[1]), and was likewise hollowed in the hinder part of the upper surface; it was 4mm broad by a length and height of 3mm. The light yellow mandibles had the same form as in the following species; only the keel in front on the outside was a little slighter; the masticatory process and the masticatory edge were quite as described below. The tongue was quite as in the following species; in the colourless radula 8 series of teeth were seen, and as many in the short radula sheath, which was directed backward; thus the total number of series was 16, of which the two hindmost ones were not yet quite developed. The tooth-plates were almost quite colourless; the breadth of the median teeth rose to 0·20mm by a height of 0·10mm, and a length of 0·35mm; the length of the lateral teeth rose to 0·20mm. The form of the median tooth-plates (figs. 16a, 17a) was between the form of those in the preceding species and those in the following one, though nearer to the latter; on each side of the rather short point 12—15 rather strong denticles were seen. The lateral tooth-plates (figs. 15b, 17b) were shorter and more clumsy than in both the other species, and without denticulation.

1) Comp. R. Bergh, die Nudibranchien ... des »Willem Barents«. l. c. p. 11. Taf. I, Fig. 11.

The anterior genital mass was of about the same form as in the typical species, 6^{mm} long by a breadth of 4^{mm} and a thickness of 5^{mm}. The ampulla of the duct of the hermaphrodite gland was also as in the typical species, forming several windings. As in the following species[1]) a little whitish prostate gland of a diameter of 2^{mm} was found, formed of fine interwoven windings; the muscular seminal duct arising from this gland, was loosely rolled to a little bundle, also as in the following species, its thinner fore end plunged into the top of the little preputial bag which projected externally with its foremost edge; from this bag the highly tapering glans penis projected 3^{mm}[2]). The seminal vesicle as in the other species continuing in its powerful duct, the opening of which was seen in the depth of the vulva[3]) that projected externally. The white and whitish albuminous-mucous gland formed the greater part of the anterior genital mass.

By the examination and the specific determination of Nudibranchiata it is frequently an awkward thing that this examination and determination has to be made by the means of only one individual, especially when the forms of this individual as far as possible have to be spared. Many of these animals seem to be able to vary considerably as well with regard to the outer as to the inner structure. The individual here examined, agreed in the outer form more with the typical species, in the nature of the mandibles and the presence of a prostate gland with the following species, but differed from both by the structure of the radula.

3. **Gon. atypica,** Bgh. n. sp.

Pl. IV, figs. 6—15; Pl. V, fig. 1.

Of this form one specimen was taken on July 11^{th} 9·30 a. m. on 66°43′ Lat. N., 55°57′ Long. W. with the trawl from a depth of 88 faths (temp. 2·6—2°).

The individual, which was well preserved in alcohol, was generally of a whitish colour[4]). — It surpassed in size the hitherto found Goniëolides; its length[5]) was $5{\cdot}5^{cm}$, by a breadth of the back of $1{\cdot}6^{cm}$ and a height of $1{\cdot}3^{cm}$. The length of the tentacles in this colossal individual rose to 11^{mm}, and that of the rhinophores to 15^{mm}; the breadth of the lateral parts of the back, that were set with papillæ, appeared to rise to 4—5^{mm} and the remaining papillæ rose only to a length of at most 3^{mm}. The length of the foot was almost 5^{cm} by a breadth of up to $1{\cdot}6^{cm}$; the breadth of the foot-brim was 3^{mm}, and the length of the tail 3^{mm}.

The form is somewhat flattened, and the height evenly decreasing backward, very slight at the hinder end. The head (figs. 6, 7), the region between the rhinophores and the tentacles, sloping

1) It is hardly possible that I should have failed to notice the existence of a prostate gland in the typical species.

2) Comp. R. Bergh, die Nudibranchien ... des Willem Barents. l. c. p. 18. Taf. III, Fig. 25 cf. 2.

3) Comp. l. c. p. 18. Taf. III, Fig. 2 f.

4) According to Sars the colour of the typical species is commonly yellowish white, only the lateral parts of the back (on account of the liver) being yellowish brown; in the median line of the body, especially on the sole of the foot, a minium-red stripe shone through.

5) The (3) individuals of *Gon. typica* examined by Sars, measured 12^{mm}, the (3) specimens earlier examined by me, measured 2—$2{,}3^{cm}$ in length.

forward; in front the strong conical tentacle (fig. 6a) projects on either side; behind the rather close set, longer, and more powerful rhinophores, likewise conical (fig. 6b); in front the roundish outer mouth. The back is broad, its last fourth part highly decreasing in breadth, almost flat, smooth; its lateral parts rising only a little over the sides of the body. The papilligerous lateral parts are rather narrow, in front almost stretching to the base of the tentacles (fig. 6c—a), behind almost meeting at the base of the tail. The papillæ were densely crowded without being distinctly placed in oblique series, those series perhaps containing 6—8 papillæ[1]). The size of the papillæ is upon the whole as in other Aeolidiadae, decreasing outwardly; the remaining papillæ were uncommonly small, conical, and did not fall off quite easily. The sides of the body were not quite low. In the region under the right rhinophore a rather long and rather strongly projecting fold was seen running towards the anus; the fore end (praeputium penis) of this fold projected 5^{mm} in a lobelike manner, and behind and partly covered by this fold the genital aperture was seen (fig. 6). Farther back, about at the middle of the side of the body the anal papilla was found directed a little upward, and before it the little renal papilla (fig. 6d). The foot is powerful, the rounded fore end with a deep marginal furrow (fig. 6), and medianly emarginate upper lip; the foot-brim not narrow; the tail flat, lanceolate, rather short.

At the uppermost part of the sides of the body towards the dorsal edge the liver shone through as quite small, slightly yellowish white grains; similar grains, but more powerful (for a great part with mark from fallen-off papillæ) were seen on the lateral parts of the back towards the papillæ.

The central nervous system showed almost the same structure as was seen by the preceding examination[2]) of the typical species; especially on account of the contractility of the enclosing loose capsula, the absolute and relative form and size of the different ganglia vary not a little in the Nudibranchiata. The boundary between the cerebral ganglia and the pleural ones (fig. 8a) was rather distinctly marked, and the pedal ganglia (fig. 8b) a little larger than the cerebro-pleural ones. The strong ganglia rhinophorialia (olfactoria) (fig. 8c) were rather short-stalked; the buccal ganglia and the gastro-oesophagal ones (fig. 8d) were as before described. The pedal commissure was a double one, before it the much thinner pleural one was seen, and in front a subcerebral commissure.

The otocysts as earlier described. I succeeded also in this individual in finding eyes (fig. 8); they were almost sessile, of a diameter of about $0{\cdot}16^{mm}$, with a black pigment and a yellowish lens.

The buccal tube is short. The bulbus pharyngeus very strong, short[3]), 8^{mm} broad by a length of 6^{mm}, and a height of 6^{mm}, the radula sheath not projecting or indicated on the hinder end. The mandibles were as long and high as the bulb, light amber coloured, only the crista connectiva and the masticatory edge yellowish brown (fig. 9); in front on the outside was seen a short, strongly projecting, broad keel (fig. 10); the masticatory edge rather broad (—$0{\cdot}010^{mm}$), the masticatory process rather short, straight; the masticatory edge somewhat worn with many (up to about 20) irregular rows of close set, little ($0{\cdot}013^{mm}$) projecting nodules, most frequently obtuse and cleft (fig. 11). The secondary oral cavities rather large with a rather wide opening; their hinder wall had a slightly yellowish

[1]) In the (smaller) individuals of the typical species earlier examined by me, the series appeared to contain more (8—10) papillæ, and the innermost of these to rise to a greater length ($5{\cdot}5^{mm}$).

[2]) l. c. fig. 5.

[3]) Comp. l. c. Taf. III, fig. 7.

cuticula, that was dark-coloured towards its inner edge. The tongue was short and powerful, only $2{\cdot}25^{mm}$ long, and of almost the same height and breadth, with an almost colourless radula. In this latter were counted 13 series of tooth-plates; farther back, in the short (2^{mm} long) whitish radula sheath that was directed backward, 12 series were found, two of which were not yet quite developed; thus the total number of series was 25; but on the lower edge of the tongue marks were visible of 8 series that had fallen off. The tooth-plates were almost colourless (very pale yellowish), highly fragile, and all the plates on the tongue were worn or otherwise injured (fig. 14). The breadth between the legs of the foremost tooth-plates was $0{\cdot}20^{mm}$, but it rose to $0{\cdot}35^{mm}$. The median tooth-plates (fig. 12) were of a shape somewhat different from that in the two other species; they were broader and their hook shorter. The lateral plates were likewise of a somewhat different shape (figs. 13—15), and the denticulation of the edge of the hook was far slighter than in the typical species.

The whitish salivary glands were lengthened and stretched to the lower side of the stomach; their excretory duct was rather long.

The oesophagus short (4^{mm} long). The form of the stomach was oval, it had a length of 13^{mm} by a diameter of up to 7^{mm}, and on the inside were strong longitudinal folds; it receives on either side a biliary duct, and from the hindmost part of its right side it sends forth the intestine, inside of which it, as it were, continues in the chief biliary duct (the blind bag of the stomach). The intestine runs along the upper edge of the anterior genital mass, forms a curve downward, and rises to the anal papilla; its whole length was 18^{mm} by diameter of $2{\cdot}5$—2^{mm}; its inside showed numerous longitudinal folds. — The abundant white contents of the alimentary canal were an indeterminable animal mass, in which were to be seen remains of Copepoda, bristles of Annelids, and a large quantity of cnidæ.

The chief biliary duct runs somewhat curved in a deep furrow on the lower side of the hermaphrodite gland, receives from either side several rather short, ramifying biliary ducts, and continues a little way behind the hermaphrodite gland. The branches of this duct, as well as of the other two biliary ducts are covered with liver-cells, and form thus the thick, and, as it were, somewhat spongy layer of slightly yellowish liver mass covering the sides of the body above and the lateral parts of the back, and shining through on the outside (fig. 7); from this layer the liver lobes of the dorsal papillæ rise, almost filling out their cavity; they are almost cylindrical, only little rugged. At the points of the papillæ the lengthened cnidocyst is seen, filled with mostly rounded cnidæ.

The ventricle of the heart had a length of $4{\cdot}5^{mm}$. The renal layer and the pericardio-renal organ as before described.

The hermaphrodite gland was powerful, yellowish, its whole length was 22^{mm} by a breadth in front of 9^{mm}; in front it projects with a somewhat flattened lobe under the rectum and the stomach; it consists of a number of large lobes, made up of smaller ones; its end-lobes contained large oogene cells and developed zoosperms. — The anterior genital mass was large, lengthened, compressed, running along, and attached to, the right side of the stomach; it had a length of 14^{mm} by a height of $9{\cdot}5^{mm}$, and a thickness of 5^{mm}; the light yellowish gray ampulla of the duct of the hermaphrodite gland (fig. 1 b) ran for the greater part of its length along its inside; at its fore end the windings of the seminal duct were seen, behind them on the inside the prostate gland, and under that the seminal bag was found. The ampulla was 19^{mm} long by a diameter of 2^{mm}; anteriorly it sends forth a quite short oviduct and a seminal duct a little longer. The latter formed a large prostate mass (fig. 1 c), 7^{mm} long, $3{\cdot}5^{mm}$ high, and 3^{mm} thick, which mass was bent once or twice, and measured, when stretched out, 20^{mm} by a diameter of 2^{mm}; it consisted of close set, quite fine windings; anteriorly it tapered a little, and passed into the muscular continuation of the seminal duct (fig. 1 d). The windings of this duct measured, when stretched out, 18^{mm}; it tapered anteriorly, and ended in a hollow on the top of the $2{\cdot}5^{mm}$ broad, thin-walled hinder end of the penis bag (fig. 1 e), which bag continues in the outer, free part (fig. 1 f) that inclosed 4^{mm} of the glans (fig. 1), the whole length of which was $6{\cdot}5^{mm}$, and which is covered by a strong ciliated epithelium; the seminal duct that grew thinner in its course, continued in snake-like windings to the very point of the glans. The seminal bag (fig. 1 g) the position of which is rather hidden, is globular, of a diameter of $2{\cdot}5^{mm}$; it passes by degrees into its only a little longer duct (fig. 1 h). The whitish and limewhite mucous-albuminiparous gland formed the greater part of the anterior genital mass.

This species is especially by the remarkable formation of a fold on the right side of the body marked off from both the other species, from which it further appears to deviate with regard to the nature of the lateral teeth of the radula.

Subfam. **Tergipedinae.**

R. Bergh, System der nudibranch. Gasteropoden. 1892. p. 1024—1027.

This group contains forms with a somewhat compressed body, simple rhinophores, and a latero-dorsal position of the anal papilla; the dorsal papillæ are short and thick, clubshaped, and, as it were, arranged in one or a few longitudinal series; the foot is rounded anteriorly. — The masticatory edge of the mandibles bears mostly a single series of denticles; the tongue has most frequently only a single series of tooth-plates. The otocyst contains only a single otolith.

The family comprises the genera: *Tergipes* (Cuv., Ald. et Hanc.) with a single series of papillæ and unarmed penis; *Capellinia* (Trinchese) also with only one series of papillæ, but with three series of tooth-plates (like the Galvinae) and with armed penis; *Embletonia* (Ald. et Hanc.) has one or more series of papillæ, a smooth masticatory edge, and unarmed penis; nearly related with this genus is *Ennoia* (Bgh.), which has, however, real tentacles (and not head-lobes). *Amphorina* (Quatrefages) has peculiar tooth-plates, large Gl. ptyalinae, and armed penis; *Galvina* (Ald. et Hanc.) has three series of toothplates, also Gl. ptyalinae, but unarmed penis; *Myja* (Bgh.) resembles somewhat *Tergipes*, but has a smooth masticatory edge; perhaps also the singular *Forestia* (Trinchese) in which the radula is transformed into a serrated band, must be referred to this family.

Amphorina, Quatrefages.

Amphorina. Q. Mém. sur les Gastérop. phlebenterés. Ann. des sc. nat. 3 S. I. 1844. p. 145—151.

— . Q. R. Bergh, Beitr. z. Kenntn. d. Aeolidiaden. VII. Verh. d. k. k. zool. bot. Ges. in Wien. XXXII. 1882. p. 54—61. — VIII. l. c. XXXV. 1885. p. 37—39.

— . Q. Vayssière, rech. sur les moll. opisthobr. II. Nudibranches et Ascoglosses. 1888. p. 107—111.

Trinchesia. Iher. Zoolog. Anz. II. 1879. p. 137 Note.

Papillae subinflatae, fusiformes.

Margo masticatorius serie denticulorum minutorum praeditus. Dentes (mediani) apice quasi elevato. Glandulae ptyalinae. — Penis stylo recto vel curvato armatus.

The genus comprises only a few species:

1. *A. Alberti*, Quatref.
   var. *leopardina*, Vayss.
   M. atlant., mediterr.
2. *A. coerulea* (Mtg.).
   Eolidia Bassi, Ver.
   M. atlant., mediterr.
3. *A. molios*, Herdmann.
   M. atlant.

Amphorina Alberti, Quatrefages?

R. Bergh, Beitr. zur Kenntn. d. Aeolidiaden. VII. l. c. XXXII. 1882. p. 55—57. Taf. IV, Fig. 10—24; Taf. VI, Fig. 19—21.

Pl. V, figs. 24—28.

On the 10th of May 1895 two specimens probably of this species were taken at Trangisvaag.

One individual had a length of 4^{mm}, the other of $5{\cdot}5^{mm}$, by a height of about 1^{mm}, and a breadth of almost $0{\cdot}75^{mm}$; the height of the papillæ rose to about $1{\cdot}25^{mm}$. The body had a yellowish white colour, the head was whitish, the dorsal papillæ were brownish gray with a whitish point.

The form was the common one. The body was lengthened and narrow; the smooth, a little truncate rhinophores and tentacles were not long. The papillæ were arranged in six groups with two, sometimes three papillæ in each; in the groups in front the papillæ were smaller, and in the hindmost group they were quite small; the two inmost papillæ were of about equal size, and in the three groups very powerful, short-fusiform; if a third papilla was found it was always much smaller. The anal papilla was situated immediately at the outer edge of the fourth group of papillæ. The foot was narrow, anteriorly a little broader, with rounded corners; the tail was short.

The bulbus pharyngeus was of an oval form, $0{\cdot}8^{mm}$ long. The hinge-part of the mandibles (fig. 24 a) was strongly yellowish, otherwise they were almost colourless; the not short masticatory edge had a single series of pointed denticles of a height of $0{\cdot}0045^{mm}$ (fig. 24 b). The lengthened, narrow tongue showed a very slightly yellowish radula containing 46 tooth-plates (34 on the lower side, 12 on the upper one), and two were further found lying loose posteriorly at the base of the tongue; in the radula-sheath 20 tooth-plates were seen, of which the three hindmost ones were not yet fully developed; thus the total number of tooth-plates was 66[1]). The tooth-plates were yellowish; they had a breadth of $0{\cdot}06^{mm}$ by a height of $0{\cdot}04^{mm}$, and were of the earlier described form with 6 pointed denticles on each side of the but little strong hook (figs. 25—27).

The liver-lobes were as before mentioned. The pyriform cnidocyst was in the largest papillæ $0{\cdot}30^{mm}$ long; the cnidæ were roundish, their largest diameter $0{\cdot}007$—$0{\cdot}013^{mm}$.

The penis was as described before; the colourless hook that was slightly curved, and at the end, as it were, obliquely cut off, (fig. 28 a) was about $0{\cdot}07^{mm}$ long.

Galvina, Ald. et Hanc.

R. Bergh, System der nudibranchiaten Gasteropoden. 1892. p. 1026—1027.

The Galvinae form a rather well marked g oup. Even their exterior is remarkable by the dorsal papillæ being, as it were, somewhat inflated; they show, however, especially a quite peculiar structure of the radula, which has strong median teeth, the hooks of which are, as it were, bent down and situated below the level of these teeth; the lateral teeth are very broad, and their inner part projects backwards in a lanceolate hook.

The Galvinae seem chiefly to belong to the less warm tracts of the sea.

Galvina sp. (anonyma).

Pl. IV, figs. 21—25.

Together with some specimens of *Coryphella salmonacea* (mentioned above) another little Aeolidia was taken, which, in a short notice, is said to have been whitish with red dorsal papillæ.

The individual, which was only middlingly preserved in alcohol, was of a yellowish white colour. Its length was 10^{mm}, by a breadth of the body of up to 3^{mm}, and a height of up to $2{\cdot}5^{mm}$. The rhinophores were 2^{mm} long, the tentacles 1^{mm}, and the (remaining) dorsal papillæ likewise only 1^{mm} long.

The form was the common one. The lateral parts of the back that were covered with papillæ, were more narrow than the naked middle part; the number of series of papillæ was not large, and the number of papillæ in a series exceeded scarcely 6. The papillæ were conical, partly somewhat inflated, a great deal had fallen off. The foot was anteriorly rather broad, almost without projecting corners.

To spare the only known individual, only the bulbus pharyngeus was examined. It showed the usual form, the radula formed a cone on the hinder end; the length was $2{\cdot}3^{mm}$, by a breadth

1) The number of tooth-plates in the (3) earlier examined specimens was 67, 61, 64; in *A. coerulea* it was 60, 57, 60.

of 2^{mm}, and a height of $1{\cdot}3^{mm}$; the hinge-part was not strong; the masticatory process was rather short and slightly bent; the masticatory edge had a few series of short teeth, displaced among each other (fig. 21). The tongue was of the common form; the radula was almost colourless, and had on its long lower edge and short upper one 35 series of teeth (and besides a loose lying median tooth below); in the radula sheath 41 series were seen, the four hindmost of which were not yet completely developed; thus the whole number of series was 76. The median teeth were slightly yellowish, the lateral teeth colourless. The height of the oldest (foremost) median teeth was $0{\cdot}08^{mm}$, and the breadth likewise $0{\cdot}08^{mm}$; the hindmost ones seemed to have the same measures, as also the lateral teeth, the breadth of which was $0{\cdot}12^{mm}$. The tooth-plates were of the form, which has been pointed out in the other Galvinae; the strong median teeth (figs. 22 a, 23, 24, 25 a) had the usual bent down hook, and to each side of that four, more rarely three, denticles, of which the inner one was the more clumsy. The weak, but broad lateral teeth (figs. 22 b, 25 b) showed the usual lanceolate, short hook.

None of the hitherto known (northern) Galvinae have shown the above mentioned colours, and thus the possibility is not excluded that we have here a new form. It seems not to be possible to differentiate the Galvinae by means of the structure of the radula.

EXPLANATION OF THE PLATES.

Most of the figures are drawn by means of the camera lucida.

Pl. I.

Bathydoris Ingolfiana, Bgh.

Fig. 1. The animal, from behind. Natural size.
— 2. The same, from before. Natural size.
— 3. One of the papulæ of the back.
— 4. The bulbus pharyngeus, lateral view. Natural size. *a* the labial disk, *b* the region of the outer margin of the mandible, *c* the radula-sheath, *d* the oesophagus, *e* the duct of the salivary gland with its ampulla.
— 5. The tongue with *a* the radula, behind this the tectum radulae, and hindmost *b* the end of the radula-sheath.
— 6. The mandibles, from before, *a* the upper end. Natural size.
— 7. A piece of the median part of the radula, with *a* median tooth, and *bb* innermost lateral tooth. × 100 diam.
— 8. Median tooth. × 200 diam.
— 9. First lateral tooth. × 100 diam.
— 10. The same, lateral view. × 100 diam.
— 11. Two of the largest lateral teeth. × 100 diam.
— 12. Outermost part of a series of teeth with 11 tooth-plates, *a* the outermost one. × 100 diam.
— 13. One of the outer tooth-plates, lateral view. × 100 diam.
— 14. A couple of the outermost tooth-plates, from above. × 100 diam.
— 15. (abnormal) double tooth-plate. × 100 diam.
— 16. The hermaphrodite gland, from its upper side.
— 17. Follicles of the hermaphrodite gland.
— 18. The anterior genital mass; *a* the mucous gland, *b* the spermatheca, in front of and upon it the penis bag, *c* the coalesced genital vulvarian folds.
— 19. *a* the duct of the hermaphrodite gland, *b* oviduct, *c* seminal duct, *d* the base of the praeputium, *e* glans penis, *f* the aperture on its point.
— 20. *a* seminal duct, *b* glans penis, slit longitudinally, with the continuation of the seminal duct to the aperture *c* on its point.

Pl. II.

Bathydoris Ingolfiana, Bgh.

Fig. 1. *a* labial disk, *b* bulbus pharyngeus, *cc* the salivary glands on the sides of the first stomach, to the left of this the second stomach, *dddd* the intestine, circumscribing the liver, and to the right the renal branches with the base of the urinal chamber.

— 2. The central nervous system, mostly drawn with cam. luc. *aa* Ganglia cerebralia, *bb* G. pleuralia, *cc* G. pedalia, *d* Commissura magna, *ee* G. buccalia, *f* Comm. buccalis.

Doridoxa Ingolfiana, Bgh.

Fig. 3. The animal from the ventral side. $^4/_1$.

— 4. The central nervous system, from above. × 55 diam. *aa* cerebro-pleural ganglia, *bb* pedal ganglia, *c* buccal ganglia.

— 5. The bulbus pharyngeus, from the lower side, a little obliquely.

— 6. The same, lateral view. *a* oesophagus.

— 7. The mandibles, from before; *a* processus masticatorii. $^{10}/_1$.

— 8. A piece of the innermost part of the masticatory edge. × 350 diam.

— 9. The tongue with the radula, from before.

— 10. The same, lateral view.

— 11. The middle part of the radula, from below. *a* median teeth, *bb* innermost lateral tooth.

— 12. A piece of the middle part of two series of teeth.

Figs. 11—12 drawn with cam. luc. × 350 diam.

— 13. The alimentary canal. *a* oesophagus, *b* stomach, *cc* intestine, *d* biliary bladder.

— 14. *a* the thinner, *b* the thicker part of the seminal duct, *c* penis. × 55 diam.

— 15. Seminal vesicle, *a* its duct. × 55 diam.

Cadlina repanda (A. et H.).

Fig. 16. A piece of the labial plate.

— 17. Middle part of the radula, *a* median teeth.

— 18. The largest tooth-plates.

— 19. Piece of the armature of glans penis and seminal duct.

Figs. 16—19 drawn with cam. luc. × 350 diam.

Candiella Ingolfiana, Bgh.

Fig. 20. The first lateral tooth.

— 21. Second and third lateral teeth.

— 22. One of the largest lateral teeth.

Figs. 20—22 drawn with cam. luc. × 350 diam.

Pl. III.

Doridoxa Ingolfiana, Bgh.

Fig. 1. The middle part of the radula, from above. *a* median teeth, *b* innermost lateral tooth.
— 2. Similar part, partly lateral view. *a* and *b* as in fig. 1.
— 3. Outermost part of two series of teeth. *aa* outermost tooth-plate.
Figs. 1—3 drawn with cam. luc. × 350 diam.

Candiella Ingolfiana, Bgh.

Fig. 4. A piece of the masticatory edge of the mandible, *a* the free edge. × 200 diam.
— 5. A piece of the middle part of the radula, *a* median tooth.
— 6. One of the largest lateral teeth.
— 7. The outer end of a series of teeth, *a* outermost tooth.
Figs. 5—7 drawn with Cam. luc. × 350 diam.
— 8. *a* Seminal vesicle, *b* its duct.
— 9. *a* Seminal duct, *b* penis bag with the glans penis situated in its cavity.

Althila Ingolfiana, Bgh.

Fig. 10. The fore end of the body with the oral aperture, tentacles, and fore edge of the foot.
— 11. The two-lipped sheath of the rhinophore, between the two unequally long lobes the point of the club of the rhinophore is seen.
— 12. The central nervous system, drawn with cam. luc. × 55 diam. *a* cerebro-pleural ganglia, *b* pedal ganglia, *c* buccal ganglia, *d* the large common commissure, *e* the buccal commissure.
— 13. Otocyst. × 350 diam.
— 14. The bulbus pharyngeus from above, the pharynx removed, so that the tongue is laid bare, *a* the region of the fore end of the mandibles.
— 15. The mandibles, from before, *a* the hinge-part. $^{8}/_{1}$.
— 16. The hinder end of the mandible. × 100 diam.
— 17. The hindmost part of the masticatory edge of the same. × 100 diam.
— 18. The tongue, from below, with radula.
— 19. Median tooth from three series of teeth.
— 20. The first lateral tooth.
— 21. A similar one in another position.
— 22. *a* two median teeth, and *b* first lateral tooth, lateral view.
— 23. The ninth and tenth lateral teeth (counted from the median tooth) of two series.
— 24. One of the largest lateral teeth.
— 25. The outer end of a series of tooth-plates with 5 tooth-plates, *a* the outermost one.
Figs. 19—25 drawn with cam. luc. × 350 diam.
— 26. Dorsal papilla.

Dendronotus robustus, Verrill.

Fig. 27. The rhinophore with its sheath and club.
— 28. The tongue from above with the radula-sheath shining through and with the upper end of the radula.
— 29. *a* Seminal duct, *b* glans penis projecting from the bottom of the praeputium.

Pl. IV.

Dendronotus robustus, Verrill.

Fig. 1. The fore end of the animal.
— 2. The tail of the animal.
— 3. Elements of the prehensile ring. × 350 diam.
— 4. A median tooth, from above. × 200 diam.
— 5. The outer end of a series of teeth, *a* the outermost tooth, *b* the edge of the radula. × 350 diam.

Goniëolis atypica, Bgh.

Fig. 6. The fore end of the animal, from the right side, with *a* tentacles, *b* rhinophores, and *c* dorsal papillæ; with the genital aperture, the renal pore, *d* anal papilla, and *e* foot-brim.
— 7. The fore end, from above; *aa*, *c* as in fig. 6.
— 8. The central nervous system, from above, drawn with cam. luc; *a* Ganglia cerebro-pleuralia, *bb* Ganglia pedalia, *cc* Ganglia olfactoria, *dd* G. buccalia and gastro-oesophagalia, *e* commissura subcerebralis, *f* comm. pleuralis, *g* comm. pediaea.
— 9. The mandibles from the fore side. $^5/_1$.
— 10. The hinge-part of the right mandible, from before.
— 11. A piece of the masticatory edge, *a* fore edge. × 350 diam.
— 12. Median tooth-plates, from above.
— 13. Lateral tooth-plate, from the radula.
— 14. Worn foremost (oldest) lateral tooth-plate.

Figs. 12—14 drawn with cam. luc. × 200 diam.

— 15. Lateral tooth-plate. × 250 diam.

Goniëolis intermedia, Bgh.

Fig. 16. From the middle part of the radula, *a* median plate, *b* lateral plate.
— 17. A similar piece, lateral view. *a* and *b* as in fig. 16.

Figs. 16—17 drawn with cam. luc. × 350 diam.

Coryphella salmonacea (Couth.).

Fig. 18. Excretory duct of the Gland ptyalina? × 100 diam.
— 19. Lateral teeth. × 350 diam.

Coryphella sp. (anonyma).

Fig. 20. A piece of the radula, lateral view, *a* median teeth, *bb* lateral teeth. × 350 diam.

Galvina sp. (anonyma).

Fig. 21. A piece of the masticatory edge of the mandible.
— 22. A piece of the radula, from above, *a* median teeth, *b* lateral teeth.
— 23. A median tooth, from above.
— 24. Two median teeth, from the under side.
— 25. A piece of the radula, lateral view; *a* and *b* as in fig. 22.

Figs. 21—25 drawn with cam. luc. × 350 diam.

Pl. V.

Goniëolis atypica, Bgh.

Fig. 1. The efferent ducts of the genital system, viewed from the inside of the anterior genital mass. ** the hinder edge of the anterior genital mass; *a* the duct of the hermaphrodite gland, *b* ampulla of the same; *c* the prostatic part, and *d* the musculous part of the seminal duct; *e* the inner part, and *f* the outer part of the penis (with glans); *g* the seminal vesicle, and *h* its duct.

Coryphella salmonacea (Couth.).

Fig. 2. A piece of the masticatory edge of the mandible, *a* the free edge. × 350 diam.
— 3. A piece of the radula, lateral view, *aa* median teeth, *bb* lateral teeth. × 200 diam.
— 4. A lateral tooth. × 350 diam.
— 5. A piece of the salivary gland (Gl. saliv.).
— 6. A piece of the gland of the oral tube (Gl. ptyalina).

Figs. 5 and 6 drawn with cam. luc. × 100 diam.

— 7. *a* seminal duct, *b* penis bag.
— 8. *a* seminal duct, *b* glans penis.

Coryphella salmonacea (Couth.), *var.*

Fig. 9. Lateral tooth-plate, from abowe.
— 10. Median tooth-plate, lateral view.

Fig. 9—10 drawn with cam. luc. × 350 diam.

Coryphella sp.

Fig. 11. A piece of the masticatory edge of the mandible, *a* the hinder end.
— 12. A piece of the radula, lateral view, *aa* median teeth, *bb* lateral teeth.
— 13. A median tooth, from the under side.

Coryphella sp. (anonyma).

Fig. 14. A piece of the edge of the masticatory process of the mandible, *a* the free edge.
— 15. A median tooth, from the under side.
— 16. Two lateral teeth, from above.

Figs. 11—16 drawn with cam. luc. × 350 diam.

Aldisa zetlandica (Ald. et Hanc.).

Fig. 17. The central nervous system, from above. × 55 diam. *aa* cerebral ganglia, *bb* pleural ganglia, *cc* pedal ganglia.
— 18. Otocyst. × 350 diam.
— 19. One of the largest tooth-plates.
— 20. One of the outermost plates in the series of teeth.

Figs. 19—20 drawn with cam. luc. × 750 diam.

— 21. Glans penis. × 350 diam.
— 22. A piece of the latter part of the seminal duct. × 350 diam.
— 23. Elements of the armature of the same. × 750 diam.

Amphorina Alberti, Quatref.

Fig. 24. The fore end of the mandible, with *a* the hinge-part, *b* the masticatory process.
— 25. A tooth-plate, from above.
— 26. A similar one, from the under side.
— 27. A similar one, lateral view.
— 28. Penis, with *a* its hook.

Figs. 24—28 drawn with cam. luc. × 350 diam.

Doridoxa Ingolfiana, Bgh., *var.*

Fig. 29. Median teeth, from above (the denticles drawn too strong).
— 30. Lateral tooth-plates of the outer third part of a series.

Lamellidoris muricata (O. F. Müll.).

Fig. 31. A piece of the radula; *a* false median tooth-plates, *b* lateral tooth-plates, *c* outermost tooth-plates.

Figs. 29—31 drawn with cam. luc. × 350 diam.

— 32. Crop of the bulbus pharyngeus, *a* the stem of the same.

Bathydoris Ingolfiana B.

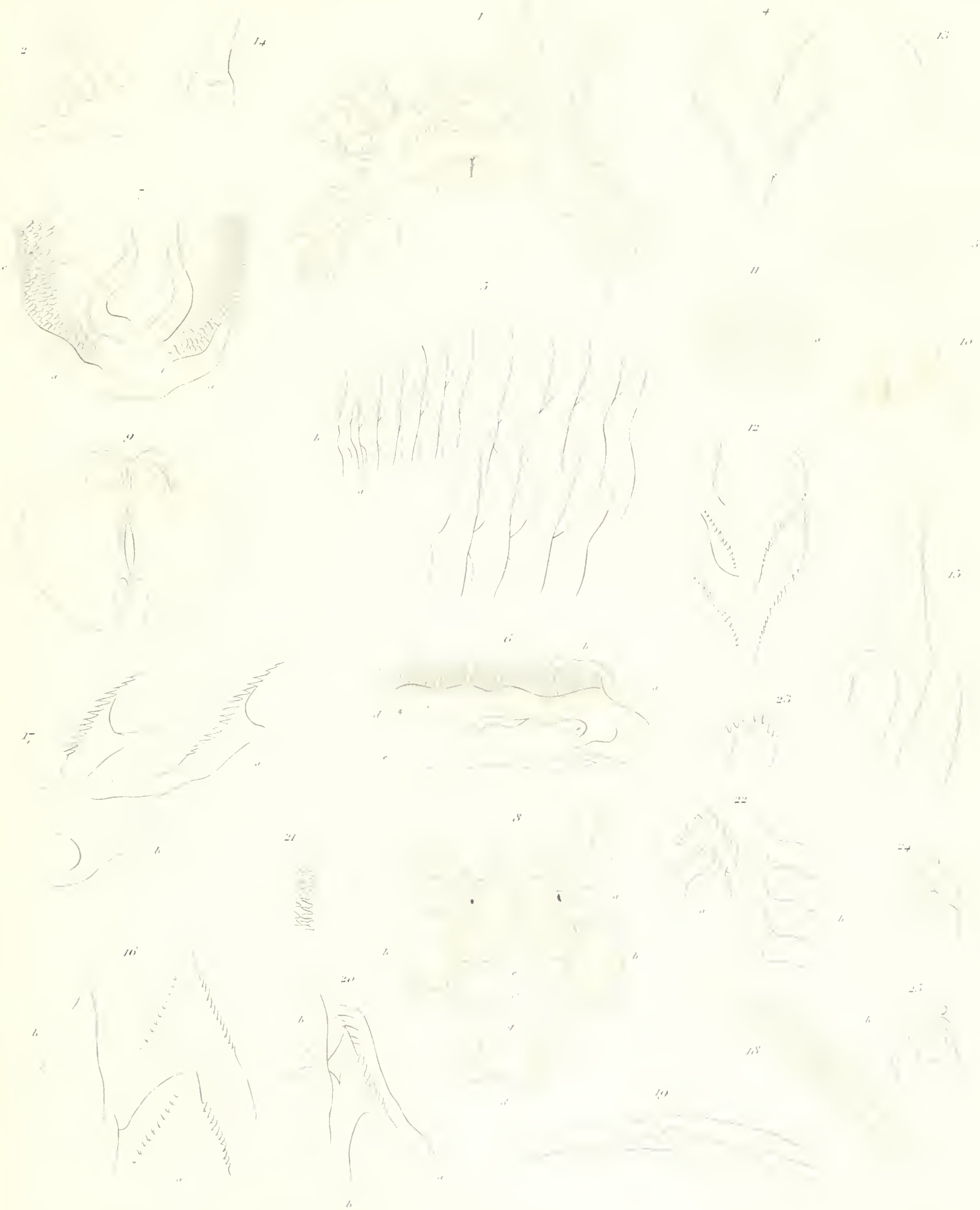
1-2. Bathydoris Ingolfiana B.

15 Doridoxa Ingolfiana B. 16-19 Cadlina repanda (A&H) 20-22 Cratena Ingolfiana B.

1–3. Doridoxa Ingolfiana B. 4–9. Candiella Ingolfiana B.

10–26. Atthila Ingolfiana. B. 27–29. Dendronotus robustus. V.

R. Bergh del.



1–5 Dendronotus robustus V. 6–15 Goniaeolis atypica B. 16–17 Gon. intermedia B.
18–19 Coryphella salmonacea C. 20 Cor. sp. 21–25 Galvina sp.

R. Bergh del.

1 Goniolis atypica Bgh 2 8 Coryphella salmonacea C 9 10 Cor salmonacea var
11 13 Coryphella sp. 14 16. Cor sp anonyma 17 23 Aldisa zetlandica A et H
24 28 Amphorina Alberti Quatref. 29 30. Doridoxa Ingolfiana B 31 Lamellidoris muricata O F Müll
R Bergh del

50

THE DANISH INGOLF-EXPEDITION.

VOLUME II.

4.

THE NORTH-EUROPEAN AND GREENLAND *LYCODINÆ.*

BY

ADOLF SEVERIN JENSEN.

WITH 10 PLATES, 1 CHART AND 33 FIGURES IN THE TEXT.

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CONTENTS.

The North-European and Greenland Lycodinæ.

The Lycodinæ of North Europe and Greenland.

By

Adolf Severin Jensen.

Whilst engaged in working at the section *Pisces* for the *Conspectus Faunæ Groenlandicæ*, the present author undertook a more extended research into the Greenland species of *Lycodinæ*. This led quite naturally to a revision of the remaining Lycodes-material in the Zoological Museum, so that the work gradually developed into a systematic working out of all the species of North Europe and Greenland. From lack of material I was unfortunately obliged to omit the North American forms almost entirely.

It is right and fitting that the work in its entirety, as it now appears, should be published in the reports of "The Danish Ingolf-Expedition" as a supplement to "The Ichthyological Results", seeing that this Expedition has provided the greater proportion of the material for the research. It seems to me also that it would be an injustice to the Expedition, if its rich and valuable collection of fishes were not utilised scientifically in a greater degree than has hitherto been done, the late Prof. C. F. Lütken having been prevented by ill health from going deeper into the work.

Several zoologists in foreign countries have afforded very great assistance during the course of the work, by lending me specimens which it was of special interest to study anew; without this assistance various important questions would have remained unsolved, and I take this opportunity to express my warmest thanks to the following scientists: Conservator J. Grieg (Bergen), Prof. N. Knipowitsch (St. Petersburg), Dr. E. Lönnberg (Upsala), Geh. Regier.-Rat, Prof. K. Möbius (Berlin), Hofrat, Dr. F. Steindachner (Vienna) and Prof. T. Tullberg (Upsala).

I owe especial thanks to Prof. F. A. Smitt (Stockholm) and to Prof. R. Collett (Christiania).

Prof. Smitt with the utmost willingness, gave me the greatest possible freedom to study the rich collection of Lycodes in the Riks-Museum. This collection was of great value as it supplemented that of the Museum here in many ways.

Prof. Collett with rare generosity has sent me several of his type-specimens for examination, so that my determinations have attained a surety which otherwise would not have been reached. I have been permitted also, to study a large portion of the valuable Lycodes-material which has been received at the Christiania Museum within recent years. To Prof. Collett, who has laboured indefatigably throughout a long period of years, to increase our knowledge of the Lycodes-group and has enriched the literature with a series of fundamental papers on the subject, I feel myself in addition in a debt of a more personal character for the interest with which he has followed the progress of my work.

My manuscript was completed in early summer 1902, but the printing was delayed as, during that summer through the kindness of Dr. Johan Hjort, I got the opportunity to take part in the investigations of the steamer »Michael Sars«. An important collection of Lycodes was made during the expedition and I was permitted to include this material in my work. For this friendliness I would request Dr. Hjort to accept my best thanks.

Last but not least, to Mr. Th. Bloch my thanks are also due for the care with which he has executed all the figures of the 10 plates as well as most of the drawings in the text. If one has not made oneself familiar with the Lycodes through several years study, an exact determination of the species is often of great difficulty (insurmountable in many cases for the young stages), and one is frequently at a loss if descriptions only are given. I consider the many figures in this treatise to be of great value therefore, especially the series which illustrates the diverse appearances of certain species according to age, sex and individual variation.

Dr. H. M. Kyle has done me the favour of undertaking the translation into English.

Introductory Remarks.

Systematic.

The first certain knowledge concerning the group of fishes here dealt with, dates from 1831 when J. Reinhardt sen. formed the genus *Lycodes.* With regard to the systematic position of this new genus, the same author in 1838 expressed as his opinion that it was very closely allied to *Zoarces* on account of the slight developoment of the ventral fins, the lack of a swimbladder, the formation of the digestive organs, mode of fixation of the scales and the whole form of the body[1]). With regard to the structure of the skeleton also, the two genera agree as was shown much later by W. Lilljeborg[2]).

It must be accepted therefore as perfectly correct when the American ichthyologists D. S. Jordan & B. W. Evermann[3]) make the *Lycodinæ* a subdivision of the family *Zoarcidæ* Swainson (1839), characterised (as opposed to *Zoarcinæ*) by the unpaired fins being evenly developed all round, the dorsal fin having no lower spinous portion, and (as opposed to *Gymnelinæ*) by ventral fins being present.

As time went on, a considerable number of species has been described from Greenland and North Europe, and their authors have retained them within the original genus *Lycodes* Reinh. It seems to me more natural to subdivide the species of North Europe and Greenland into 3 genera: *Lycodes*, *Lycenchelys* and *Lycodonus.* Compared with some foreign (American) genera these have the following structural characters in common: teeth occur both on the intermaxillary and the mandible, and on the vomer and palatines; the mandible has no barbule. The relationships may be shortly displayed in the following manner[4]):

[1]) Kgl. D. Vidensk. Selsk. Skr. VII, 1838, p. 153.
[2]) Sveriges och Norges Fiskar, II, 1891, p. 4 & 13—18.
[3]) Jordan & Evermann: The Fishes of North and Middle America, Part III, 1898, p. 2456. (Washington).
[4]) A more detailed diagnosis of the genera will be given later.

Lycodes Reinhardt.

Lycodes Reinhardt, Overs. K. D. Vidensk. Selsk. Forhandl., 1830–31, p. 74 (*vahlii*).

Body moderately elongated (zoarciform), height over the anus ca. 7—12½ times in the total length. R. br. 6.

Lycenchelys Gill.

Lycenchelys Gill, Proc. Acad. Nat. Sci. Philad., 1884, p. 180 (*muræna*).

Body very elongated (anguilliform), height over the anus ca. 16—24 times in the total length. R. br. 6.

Lycodonus Goode & Bean.

Lycodonus Goode & Bean, Bull. Mus. Comp. Zool., X, No. 5, 1883, p. 208 (*mirabilis*).

Body very elongated (anguilliform), height over the anus ca. 21—30 times in the total length. R. br. 5.

In addition to being natural, such a division of the old genus *Lycodes* Reinh. contributes in an important manner to simplify a review of the species. In the present treatise 19 species are described in detail. Of these 6 can now be ascribed to the genera *Lycenchelys* and *Lycodonus*, which are characterised by a very elongated, eel-shaped body. The genus *Lycodes* thus limited contains the 13 species with a less elongated, zoarciform body.

We may now pass over in review the characters of importance for the distinction of the species, beginning with the genus *Lycodes*, which in spite of the reduction that has taken place contains a somewhat considerable number of very difficult and much disputed species.

Lycodes Reinhardt.

(cf. the synoptic table p. 11—12).

In a treatise on »Grønlands og Islands Lycoder«, C. F. Lütken has given a review of some species known to him and divides them into three subdivisions according to the course taken by the lateral line[1]). A foundation is thus laid, in my opinion, for a natural grouping of the species of *Lycodes*, on which one must build further.

The species dealt with in the present work may also be grouped according to Lütken's system, in the following manner[2]):

a) lateral line single, ventral:

L. vahlii Reinh.[3])

L. frigidus Coll.

L. atlanticus Jensen.

[1]) Lütken: Korte Bidrag til nordisk Ichthyographi. III. Vidensk. Meddel. Naturhist. Foren. Kbhvn., 1879—80 (p. 329).

[2]) A single species, *L. microcephalus* Jensen, cannot for the present be brought into any certain group, as it is only known from a quite small individual on which the course of the lateral line cannot be determined with certainty.

[3]) Concerning the proper place of this species Lütken has had some doubt, as he writes: »Lineæ medio-lateralis interdum vestigium?» but that has happened because he had assigned to *L. vahlii* a specimen of *L. eudipleurostictus* mihi which possesses a double lateral line.

b) lateral line double, ventral and mediolateral:

L. esmarkii Coll.

L. eudipleurostictus Jensen.

L. pallidus Coll.

L. platyrhinus Jensen.

c) lateral line single, mediolateral:

L. rossi Malmgr.

L. lütkenii Coll.

L. reticulatus Reinh.

L. seminudus Reinh.

L. agnostus Jensen.

With regard to the second group, it must be mentioned that the mediolateral branch of the lateral line is frequently indistinct in two of the species, namely *L. esmarkii* and *L. pallidus*, so that it is often only after a very careful study of a large number of specimens that one can rightly determine their position — this holds especially for *L. pallidus*, which stands as a sort of transition form between groups a and b, so far as the lateral line is concerned [1]).

For the rest, the groups a and b seem in other respects also, to stand near to one another and to form together a separate subdivision contrasted with group c. Thus, in groups a and b the tail is relatively long, whilst the head and trunk together (or the distance between the snout and the anus) most often amount only to 36,5—45 % of the total length (sometimes reaching 47 % in males of *L. frigidus)*; in group c on the other hand the tail is relatively short, whilst the head and trunk together amount to 43—52 % of the total length. Groups a and b may therefore be described as long-tailed, group c as short-tailed.

In close connection herewith is the number of rays in the unpaired fins. This is throughout larger in the long-tailed species than in the short-tailed, and very naturally so, since the anal fin entirely and the dorsal fin for the most part, belong to the tail. In groups a and b the number of rays in the dorsal fin is 94—118, in the anal fin 81—102 [2]), in group c the number is 90—97 for the dorsal fin, 70—78 for the anal [3]).

It will appear from the foregoing that the groups of Lütken based on the lateral line only, are not of equal value, but that the groups having the ventral and ventral-mediolateral lines form together one subdivision over against the group with the mediolateral lateral line. For practical

[1]) Whilst speaking of the lateral line, it should be mentioned that one finds in some of the species, and in all three groups, a shorter or longer series of pores placed relatively remote from one another on each side of the back an indication of a dorsal lateral line.

[2]) Both here and in the special portion of the work, the upper rays of the tail fin are reckoned with the dorsal fin, the lower rays with the anal fin. since the unpaired fins pass without break right round the tip of the tail. — I think it not unnecessary to remark that all my statements of the number of fin-rays are based on my own observations, which do not always agree with those given in the literature.

[3]) Probably the number of the vertebræ will also be greater in the long-tailed than in the short-tailed species, but the material in my hands is too little to allow any certain conclusions to be drawn in this regard; in four species of groups a and b I have counted 98—118 vertebræ (*L. vahlii* 98—116, *L. frigidus* 103—107, *L. eudipleurostictus* 106 and *L. esmarkii* 115—118), in two species of group c (*L. reticulatus* and *L. seminudus*) 93—96 vertebræ.

reasons however, it is convenient to again split up the first division according as the lateral line is ventral or ventral-mediolateral (cf. the table of analysis p. 11—12).

We may now refer to some of the characters which have special importance in distinguishing the species within the greater groups based on the course of the lateral line.

Scales. Of the present species two are perfectly devoid of scales, namely *Lycodes agnostus* Jensen (Tab. VI, fig. 1) and *L. platyrhinus* Jensen (Tab. VI, fig. 2). The well-known ichthyologist P. Bleeker has laid such great weight on the absence of scales that he has formed a special genus *Lycodalepis*[1]), which only differs from *Lycodes* in this one character, and the later American naturalists have followed him. It seems to me that *Lycodalepis* is an unnatural genus. If the two scaleless species mentioned are removed from the genus *Lycodes*, they are then separated from species to which in other respects they are closely allied. *L. agnostus* has its true place amongst the species of *Lycodes* with mediolateral lateral line, not only on account of the situation of the lateral line, but also on account of the relatively short tail (the head and trunk together are 46—52 % of the total length) and the number of rays in the unpaired fins (D. 90—93, A. 70—72). *L. platyrhinus* on the other hand, belongs rightly to the *Lycodes* with double lateral line, partly because of the ventral-mediolateral lateral lines, partly because of the long tail (head and trunk together are 37 % of the total length) and the number of rays in the unpaired fins (D. 99, A. 82). One must be content therefore, to regard the absence of scales as a good specific character and not ascribe to it any generic importance.

Of the remaining species of *Lycodes* dealt with in this treatise, there is one which in its slight development of the scaly covering, is a transition form to the naked species, namely *L. seminudus* Reinh. As the name denotes, it is only half covered with scales, on the tail namely[2]), and moreover the scaly area ends in front in the shape of a wedge leaving a naked part dorsally and ventrally (Tab. IX & Tab. X, fig. 1). Some variation appears in this species however, as the scaly wedge sometimes sends a portion forward on to the trunk; but as a rule the naked abdominal region is one of the characters which aids to a ready determination of *L. seminudus*.

The naked *L. agnostus* and the half naked *L. seminudus* belong, as mentioned, to the group with mediolateral lateral line. The remaining species of this group, *L. rossi* Malmgr., *L. lütkenii* Coll. and *L. reticulatus* Reinh. have the scaly covering developed almost to the same extent, and it extends forwards on the sides of the trunk to a point which lies under or a little in front of the beginning of the dorsal fin; but the front part of the back and the belly are always naked, and the fins are likewise devoid of scales.

Most of the species of the groups with ventral or ventral-mediolateral lateral lines are remarkable for the stronger development of the scaly covering. In adult individuals the scales cover the whole of the body (head excluded) and extend on to the unpaired fins. Such is the case in *L. vahlii* Reinh., *L. frigidus* Coll., *L. atlanticus* Jensen, *L. esmarkii* Coll. and *L. eudipleurostictus* Jensen. Of these species *L. frigidus* is easily recognisable by its extremely small scales (Tab. V, fig. 1 a). *L. pallidus*

[1]) Versl. K. A. W. 2 e Rks. VIII, 1874, p. 369 (*mucosus*).

[2]) Jordan & Evermann form a subgenus *Lycias* under *Lycodes*, characterised by the tail only being scaled; into this subgenus are brought *L. seminudus* Reinh. and the imperfectly described *L. nebulosus* of Krøyer, later lost and never rediscovered (Fishes of North and Middle America, III, 1898, p. 2463).

Coll. as a rule has a less developed scaly covering, as the anterior portion of the back and a large part of the belly are naked, and the scales (in general) do not extend on to the unpaired fins (Tab. IV, fig. 1 & Tab. V, fig. 2); in the variety *squamiventer* mihi however, the scales reach to the neck and to the underside of the belly, and appear as well on the unpaired fins (Tab. IV, fig. 2), but it is not excluded that I have made an error in considering this form as a variety of *L. pallidus;* it must perhaps be raised to a separate species. Lastly *L. platyrhinus*, as stated above, is entirely naked.

All in all, the extent of the scaly covering furnishes often a good specific character when adult individuals can be examined.

Colour. One species can be said with certainty to be uniformly coloured at all ages, without spots or bands, and that is *L. frigidus* Coll. (Tab. V, fig. 1 a, b). The reason for this, I presume, is that this species is restricted to great depths (450—1455 fathoms). *L. atlanticus* Jensen, *L. pallidus* Coll. var. (vel sp. n.) *squamiventer* mihi (Tab. IV, fig. 2 a, b), *L. microcephalus* Jensen (Tab. I, fig. 1) and *L. platyrhinus* Jensen (Tab. VI, fig. 2) have likewise no markings so far as one can judge from the present scarce material, and they all live at great depths (respectively 516—1423 f., 537—957 f., 799 f. and 1010 f.).

The remaining species which do not reach in general to so great depths, possess a more lively colouration as a rule, because dark and light alternate; dark and light cross-bands are the most frequent combination, but rings, network or festooned markings can also occur. Some examples may here be mentioned where the colour markings afford a method of determining certain species.

L. esmarkii Coll. is remarkable for a specially characteristic colouration. When quite young (Tab. III, fig. 2 a) it shows light, Λ-shaped cross-bands, which in medium-sized individuals (Tab. III, fig. 2 b) enclose dark spots or stripes, and which finally in the adults (Tab. III, fig. 2 c) change to form festooned markings.

In all the remaining species, the body of the quite young is adorned with dark and light cross-bands (sometimes the one, sometimes the other is the more prominent), and this colouration is still retained essentially in the older individuals of the following species: *L. eudipleurostictus* Jensen, *L. rossi* Malmgr., *L. lütkenii* Coll. and *L. agnostus* Jensen, whereas *L. pallidus* Coll., *L. vahlii* Reinh., *L. reticulatus* Reinh., and *L. seminudus* Reinh. frequently assume another colouration with age. *L. pallidus* as a rule becomes uniformly coloured with age, and the same is often true of *L. seminudus*. In *L. vahlii* the bands disappear almost entirely in the adults or become resolved into ringshaped stripes and irregular spots; one, two or three black spots, the one behind the other, occur almost always on the anterior corner of the dorsal fin, so that the species can readily be recognised (Tab. I, fig. 2 & Tab. II, fig. 1). In *L. reticulatus* the bands change in the older individuals to form a characteristic network, especially on the anterior portion of the body (Tab. II, fig. 2 & Tab. VIII).

However variable the colour markings may on the whole seem to be, they frequently give good specific characters. On the other hand, it must not be forgotten that especially the young of various species are so similar to one another in colouration, that confusion may very readily occur.

The pectoral fins often give good specific characters. The number of rays in the present species varies from 15 to 23, but the variation within the individual species is sometimes very limited. The length of the pectoral fin also is sometimes a good determining character between nearly allied species. The posterior margin of the pectoral fin is in general rounded, but the condition in *L. eudipleurostictus* (Tab. III, fig. 1) is characteristic in that the lower rays are somewhat longer than the middle ones, so that an indentation occurs (the same may also occur in individuals of *L. frigidus*, see Tab. V, fig. 1 a).

Other characters which might be taken into consideration, though not to so great an extent, are the relative height of the body (the dimension chosen in this work for the greater or less elongation is always the height over the anus, which is to some extent independent of distension caused by food or sexual products), the relative length of the head (which is nevertheless rather variable within the individual species, the males as a rule having longer heads than the females or young), size of the eyes, condition of the teeth etc.

A gap in the present work is the almost entire absence of the structural anatomy; I must leave this aspect of the diagnosis of the Lycodinæ to others who can afford the necessary time. I have only been able to examine the *appendices pyloricæ*, which in the present species of the genus *Lycodes* are always two and very small, with exception of *L. esmarkii* Coll., where they are wanting altogether.

Geographical Distribution. A not unimportant factor to be taken into account in determining a specimen, is where it was found, each species hawing its characteristic, horizontal and vertical distribution, as will be mentioned in detail in the special part. A summary is given on p. 9—10 for orientating the species which inhabit the various seas within the entire area; but though this summary is based on a large amount of material, the possibility is of course not excluded that future investigations may still find new forms within these seas.

Lycenchelys Gill and Lycodonus Goode & Bean.

To the genus *Lycenchelys* I have referred 4 European and Greenland species: *L. murœna* Coll., *L. sarsii* Coll., *L. kolthoffi* Jensen and *L. ingolfianus* Jensen, the determination of which does not cause great difficulty. A good specific character is formed seemingly by the large pits of the lateral line along the upper jaw and under the eye. In *L. ingolfianus* their number is 8, in the others only 7. Other good characters are to be found in the distance of the dorsal fin from the snout, the relative length of the head and the number of rays in the pectoral fins. The colouration in *L. murœna* is uniform, and this species also is restricted to great depths (340—620 f.); what the condition is in *L. ingolfianus* is not known, as only one adult specimen (uniformly coloured) has been found; *L. kolthoffi* has a strongly spotted (marbled) colouration; *L. sarsii* has dark markings in the young becoming indistinct in the older stages. Each of these four species has its own separate area of the sea, so that one can conclude from the region alone which species is to hand. — Cf. for the rest, the synoptical table which is given later.

Of the genus *Lycodonus* only two species are present from the region here considered: *L. flagellicauda* Jensen which inhabits the polar depths from Spitsbergen down to Iceland and the Færoe Channel, and *L. ophidium* Jensen of which only a young specimen from the depths of the Atlantic Ocean (south from Iceland) has been found. Cf. for the rest, the synoptical table.

Biology.

The *Lycodinæ* are bottom-fishes which swim by vigorous movements of their strong tail. As the fishing apparatus often brings them up alive to the surface, even from great depths, one can well believe that they are tenacious of life. *Lycodes frigidus*, for example, which is essentially a deep water fish, was kept alive during the Norwegian North-Atlantic Expedition by being placed in some water in a tub; according to Collett, they generally remained at rest in a half coiled-up condition, somewhat like *Zoarces viviparus*. During the Michael Sars expedition of 1902 I placed two *Lycodes esmarkii*, taken from 275 fathoms depths, in a tub with water and they remained alive several hours; other individuals of the same species showed themselves extremely active on being preserved and remained living for a long time.

According to the observations of Collett, myself and others, the *Lycodinæ* live chiefly on crustacea: copepods *(Calanus)*, cumaceæ, isopods, amphipods and decapods (*Hippolyte*, *Hymenodora* etc.). In the alimentary canal of the following species only the remains of crustacea were found: *Lycodes rossi*, *L. reticulatus*, *L. seminudus*, *L. agnostus* and *Lycodonus flagellicauda*. *Lycodes vahlii* and *Lycenchelys sarsii* feed both on crustacea and small bivalves. *Lycodes frigidus* according to Collett, lives chiefly on crustacea, but he has also found in them the remains of a cephalopod; during the Ingolf Expedition a *Gonatus* was found in one, and I have taken from their stomachs the beaks of ink-fish and remains of fishes. Collett found fish remains in *Lycodes lütkenii*. *Lycodes eudipleurostictus* feeds on crustacea, but one just as frequently finds in them the tubes of tubicolous worms, and once I have taken a *Priapulus* from its stomach. *Lycodes esmarkii* seems to feed exclusively on echinoderms, especially ophiuroids, partly also on *Antedon* and *Echinus*; both Collett and I myself have found their stomachs and intestines crammed full of broken skeletons of these animals.

The *Lycodinæ* are not despised either by other fishes. At West Greenland they are found not rarely in the stomachs of the Greenland shark *(Somniosus microcephalus)*, and I have once taken a *Lycodes* (indeterminable) from the stomach of a cod.

Concerning the beginning of the spawning period but little is known. Collett says that *Lycodes esmarkii* spawns in the early winter months at Finmark, and that *L. vahlii* (= *L. gracilis*) spawns during July—October in the Skagerak; I have found the last named species with ripe roe in the beginning of July (Iceland). In the cold area (the Polar Depths) the breeding time may begin at the end of August, as I have observed the ripe roe at that time in *Lycodes frigidus* and *L. eudipleurostictus*.

The *Lycodinæ* are oviparous. The eggs are of considerable size and consequently relatively few in number. Collett has found ovarian eggs in *Lycodes esmarkii* which were 6 mm. in diameter and he puts their number at about 1200. In a specimen of *Lycodes frigidus*, 500 mm. long, I have counted 500 eggs each ca. 7 mm. in diameter. The eggs are large also in the smaller species; in *Lycodes vahlii* (from Iceland) I have found them to be 4,5 mm. in diameter, in *L. eudipleurostictus* 5 mm. in diameter (the number ca. 250) and in *L. agnostus* 4,5 mm. in diameter.

The eggs are laid without doubt on the bottom, as no pelagic egg is known which could be ascribed to the *Lycodinæ*. The brood also must apparently live on the bottom; tolerably small young, for example, have often been taken in the trawl which is dragged on the bottom, never however in the pelagic net.

Distribution of the Species of Lycodinæ in the North European and Greenland Waters.

A. Species taken within the 300 fathom line.

1. Kattegat (as far as the deep channel E. from Læso):
   Lycodes vahlii Reinh. (= *L. gracilis* M. Sars).

2. Skager Rak:
   Lycodes vahlii Reinh. (= *L. gracilis* M. Sars).
   Lycenchelys sarsii Coll.

3. Norway:
   Lycodes vahlii Reinh. (= *L. gracilis* M. Sars).
   — *esmarkii* Coll. (Finmark and towards Bear Island).
   — *rossi* Malmgr. (Porsanger Fjord in East Finmark).
   Lycenchelys sarsii Coll.

4. Norway-Shetland Slope („Eggen"):
   Lycodes esmarkii Coll.

5. Færoe Isles:
   Lycodes esmarkii Coll.

6. Færoe-Iceland Ridge:
   Lycodes esmarkii Coll.

7. Iceland:
   Lycodes vahlii Reinh. (= *L. lugubris* Lütk.).
   — *esmarkii* Coll. (E. from Iceland).
   (— *pallidus* Coll. [N. from Iceland, in the cold area]).

8. Kara Sea:
   Lycodes pallidus Coll.
   — *rossi* Malmgr.
   — *seminudus* Reinh.
   — *agnostus* Jensen.

9. Spitzbergen:
   Lycodes pallidus Coll.
   — *eudipleurostictus* Jensen.
   — *rossi* Malmgr.
   — *seminudus* Reinh.

10. Jan Mayen:
   Lycodes reticulatus Reinh. var. *macrocephalus* mihi.

11. Northerly East-Greenland:
   Lycodes pallidus Coll.
   — *eudipleurostictus* Jensen.
   — *reticulatus* Reinh. var. *macrocephalus* mihi.
   — *seminudus* Reinh.
   Lycenchelys kolthoffi Jensen.

12. West-Greenland:
   Lycodes vahlii Reinh. (S. W. Greenland).
   — *eudipleurostictus* Jensen.
   — *reticulatus* Reinh.
   — *seminudus* Reinh.

B. Species taken beyond the 300 fathom line.

1. Polar Depths or the cold area [1]):
   Lycodes frigidus Coll.
   (— *esmarkii* Coll. (juv.; Færoe-Channel)).
   — *eudipleurostictus* Jensen.
   — *pallidus* Coll.
   — *platyrhinus* Jensen (between Iceland and Jan Mayen).
   — *lütkenii* Coll. (W. from Spitzbergen).
   Lycodes seminudus Reinh.
   Lycenchelys muræna Coll.
   Lycodonus flagellicauda Jensen.
2. North Atlantic Ocean:
   Lycodes microcephalus Jensen. (S.W. from Iceland).
   Lycenchelys ingolfianus Jensen. (Davis Straits).
   Lycodonus ophidium Jensen. (S. from Iceland).

Systematic Part.

Fam. *Zoarcidæ* Swainson (1839).

Subfam. *Lycodinæ* Jordan & Evermann (1898).

Body elongated, zoarciform or anguilliform, covered to a more or less extent by small round, non-imbricate scales, which are sometimes wanting. Lateral line ventral, mediolateral or double, often less distinct. Fin-rays soft and jointed; the unpaired fins are continuous, and the dorsal fin has no depressed portion; pectoral fins well-developed; ventral fins present, with few short rays, jugular in position. Gill-membrane firmly united below to the throat. Teeth on the mandible and intermaxillary, often also on the vomer and palatal bones. Pseudobranchiæ present; no swimbladder; pyloric appendages rudimentary (2) or absent.

Key to the determination of the European and Greenland genera of Lycodinæ.

I. Body zoarciform, height over the anus contained ca. 7—12½ times in the total length. *Lycodes* Reinh. P. 10.
II. Body anguilliform, height over the anus contained ca. 16—30 times in the total length.
   A. Branchiostegal rays 6. *Lycenchelys* Gill. P. 82.
   B. Branchiostegal rays 5. *Lycodonus* Goode & Bean. P. 93.

Lycodes Reinhardt.

Lycodes Reinhardt, Overs. K. D. Vidensk. Selsk. Forhandl., 1830—31, p. 74 (*vahlii*).
Lycodalepis Bleeker, Versl. K. A. W. 2 e Rks., VIII, 1874, p. 369 (*mucosus*).
Lycias Jordan & Evermann, The Fishes of North and Middle America, Part III, 1898, p. 2463 (*seminudus*).

[1]) By »Polar Depths« I understand the deep waters which are bounded to the south, not by the polar circle, but by the submarine ridge between Greenland-Iceland-Færoe Isles-Shetland; because north of this ridge, polar water with a temperature under 0° C. (the »cold area«) is constantly found at the bottom where this lies more than c. 300 fathoms under the surface.

Body moderately elongated (zoarciform), height over the anus ca. 7—12½ times in the total length. Teeth on the intermaxillary and mandible, vomer and palatines. Underjaw without barbules. Scales small, covering a greater or less part of the trunk and tail, sometimes wanting. Lateral line ventral or mediolateral or both mediolateral and ventral. Branchiostegal rays 6.

The characters which are of special importance for distinguishing between the numerous species of this genus have been mentioned in detail in the introduction (p. 3—7). A detailed diagnosis is given under each species and I shall here endeavour (p. 11—12) to draw up a Key for the determination of the North European and Greenland species — the many difficulties in the way of separating such nearly allied species must be the excuse for the apparent shortcomings.

Tentative key for the determination of the European and Greenland species[1] (and varieties) of Lycodes.

I. *Vahlii-esmarkii* group: Lateral line ventral or both ventral and mediolateral. Distance between the snout and the anus 36,5—45 (47) % of the total length. D. 94—118; A. 81—102.
- A. Lateral line single, ventral.
  - a. Rays in the pectoral fins 23. (East coast of North America; 516—1423 fathoms). *L. atlanticus* Jensen; p. 25.
  - b. Rays in the pectoral fins 17—21.
    1. Colour (at all ages) uniform, without spots or bands. (Polar Depths from Spitzbergen to Iceland and Færoe Isles; (260?) 450—1455 fathoms). *L. frigidus* Coll.; p. 22.
    2. Body with dark cross-bands, in adults ring-shaped markings or more uniform; in the anterior corner of the dorsal fin almost always one or more dark spots. (Kattegat, Skager Rak, Norway, Iceland, southerly West-Greenland; 30—300 fathoms). *L. vahlii* Reinh.; p. 13.
- B. Lateral line double, ventral and mediolateral.
  - a. Body naked. (Polar Depths between Jan Mayen and Iceland; 1010 fathoms). *L. platyrhinus* Jensen; p. 51.
  - b. Body with scales.
    - α. Pyloric appendages absent. Rays in the pectoral fins 22—23, in the dorsal 113—118, in the anal 97—102. Hind-margin of pectoral not indented. (Finmark and towards Bear Island, Norway-Shetland Slope, Færoe Channel, east of the Færoes, Færoe-Iceland Ridge, east of Iceland, Nova Scotia; 150—300 (620) fathoms). *L. esmarkii* Coll.; p. 27.
    - β. Pyloric appendages present. Rays in the pectoral fins 20—22 (23), in the dorsal 100—103, in the anal 88—92. Hind-margin of pectoral indented. (Polar Depths west from Norway, north from the Færoe Isles and east from Iceland, Spitzbergen, northerly East- and West-Greenland; 150—470 fathoms). *L. eudipleurostictus* Jensen; p. 33.

[1] A North American species, *L. atlanticus* Jensen, is included in the key because I know it at first hand. *L. microcephalus* Jensen (from the Atlantic Ocean south from Iceland, 799 fathoms; p. 53) is omitted, because the course of the lateral line in this species cannot be determined with certainty — only one small specimen being known; for the rest, it is easily distinguished from all the above species by reason of its small head, which is only 17,3 % of the total length.

γ. Pyloric appendages present. Rays in the pectoral fins 17—21, in the dorsal 94—101, in the anal 81—86.

* Belly naked on the underside.

1. Longitudinal diameter of the eye 4,5—3,1 % of the total length. (Kara Sea, Polar Depths west from Norway, north from the Færoe Isles and north from Iceland, Spitzbergen, northerly East-Greenland; 18—495 fathoms). *L. pallidus* Coll.; p. 38.

2. Longitudinal diameter of the eye 5,6—4,7 % of the total length. (Polar Depths south from Jan Mayen; 371 fathoms). *L. pallidus* Coll. var. *similis* mihi; p. 39.

** Belly with scales also on the underside (either the whole or in all cases the greater portion). (Polar Depths west from Norway, north from the Færoe Isles and east from Iceland; 537—957 fathoms). *L. pallidus* Coll. var. (vel sp. n.) *squamiventer* mihi; p. 39.

II. *Reticulatus* group: Lateral line mediolateral. Distance between the snout and the anus 43—52 % of the total length. D. 90—97; A. 70—78.

a. Body naked. (Kara Sea, Ice Sea of Siberia; 15—100 fathoms). *L. agnostus* Jensen; p. 79.

b. Body more or less covered with scales.

α. Length of the pectoral fin 16,8 % of the total length, number of rays 23. (West from Spitzbergen; 459 fathoms). *L. lütkenii* Coll.; p. 59.

β. Length of the pectoral fin 14,4—13 % of the total length, number of rays 17—21.

* Colour marked by dark cross-bands. Rays in the pectoral (17) 18—19 (20). (Kara Sea, East Finmark, Spitzbergen; 5—100 fathoms). *L. rossi* Malmgr.; p. 55.

** The dark cross-bands (in older individuals) form network patterns. Rays in the pectorals 19—21.

1. Longitudinal diameter of the eye 2,7—4 % of the total length. (West Greenland; 100 fathoms). *L. reticulatus* Reinh.; p. 61.

2. Longitudinal diameter of the eye 4,3—4,8 % of the total length. (Northerly East Greenland, Jan Mayen; 40—150 fathoms). *L. reticulatus* Reinh. var. *macrocephalus* mihi; p. 66.

γ. Length of the pectoral fin 11,8—9,6 % of the total length, number of rays 19—22. (Kara Sea, Polar Depths between Norway and Færoe Isles, east from Iceland and south from Jan Mayen, Spitzbergen, northerly East Greenland, West Greenland; 100—600 fathoms). *L. seminudus* Reinh.; p. 71.

Lycodes vahlii Reinhardt.

Tab. I, Fig. 2 a, b, c & Tab. II, Fig. 1 a, b.

Fig. 1 & 2 in text.

1831. *Lycodes Vahlii* Reinhardt, Overs. Kgl. D. Vidensk. Selsk. Forh. 1830 31, p. 74.
1835. *L. Vahlii* Reinhardt, Overs. Kgl. D. Vidensk. Selsk. Forh. 1834—35, p. 77.
1838. *L. Vahlii* Reinhardt, Kgl. D. Vidensk. Selsk. Skr. VII, p. 153, Tab. 5.
1866. *L. gracilis* M. Sars, Forh. Vidensk. Selsk. Chria. 1866, p. 40, Pl. 1, Fig. 1—3.
1875. *L. gracilis* Collett, Norges Fiske; Tillægsh. til Forh. Vidensk. Selsk. Chria. 1874, p. 100.
1880. *L. Vahlii* Lütken, Vidensk. Medd. Naturh. Foren. Kbhvn., p. 311.
1880. *L. lugubris* Lütken, ibid. p. 315.
1891. *L. rossii* Lilljeborg (nec Malmgren), Sveriges och Norges Fiskar, III, p. 785.
1895. *L. Vahlii* Smitt, Skandinaviens Fiskar, II, p. 613 (partim).
1898. *L. gracilis* Lütken, The Danish Ingolf Expedition, II, 1, p. 22.
1899. *L. gracilis* Collett, Vidensk. Selsk. Skr. Chria. No. 6, Pl. I—III.
1901. *L. Vahlii* forma *gracilis* Smitt, Bih. K. Sv. Vet.-Akad. Handl. Bd. 27, Afd. IV, No. 4, p. 22.
1901. *L. vahlii* Jensen, Vidensk. Medd. Naturh. Foren. Kbhvn. p. 202 & p. 212.

The height over the anus amounts in general to 8—11 % of the total length. The length of the head in the males is 19,6—23,8 %, in the females 18,8—21,4 % of the total length. The tail is considerably longer than the head and trunk together, the distance from the snout to the anus being in males 37,8—42,3 %, in females 36,5—41,7 % of the total length. The young have 8—10 broad, dark cross-bands over the body; these bands in the adults either disappear entirely or dissolve into ring-shaped stripes and irregular spots; on the anterior corner of the dorsal fin is almost always a black-brown patch, behind which there often is one or two more dark spots. Scales begin to appear at a total length of ca. 60 mm.; at a length of ca. 100 mm. the tail and the trunk are completely covered by scales, as also the base of the unpaired fins. Lateral line ventral. Pyloric appendages 2. The length reaches 520 mm.

D. 95—117. A. 84—98. P. 17—20. Vert. 98—116.

Distribution. Southerly West-Greenland, Iceland, Scandinavia; 30—300 fathoms.

L. vahlii typica: maximum length 520 mm. D. 117—113; A. 98—90; P. 20—19. Vert. 116—112. Greenland.
— *lugubris*: maximum length 355 mm. D. 105—103; A. 90; P. 19—18 (17). Vert. 105. Iceland.
— *gracilis*: maximum length 196 mm.[1] D. 97—95; A. 86—84; P. (19) 18—17. Vert. 100—98. Scandinavia.

Remarks on the Synonymy.

In 1866 a Lycodes, taken in the Christiania Fjord, was described by M. Sars under the name *L. gracilis*. It was a very young specimen, only 43 mm. long, characterised by 10 saddle shaped cross-bands on a whitish background. The species was not rediscovered until in 1888, when Conservator Storm took 4 specimens, 97—137 mm. long, in Trondhjem Fjord; a fifth, very small individual was taken in the same fjord 6 years later. Lastly, during some of the practical fisheries investigations

[1] Cf. however Appendix, p. 21.

carried out by Dr. C. G. Joh. Petersen and Dr. Johan Hjort in 1897—98, a very large number of individuals was taken in the Kattegat, Skager Rak and Christiania Fjord. Based on this rich material, Prof. R. Collett published in 1899 a detailed description with numerous figures of the species and of its changing appearances from the young stages up to the reproductive period, the latter stage being reached in these waters at a length of 125—150 mm.; the largest specimen was 178 mm.[1] During the same period, the geographical distribution of this species became widened to embrace Iceland and West Greenland[2]; Collett had obtained from Iceland in 1891 a young specimen from B. Grondal of Reykjavik, and the Ingolf expedition took 2 specimens 143 and 244 mm. long in Davis Straits in the summer of 1895; the last specimens were determined by the present author as *L. gracilis* and were published under this name in the report on the ichthyological results of the Ingolf expedition (Lütken l. c.).

Prof. Collett in the same treatise, examined the relation of *L. gracilis* to allied species. Lack of sufficient material obliged Collett to leave unsettled whether or not *L. gracilis* is identical with *L. rossi* Malmgr. and *L. pallidus* Coll., both known from Spitzbergen. Further it is possible, he states, that *L. gracilis* may be shown to grow elsewhere to a greater size and be identical with some earlier described form, whose young stages are as yet unknown.

On the first possibility, I am unable to give Prof. Collett any support, as *L. rossi* is in all probability the young stage of another species (= *L. celatus* mihi)[3] and *L. pallidus* is a good species as I shall show later.

On the other hand, *L. gracilis* is in my opinion identical with the species long known from Greenland which Reinhardt (sen.) set up as the type of the genus, namely *L. vahlii*[4]. Our Museum possesses half a score of specimens of this Lycodes, and 7 of these were examined by Reinhardt and Lütken whilst 3 are of more recent date (1885); the value of the material is diminished by the bad preservation of the specimens on the whole, but it is quite sufficient to sustain the certainty of the contention here set forth.

Further, I am in a position to furnish proof that the *L. lugubris* from Iceland (Ofjord), described by Lütken in 1880, must also be referred to *L. vahlii*.

We see therefore the peculiar phenomenon that one and the same fish has been ascribed to 3 different species, according as it lives in the waters of Scandinavia, Iceland or Greenland. The reasons for this are twofold: partly because the separate authors have had only a limited material to decide upon; partly because the specimens fall into three groups, which severally present certain differences, and each of these groups possesses its own geographical and separate region.

As a contribution to the knowledge of the importance of geographical elements[5] for the formation of separate races the present example is not without interest, and we shall therefore look into this point a little closer later (p. 19).

I shall proceed now to treat of the separate forms, employing as titles the names they have hitherto borne.

Lycodes gracilis M. Sars.

The form from Scandinavia is so well known from Collett's latest researches (1899) that I need not dwell upon it. Collett's treatise I shall suppose as known in the following pages.

Lycodes vahlii Reinhardt.

Tab. I, Fig. 2 a, b.

At the time when I was assisting Prof. Lütken with the revision of the manuscript of "The Ichthyological Results" of the Ingolf Expedition, I saw that two small Lycodes, taken in Davis Straits out from Sukkertoppen in 88 fathoms, must be ascribed to *L. gracilis* with which I was familiar through the numerous specimens from the Skager Rak presented by Dr. C. G. Joh. Petersen to the Zoological Museum. Prof. Lütken sent these two specimens to Prof. Collett who was then busy with his monograph on *L. gracilis;* Prof. Collett acknowledged the correctness of the determination and has mentioned the discovery in his treatise.

At the same time, subjecting the other preserved material in the Museum of Lycodes from Greenland to a hasty review, it struck me that the youngest of the specimens labelled under the

[1] A somewhat larger specimen, 196 mm. long, was taken later (1900) in the Gullmar Fjord (Bohuslän); it is preserved in the Riks-Museum at Stockholm, where I have had the opportunity of seeing it.

[2] By an error in writing Collett has "East-Greenland" (l. c. p. 8).

[3] Later: A rich material recently obtained has made it clear to Prof. Collett also that *L. rossi* is an independent species.

[4] It might appear as if Prof. Smitt had already published a similar opinion, but his «*L. vahlii*» is not the same as *L. vahlii* Reinhardt. See further p. 15, note 1.

[5] By "geographical elements" I understand the sum of the natural conditions in the region.

name *L. vahlii* Reinh. were apparently not distinguishable from the Ingolf's two *L. gracilis*. At that time I had no opportunity of following up the matter; but now that I have examined it more thoroughly I find that my first impression was correct.

Proportions of the body. In order to display the proof of the correctness of this position, I give here the measurements of a number of specimens, in part the two from the Ingolf, identified by me as *L. gracilis*, in part the earlier ones ascribed by Reinhardt and Lütken to *L. vahlii*.

Measurements of *L. vahlii* Reinh. from West Greenland:

		♂	♀	♀	♀	♂	♀	♀	♀	♂	♂	♂	♀
Total length	in mm.	143	197	235	244	260	295	310	335	365	385	410	415
Length of the head		28	37	45	49	52	58,5	65	66	87	90	90	80
Distance from snout to anus		54	72	88	95	99	118	127	128	152	157	160	170
Height over the anus		13,5	19,5	?	23	22	25	32	31	35	30	33	44

The length of the head is therefore in females 18,8—21 %, in males 19,6—23,8 % of the total length; in the specimens from Scandinavia the figures, expressed in % from Collett's statement of measurements, are 18,8—21,4 % and 20,4—22,7 % respectively. Further, the head and the trunk together (i. e. distance from snout to anus) is in the Greenland specimens 36,4—41,6 %, in those from Scandinavia 37,1—41,3 % of the total length. — In other words, there is as close an agreement as is possible between the Greenland *L. vahlii* and Scandinavian *L. gracilis*, with regard to the most important measurements of the body[1]).

Colour-markings. The smallest, Greenland specimen (one from the Ingolf Expedition) is a male 143 mm., figured in Tab. I, fig. 2 a. The body is adorned with broad, dark cross-bands, 2 on the trunk and 7 on the tail; on the tail posteriorly the bands extend right across and out to the borders of the unpaired fins, further forward they reach below to only a little under the median line; for the rest, each band has a light part in the centre which is not much darker than the grayish yellow ground-colour of the back and sides. In the anterior part of the dorsal fin are 3 very dark, elongated spots, the

[1]) In his work »Skandinaviens Fiskar« II, 1895, p. 615, Prof. F. A. Smitt has expressed the conjecture that *L. gracilis*, which was only known at that time (in the literature) from the original specimen of Sars, is the young stage of *L. vahlii*. In a later note »On the Genus Lycodes« (Ann. Mag. Nat. Hist. (7) V, 1900, p. 57), written after the appearance of Collett's treatise on *L. gracilis*, the same statement is repeated, but at the same time, *L. gracilis* is given in his analytical table as a peculiar form (*borealis*) of *L. vahlii*, specially characterised by this that the length of the head is »usually« less than 22 % of the total length, whilst in *L. vahlii typica* (forma *arctica*) the length of the head exceeds 22 % of the total length; with regard to the first form it is correct that the length of the head is usually less than 22 % of the total length (see above); but it does not agree with the results of my measurements to say, that the length of the head in *L. vahlii* exceeds more than 22 % of the total length (see above) — for the simple reason that Smitt's »*L. vahlii*« is not the same as *L. vahlii* Reinhardt, as we shall soon see. — Lastly, in his latest contribution concerning the systematic relations of the genus, Smitt speaks thus: »Within the limits of the former species (i. e. *L. vahlii*) it is easy enough to distinguish a local form, *gracilis*, living in the more southerly localities on the European side of the Atlantic ..... and perhaps by this geographical selection from the true home of the genus stopped in the evolution and retaining the juvenile characters«. (On the genus Lycodes. II. Bih. K. Sv. Vet.-Akad. Handl. Bd. 27, Afd. IV, No. 4, 1901, p. 20). About the same time I expressed a similar idea, as I also looked on *L. gracilis* as a local form of *L. vahlii* (but as a dwarf form indeed, not as a form which had preserved the characters of the young of *L. vahlii*; cf. Vidensk. Medd. Naturh. Foren. Kbhvn. 1901, p. 202 and the present treatise p. 19), and in a footnote (l. c. p. 203) I cited Prof. Smitt's opinion as agreeing essentially with my view; but since I have had the opportunity, thanks to Prof. Smitt, of examining his »*L. vahlii typica*«, at Stockholm, I must take back my earlier half-agreement with his view; the form mentioned is not *L. vahlii* Reinhardt at all, but contains heterogeneous elements, chiefly specimens of *L. pallidus* Collett and *L. eudipleurostictus* mihi — two species which, in my opinion, show no special relationship to *L. vahlii* Reinhardt.

2nd and 3rd of which are in line each with its cross-band, whilst the 1st, in the very front corner of the fin, is in line with the posterior edge of the foremost cross-band. Specimens from the Skager Rak show the same colour-markings as the foregoing, but the comparison must be made with much smaller specimens, because the cross-bands in those from the Skager Rak have already disappeared as a rule at the same size as the above.

The next larger specimen is a female of 197 mm. long, determined as *L. vahlii* by Lütken. The colour-markings are as in the foregoing; the dark cross-bands are however somewhat fainter, but that may perhaps be due to their longer preservation in spirit.

Observation of the remaining specimens shows that the colour-markings of the young become more and more indistinct with age, especially in the males. Even in the largest female, 415 mm. long, there are still traces of the dark bands, although they are partly resolved into ring-shaped markings. The larger males, on the other hand, are darker than the females on the whole, so that the bands, partly in the form of rings, can scarcely be discerned or have entirely disappeared; at the same time, the belly is often of a sharply delimited, relatively light, sometimes even quite white colour (Tab. I, fig. 2 c). The dark spot on the anterior corner of the dorsal fin is very conspicuous both in the male (Tab. I, fig. 2 c) and female (Tab. I, fig. 2 b), sometimes also the second and third spot.

The scaly covering has already attained essentially to its fullest extent in the 143 mm. long specimen (Tab. I, fig. 2 a), as it extends forwards to the neck (on a line across the gill openings), to the bases of the pectoral fins and of the ventrals as well as out on to the unpaired fins.

The lateral line is as in *L. gracilis*: it courses along the ventral border of the tail and rises dorsally over the anus in order to reach the upper notch of the gill-opening[1]).

The number of fin-rays differs somewhat from that in the Scandinavian specimens, which is probably in relation to the fact that the Greenland form, taken on the whole, is a stronger race; in this regard also, the Iceland specimens are transition-forms so that no specific distinctions can be grounded on these differences. This point will be further considered later (p. 19).

Since the general appearance of the body offers no mark of distinction either — that the species reaches a very much greater size at Greenland than at Iceland (cf. p. 19) denotes again only a racial difference — I look upon it as certain, that the Greenland *L. vahlii* and the Scandinavian *L. gracilis* belong to the same species.

Lycodes lugubris Lütken.

Tab. II, Fig. 1 a, b.

Before treating of this form I think it opportune to refer to some Lycodes which have recently been received at the Zoological Museum from the east coast of Iceland. They were procured by

[1]) This seems to dispute Lütken's observation: As Hr. Collett has called to my attention, there is some reason for considering there is another lateral line, a mediolateral, in one of the present specimens (Nr. 7) ...... (Vidensk. Medd. Naturh. Foren. 1880, p. 312) and Collett's still more definite assertion: it must however be admitted, that one of the typical specimens of *L. vahlii* exhibits traces of a mediolateral line (The Norw. North-Atl. Exp., Fishes, p. 86). From an exact examination of the specimen concerned, I have come to the result that Collett's observation was perfectly correct; but at the same time I am nevertheless of the opinion that this specimen is not *L. vahlii* at all — in spite of the fact that it is one of Reinhardt's type-specimens — but on the contrary, is identical as species with the fishes brought home by the Norwegian North-Atlantic Expedition from Spitzbergen, which Collett took for young specimens of *L. esmarkii* Coll., but which I have been obliged to distinguish as a special species (see further under *L. eudipleurostictus* p. 36).

stud. mag. R. Horring during his cruise on the navy-schooner "Diana". Their number is half a score, of various sizes, and they are readily recognised as being of the same species as *L. gracilis*. Measurements of some of the specimens will shew the exact agreement with those from the Skager Rak.

Measurements of Lycodes from Iceland, identified as "*L. gracilis*" M. Sars:

				♀	♂	♂	♀	♀	♀
Total length	in mm.	87	95	121	130	180	190	200	210
Length of the head		17	19,5	23	27	37,5	37,5	38	43
Distance from snout to anus		33,5	36	47	53	69	76	76	79
Height over the anus		8	8,5	11	12	15	17,5	19	21

The length of the head therefore, amounts to 19—20,5 % of the total length in the females, and to 20,8 % in the males; in specimens from Scandinavia these proportions, reckoned in percentages from Collett's data, are 18,8—21,4 % and 20,4—22,7 % respectively. Again, the head and the trunk together (i. e. the distance from the snout to the anus) amounts to 37,6—40,8 % of the total length in the Iceland specimens, and to 37,1—41,3 % in the Scandinavian. The narrower limits to the percentages in the Iceland specimens arise naturally from the fewer individuals on which the measurements are based. In regard to the general form of the body, course of the lateral line etc. they agree exactly with the specimens from the Skager Rak.

The colour-markings in the Iceland specimens do not differ from those of the Skager Rak specimens. The youngest individuals (ca. 90 mm. long) are provided as a rule with 8 to 9 broad, dark cross-bands, but these are already not very conspicuous; in older individuals they can just be seen or have wholly disappeared. On the dorsal fin anteriorly there are 2 (sometimes 3, sometimes only 1) black spots; this marking seems tolerably constant, even when the others disappear (Tab. II, fig. 1 a, b). The youngest individual farther, possesses a light stripe across the neck. The ground colour is brownish above, gray-yellow below.

The scales appear at the same size as in the Scandinavian specimens. A young specimen of 87 mm. shows some portions here and there where the skin is still naked, but in a slightly older specimen of 95 mm. the scales are complete.

From an examination of these specimens I have arrived at the same conclusion as Collett from his investigation of his specimen from Iceland, viz. that a *Lycodes* identical as species with *L. gracilis* occurs at this island.

Accepting this as a fact, we may now enquire more closely into the single *Lycodes* formerly known from the coast of Iceland, namely *L. lugubris* Lütk.

Of the 5 specimens, 4 males and 1 female, which in 1880 formed the basis for the establishment of this species by Lütken, only three, 2 males and 1 female now remain; a mounted skeleton in the Museum labelled "*L. lugubris*" is certainly identical with the fourth specimen but the fifth is no longer in the Museum.

Lütken has remarked that his Iceland Lycodes stood near to *L. vahlii* in respect to body form, scale-covering and course of the lateral line.

As a determining character, he first names the colour which, in the Iceland specimens is of a perfectly uniform grayish or gray-brownish, without bands, network or the like, either on the back or fins; the only marking apparent to the eye is that the under part of the belly and head are somewhat lighter, though to a varying degree in the different individuals, and a whiter part especially is present at the corners of the mouth, embracing generally the limbs of the underjaw and the overlip and with a tolerably sharp boundary where it meets the darker head above . It may be remarked meantime that *L. vahlii* — according to Lütken's own perfectly correct statement — has only dark bands in the young, and that the bands in the old (at least in the males) seem to dissolve entirely into an uniform dark colour . Since he pointed out the probable difference in the colouring, Lütken has obviously compared the Iceland specimens with young *L. vahlii;* if the comparison however had been made with older *L. vahlii* — which would have been better, since *L. lugubris* Lütken consisted only of developed specimens — the result would have been quite different, namely that there was the most perfect agreement between them; even the white part along the limbs of the underjaw and the overlip are found in individual larger males of *L. vahlii.* An important patch of colour, which Lütken either overlooked or attached no weight to, has also to be mentioned: in the anterior corner of the dorsal fin the characteristic dark spot of *L. vahlii-gracilis*, so often referred to above, is clearly seen in two specimens, less clearly in the third, of *L. lugubris.*

Again, according to Lütken, the Iceland form differs from the Greenland in having fewer rays in the pectorals, namely 17—18 against 19—20 in *L. vahlii.* The break is rather small by itself to make one think this a good specific character to distinguish it from *L. vahlii* . It is due to chance also that all Lütken's specimens showed the low number. One specimen sent from Arnarfjord in the North-West Land in 1894, and ascribed by Lütken himself to *L. lugubris*, possesses 19 rays in the pectorals; I find the same number in a specimen which came from the same fjord as those of Lütken, namely Ofjord, and would be ascribed to *L. lugubris* Lütk. — Since the numbers of the rays in the pectorals thus overlap in the two forms, this loses essential importance as a specific determining character.

A further specific character is found by Lütken in this, that whilst the row of palatal teeth is as a rule longer than that on the intermaxillary in *L. vahlii*, very rarely if ever, shorter than on the latter, in *L. lugubris* it is always somewhat shorter than that on the intermaxillary. To obtain this result Lütken must certainly have had before him male individuals of *L. lugubris*, and of *L. vahlii* females more particularly; because in the single ♀ *L. lugubris*, in the collection of the Museum, the row of teeth on the palatal is of the same length (a little longer indeed on the one side) as that on the intermaxillary; and contrariwise, I find that the row on the palatals is distinctly shorter than that on the intermaxillary in all older males of *L. vahlii.* This, which Lütken had taken for a specific distinction, is thus reduced to a sexual character, which appears equally in the one form as in the other.

I think I have thus sufficiently explained the untenableness of Lütken's expressed reasons for considering *L. lugubris* distinct from *L. vahlii.* There remains only to show from measurements of *L. lugubris*, that it and *L. vahlii-gracilis* are in perfect agreement.

Measurements of *L. lugubris* Lütk.:

		♂	♀	♂	♂	♂
Total length	in mm.	300	312	320	330	355
Length of the head	—	70	59	74	75	80
Distance from snout to anus	—	127	130	128	135	147
Height over the anus	—	27	34	27	29,5	33

The length of the head is thus 18,9 % in the females, 22,5—23,3 % in the males, of the total length; the distance between the snout and the anus is 40—42,3 % of the total length. These numbers thus agree very closely with those of adult *L. vahlii*.

Remarks on the variation of the species.

From the examination just completed it will be evident that *L. vahlii-lugubris-gracilis* cannot be regarded as separate species. At the same time, it must be put forward that the members of this chain represent 3 races, each possessing its own geographical and separate region, namely Greenland *(L. vahlii typica)*, Iceland *(L. vahlii lugubris)*, and Scandinavia *(L. vahlii gracilis)*.

First of all, there is a remarkable variation in regard to size. The species reaches its maximum size at Greenland to over 1/2 m. (ca. 52 cm.) long; at Iceland the maximum is 35,5 cm., and from Scandinavia no greater specimen than 19,6 cm.[1]) is known. Since these measurements are based on a large number of specimens they can scarcely be regarded as resting on chance, but one may believe that the species decreases in size as it approaches the more easterly (and southerly) regions.

Parallel with this decrease in size there is a diminution in the number of fin-rays and vertebræ, as will be seen in the following tabular review.

	Greenland *L. vahlii typica*	Iceland *L. vahlii lugubris*	Scandinavia *L. vahlii gracilis*
Maximum length in mm.	520	355	196
Number of rays in pectoral fin	20—19	19—18 (17)	(19) 18—17
— — dorsal	117—113	105—103	97—95[2])
— — anal	98—90	90	86—84
Number of vertebræ	116—112	105	100—98

It seems therefore as if the species taken as a whole, reaches its greatest development at Greenland; at Iceland there is already a recognisable decline, and at Scandinavia we meet with the species in its most reduced condition[3]).

Differences between the sexes.

Prof. Collett has observed on specimens from Scandinavia that it is easy as a rule to distinguish males from females by their relatively longer head. The same is the case in Greenland and

[1]) Cf. Appendix however, p. 21.
[2]) Collett gives the number as ca. 120, but this must be due to an error in counting.
[3]) Cf. Appendix however, p. 21.

3*

Iceland specimens, cf. p. 15 and p. 17 (see also Tab. I, fig. 2 b [♀] and fig. 2 c [♂]; Tab. II, fig. 1 a [♂] and fig. 1 b [♀]). On account of the greater length of the head (which shows almost to an equal degree on the pre- and post-orbital portion) the profile in the males varies also with age; the upper margin is straightened out and forms from the eye forward a faint, sloping line (see Tab. I, fig. 2 c and Tab. II, fig. 1 a); it is characteristic of the females (and the young individuals) that the upper margin from the eye forward declines somewhat sharply towards the snout (see Tab. I, fig. 2 b and Tab. II, fig. 1 b, also fig. 2 a, Tab. I of a young individual). Farther, the head of the males is broader over the cheeks than that of the females (cf. text fig. 1, ♂ and fig. 2, ♀), which has already been remarked by Collett in *L. gracilis*». Here may be added also that in the older males, the row of teeth on the intermaxillary becomes

Fig. 1. *L. vahlii* ♂.

Fig. 2. *L. vahlii* ♀.

longer than that on the palatals, whilst in the females the row on the intermaxillary is only of the same length or even shorter than that on the palatals.

Concerning the colour, Collett states that old males seem as a rule to be more uniform than the females usually are at the same stage. The same holds also, but in greater degree, for the specimens from Greenland.

Reproduction.

According to Collett, *L. vahlii* (*L. gracilis*) spawns in the Skager Rak from July to October; the greatest number of eggs he found in a female was 30—48 and their maximum size was reckoned to 4 mm. in diameter. In a female 210 mm. long, taken on July 8th, 1899 at Seydisfjord on the east coast of Iceland, I find on the contrary not less than 93 eggs, whose size is 4,5 mm. in diameter (in addition, this female contained some individual eggs, obviously late in development, and numerous small eggs reserved for the next spawning period). The Greenland specimens do not throw much light on the breeding conditions, partly on account of the bad state of preservation, partly because data with regard to the catch are wanting. In a 247 mm. long female, taken on July 11th 1895 off Holstensborg, the eggs measured scarcely 1 mm. in diameter, so that it was hardly ready for spawning in that year. A female 310 mm. long, taken at Sukkertoppen August 5th 1885, seems to have spawned as the ovaries are collapsed and contain very small eggs only.

In a male of 180 mm., taken at Iceland on April 30th, the testes are very small (9,5 mm.) and little developed. In a male 300 mm. long, likewise from Iceland, the testes measured ca. 30 mm. (the free folds being ca. 7 mm.) and are much swollen. In larger males from Greenland the testes reach a length of ca. 45 mm. (folds ca. 20 mm.).

Distribution.

In Scandinavia the species has been taken in Trondhjem fjord[1]), in the Christiania fjord, also in the Skager Rak and in the eastern Kattegat as far as the deep channel E. from Læso, at 30—300 fathoms depth (cf. Collett l. c. 1899 and C. G. Joh. Petersen[2])). At Iceland: on the east coast stud. mag. Horring has taken 7 specimens at Reydarfjord, 44 fathoms, one in outer Reydarfjord, 60—80 fathoms, one in Nordfjord's Flóin, 35—55 fathoms and one in Seydisfjord, 30—60 fathoms; from the North Land the Museum has obtained 5 specimens during the seventies from Ofjord; I have also had a further specimen from the same fjord but of later origin[3]); in the North-West Land, Capt. Bast obtained a specimen in Arnarfjord in 1894, and lastly a specimen[3]) has been taken at North-west Iceland, ca. 80 fathoms. At Greenland: the species has been taken at the following places all lying along the south-westerly stretch of coast: Nanortalik (ca. 60° N.L.), Fiskenæs, Godthaab, Sukkertoppen and Ingolfs St. 31 (66° 35' N.L.), 88 fathoms; the distribution therefore extends over ca. 6½ degrees of latitude.

Appendix.

During my participation in the cruise of the Norwegian fisheries steamer, Michael Sars in the summer of 1902, a specimen of *Lycodes vahlii gracilis* was taken in the English trawl at a depth of 190 fathoms; the place (St. 47) lay off the south-west of Norway (60° 57' N.L. 3° 42' E.L.).

Lastly, through the kindness of Prof. Collett, I have had the opportunity to examine a specimen which was taken (by the Michael Sars, 14.5.01) much further to the north of Norway than the species was hitherto known, namely at Baadsfjord (East Finmark). This specimen is conspicuous by its considerable size, 268 mm. Amongst the hundreds of specimens which have previously been reported from Scandinavia, none — as already mentioned — exceeded 196 mm. in length, but they came from much more southerly regions (especially the Skager Rak). In the fjords of East Finmark, where the conditions are half arctic, the species can thus attain almost as great a size as at Iceland; in the number of fin-rays also this specimen approaches to the variety *lugubris*, as the pectoral fins have 19 rays, the dorsal fin 101, and the anal 89.

1) Cf. Appendix this page.

2) Beretning IX fra den biologiske Station, p. 17—32; Fiskeri-Beretning for Finansaaret 1898—99 (Kjobenhavn, 1900).

3) This belongs to the Natural History Society at Reykjavik and was kindly lent me by my friend, Adjunkt B. Sæmundsson.

Lycodes frigidus Collett.

Tab. V, Fig. 1 a, b.

1878. *Lycodes vahlii* Collett, Fiske indsamlede under den norske Nordhavs-Expeditions 2 forste Togter; Forh. Vidensk. Selsk. Chria. 1878, No. 4, p. 11 (partim).
1878. *L. frigidus* Collett, Fiske fra Nordhavs-Expeditionens sidste Togt; Forh. Vidensk. Selsk. Chria. 1878, No. 14, p. 45.
1880. *L. frigidus* Collett, The Norwegian North-Atlantic Expedition, Fishes, p. 96, Pl. III, Fig. 23—24.
1887. *L. reticulatus* Günther (nec Reinhardt), The Voyage of H. M. S. Challenger, XXII, Report on the Deep-Sea Fishes, p. 77, Pl. XIII.
1887. *L. frigidus* Günther, ibid. p. 79.
1891. *L. frigidus* Lilljeborg, Sveriges och Norges Fiskar, II, p. 19.
1895. *L. frigidus* Smitt, Skandinaviens Fiskar, II, p. 610, Fig. 146.
1898. *L. frigidus* Lütken, The Danish Ingolf-Expedition, II, 1, p. 20 (partim).
1899. *L. frigidus* Lönnberg, Bihang K. Sv. Vetensk.-Akad. Handl. Bd. 24, Afd. IV, No. 9, p. 24.
1901. *L. reticulatus* forma *frigida* Smitt, Bih. K. Sv. Vetensk.-Akad. Handl. Bd. 27, Afd. IV, No. 4, p. 29 (partim), No. 10, 11 & 12.
1901. *L. frigidus* Jensen, Vidensk. Medd. Naturh. Foren. Kbhvn., p. 213.

The height over the anus amounts to 9,5—14,2 % of the total length (in the young, 8—9,6 %). The length of the head in the males is 23,6—27,6 %, in the females 22,4—25,2 % of the total length. The tail is somewhat longer than the head and trunk together, as the distance between the snout and the anus is in the males 43,7—47 %, in the females 38,2—45,6 % of the total length. The colour is uniformly reddish gray or brown gray (in living specimens, yellow brown to chocolate colour), without bands or spots; the gill-covers and fins are dark brown toward the margins. The scales are unusually small, covering the whole of the body as far as the head, and the base of the fins also in the fully grown; in the younger, the middle part of the belly, the fins and along their bases are most often naked. Lateral line ventral[1]). Pyloric appendages 2[2]). The size reaches to ca. 560 mm.

D. 99—104. A. 85—90. P. 19—21. Vert. 103—107 (21—22 + 81—85).

Distribution. Polar depths from Spitzbergen down to Iceland and the Færoes, (260?) 450—1455 fathoms.

Prof. Collett has given detailed information with regard to the numerous specimens taken on the Norw. North-Atlantic Expedition, representing the species from the younger stages up to 510 mm.; a new and searching description is therefore unnecessary. I shall simply content myself with making some comments, in part supplementary, in part for correction.

I give below the measurements of 17 specimens from the Ingolf Expedition; the sex is stated where it could be determined with certainty, which is already possible at a length of ca. 100 mm.

[1]) In well-preserved specimens a series of dorsal pores remote from one another, can also be seen.

[2]) I do not agree here with Collett, who states that the pyloric appendages are wanting.

						♂	♀	♂	♀	♂	♀	♀	♂	♀	♀	♂	♂	♂
Total length	in mm.	49,5	56,5	76	83,5	104,5	136	173	204	215	226	290	327	345	402	406	428	515
Length of the head	—	11,75	13,5	17,5	20,5	24,5	30,5	44	50	51	57	72	82	82	96	112	101	136
Distance from snout to anus	—	19,5	22,5	29,5	36	42,5	52	78	90	94	103	130	146	160	180	189	190	242
Height over the anus	—	4	4,5	6,5	8	9,5	13	20	24	25	26	35	45	44	56	50	51	73

The length of the head therefore, amounts to 23,6—27,6 % of the total length in the males, 22,4—25,2 % in the females (23—24,6 % in the young); the distance from the snout to the anus is 43,7—47 % of the total length in the males, 38,2—45,6 % in the females (38,8—43,1 % in the young); the height over the anus 9,5—14,2 % (8—9,6 % in the young) of the same dimension.

Collett (Norw. North-Atlantic Expedition, Fishes, p. 100) states that the scales begin to develop in the young when they are about 50 mm. long, as in one specimen (from St. 124) of 62 mm. total length, the scales had begun to appear on the anterior part of the body. This statement does not agree with my experience. Thus 10 specimens (Ingolf Expedition), whose lengths lay between 49,5 and 105 mm. are quite devoid of scales. The smallest specimen on which scales can be observed, is 101 mm. long; in it scales appear about the median line of the side, on the posterior half of the trunk, and on the anterior two-thirds of the tail. This seems therefore to point to the conclusion, that the scaly covering begins to form at the earliest at a total length of ca. 100 mm., also that Collett's specimen, which was already furnished with scales at 62 mm., hardly belonged to the present species. For the rest, there is some variation in the place of appearance and distribution of the scaly covering. Four specimens, whose lengths are 108,5, 118, 120 and 138 mm. have it relatively less developed than the one just mentioned of 101 mm., as only on a small part over the anus, round the median line, do the scales make their appearance. Five individuals of 120, 125, 137, 148 and 162 mm. are quite different from these, as no scales appear on the trunk, but they are present on the other hand on the middle third of the tail. Consequently, the scales may first appear either on the middle of the body, or on the middle of the tail. At a total length of ca. 170 mm., the scaly covering extends in general from a little behind the gill-covers to the neighbourhood of the end of the tail, also below on to the underside of the belly, but the anterior part of the back (with a small strip under the front part of the dorsal fin) together with the fins are bare. At a total length of ca. 180 mm., the scales also appear on the part in front of the dorsal fin, and at ca. 200 mm. they show on the base of the dorsal fin. In the adults, the scales extend over the body right to the head as also out on the unpaired fins, but in two of the largest specimens I cannot detect scales on the front part of the back (in front of the dorsal fin), nor partly either on a strip under the front part of the dorsal fin.

Although *L. frigidus* is a well characterised species, and from its small scales and uniformly coloured body at all ages is the most readily recognised of all the Lycodes here dealt with, yet a doubt has been expressed lately from two sides as to whether it is a good species.

F. A. Smitt thus states in his great work on the fishes of Scandinavia, that the possibility is not excluded that under Collett's *L. frigidus* is concealed „a number of sterile perhaps hybrid individuals"; the species, to which he refers, being *L. vahlii* and *L. reticulatus*. And from a note[1]) which

[1]) Smitt: On the Genus *Lycodes*. Ann. Mag. Nat. History (7), 5. 1900, p. 56.

has but recently appeared, it is evident that Prof. Smitt has not changed his standpoint in this regard.

If one but reflects that *L. frigidus* is exceedingly common in nature — both the North-Atlantic and Ingolf Expedition have taken it more frequently and in much greater numbers than any other *Lycodes* — and that it has quite a different area of distribution from *L. vahlii* or *L. reticulatus*, which are both (as shown in the present work) restricted to relatively small depths, whilst *L. frigidus* is confined to the deeper and deepest part of the »cold area«, this supposition of Prof. Smitt that *L. frigidus* is a number of sterile and hybrid (?) individuals of the two named species, strikes one at once as unnatural. I can also assert that the specimens in my hands give no indications whatsoever of being sterile; both the male and female sexual organs are well-developed, though not fully ripe, since the specimens have obviously not been taken during the spawning-period. In the largest male from the Ingolf Expedition the testes are 65 mm. long and 10 mm. broad, without free folds and of equal length (Collett mentions that in a 510 mm. long male the left testis was rudimentary); the eggs in the largest female are 1,5 mm. in diameter in the sack-shaped, ca. 55 mm. long, ovary[1]).

Again, Dr. E. Lönnberg (l. c.) is inclined to regard *L. frigidus* and *L. pallidus* as colour-varieties of one and the same species[2]). If this author had had specimens of *L. pallidus* for comparison, he would certainly not have adopted this view. *L. frigidus* is distinguished in a moment, so to speak, from *L. pallidus* — and indeed from all other scaled (European and Greenland) Lycodes species — by its extremely small scales. So small are the scales in *L. frigidus* that there are ca. 48 scales in a vertical line from the anus to the base of the dorsal fin in a specimen of 226 mm., whilst in a specimen of *L. pallidus* (var. *squamiventer*), 230 mm. long, there are only 27 scales on the same line.

In his latest treatise on the genus *Lycodes*, F. A. Smitt (l. c. 1901) has so far changed his view that he now brings under *L. reticulatus* a singular »forma *frigida*«; during my visit to the Stockholm Riks-Museum I discovered that under this denomination were placed: 1 specimen of *L. perspicillum* Kroyer (= *L. reticulatus* Reinh. juv.?) (No. 1), 8 specimens of *L. pallidus* Coll. (No. 2—9) and 3 specimens of the veritable *L. frigidus* Coll. (No. 10—12).

Distribution.

The Ingolf Expedition has taken *L. frigidus* at the following stations which all lie north, north-east and east of Iceland and south of Jan Mayen[3]):

St. 124	495 fathoms	÷ 0°6 C.	5 specimens
- 125	729 —	÷ 0°8 -	1 —
- 120	885 —	÷ 1°0 -	6 —
- 110	781 —	÷ 0°8 -	2 —
- 102	750 —	÷ 0°9 -	6 —
- 104	957 —	÷ 1°1 -	7 —

[1]) After this was written, I have observed a female *L. frigidus* with fully ripe eggs. The specimen was ca. 500 mm. long, with an enormous ovary, 84 mm. long, 47 mm. broad, which contained 500 eggs, almost ready to be spawned, of a diameter of 7 mm. It was taken on the 29th of August 1902, north from the Færoes (63° 13′ N.L., 6° 32′ W.L., depth 975 fathoms, temperature of the bottom ÷ 0,51° C.) by the fisheries steamer »Michael Sars«.

[2]) Lütken has also suggested that *L. pallidus* was a »subspecies or form« of *L. frigidus*. Vidensk. Medd. Naturhist. Foren. Kbhvn., 1880, p. 317.

[3]) 2 other specimens were brought home in addition to these 63, but the number of the station was lost later.

St. 111	860 fathoms	÷ 0°9 C.	6 specimens
- 119	1010 —	1°0 -	10 —
- 112	1267 —	÷ 1°1 -	6 —
- 118	1060 —	÷ 1°0 -	8 —
- 117	1003 —	÷ 1°0 -	5 —
- 113	1309 —	1°0 -	1

The English expeditions of the "Knight Errant" and "Triton" (1880 and 1882) caught a large number of specimens in the "cold" portion of the Færoe Channel at 540—640 fathoms, bottom-temperature 29°2 and 30° F.; the largest of these specimens was a male which measured ca. 558 mm. (22 inches)[1]. The Norw. North-Atlantic Expedition took 15 specimens, 37—510 mm. long, off the west of Norway, west from Bear Island and west from Spitzbergen; the depths were (260) 457—1333 fathoms, bottom-temperature (+ 1°1) ÷ 0°7 to ÷ 1°6 C.[2]). Again, the Nathorst Expedition of 1898 took 1 specimen off West Spitzbergen where the depth was 2750 meters and the bottom-temperature ÷ 1°4 C. Further, the Kolthoff Expedition of 1900 caught 3 specimens between Jan Mayen and Greenland (72° 42' N.L. 14° 49' W.L.) at 2000 meters. Lastly, the "Michael Sars" in 1902 caught 17 specimens (290—530 mm. long) north from the Færoes (63° 13' N.L. 6° 32' W.L.), where the depth was 975 fathoms, also 2 specimens (366—430 mm. long) in the "cold area" off western Norway (63° 7' N.L. 1° 38' E.L.), where the depth was 650—720 fathoms.

L. frigidus is so generally distributed over the deeper and deepest parts of the Polar Depths, from Spitzbergen down to Iceland and the Færoes, that it may be reckoned amongst the most characteristic inhabitants of this deep-sea basin.

I feel very dubious, therefore, on finding that the American authors have identified a Lycodes occurring generally in the western part of the true Atlantic Ocean, with *L. frigidus* Coll. from the ice-cold Polar Depths. I believe, indeed, I am in a position to say there must be some error in this determination. Although it is beyond the scope of the present work to enter upon the American forms, I shall yet make an exception in this case since it presents a very important question in biological regard, namely, whether a species of fish can be common to the warm ground in the depths of the Atlantic and to the ice-cold depths of the Northern Ocean.

Lycodes atlanticus Jensen.

1895. *Lycodes frigidus* Goode & Bean (nec Collett), Oceanic Ichthyology, p. 305; Mem. of the Museum of Comp. Zool. at Harvard College, vol. XXII.

1898. *L. frigidus* Jordan & Evermann (nec Collett), Fishes of North America, III, p. 2465.

1901. *L. atlanticus* Jensen, Vidensk. Medd. Naturh. Foren. Kbhvn., p. 207.

[1]) Günther (l. c.) has referred this to *L. reticulatus* Reinh., but both F. A. Smitt and Lütken have remarked upon its resemblance to *L. frigidus* Collett. It agrees perfectly in fact with the large male of *L. frigidus* from the Ingolf Expedition, as appears both from Günther's description and figure; only, Günther gives his specimen a mediolateral lateral line, which must rest on some error.

[2]) It is possible that the specimen from the relatively small depth (260 fathoms) with high bottom-temperature (+ 1°1 C.) arises from an error in determination; Prof. Collett has kindly informed me that it was given away to some Museum so that the determination cannot now be controlled; concerning a second specimen from 350 fathoms (N. North-Atlantic Exped. St. 124) which Collett has mentioned, I have already remarked that the early appearance of the scaly covering indicates that it is no *L. frigidus* (cf. p. 23).

The length of the head amounts to 22,6 % of the total length, the distance between the snout and the anus 37,6 %, the height over the anus 11,4 %. Colour uniformly brown, without bands or spots. The scales, which are of the usual size, extend forward to the head as well as out on to the unpaired fins and base of the pectorals. Lateral line ventral. P. 23.

Distribution: Atlantic Ocean off the east coast of North America, 516—1423 fathoms.

In the work mentioned above, Goode & Bean have identified a Lycodes taken in large numbers in the waters of the Atlantic Ocean off the east coast of North America (35° 12' 10"—41° 53' N.L. 65° 35' 74 34' 45" W.L.), at 516—1423 fathoms depth, with *L. frigidus* Collett from the ice-cold depths of the Northern Ocean.

Unfortunately, the authors have contented themselves with copying Collett's diagnosis, and impart no information whatsoever on their material apart from a recital of the separate localities. And if one consults the most recent and principal work on the North American fishes by Jordan & Evermann, one also finds nothing concerning the American form, as these authors have contented themselves with studying a type-specimen from the Northern Ocean sent by Prof. Collett.

Thanks to the generosity of the Smithsonian Institution our Zoological Museum has meantime come into the possession of a specimen of the American *L. frigidus*.

On comparing this individual with specimens from the Polar Depths I find that they belong to two distinct species. In the uniform brown colouration, the ventral lateral line and other, though more general, features the two forms present a certain resemblance to one another, but on closer examination they are seen to be quite different in important characters.

Measurements of the American specimen are as follows:

Total length	338 mm.
Length of the head	76,5 —
Distance from snout to anus	127 —
Height over the anus	38,5 —

Put into percentages, the length of the head is therefore 22,6 %, the distance between the snout and the anus 37,6 %, the height over the anus 11,4 % of the total length. The sex cannot be determined as the internal organs of the fish have been destroyed.

Comparing this individual now with specimens from the Polar Depths, of the same length and of both sexes, we find a very distinct difference with regard to the most important measurements.

		L. frigidus Coll. ♂	*L. frigidus* Coll. ♀	*L. frigidus* G. & B.
Total length in mm.		327	345	338
Length of the head	in % of the total length	25,1	23,8	22,6
Distance from snout to anus	—	44,6	43,4	37,6

The tail in the American form has therefore a much greater proportion of the length in relation to the rest of the body; in agreement with this its head is relatively somewhat smaller.

Other differences are also present, which just as distinctly declare against the two forms being identical. The American specimen, for example, has much larger scales so that the number in the vertical line from the anus to the base of the dorsal fin amounts to 34; whereas, on the same line in a specimen of *L. frigidus* from the Polar Depths there are ca. 55 scales, although its total length is the same. Lastly, the American form has 23 rays in the pectoral fins whilst the number in the species from the Polar Depths is at most 21.

I can come to no other conclusion therefore, than that we have to deal with two species well separated in important structural features. The American form must consequently be renamed, and conveniently *L. atlanticus*[1], which characterises it zoo-geographically in contrast to the *L. frigidus* of the ice-cold Polar Depths.

For the rest, it must be left to the American ichthyologists to give us further enlightenment upon this species since they have of it a large material at their disposal.

Lycodes esmarkii Collett.

Tab. III, Fig. 2 a, b, c.

1869. *Lycodes Vahli* Esmark, Bidrag til Finmarkens Fiskefauna; Forh. v. Skand. Naturf. 10. Møde i Chria. 1868, p. 524.

1875. *L. esmarkii* Collett, Norges Fiske; Tillægsh. til Vidensk. Selsk. Forhandl. Chria. 1874, p. 95.

1879. *L. vahlii* Collett, Meddelelser om Norges Fiske i Aarene 1875—78; Forhandl. Vidensk. Selsk. Chria. 1879, No. 1, p. 62 (partim).

1880. *L. esmarkii* Collett, The Norw. North-Atlantic Expedition, Fishes, p. 84 (partim), Pl. III, Fig. 22.

1884. *L. esmarkii* Collett, Meddelelser om Norges Fiske i Aarene 1879—83; Nyt Magaz. f. Naturvidensk. 29 B., p. 73 (partim).

1891. *L. esmarkii* Lilljeborg, Sveriges och Norges Fiskar, II, p. 6 (partim).

1895. *L. Vahlii* Smitt, Skandinaviens Fiskar, II, p. 613 (partim), Fig. 149.

1899. *L. vahlii* Lönnberg, Bihang K. Sv. Vetensk.-Akad. Handl. Bd. 24, Afd. IV, No. 9, p. 23.

1901. *L. esmarkii* Jensen, Vidensk. Medd. Naturh. Foren. Kbhvn., p. 213.

Height over the anus amounts to 8,9—14,4 % of the total length. Length of the head in adult males is 21—24 %, in adult females and young individuals 19,2—21,9 % of the total length. The tail is distinctly longer than the head and trunk together, as the distance between the snout and the anus amounts to 37,5—42,9 % of the total length. The posterior margin of the pectorals rounded without indentation. Colour brown, with a light stripe over the neck (or a light spot on each

[1] I ought however to explain, that the new species has points of connection with the *Lycodes terræ novæ* from the banks of Newfoundland, 155 m., founded by R. Collett in 1896 (Résultats Camp. Scient. Albert I. Fasc. X, p. 54). But in two specimens of similar size (370 & 310 mm.) to the above named *L. atlanticus*, the length of the head is 18,9—18,4 %, the distance from snout to anus 35,1—35,5 %, of the total length. In addition, there is a characteristic difference in regard to the teeth equipment of the palatines: in *L. terræ-novæ* there are only 3—5 teeth on the palatines, and the whole row is scarcely half so long as that on the intermaxillaries; whereas, in *L. atlanticus* there are 10 teeth on the palatines, and the whole row is more than double that on the intermaxillaries.

side of the neck) and 5—9 whitish yellow cross-lines on the body, which are ⋏-formed in the young, but in the medium-sized specimens enclose dark spots or stripes and finally form festoon-shaped markings. The scales cover the whole of the body as far as the neck and base of the ventral fins and extend far out on to the unpaired fins. The lateral line is double, mediolateral and ventral, but often indistinct, especially the mediolateral. Pyloric appendages are wanting. The length reaches to 705 mm.

D. 113—118. A. 97—102. P. 22—23. Vert. 115—118 (23 + 92—95)[1].

Distribution. Finmark, 150—200 fathoms; between Norway and Bear Island, 200 fathoms; Norway-Shetland Slope, 275 fathoms; Færoe Channel, 620 fathoms; east from the Færoes, 228 fathoms; between the Færoes and Iceland, 250 fathoms; east from Iceland, 300 fathoms; Nova Scotia.

Remarks on the Synonymy.

L. esmarkii was founded in 1874 by Collett for a Lycodes occurring in the fjords of Finmark, which was however already mentioned by Esmark in 1868 and referred by him to *L. vahlii* Reinh.; Collett also, at a certain period (1878—79), was inclined to place these two species together, but finally raised *L. esmarkii* to an independent position. Through Collett's exertions a by no means small material was gradually acquired; in 1883 the number amounted to 22. All these specimens were remarkable for their large size, lying between 575 and 705 mm. Prof. Collett kindly permitted me to examine the smallest specimen which up to the present has come from Finmark; it measured about 443 mm. Further I have had 3 larger specimens under examination which our Zoological Museum owes to the generosity of Collett.

Meantime, the Norwegian North-Atlantic Expedition during 1877—78 found 4 Lycodes, 81—295 mm. long, on the banks off the Lofotens and on the north-west coast of Spitzbergen, concerning which Collett holds it for extremely probable that they are the hitherto wanting young stages of *L. esmarkii*; the three largest of these are figured in the work on the fishes of the expedition (Pl. II, fig. 19, 20, 21) and for comparison an adult *L. esmarkii* from Finmark is also given (Pl. III, fig. 22). The differences which appear between them, especially in the colour-markings, could be ascribed according to Collett, to the great difference in age and size.

In 1896, the Ingolf Expedition obtained a 260 mm. long Lycodes north-west from the Færoes which in colour-marking recalls greatly the largest from the Norwegian North-Atlantic Expedition, and for other reasons also must be considered identical with the presumed young stages of *L. esmarkii* Coll. On opening this specimen I found the gut provided with two pyloric appendages, small yet quite distinct, whilst *L. esmarkii* of Collett displays no trace of these[2]. An investigation, undertaken thereafter on a specimen from the Norwegian North-Atlantic Expedition, showed that this likewise possessed pyloric appendages. It was therefore clear that the supposed young of *L. esmarkii* could not be stages in the development of this fish, but must belong to a separate species. A detailed comparison further strengthened the independence of the two forms, so that I was obliged to set up a new species for the specimens obtained away from Finmark, which I have called *L. eudipleurostictus*; an explanation of this point will be given later (p. 34—37).

Whilst I have been obliged to remove from *L. esmarkii* a form that had previously been considered its young stages, I have at the same time had the satisfaction of being able to show a true early stage of *L. esmarkii*. This I found in a small Lycodes, which the Swedish Nathorst Expedition of 1898 obtained between Norway and Bear Island, and which has already been described as to its most important characters by Dr. E. Lönnberg (l. c.). This author ascribed it to *L. vahlii*, as he like Prof. Smitt declares himself unable to distinguish between *L. esmarkii* and *L. vahlii*, a position I cannot agree with (cf. p. 31—32).

On a young specimen of *Lycodes esmarkii*.

Tab. III, fig. 2 a.

A comparison between the specimen just referred to (from the sea between Norway and Bear Island) and *L. esmarkii* from Finmark will show how it may rightly be considered as a very young specimen of *L. esmarkii*.

[1]) Collett found Vert. 23 + 95 in one specimen, in another I counted 23 + 92, Lilljeborg (l. c. p. 16) also 23 + 92 in a third.

[2]) After this was written, I have been able through Dr. E. Lönnberg's kindness, to examine a well-preserved specimen in the Museum at Upsala of the Finmark *L. esmarkii* and could convince myself that the pyloric appendages were completely wanting.

Its dimensions are as follows:

Total length	192 mm.
Length of the head	39 —
Distance between snout and anus	73 —
Height over the anus	17 —

The length of the head is thus 20,3 % of the total length and falls therefore within the limits of variation occurring in the adult specimens from Finmark; thus, the measurements given by Prof. Collett, reckoned in percentages, show the length of the head as 19,2—24 % of the total length (in 10 males 22,2—24 %, in 12 females 19,2—21,9 %). Again, the head and trunk together (or distance between snout and anus) is 38 % of the total length, which figure is very close to that of the adult individuals, where (in 4 specimens) it is 38,3—42,9 %[1]).

It is the colouration however which makes one think at once of *L. esmarkii*. The ground-colour is dusky brown above, yellowish white below; the scales are whitish and show as light points against the dark background. On the brown ground-colour the body is marked by 7 whitish yellow bands which are distributed wide apart with exception of the last. The foremost of these bands extends from the gill-cover over the edge on to the middle line of the neck; the band on the one side does not reach so high up and does not therefore meet with that on the other side. The second band lies almost over the end of the pectorals; it begins at the upper margin of the dorsal fin and divides like a horse-shoe a little below the line of the back. The third band, which lies somewhat behind the anus, is similarly branched but more angularly; the fourth and fifth bands have also more or less the distinct form of a λ. The sixth band as also the seventh, which lies near to the sixth, just at the end of the tail, extends across the tail and out to the borders of the fins in the form of forward projecting arches. — If one compares this with Collett's figure of an adult *L. esmarkii* (l. c. Pl. III, fig. 22) one sees that the colouration of the latter is only a further development of that in the present young specimen, as the bands by much branching have assumed the form of festoons.

The pectoral fins have 22 rays, which number agrees with that of the adults from Finmark; in five of these I have counted 22—23 rays, the above mentioned specimen of 443 mm. has 23 rays[2]). The lower rays are gradually shortened so that the posterior margin of the fin is evenly rounded as in the adults. The dorsal fin has 117 rays, the anal 102, which numbers also fall within the variations found in the adult specimens from Finmark, viz. 113—118 rays for the dorsal, 97—102 for the anal, according to Collett.

The scaly covering extends forward to the light band on the neck, to the base of the pectorals and ventrals, also some way on to the unpaired fins, especially the dorsal fin, but the foremost part of the anal fin on the other hand is naked. The scales have therefore almost reached their complete distribution.

[1]) As it might be of interest to have the measurements of the specimen ca. 443 mm. mentioned above, the smallest hitherto obtained from Finmark, I give them here: distance between snout and anus 175 mm. (39,5 % of the total length), length of the head 90 mm. (20,3 % of the total length), height over the anus 54,5 mm. (12,3 % of the total length). The specimen is badly preserved and the colour has almost entirely disappeared, the internal organs have been removed so that the sex cannot be determined.

[2]) When Collett gives 20—23 rays, it must be remembered, that the lower number has arisen through including under *L. esmarkii* the specimens with smaller number of fin-rays (= *L. eudipleurostictus*) from the Norwegian North-Atlantic Expedition.

The lateral line begins above the upper notch of the gill opening; its pores to the number of some twenty can be followed as far as the middle of the posteriorly extended pectoral; from this point one can observe by good light a very weak light line bending down towards the anus and further along the lower border of the tail; this fine line represents the ventral lateral line, but pores can only be seen here and there singly and indistinct. I believe I have seen weak traces of a mediolateral lateral line in the form of a few widely separated pores. The lateral line in this young specimen is thus in the same stage of development as in the adult *L. esmarkii;* in these the lower (ventral) branch can as a rule be followed; so far as concerns the upper (mediolateral) branch, Collett declares that it is always indistinct[1]), and this I can confirm as only in one of the three adult specimens at my disposal have I found it possible to trace some single oblong pores.

Lastly, it may be added that this young specimen shows not the slightest trace of pyloric appendages, which are also wanting in the adult *L. esmarkii*, as already mentioned (p. 28).

All the characteristics displayed above lead to the conclusion that this small specimen from the open sea off Finmark is a young stage of *L. esmarkii* from the coasts of Finmark.

Appendix.

After the foregoing had been written I have had the further opportunity of examining 6 specimens of *L. esmarkii* obtained during my participation in the 1902 summer-cruise of the Michael Sars to the seas of Shetland, the Færoes and Iceland. The distribution of this species — hitherto considered somewhat local — has thus become considerably extended. Some remarks on these specimens may fittingly find a place here.

The smallest of the specimens was taken in the Færoe Channel. The total length is 188 mm., 4 mm. smaller therefore than the one referred to (p. 28—30) from the seas between Norway and Bear Island. For the rest, they agree very closely, chiefly in regard to the most important proportions, as will be seen:

		L. esmarkii juv. from	
		Mich. Sars 1902	Nathorst-Exped. 1898
Total length in mm.		188	192
Length of the head	in % of the total length	20,7	20,3
Distance between snout and anus	— —	38,3	38
Height over the anus	— —	9,6	8,9

In the new specimen there are also 7 light bands. The foremost of these (neck-band) is broken off at the middle of the back, so that it appears as a light spot on and over the edge of the gill-cover, round the origin of the lateral line. The remaining bands have quite the same situation as in the foregoing specimen; the second to the sixth have the distinct form of a ⅄, only the seventh, at the end of the tail, is unbranched. The scaly covering and the mediolateral lateral line are in essential agreement; the ventral line however is distinct, not only from the neck down to the anus,

[1]) Nyt Magaz. f. Naturvidensk. 29 Bd., 1884, p. 77. Nevertheless, the figure in the work on the fishes of the Norw. North-Atlantic Expedition (Pl. III, fig. 22) shows a clearly marked mediolateral lateral line.

but also for a considerable distance along the underside of the tail. The pectoral fin has 23 rays and is not indented at its posterior margin. Pyloric appendages are wanting.

The others are medium-sized or larger specimens, the most important measurements of which are the following:

		L. esmarkii from Mich. Sars 1902				
		♂	♂	♂	♂	♂
Total length	in mm.	371	374	383	521	552
Length of the head	—	78,5	78,5	86	121	120
Distance between the snout and the anus	—	139	142	150	208	215
Height over the anus	—	41	44	42	72	66

The length of the head is therefore 21—23,2 %, the distance from the snout to the anus 37,5—39,9 %, the height over the anus 10—13,8 % of the total length.

The colouration of the three medium-sized individuals (371—383 mm.) can be derived from that of the young individual referred to above. In the light vertical bands, whose number is 6—9, spots or stripes of the dark ground-colour have appeared, both on the dorsal fins and lower down (Tab. III, fig. 2 b). The light neck-band is fully developed in one of these specimens and extends from gill-cover to gill-cover, enclosing a dark stripe; in the second specimen the neck-band is restricted to one, yet of good size, light spot on each side of the neck, enclosing a dark spot; in the third there is only an ill-defined lighter part on the upper edge of the gill-cover. In the large specimens the light bands are still further resolved into festoon-shaped markings (Tab. III, fig. 2 c).

The pectoral fins have 23 rays in four specimens, 22 in the fifth; in none of them is there any indentation of the posterior edge of the fin. In two of the specimens the dorsal fin has 115 rays, the anal 97.

The scaly covering has attained its full distribution, forwards as far as the neck and base of the ventral fins, also on the unpaired fins to near their margin.

After what has been said above, the lateral line presents the somewhat unusual, as it seems, peculiarity that the mediolateral line is rather distinct in several of the specimens.

The gut is lacking in pyloric appendages; in several specimens it was quite full of skeletal remains of echinoderms (ophiuroids).

Relation of *L. esmarkii* to *L. vahlii*.

After Prof. Collett had in his later treatises withdrawn his earlier expressed opinion that *L. esmarkii* was the same species as the Greenland *L. vahlii* Reinh., Prof. F. A. Smitt and Dr. Einar Lönnberg again took up the matter and declared themselves unable to separate the two forms from one another. This is not remarkable in itself, since neither of these authors have had specimens of *L. vahlii* at their disposal; their acquaintance with this fish was restricted to what they could read of it in Lütken and Collett. And their doubts concerning the independence of the two forms, might be justified even more as some of the distinctions put forward by Collett are not constant.

There is not the difference with regard to the length of the head, which Collett has mentioned, namely that the head in *L. esmarkii* is on the whole somewhat longer than in *L. vahlii*. Lönnberg considers that his specimen (which I have examined in detail p. 28—30) fills up the gap between the two forms in this regard. Lönnberg might even have concluded this from the large series of measurements of *L. esmarkii*, which Collett published in 1884. Putting these into percentages, they show that the length of the head in *L. esmarkii* varies from 19,2—24 % of the total length; as the relation in *L. vahlii* according to numerous measurements by myself, is 18,8—23,8 %, no specific difference consequently can be founded on this. Nor does the second important proportion give any basis for a distinction; the distance between the snout and the anus for example is in *L. esmarkii* 38—42,9 %, in *L. vahlii* 36,5—42,3 %[1]).

When Collett further asserts that the shortness of the row of teeth on the palatal bones distinguishes *L. esmarkii* from *L. vahlii*, where this row is as a rule longer than that on the intermaxillary, seldom if ever shorter, he has allowed himself to be misled by Lütken's erroneous observations; as we have seen (p. 18 & p. 20) the palatal row of teeth in the adult males of *L. vahlii* is always shorter than that on the intermaxillary. This character on whose uncertainty Prof. Smitt has already remarked, must therefore also fall to the ground.

Lastly, Lönnberg remarks that little reliance can be placed on the character, that *L. vahlii* has only one, *L. esmarkii* two lateral lines, since Collett has seen traces of a mediolateral lateral line in one of the type-specimens of *L. vahlii*, and conversely the mediolateral line in *L. esmarkii* is often defaced. This must however be corrected, as *L. vahlii* never occurs with a mediolateral lateral line; this specimen, on which Collett has based his statement and which is in reality one of Reinhardt's type-specimens, is in no way *L. vahlii* but belongs to the following species which is provided with two lateral lines (see more in detail p. 36).

If now, one wishes to settle the independence of *L. esmarkii* — just as it has been done above, by consideration of the identical and exclusion of the unrelated elements — as against *L. vahlii*, one must first and foremost lay stress on the following characters: (1) want of pyloric appendages; (2) the larger number of rays in the pectorals; (3) the characteristic colouration; (4) the double (ventral and mediolateral) lateral line.

They differ from one another also in biological relations; *L. esmarkii* lives on the whole at greater depths than *L. vahlii*, and feeds chiefly on echinoderms whilst *L. vahlii* feeds on crustacea and Mollusca.

Distribution.

According to Collett, *L. esmarkii* must be considered a stationary and scarcely a rare fish on the coasts of Finmark; almost all the specimens examined hitherto have been caught in the Varanger Fjord on lines, and at the depth of 150—200 fathoms. Between Norway and Bear Island (73° 3' N.L. 18° 30' E.L.), where the depth was 410 m. and bottom-temperature + 2° C. the Nathorst Expedition caught the young specimen (192 mm.) referred to in detail above (p. 28) on the 4th of September 1898.

It was taken by the Norwegian Fisheries steamer "Michael Sars" in the summer of 1902 at the following places: Slope between Norway and Shetland (62° 30' N.L. 1° 56' E.L.), depth

[1]) The apparently smaller variation in *L. esmarkii* arises from the fact that the numbers are based on measurements of only 5 specimens and of these but one only was a young individual. (Appendix: in one of the specimens obtained later ["Michael Sars" 1902] the distance between the snout and the anus amounts to only 37,5 % of the total length).

275 fathoms, bottom-temperature + 4°88 C., 2 specimens (371—374 mm). Channel between Shetland and the Færoes (60° 19' N.L. 5° 39' W.L.), depth 620 fathoms, bottom-temperature ÷ 0°15 C., 1 young specimen (188 mm.)[1]); east from the Færoes (62° 26' N.L. 4° 49' W.L.), depth 228 fathoms, 1 specimen (552 mm.)[2]); between the Færoes and Iceland (62° 59' N.L. 10° 37' W.L.), depth 251 fathoms, bottom-temperature + 3° 24 C., 1 specimen (521 mm.); east from Iceland (64° 58' N.L. 11° 12' W.L.), depth 300 fathoms, bottom-temperature — 0°38 C., 1 specimen (383 mm.).

Judging from these captures, *L. esmarkii*, which was hitherto considered as a species occurring locally at Finmark, has probably a continuous distribution over the deeper parts of the coastal plateau of the Northern Ocean and its shelving sides ("slopes"), from Bear Island and Finmark down to Stat, thence towards Shetland and the east banks of the Færoes, north of the Færoes and along the broad ridge from the Færoe Isles to the Iceland plateau. Exceptionally, it may venture over the sloping banks of the ocean down into the polar depths.

Again, it occurs on the east coast of North America, as Collett has identified 4 fully grown specimens from off the coast of Nova Scotia[3]).

Lycodes eudipleurostictus Jensen.

Tab. III, Fig. 1 a, b.

1878. *Lycodes vahlii* Collett, Fiske indsamlede under den norske Nordhavs-Expeditions 2 første Togter, 1876 og 1877; Forh. Vidensk. Selsk. Chria. 1878, No. 4, p. 11 (partim).

1878. *L. vahlii* Collett, Fiske fra Nordhavs-Expeditionens sidste Togt, Sommeren 1878; Forh. Vidensk. Selsk. Chria. 1878, No. 14, p. 54 (partim).

1879. *L. vahlii* Collett, Meddelelser om Norges Fiske i Aarene 1875—78; Forh. Vidensk. Selsk. Chria. 1879, No. 1, p. 62 (partim).

1880. *L. esmarkii* Collett, The Norw. North-Atlantic Expedition, Fishes, p. 84 (partim), Pl. II, Fig. 19—21.

1891. *L. esmarkii* Lilljeborg, Sveriges och Norges Fiskar, II, p. 6 (partim).

1895. *L. vahlii* Smitt, Skandinaviens Fiskar, II, p. 613 (partim).

1898. *L. Esmarkii* Lütken, The Danish Ingolf Expedition, II, 1, p. 21.

1901. *L. esmarki* Knipowitsch, Ann. Musée zool. l'Acad. Imp. St. Pétersbourg, T. VI, p. 21.

1901. *L. Vahlii* forma *pallida* Smitt, Bih. K. Sv. Vet.-Akad. Handl. Bd. 27, Afd. IV, No. 4, p. 24 (partim), No. 13.

1901. *L. Vahlii typica* Smitt, ibid. p. 26 (partim), No. 40, 41 & 42.

1901. *L. eudipleurostictus* Jensen, Vidensk. Medd. Naturh. Foren. Kbhvn. p. 206.

The height over the anus amounts to 8,1—13,6 %, the length of the head to 19,8—24,3 % of the total length. The tail is distinctly longer than the head and trunk together, as the distance between the snout and the anus is 36,7—41,4 % of the total length. The posterior margin of the pectoral is indented. Colouration

[1]) Günther (Chall. Exped. Deep-Sea Fishes, 1887, p. 77) also refers 2 specimens from the Færoe Channel, 608 fathoms, to this species, but they perhaps belong to *L. eudipleurostictus* mihi which has been confused with *L. esmarkii*.

[2]) This specimen was taken on a line, the other specimens in the English trawl.

[3]) Goode and Bean refer also to this species a number of specimens, taken at 39° 43'—42° 43' N.L. and 62° 20'—71° 42' W.L., 224—420 fathoms (Oceanic Ichthyology, 1895, p. 303), but one cannot tell if the determination is correct.

brown with a light spot on each side of the neck (sometimes a light stripe across over the neck), and with 5—8 as a rule narrow whitish yellow cross-bands over the trunk and tail (sometimes partly assuming a ring-form). The scales cover the whole of the body to in front of the dorsal fin and to the ventrals, and extend out on to the unpaired fins. The lateral line is double, divided just behind the root of the pectoral into a mediolateral and a ventral branch, both distinct. Pyloric appendages 2. Size reaches to 325 mm.

D. 100—103. A. 88—92. P. 20—22 (23). Vert. 106 (20+86).

Distribution. Northerly West- and East-Greenland, ca. 150—400 fathoms; Spitzbergen, 260—460 fathoms; west from Lofotens in Norway, 350 fathoms; off Norway-Shetland Slope, 360—420 fathoms; north from the Færoes, 470 fathoms; east from Iceland, 300—340 fathoms.

I have been obliged to found this new species for the 4 specimens brought home by the Norwegian North-Atlantic Expedition from Spitzbergen and from the seas off Lofoten, which Prof. Collett after some reflection, considered were young specimens of *L. esmarkii* of Finmark, also for a similar specimen (260 mm. long) taken by the Ingolf Expedition north-west from the Færoes (figured in fig. 1 a of Tab. III). In addition, there is a further specimen from Umanak in West Greenland, referred formerly by Reinhardt sen. to the *L. vahlii* founded by him. Lastly, I have been able to examine 4 specimens in the Stockholm Riks-Museum, taken in Franz Joseph's Fjord (northerly East Greenland) by the Nathorst and Kolthoff Expeditions, and considered by Prof. F. A. Smitt as forms of *L. vahlii*[1]).

As I shall now proceed to confirm the necessity of the resolved upon separation from *L. esmarkii*, I may first of all set down the proportions of the 9 specimens.[2])

		Franz Josephs Fjord	Off Lofoten	Spitzbergen	Franz Josephs Fjord ♀	Franz Josephs Fjord ♂	N.W. f. Færoes ♀	Spitzbergen ♂	Spitzbergen ♀	Franz Josephs Fjord ♂
Total length	in mm.	68	81	114	165	227	260	265	295	320
Length of the head	—	16,5	18,5	25	39	54	57	60	65	75
Distance from snout to anus	—	27	31,5	45	66	94	102	105	116[3])	126
Height over the anus	—	5,5	7	12	17	26	31,5	32	40	35

The form of the body is on the whole not unlike that of *L. esmarkii*, and the most important proportions are somewhat similar; thus, the length of the head amounts to 21,9—24,3 %, the distance between the snout and the anus to 38,9—41,4 % of the total length.

The fins on the other hand show in several ways, tolerably great differences from those of the foregoing species. Whilst the pectorals in *L. esmarkii* have 22—23 rays, the number in the present species is mostly 21, more rarely 22, only in a single specimen and in one of its pectoral fins is the

[1]) My original diagnosis (l. c.) has been changed somewhat out of regard for these 4 specimens (likewise also for the still later obtained 17 specimens of the »Michael Sars« Expeditions of 1900 and 1902 [cf. p. 36]).

[2]) The West Greenland specimen is in a tolerably bad condition and will therefore be described by itself (p. 36).

[3]) Collett has 160, which must be a misprint.

number 23. Again, the pectoral fins in *L. eudipleurostictus* are remarkable in that the lower rays are somewhat prolonged and project distinctly forward beyond the middle rays; the posterior border of the fin thus displays a distinct indentation. Collett even has remarked upon this peculiarity in his young specimens of *L. esmarkii*, but he imagines that the fin changes during development — a condition, Collett admits however, he has never seen, nor anything similar, in other species. We have just seen (p. 29 and p. 31) that the real young stage of *L. esmarkii* shows no such incision of the pectoral — so that this may be considered as one of the characteristic features of *L. eudipleurostictus*[1]).

Again, the vertical fins have distinctly fewer fin-rays. In the *L. esmarkii* from Finmark, according to Collett, the dorsal fin has 113—118 rays, the anal 97—102; in the specimens from the Norw. North-Atlantic Expedition on the other hand, the dorsal fin has only 102—103 rays (from the Ingolf Expedition, 100), and anal fin 88—92 rays (from the Ingolf Expedition, 90). Collett explains the larger number of fin-rays in the large specimens from Finmark by assuming that vertebræ might continue to be laid down along with the rays belonging to them during the whole development, but I hardly think that Prof. Collett retains this opinion.

Scales. Concerning the two largest specimens (265 and 295 mm.) from the Norw. North-Atlantic Expedition, Collett has declared that the scaly covering extends forward in front of the beginning of the dorsal fin, and on the belly to the ventrals; the dorsal and anal fins are likewise covered with scales nearly to their margins. The 260 mm. long specimen from the Ingolf Expedition is quite similar. In the two young specimens from the Norwegian North-Atlantic Expedition the scaled integument is for the most part fully developed on the body; in the largest individual (114 mm. total length) both the fins and the skin along their base are still naked; in the smallest (81 mm. total length) the scales on the tail are just beginning to develop. With regard to the three larger specimens (165—320 mm) in the Stockholm Museum, I have noted that the scales reach forward to the head and out on to the unpaired fins; the 68 mm. long individual was still naked on the posterior half of the tail, whereas the remaining part of the tail as well as the trunk to a little behind the base of the pectoral shows indications of scales.

The lateral line in *L. eudipleurostictus* is very distinctly double (I have founded the name of the species on this characteristic). It arises singly at the upper end of the gill-openings, forms a slight arch over the free edge of the gill-cover, then divides a little posterior to this into two branches, the upper of which, the mediolateral, is the most distinct and courses along the middle line of the whole body right to the caudal fin; the lower branch, the ventral, courses slantwise downwards towards the anal fin, then runs along the edge of this fin towards the caudal fin. Such is the case in the medium-sized and largest specimens. In the 81 mm. long specimen both lines are still indistinct, but they are already apparent in the one 114 mm. long. — In *L. esmarkii* the mediolateral line is often more or less indistinct.

The colouration of *L. eudipleurostictus* is rather different from that of the foregoing species and can hardly be thought to give rise to that in *L. esmarkii*, as Collett believed. The ground-

[1]) Smitt (l. c. 1901) states that the pectoral is incised in more of the Nathorst Kolthoff Expeditions' Lycodes than the four I have here referred to *L. eudipleurostictus*, but after a personal inspection of the specimens in question I have not been able to confirm this statement. In *L. frigidus* on the other hand, the posterior margin of the pectoral is often weakly incised.

colour is brown, more or less dark, with narrow whitish yellow cross-bands whose number varies from 5—8. Further, as sign of a neck-band, there is a more or less distinct whitish yellow spot immediately over the upper end of the gill-opening, sometimes lower down on the edge of the gill-cover; concerning one of the specimens from East Greenland I have indeed noted: the neck light across over. What especially distinguishes *L. eudipleurostictus* from the foregoing species in the colouration, is that the vertical bands show no signs of resolving themselves into the characteristic festooned markings of the adult *L. esmarkii*.

When we add to this that the gut immediately behind the stomach is provided with 2 small appendages, whilst the *L. esmarkii* of Finmark is wanting in any trace of such, we have the most important differences between the present and foregoing species.

The Greenland specimen yet remains to be briefly mentioned. It was sent from Umanak in 1834 and mentioned by Reinhardt sen. amongst the 7 Lycodes which served for the preparation of his detailed treatise on *L. vahlii*[1]); its preservation however was not good, and R. when preparing his description, seems to have made no further use of it, otherwise its distinctness from *L. vahlii* might have been apparent to him. Nor did Lütken find anything remarkable in it. Prof. Collett however, on a visit to our Museum, discovered that this specimen showed signs of a mediolateral in addition to the ventral lateral line usual to *L. vahlii*[2]). This fact was for me still more striking: the two lateral lines are especially distinct, just as distinct as in the other specimens of *L. eudipleurostictus* at my disposal. Further, the number of rays in the pectorals agrees with this species and amounts to 21, a number that is never reached in *L. vahlii*. Where the colour is preserved, it is in agreement with the present species. Its length is ca. 275 mm.

I do not hesitate therefore to separate this specimen from *L. vahlii* and place it with *L. eudipleurostictus*.

Appendix.

After completing my MSS. on *L. eudipleurostictus* I have had the opportunity of studying a series of specimens, caught during my participation in the 1902 summer cruise of the Norwegian steamer Michael Sars . These specimens should be briefly described here as they lead to a few changes in the diagnosis.

The most important measurements of these 16 specimens, likewise of a 17th taken during the 1900 cruise of the Michael Sars , are as follows:

				♂	♂	♀	♂	♂	♂	♂	♂	♀	♂	♀	♂	♀	♂	♂
Total length	in mm.	75	152	203	205	206	209	223	232	253	277	285	293	302	307	315	323	325
Length of the head	—	16	34	43	44	46,5	45	50,5	52	56	59,5	62	69	64,5	65	62,5	72,5	73
Distance from snout to anus	—	28	57,5	74,5	82	82	82,5	87	86	100	104	113	119	123	119	127	124	121
Height over the anus	—	6,25	17	24	21	22,5	24	24	26	29	35,5	31,5	39	37	37	40,5	40,5	41

Put into percentages of the total length therefore, the length of the head in the males is 21,2—23,6 %, in the females and young specimens 19,8—22,6 %; distance between the snout and the anus 36,7—40,7 %; the height over the anus 8,9—13,3 %.

1) K. D. Vidensk. Selsk. Skr. VII, 1838, p. 165.

2) The Norwegian North-Atlantic Expedition, Fishes, 1880, p. 86.

The number of rays in the pectoral fin varies from 20—22; there are 20 rays in 6 specimens, 21 in 8, 22 in 2; in all, the posterior edge of the fin is distinctly indented. In one of the largest specimens I have counted 103 rays in the dorsal fin, 88 rays in the anal and 106 vertebræ in all (20 in the trunk, 86 in the tail); the number of the vertebræ is thus less than in *L. esmarkii* (23 + 92—95) and has to be reckoned amongst the distinguishing characters from that species.

In the smallest specimen (total length, 75 mm.) figured in fig. 1 b on Tab. III, the hindmost portion of the tail is naked, whereas scales have begun to appear on the anterior part of the tail as well as on the trunk. In all the remaining specimens the scaly covering extends from the end of the tail to the head. The scales extend more or less out on to the unpaired fins, least on the anterior part of the dorsal and anal.

The lateral line is distinct (except in the young specimen), both the mediolateral and the ventral branch.

The colour is dark brown, with 5—7 whitish yellow, as a rule very narrow cross-bands; sometimes indeed single light bands show transition stages to a ring-form, or (only in a single individual) they may be relatively broad, and the dark ground-colour between them appears light in the middle, so that we obtain a colouration recalling somewhat that in *L. rossi;* there is one specimen also where one or other of the vertical stripes shows signs of bifurcation below. The upper part of gill-covers have a light border; sometimes the light colour extends a little also on to the neck above, over the gill-openings.

All the specimens have two small appendages behind the pylorus.

Two of the females have large eggs in the ovary. In the one, 315 mm. long, caught on the 19th of July, the diameter of the eggs is 4—4,5 mm., and their number ca. 250 (apart from many very small eggs in the ovary); in the other, 302 mm. long, taken on the 25th of August, the diameter of the eggs is 5 mm.

If we now, with this extended knowledge of *L. eudipleurostictus*, wish to sum up the characters in which this species differs from *L. esmarkii*, these would be chiefly:

(1) the indentation in the posterior margin of the pectoral fin,

(2) the smaller number of rays in the dorsal and anal fins,

(3) the smaller number of vertebræ,

(4) presence of two small pyloric appendages,

and in the second place:

the always distinct, double lateral line,

the (as a rule) simple banded markings.

In biological regards also the two forms are markedly different: *L. eudipleurostictus* is pre-eminently a cold water, *L. esmarkii* on the other hand mainly a warm water form; *L. esmarkii* lives almost exclusively on echinoderms (especially ophiuroids), *L. eudipleurostictus* on worms and crustacea. Nor does *L. eudipleurostictus* become nearly so large as *L. esmarkii*.

Distribution.

In Europe, *L. eudipleurostictus* has been caught at several places in the »cold area», and extends from thence over to the east coast of Greenland and probably north of that land, as well as a stretch along the west coast, as a specimen has been taken there at Umanak (70° 40' N.L.). At East Greenland it has been taken in Franz Josephs Fjord, e. g. 2 specimens at 760 meters by the Nathorst Expedition of 1899, and 2 specimens at 200—300 meters by the Kolthoff Expedition of 1900. At Spitzbergen, the Norwegian North-Atlantic Expedition took 3 specimens at depths of 459 and 260 fathoms, bottom-temperature — 1° C. and + 1°1 C.[1]); a Russian Expedition in 1899, one specimen, where the depth was 497 meters and bottom-temperature — 0°9 C.[2]). The Norwegian North-Atlantic Expedition took one specimen off Helgeland in Norway where the depth was 350 fathoms, and bottom-temperature — 0°9 C. Again, the Ingolf Expedition caught a specimen N.W. from the Færoes (St. 138) where the depth was 471 fathoms and bottom-temperature — 0°6 C. Lastly, the steamer »Michael Sars» obtained it at the following places in 1902: off the Norway-Shetland Slope (62° 43' N.L. 1° 26' E.L.), depth 420 fathoms, bottom-temperature under 0° C. (2 specimens) and (62° 40' N.L. 1° 56' E.L.), depth 360 fathoms, bottom-temperature — 0°3 C. (2 specimens); east from Iceland (64° 58' N.L. 11° 12' W.L.), depth 300 fathoms, bottom-temperature — 0°38 C. (12 specimens); and in 1900: east from Iceland, depth 340 fathoms, bottom-temperature — 0°69 C. (1 specimen).

Lycodes pallidus Collett.

Tab. IV, Fig. 1 a, b, c, d, e.

1878. *Lycodes pallidus* Collett, Fiske fra Nordhavs-Expeditionens sidste Togt, Sommeren 1878; Forh. Vidensk. Selsk. Chria. 1878, Nr. 14, p. 70.

1880. *L. pallidus* Collett, The Norwegian North-Atlantic Expedition, Fishes, p. 110, Pl. III, Fig. 26—27.

1886. *L. pallidus* Lütken, Dijmphna-Togtets zoologisk-botaniske Udbytte, p. 134, Tab. XVII, Fig. 1—3.

1898. *L. pallidus* Lütken, The Danish Ingolf-Expedition, II, 1, p. 22 (partim).

1901. *L. pallidus* Knipowitsch, Zool. Ergebn. d. Russ. Exped. nach Spitzbergen, Fische; Ann. Musée Zool. de l'Acad. Imp. d. Sci., St. Pétersbourg, T. VI, 1901, p. 23.

1901. *L. vahlii* forma *pallida* Smitt, Bihang. K. Sv. Vet.-Akad. Handl. Bd. 27, Afd. IV, No. 4, p. 24 (partim), No. 12 & 14—26.

1901. *L. vahlii* forma *typica* Smitt, ibid. p. 26 (partim), No. 30—39.

1901. *L. reticulatus* forma *frigida* Smitt, ibid. p. 29 (partim), No. 2—9.

In proportions of the total length the height over the anus is 8[3])—10,6 %, the length of the head 20,7—25,3 % (in females 20,9—23,8 %, in males 22—25,3 %), the distance between the snout and the anus 38—44,7 %, the longitudinal diameter of the eye 3,1—4,5 %. The young and smaller individuals are coloured on the back and

[1]) The station lies however just on the boundaries of the »cold area».

[2]) From the report, which Prof. N. Knipowitsch has given (l. c.) of this but 87,5 mm. long specimen, it is clearly seen that it belongs to the same species as Collett's »*L. esmarkii* juv.», or — in other words — that it is a *L. eudipleurostictus*.

[3]) In weakly young specimens sometimes sinking to 7,3 %.

sides with dark cross-bands which become indistinct in the older, they remain longest as dark patches on the dorsal fin but may also disappear from there, so that the colour in the end becomes uniformly brownish, as a rule however, darkened on the belly and posterior border of the gill-covers; the anal fin dark posteriorly (or with several dark patches); sometimes a light spot over the gill-cover or a light stripe across the neck. In older specimens the scales extend from the end of the tail almost to the root of the pectorals, but the anterior part of the back and a large portion of the belly are naked; as a rule there are no scales on the unpaired fins. The lateral line double, ventral and mediolateral, but in general only distinct in its course down towards the anus. Pyloric appendages 2. The size reaches 207 mm.

D. 97—101. A. 84—86. P. (17) 18—20 (21).

Distribution. Kara Sea, 46—106 fathoms; Spitzbergen, 60—459 fathoms; north-eastern Greenland, (6½) 18—400 fathoms; north from Iceland, 293—495 fathoms; north from the Færoes, 471 fathoms; off the Shetland-Norway Slope, 420 fathoms.

var. **similis** m.

Tab. V, Fig. 2 a, b, c, d & Tab. VI, Fig. 3 a, b, c, d.

1898. *Lycodes pallidus* Lütken, The Danish Ingolf-Expedition, II, 1, p. 22 (partim).

1898. *L. Lütkenii* Lütken, ibid. p. 21 (partim).

1901. *L. similis* Jensen, Vidensk. Medd. Naturh. Foren. Kbhvn., p. 205.

In proportions of the total length the height over the anus is 10—12,4 %, the length of the head 23—25,9 % (in females 23—24 %, in males 24,8—25,9 %), distance between the snout and the anus 41,4—44 %, longitudinal diameter of the eye 4,7—5,6 %. The colour is yellowish or brownish, in some individuals with indistinct dark cross-bands, in others distinct cross-bands, dark-brown with lighter colour in the middle, and with a light stripe across the neck. In the adults the scales cover the tail and the trunk as far as the neighbourhood of the base of the pectorals, but the anterior part of the back, a stripe under the foremost part of the dorsal fin and the greatest portion of the belly (in front of the anus) are naked; no scales on the unpaired fins. The lateral line is double, ventral and mediolateral, but usually only distinct in its course down towards the anus. Pyloric appendages 2. The size reaches to 175 mm.

D. 94—96. A. 81—82. P. 19—20 (21).

Distribution. South from Jan Mayen, 371 fathoms.

var. **squamiventer** m.

Tab. IV, Fig. 2 a, b.

1898. *L. pallidus* Lütken, The Danish Ingolf-Expedition, II, 1, p. 22 (partim).

In proportions of the total length, the height over the anus is 9,4—10,8 %, the length of the head 19,6—22,4 %, the distance between the snout and the anus 37,9—

41,1 %, the longitudinal diameter of the eye 3—4,4 %. The colour is uniform, brown or grayish, without bands or spots[1]; the belly and posterior border of the gill-cover darkish. The scales are small, relatively smaller than in the two foregoing forms and have a somewhat wider distribution, as they extend from the end of the tail not only to near the base of the pectorals, but also to the neck (sometimes however, a bare strip occurs in the middle line of the back in front of the dorsal fin), as well as on the underside of the belly, which is scaled a considerable portion in front of the anus, often just to the tip or even to the root of the ventral fins; in medium-sized and adult individuals the scales spread out also on to the unpaired fins. The lateral line is double, ventral and mediolateral, most distinct in its course down towards the anus. Pyloric appendages 2. The size reaches to 260 mm.

D. 96—97. A. 81—82. P. 18—20.

Distribution. East from Iceland, 537—957 fathoms; north from the Færoes, 679 fathoms; off the Shetland-Norway Slope, 650 fathoms.

Remarks on the Synonymy.

L. pallidus was formed by R. Collett for two small Lycodes, taken by the Norwegian North-Atlantic Expedition in 1878, north-west from Spitzbergen at 260—459 fathoms depth. In 1881—82 the species was again taken in the Kara Sea by the Dijmphna Expedition, according to Lütken, who described 11 specimens from there and figured some of them. Later, the same author mentions a number of specimens, taken by the Ingolf Expedition of 1896 at 8 stations in the cold water between the Færoes, Iceland and Jan Mayen. Lastly, N. Knipowitsch has recently described a specimen, taken by a Russian expedition to Spitzbergen.

The species seems thus to have gradually gained recognition. In his latest treatise (on *L. gracilis*) Prof. Collett has meanwhile come to doubt how far *L. pallidus* (and its probable young stage *L. rossi*) is a good species, or if it possibly is synonymous with *L. gracilis* M. Sars.

The results my investigations have led to, are as follows: *L. pallidus* Collett is an independent species, which does not show any near relation to *L. rossi* or to *L. gracilis* (= *L. vahlii*). *L. pallidus* Lütken from the Kara Sea is identical with Collett's species, and the same holds for *L. pallidus* Knipowitsch. *L. pallidus* Lütken from the Ingolf Expedition belongs likewise to the same species, but in certain regards displays a tolerably great amount of variation, and for some of the specimens I have been led to form two separate varieties: *similis* (cf. p. 46) and *squamiventer* (p. 48).

After these preliminary remarks had been written down, I have had the opportunity to examine an additional and considerable number of specimens, especially from the Polar Depths and from the north-eastern Greenland; regard has also been taken for these in my diagnosis, and they are deserving of special mention.

Lycodes pallidus from the Ingolf Expedition.

Tab. IV, fig. 1 a, b, c, d, e.

There are 11 specimens in all from the seas north of the Færoes (St. 138) and Iceland (St. 124, 126); the depths varied from 293—495 fathoms.

I give below the most important measurements of these specimens:

		St. 126	St. 126	St. 126	St. 138	St. 124	St. 124	St. 138	St. 138	St. 124	St. 138 ♂	St. 124 ♀
Total length	in mm.	53	53,5	85	104	115	130	133	135	140	158	183
Length of the head		12,5	13	19	23	26	29	32	30	32	40	41
Distance from snout to anus		21,5	22	35	41	45	53	54	56	58	66	75
Height over the anus		4,5	4,5	8	9,5	10,5	13	14	13	13	16	17,5

[1] Quite young individuals are certainly not known, but such is the condition in all the specimens to hand whose total length is down to 117,5 mm.

The body is thus moderately elongated (zoarciform), as the height over the anus amounts to 9,1—10,5 % of the total length. From the neck to the anus it is almost of even height, thereafter the height gradually lessens towards the pointed end of the tail. The tail is compressed, likewise the trunk, as the thickness here is still somewhat less than the height; the greatest thickness lies forward on the cheeks and is somewhat greater than the height over the anus. The head and trunk together are a good deal shorter than the tail, as the distance between the snout and the anus amounts to 39,1—41,2 % of the total length.

The length of the head is 22,1—25,3 % of the total length. It is tolerably elongated, as the height over the neck is contained twice or somewhat more in the length; it is also compressed downwards, flatly arched above, curved outwards at the sides and tolerably flat below. Seen from the side, the over margin forms a slight curve to the fore end of the snout, whose smooth point extends more or less forward in front of the intermaxillary; this again is in front of the mandible, so that the mouth lies on the under surface of the head. The eyes are tolerably small, their longitudinal diameter (in individuals over 100 mm. length) amounting to 4—4,4 % of the total length. Seen from the side, the upper border of the eye curves up over the margin of the brow; seen from above, there is a space between the two eyes which is almost equal to the vertical diameter of the eye; they are for the rest, oval, longer than high. On the cranium, the breadth of the forehead between the eyes amounts to only ca. $^1/_{20}$ of the length of the head. The snout is tolerably long, its length reckoned to the anterior border of the eye, being ca. 7—8,5 % of the total length; the males seem to have the longest snout; in the 158 mm. long male the length of the snout is 8,5 % of the total length, in the 183 mm. long female only 6,8 %. The shallow pits along the borders of the jaws are specially distinct in well-preserved specimens. The nostrils are in the form of tubes as usual. The teeth are short, conical, truncated, but tolerably strong, inserted on the intermaxillary (double row in front, single behind), on the palatals, vomer and mandible (in several rows in front).

The dorsal fin, whose distance from the snout is 29,5—31 % of the total length, contains ca. 97—100 rays[1]), the anal ca. 84[2]); in both cases half the caudal fin is as usual included. The pectorals have (18) 19—20 (21) rays[3]). The ventral fins are relatively smaller than in other species.

The scales are laid down early. In the two smallest specimens (total length 53—53,5 mm.) the scales are already in process of development on the foremost part of the body (see Tab. IV, fig. 1 a), and in the 85 mm. long specimen (Tab. IV, fig. 1 b) they cover the anterior part of the tail, also the trunk as far as the beginning of the dorsal fin, though the anterior portion of the back and the whole of the belly are naked. The 104 mm. long specimen (Tab. IV, fig. 1 c) is already almost entirely covered with scales, from near the tip of the tail forward as far as the dorsal fin extends; the anterior part of the back is however naked, as also a small portion under the base of the foremost part of the dorsal fin and the belly, or speaking more accurately, that part of the trunk which lies under the branch of the lateral line descending towards the anus. In the 115 mm. long specimen, there is a slightly larger naked part posteriorly on the tail, but the scaly covering has the same distribution

[1]) According to Collett 98—101.
[2]) — - — 84—86.
[3]) — - — 18—19.

in front, likewise in the 130 mm. long specimen, though here the end of the tail is scaled. In the 133 mm. long specimen, there are one to two rows of scales under the descending part of the lateral line, and the scales extend a little further forward towards the head; the neck (in front of the dorsal fin) is still however naked. The scales have a similar distribution in the specimens of 135, 140 and 158 mm. length, but there are respectively 3 to 4, 2 to 3, and 2 to 3 rows of scales under the branch of the lateral line descending towards the anus; the largest of the specimens (Tab. IV, fig. 1 d) has still a naked strip under the foremost part of the root of the dorsal fin. Lastly, in the specimen of 183 mm. (Tab. IV, fig. 1 e) the scaly covering extends from the tip of the tail to tolerably near the base of the pectorals, and there are ca. 6 rows of scales under the descending portion of the lateral line, but the belly itself is still naked, as also the back in front of the dorsal fin; in one respect this specimen differs from all the foregoing, namely, that the scales extend out on to the base of the dorsal and anal fins.

The lateral line begins over the upper end of the gill-opening, forms a slight arch over the edge of the gill-cover and bends thereafter down towards the anus; from there it can be followed — though often with difficulty and only under the lens — a shorter or longer distance along the tail, in the neighbourhood of the edge of the body. Most often there are also more or less distinct traces of a mediolateral lateral line, especially on the tail. The descending part of the lateral line is developed early and is seen already on the 53 mm. long young.

Colour. The two smallest (53—53,5 mm.) show 9 dark cross-bands, which are very sharply marked on the dorsal fin, but lower down on the body become quite feeble; between these darker cross-bands the yellowish ground-colour of the body shows itself as light cross stripes; the anal fin is dark-coloured posteriorly, almost black (Tab. IV, fig. 1 a). During development the dark cross-bands become more and more indistinct; they persist longest on the dorsal fin as dark patches, especially on the hindmost part. There is also some individual variation. In one specimen of 85 mm. (Tab. IV, fig. 1 b) the bands are already tolerably faint on the dorsal fin and hardly to be distinguished on the body; in one 104 mm. long (Tab. IV, fig. 1 c) on the other hand, they are still rather distinct right across. The following remarks on the remaining specimens will be sufficient: total length 115 mm.: 10 distinct dark markings on the dorsal fin, faint shadows on the body under them, anal fin dark posteriorly; total length 130 mm.: traces of dark markings on the dorsal fin posteriorly, anal fin dark posteriorly; total length 133 mm.: 9 dark markings on the dorsal fin, two such on the posterior part of the anal fin; total length 135 mm.: faint traces of dark markings on the dorsal, under them indistinct shadows on the body, anal fin darkened posteriorly; total length 140 mm.: two very faint shadings posteriorly on the dorsal fin, anal a little darkened quite at the posterior end; total length 158 mm.: 12 indistinct dark markings on the dorsal fin, here and there traces also of faint shadows under them on the body (Tab. IV, fig. 1 d). Finally, the 183 mm. specimen is uniformly coloured, brown, with the scales showing somewhat lighter than the ground-colour (Tab. IV, fig. 1 e). The belly in consequence of the dark peritoneum, has commonly a more or less darkened appearance; also, the posterior margin of the gill-covers and the skin over the branchiostegal rays, sometimes also the pectoral fins, are darkened.

Sexual organs. Only in one of the individuals to hand are the eggs so large that they can be recognised with the naked eye, namely in the one of 183 mm.; the sack-formed ovary is 14 mm. long and contains a somewhat small number of eggs, whose diameter does not exceed 1,5 mm.: the date of capture was the 28th of July.

Lycodes pallidus from the Kara Sea.

From the Kara Sea 11 specimens, 85—160 mm. long, have been obtained and are mentioned by Lütken (l. c.). Calculated from my measurements, the height over the anus is 8,4—8,7 %, the length of the head 22,6—24,6 %, the distance between the snout and the anus 41,4—43,1 %, the longitudinal diameter of the eye 3,3—4,1 % of the total length. Compared with the specimens from the Ingolf Expedition, *L. pallidus* from the Kara Sea has therefore a somewhat more slender body and the tail is relatively a little shorter. The pectoral fins have throughout fewer rays, their number being 18 or 19, seldom 17. The head, anterior part of the back and the belly are always naked. The smaller specimens have distinct dark cross-bands on the body and unpaired fins, in the older these become less clear on the body, and the largest (160 mm.) is almost without markings. Lütken mentions only one lateral line, viz. the ventral, but faint traces of a mediolateral branch can be detected in several specimens.

Lycodes pallidus from Spitzbergen.

The two type-specimens of the species, 93 and 164 mm. long, were taken at Spitzbergen at 260 and 459 fathoms. In these, the length of the head is 22,6 %, the distance between the snout and the anus 39—39,8 %, the height over the anus 8,5—9,1 %, the longitudinal diameter of the eye 4,3 % of the total length. The pectorals contain 18—19 rays. Scales cover the body as far as the region of the pectoral fins, but the head, neck, middle of the belly and the fins are naked; in the smallest specimen the scales extend farthest forward, namely, immediately to the base of the pectorals, and only a small strip along the middle of the belly is naked; in the largest individual on the other hand, a larger part of the belly is naked (cf. Pl. III, fig. 26 and 27 in Collett, l. c. 1880). The colour is gray-brown, with 5—7 dark markings on the dorsal fin and an almost indistinguishable shading on the body under each of them; a dark patch likewise on the anal fin towards the end. Of the lateral line Collett has only seen the ventral branch. — For the rest, see the detailed and careful description of Collett.

Again, N. Knipowitsch (l. c.) has described a specimen, 188,5 mm. long, taken in Stor Fjord at 60 fathoms depth. In it, the length of the head is 25,2 %, the distance between the snout and the anus 42,4 %, the height over the anus 9 %, the longitudinal diameter of the eye 3,5 % of the total length. The pectorals contain 18 rays. The scaly covering extends to a little in front of the commencement of the dorsal fin, the belly is naked. The colour is brown-gray, with indistinct traces of darker cross-bands. The ventral lateral line is distinct, traces of a mediolateral branch are also to be seen.

Of specimens from Spitzbergen I have myself made occasional notes concerning three; one (*L. reticulatus* forma *frigida* No. 7 apud Smitt l. c.) was taken by the Kolthoff Expedition of

1900 in the mouth of the Ise Fjord at a depth of 350 meters, the other two by the "Michael Sars" in 1901 in the Ise Fjord at a depth of 260 meters. The most important measurements of these individuals are as follows:

				♀	♂
Total length in mm.			117	147	207
Length of the head	in % of the total length		21,8	23,1	24,9
Distance between the snout and anus	—	—	41	42,2	44,7
Height over the anus	—	—	10,2	8,5	9,9
Longitudinal diameter of the eye	—	—	3,6	4,1	3,1

The largest of the individuals is remarkable for its great breadth of head just behind the eyes; it is a male and the same characteristic has already been noted for this sex in another species (*L. vahlii*. cf. p. 20 with fig. 1 & 2); further, the snout in this individual extends unusually far forward in front of the underjaw. The pectorals contain 18, 18 and 19 rays. The distance of the dorsal fin from the snout is 28,2—31,2 % of the total length. On the side of the body the scales extend forward to a little behind the root of the pectorals, but both the anterior portion of the back and the belly on the other hand are free from scales, even in the largest of the specimens. The 207 mm. long specimen is wanting in cross-bands, uniformly grayish brown, lighter underneath especially on the underside of the head forward; the anal fin darkish, the front part lighter and with a light border. The colour in the 147 mm. long specimen is very dark, rusty brown, with extremely faint indications of cross-bands; the belly and fins are of a dark mouse-gray, the anal darker posteriorly, the underside of the head lighter in parts. In the one 117 mm. long, the colour is likewise very dark except on the foremost part of the underside of the head, with very indistinct bands, which are however, very apparent on the dorsal fin, especially towards the margin, to the number of 7 with a dark spot on the point of the tail; the anal fin blackish, especially posteriorly, forward lighter on the lower margin. The ventral lateral line is distinct, also the mediolateral in parts, yet only in the smallest individual.

Lycodes pallidus from East-Greenland.

In the Stockholm's Riks-Museum I have seen not less than 53 specimens, taken at the northerly East-Greenland by the Nathorst-Kolthoff Expeditions of 1899 and 1900. A large number of these specimens have been described by F. A. Smitt (l. c.) under the names: *L. vahlii* forma *pallida*, *L. vahlii* f. *typica* and *L. reticulatus* f. *frigida*.

Most of the specimens are under 100 mm. in length, only 18 are above that from 105—178 mm. In 33 of these (55,5—178 mm.) the length of the head is 20,7—25,3 %, the distance between the snout and the anus 38—44,4 %, the height over the anus 8—10,3 %[1]), the longitudinal diameter of the eye (in individuals of 125 mm. and over) 3,4—4,5 % of the total length. The pectoral fins contain 18—19, more rarely 20 rays. A young specimen of 55,5 mm. is still naked, but scales have begun to appear in another of 65 mm. In specimens of total length 70—125 mm., the scaly covering extends forward

1) In one case 11,1 %, in young specimens sometimes as low as 7,3 %.

to near the root of the pectorals, but a portion of the end of the tail is still more or less free from scales; at a total length of 137 mm. and over, the tail is completely covered with scales, so that these extend from the tip of the tail almost to the root of the pectorals, but the head, belly and fins continue to be naked even in the largest specimens. On the trunk and tail, there are 7—11 dark cross-bands (frequently also a dark spot at the end of the tail), which may become indistinct in the older (seldom in the relatively small individuals), especially on the foremost part of the body; they remain as a rule, however, on the dorsal fin; the anal fin is usually light in front, posteriorly on the other hand, it is more or less blackish (from the fusing together, entirely or in part, of the most posterior cross-bands) not rarely with a narrow, light strip along the lower margin; more rarely the anal fin is uniformly dark the whole way. Sometimes a light spot is present over the edges of the gill-cover or a light stripe across the neck. The ventral lateral line is distinct, especially on the part descending towards the anus; a distinct mediolateral lateral line is seldom seen; sometimes there is a short series of pores forwards under the dorsal fin [1]).

Lycodes pallidus from the cruise of the "Michael Sars" 1902.

Six specimens of a Lycodes, which I think *L. pallidus*, were taken off the Shetland-Norway Slope at ca. 420 fathoms depth.

The most important measurements are as follows:

							♂	♂
Total length in mm.			98	121	122	142	181	186
Length of the head	in % of the total length		22,8	23,1	23	23,2	24	22,6
Distance between snout and anus	—	—	40,8	40,9	39,8	42,3	42	41
Height over the anus	—	—	8,9	10,2	9,4	10,6	9,1	8,7

In addition, the longitudinal diameter of the eye is 4,1—3,8 %, the length of the snout (to the eye) 7,6—8,5 %, the distance of the dorsal fin from the snout 28,7—30,4 % of the total length. The pectoral fins contain 19—20 rays. The scaly covering is almost equally developed in all specimens and extends towards the root of the pectoral fins; the anterior part of the back and the fins are naked, likewise almost all that part of the belly which lies under the branch of the lateral line descending towards the anus. The ground-colour is brownish, but darkened on the belly by the peritoneum shining through; on the body itself no cross-bands appear; in the three smallest specimens on the other hand, rather distinct black markings appear on the dorsal fin, especially on the most posterior part, and weak traces of these can be detected also in the three larger individuals; the anal fin is grayish in front, dark posteriorly. The ventral lateral line is distinct, frequently even a good bit beyond the anus; a mediolateral lateral line is rather apparent in a single individual (that of 142 mm.), in others only scattered elements of it are to be seen.

[1]) I have also observed such dorsal pores sometimes, in *L. pallidus* from other regions.

Lycodes pallidus from Jan Mayen.

(var. *similis* m.).

Tab. V, fig. 2 a, b, c, d & Tab. VI, fig. 3 a, b, c, d.

I consider as belonging to a distinct variety, 15 specimens which the Ingolf Expedition obtained in the neighbourhood of Jan Mayen (St. 116), at 371 fathoms depth. Lütken (l. c.) had referred 10 of them to *L. pallidus* Coll., to which they indeed are closely related, the remaining 5 to *L. lütkenii* Coll. to which they have a certain resemblance in colour-marking but no close relation otherwise. In my preliminary report (l. c.) I have formed these Lycodes from Jan Mayen into a separate species *(L. similis)*, pointing out at the same time their near relationship to *L. pallidus;* with my present increased knowledge of *L. pallidus* I consider it best to regard them as a local variety of this species.

The most important measurements of these specimens are as follows:

								♂	♀	♀		♀	♂	♀	♀	♂
Total length	in mm.	49	73	74	106	109	118	125	125	130	132	134	143	145	170	175
Length of the head ..	—	12	18,5	18	25,5	26	28	31	30	30	31,5	31	37	35	40	44
Distance between snout and anus ..	—	21	30,5	31	46	48	51	53	55	55	57	56	62	60	73	75
Height over the anus	—	5	7,5	7,5	11,5	11,5	12,5	14	14	14	13	15,5	16	17	21	19

The body as to form has a great similarity to that in the typical *L. pallidus*, but it is throughout somewhat higher, and is thus less elongated; the height over the anus amounts to 10—12,4 % of the total length. The tail again is throughout somewhat shorter, the distance between the snout and the anus being 41,4—44 % of the body's whole length.

The head is of similar length as in the typical *L. pallidus* and amounts to 23—25,9 % of the total length. It appears however less lengthy, as the height over the neck is greater and as a rule is contained not quite twice in the length; it is consequently less depressed, and its lateral aspects approach more to the vertical. Seen from the side, its upper border from the neck to the posterior margin of the pupil is almost horizontal, and then inclines sharply almost in a straight line down to the snout. The eyes are relatively a little larger than in the typical form, their longitudinal diameter (in specimens of 118 mm. and over) being 4,7—5,6 % of the total length; their upper margin projects outwards over the level of the forehead; seen from above, there is a tolerably small space between the two eyes; on the cranium the breadth of the forehead is $^{1}/_{20}$ of the length of the head. The snout is not depressed, as in the true *L. pallidus*, but somewhat high; on the whole its head is higher than in the previous form whether the snout or the neck is considered. The length of the postorbital part of the head is somewhat the same in both forms; consequently, on account of the greater dimensions of the eye, the snout is relatively a little shorter in the variety *similis* and amounts to only 6,2—7,5 % of the total length against 6,8—8,5 % (or more) in the typical *L. pallidus*. The cup-shaped depressions along the margins of the jaws, and the nostrils are as in the typical form, nor do the teeth show any differences.

The **dorsal fin** begins about the same place as in typical specimens, namely at a distance from the snout which is 29—32,2 % of the total length; it has ca. 94—96 rays, the anal fin ca. 81—82 rays; as usual, half the tail fin is reckoned in both. The pectoral contains 19—20, seldom 21 rays. The ventral fins are just as small as in typical *L. pallidus*.

Scales. The smallest specimen (49 mm.) is naked (Tab. VI, fig. 3 a). In the 73—74 mm. long specimens the scaly covering extends from the beginning of the dorsal fin some distance on to the tail, but the anterior part of the back and the belly are naked (Tab. V, fig. 2 a). In the 106 and 109 mm. long specimens the end of the tail is further naked (Tab. V, fig. 2 b). It is only late that this portion begins to be covered with scales, viz. at a total length of 118—130 mm. In the larger specimens the scales extend from the tip of the tail forward to a line from the anterior end of the dorsal fin, yet the anterior part of the back and a strip just forward under the base of the dorsal fin as well as the greatest part of the trunk under the branch of the lateral line descending towards the anus, are free from scales (some specimens may have 2—3 rows of scales at the most, on the belly under the lateral line); scales on the unpaired fins cannot be discovered. The scales are relatively large as in the typical form and are fairly close together.

The lateral line is double. The ventral branch is distinct on the stretch from the edge of the gill-covers down to the anus, also for a shorter or longer distance along the underside of the tail; the mediolateral line is more or less apparent, sometimes specially distinct with a considerable number of pores and short lines. Some pores are sometimes seen forward under the dorsal fin.

Colour. The variety *similis* occurs in two different colour-forms, namely in one with indistinct cross-bands (Tab. V, fig. 2 a, b, c, d), another with these distinct (Tab. VI, fig. 3 a, b, c, d). Under the first come 10 specimens. The two young specimens of 73—74 mm. (Tab. V, fig. 2 a) have 4 dark bands over the first two-thirds of the dorsal fins, almost black and most distinct towards the edge of the fin; under each of these patches there is a more or less distinct, brownish cross-band on the body. The anal fin is black posteriorly, to a more or less extent, on the margin or even to the base. The peritoneum shines through giving the belly a blue-black appearance, and the posterior margin of the gill-cover as well as the skin over the branchiostegal rays is dark. Otherwise the ground-colour is yellowish brown. Two specimens which follow these in size and measure 106—109 mm., are similarly coloured; the dark markings of the fins appear mainly, however, as stripes on the margins, and the anal fin is not very dark posteriorly (Tab. V, fig. 2 b). Six other specimens at 125 (Tab. V, fig. 2 c), 130, 132, 134, 143 and 175 mm. (Tab. V, fig. 2 d), display similar colouration or have the dark markings almost entirely obliterated, so that the body seems almost uniformly brownish, with light scale-points and dark belly and gill-cover. The other colour variety is shown by 5 specimens. The first is the 49 mm. long young specimen (Tab. VI, fig. 3 a): it has a very broad cross-band on the trunk and 4 over the tail, decreasing in size posteriorly; the bands are brown, but there is a lighter part in the centre of those in front; a light band extends across the neck from gill-cover to gill-cover; the anal fin is shaded with black posteriorly. 4 specimens of 118, 125, 145 and 170 mm. have preserved this colouration in the main (Tab. VI, fig. 3 b, c, d): all show a light band across the neck as well as the dark brown cross-bands on the trunk and tail, all, or in every case the most anterior of them, with a light centre[1]); on the anal fin the dark bands may be scattered or fused together to form a lengthy patch on the fin posteriorly. In this group of specimens also, the scales appear as lighter points, and the belly and gill-covers are dark. — This remarkable variation in colour-marking is not a sex-difference as both males and females occur in both colour-forms.

The sexual organs are little developed in the specimens to hand. In the largest male (175 mm. long) the testes are 10 mm. long, 4,5 mm. broad, without developed free folds. In the largest female (170 mm.) taken on the 23rd of July, the ovary is ca. 10 mm. long, and contains a tolerably small number of eggs of 1,5 mm. in diameter.

It is especially the less elongated body-form, the somewhat shorter tail and the relatively large eyes, which justifies the variety *similis*.

Lycodes pallidus
var. *squamiventer* m.

Tab. IV, fig. 2 a, b.

The 12 specimens, now to be mentioned in more detail, were taken partly by the Ingolf Expedition of 1896 in the waters east from Iceland (St. 105, 104, 101) and north from the Færoe Isles (St. 141), partly by the «Michael Sars» Expedition of 1902 off the Shetland-Norway Slope; the depths were 537—957 fathoms.

The most important proportions of these 12 specimens are as follows:

		«M. Sars»	«M. Sars»	«Ingolf» St. 104 ♀	«Ingolf» St. 104 ♀	«M. Sars» ♂	«Ingolf» St. 105 ♂	«M. Sars» ♂	«Ingolf» St. 101 ♂	«Ingolf» St. 141 ♂	«Ingolf» St. 101 ♂	«M. Sars» ♂	«M. Sars» ♀
Total length	in mm.	117,5	128	143	147	155	170	179	180	230	245	248	260
Length of the head	—	24,5	27	32	31	34	36	37,75	37	50	55	51	51,5
Distance between snout and anus	—	47	50,5	55	60	63,75	68	68	70	90	97	94	104,5
Height over the anus	—	11	12,25	14	14	14,75	16	17,5	17	22	25	25	28

The form of the body is similar to that in the typical *L. pallidus;* the anus has almost the same position, namely in its distance from the snout which is here 37,9—41,1 % of the total length, and the height over the anus is 9,4—10,8 % of the same length.

The head is relatively shorter than in both preceding forms, as its length is only 19,6—22,4 % of the total length, somewhat depressed, especially in adult specimens. The eyes have a similar length as in the typical *L. pallidus*, their longitudinal diameter being 3—4,4 % of the total length. The snout, whose length is 7—8,7 % of the total length, is relatively somewhat higher in the young specimens than in the old, where it is depressed. The tube-shaped nostrils are well-developed; the teeth-characters as usual.

[1]) The colouration of these specimens has a delusive resemblance to that in *L. lütkenii*, which must be the reason why Lütken in the earlier report on the Fishes of the Ingolf Expedition referred them to that species.

The dorsal fin, whose distance from the snout is 27—29 % of the total length, contains 96—97 rays, the anal fin 81—82 (half the caudal fin is reckoned with each). The pectorals have 18—20 rays. The ventrals are on the whole, somewhat longer and more developed than in the other forms of *L. pallidus.*

Scales. We do not know the youngest stages, but the smallest of the present specimens is already remarkable for the strong development of scales, though it is only 117,5 mm. long; the scaly covering extends forward to the neck and almost to the base of the pectorals, as well as forward on the belly to a line drawn almost between the anterior third of the pectorals. The 128 mm. long specimen has scales on the whole of the belly, to the base of the ventrals, and scales have begun to appear on the base of the unpaired fins; the scaly covering has thus almost reached its fullest development in this small specimen, as much as it does in the *Lycodes* genus, as it is essentially only the head which remains naked. The three largest specimens (245, 248 and 260 mm.) have only advanced further in that the scales have spread out more on to the unpaired fins. The remaining specimens, whose lengths lie between 143 and 230 mm., display a little variation, as the scaly covering in some of them has almost the same distribution as in the largest individuals, whereas in others the scales on the belly only reach forward to a line between the anterior third of the pectorals or to the tip of the ventrals when stretched out backwards, and there may also be a naked strip in the middle line of the back in front of the dorsal fin; in all, the scales extend out more or less on to the unpaired fins. — Whilst, in the two previous forms of *L. pallidus,* the scales did not extend below on to the belly itself, the underpart of the belly is always scaled in the present form, either to the base of the ventrals or at least to a short distance from it, and on the whole also, the scales extend further forward on the back as well as, except in the smallest specimens, out on to the base of the unpaired fins. The scales themselves are small, on the whole less than in the other forms of *L. pallidus:* they are sometimes so close together that they partly give one the impression of being imbricate.

The lateral line has its origin over the upper edge of the gill-cover, bends down towards the anus and can be followed a shorter or longer distance along the lower edge of the tail, sometimes even to the tip of the tail. In addition to this ventral lateral line, more or less distinct traces of a mediolateral branch are to be seen, sometimes as only single pores, sometimes more numerous pores, partly also as a thin line.

The colour is uniform, without bands or spots, dark-brown or lighter, yellowish brown or gray-brown, in all the specimens at hand; the scales stand out lighter than the ground-colour; the belly and posterior margin of the gill-cover are darker.

Sexual organs. The testes are very broad relative to the length and with very small free folds; in one specimen 245 mm. long, the testis measures 16 mm. in length by 7 mm. in breadth, the free fold is only 3 mm. long. The largest individual (260 mm.) is a female taken on the 28th of June; the ovary is 22 mm. in length and contains eggs with a diameter of 3,5 mm. The next largest female is 147 mm. long; the ovary is only 8 mm. long and contains extremely small eggs.

In certain respects therefore, the present form is somewhat distant from *L. pallidus:* the head is relatively a little shorter; the scales are less and have a wider distribution, both on the belly, back and unpaired fins; the colour is uniform and shows no indication of bands or spots (though it must be remembered, however, that the young are unknown).

For the rest, it has a very great resemblance to *L. pallidus*, and I think it most prudent meantime to consider it a variety of this species. In time it may possibly be raised to a separate species, and its name *squamiventer* could then be retained as the specific name.

As the facts are at present, I regard it as a deep water form of *L. pallidus*. It lives at depths of 537—957 fathoms, whilst the true *L. pallidus* in my opinion is not known to go to greater depths than 495 fathoms. It seems to me worthy of remark in this regard, that one of the specimens of *L. pallidus* from the deepest place (the 183 mm. long specimen described before and represented in fig. 1 e on Tab. IV) forms in part a transition stage to the variety *squamiventer*, being scaled on the uppermost part of the belly (6 rows of scales beneath the descending branch of the lateral line) and contrary to the usual, has scales on the base of the unpaired fins.

Distribution.

The typical *L. pallidus* is found in the Kara Sea, at Spitzbergen, at north-eastern Greenland, and north from Iceland, north from the Færoes and N.N.E. from Shetland.

In the Kara Sea the Dijmphna Expedition took 11 specimens at a depth of 46—106 fathoms.

At Spitzbergen the Norw. North-Atlantic Expedition took 2 specimens where the depths were 260—459 fathoms, and the bottom-temperature + 1°1 and ÷ 1 C.; a Russian Expedition 1 specimen in Stor Fjord at a depth of 60 fathoms, and bottom-temperature of ÷ 2° C.; the Kolthoff Expedition of 1900 1 specimen at the mouth of Ise Fjord, where the depth was 185 fathoms, and the "Michael Sars" 1901 2 specimens at Ise Fjord at a depth of 140 fathoms.

At north-eastern Greenland no fewer than 53 specimens have been taken. The Nathorst Expedition of 1899 took it in Franz Josephs Fjord, at 400 fathoms (4 specimens) and at 73° 20' N.L. 21° 20' W.L. where the depth was 37 fathoms (1 specimen). The Kolthoff Expedition of 1900 obtained it at the following places: Franz Josephs Fjord, head of Myskoxe Bay, 53 fathoms (2 specimens); Franz Josephs Fjord, outer part of Myskoxe Bay, 106 fathoms (1 specimen); mouth of Franz Josephs Fjord, 106—212 fathoms (4 specimens); off Franz Josephs Fjord, between Bontekoe Island and Mackenzie Bay, 132 fathoms (2 specimens); Mackenzie Bay, 6½—18 fathoms (35 specimens, 1 of 178 mm., 1 of 125 mm., the rest between 40—110 mm.); off Mackenzie Bay, 53 fathoms (3 specimens); S.E. from Walrus Island (74° 30' N.L. 18° 40' W.L.), 42—53 fathoms (1 specimen).

The Ingolf Expedition of 1896 took 7 specimens north of Iceland at St. 124 and 126, where the depths were 293—495 fathoms, and bottom-temperature —0°5 and —0°6 C.

The same Expedition of 1896 took 4 specimens north from the Færoes at St. 138, at a depth of 471 fathoms, and bottom-temperature —0°6 C.

Off the Shetland-Norway Slope (62° 43' N.L. 1° 26' E.L.) the "Michael Sars" in 1902 took 6 specimens, where the depth was ca. 420 fathoms and bottom-temperature under 0° C.

The variety *similis* was taken by the Ingolf Expedition of 1896 (15 specimens) south from Jan Mayen (St. 116) where the depth was 371 fathoms and bottom-temperature —0°4 C.

The variety *squamiventer* was taken by the Ingolf Expedition of 1896 east from Iceland (St. 105, 104, 101), where the depths were 537—957 fathoms and the bottom-temperature ÷0,7 to ÷1,1 C. (5 specimens); north from the Færoe Isles (St. 141) at 679 fathoms and bottom-temperature ÷0°6C. (1 specimen); and by the "Michael Sars" in 1902 off the Shetland-Norway Slope (63° 7' N.L. 1° 38' E.L.), where the depth was 650 fathoms and bottom-temperature under 0° C. (6 specimens).

L. pallidus lives in polar waters; in southern latitudes therefore, it is first met with at great depths (300 fathoms and deeper) but in high arctic seas it comes up quite to the sublittoral zone.

Lycodes platyrhinus Jensen.

Tab. VI, fig. 2. Figs. 3—5 in text.

1898. *Lycodes frigidus* Lütken, The Danish Ingolf Expedition, II, 1, p. 20 (partim).
1901. *L. platyrhinus* Jensen, Vidensk. Medd. Naturh. Foren. Kbhvn. p. 208.

Body zoarciform, yet relatively more elongated than in most other species of the genus Lycodes, the height over the anus being only 8,2 % of the total length; the length of the head is 19,9 % of the same length, the distance between the snout and the anus 37 %. The colour is uniformly of a ruddy brown-gray. Scales are wanting. Lateral line double, ventral and mediolateral, most distinct in its course towards the anus. The size (of the single specimen) 148,5 mm.

D. 99. A. 82. P. 15.

Distribution. Between Jan Mayen and Iceland, 1010 fathoms.

Only one specimen of this species, which was placed by Lütken with *L. frigidus*, is at hand for investigation; it is a male.

The most important proportions are the following:

Total length	148,5 mm.
Length of the head	29,5 -
Distance between snout and anus	55 -
Height over the anus	12,25 -

The form of the body is more slender than in most other species of the genus *Lycodes*, the height over the anus being only 8,2 % of the total length. On the trunk the height is almost uniform and the tail tapers very gradually down to the tip. The trunk is somewhat compressed, its thickness being 1½ times in the height, and the tail becomes gradually more and more compressed. The anus lies a little behind the termination of the anterior third of the body, the distance between the snout and the anus being 37 % of the total length.

The head is broad, flat in front and tolerably short, its length being 19,9 % of the total length. The height over the crown is somewhat greater than the breadth at the same place, but further forward the head becomes very low without at the same time losing in breadth; the end of the snout is blunt, but low, seen from above it is broadly rounded off. The eyes are small, so that their longitudinal diameter is scarcely 1/9th of the total length of the head; they are placed high up, on the very margin of the forehead, but at a fairly clear distance from one another amounting to quite one and a half times the diameter of the eye. The length of the snout to the eye, is not quite $3\frac{1}{2}$ times in the whole length of the head. The lower jaw extends almost as far forward as the upper, whose posterior angle lies under the anterior third of the eye. The lips are tolerably fleshy. The teeth are small and pointed, placed as usual on the intermaxillary, palatal, vomer and mandible. The grooves for the pores of the lateral line are in parts considerable and very deep, surrounded by soft, projecting borders; from the snout to under the eye there is a row of 7 distinct pits, and another row of pits, likewise 7 in number, from the tip of the mandible to the lower posterior corner of the

3 4 5

Fig. 3—5. Head of *Lycodes platyrhinus*, seen from above, the side and from underneath. $\times$ 1.

preoperculum. The tube-shaped nostrils are situated a little above the interspace between the two foremost grooves of the upper jaw.

The dorsal fin begins almost over the posterior third of the pectoral when extended backwards, at a distance from the snout equal to 26,3 % of the total length. Both this fin and the anal fin are covered by a thick skin, so that it is difficult to count the rays; I have reckoned the number to be 99 in the dorsal fin, 82 in the anal, half of the tail fin being as usual reckoned in each. The pectoral, which contains 15 rays, is of an oblique quadrangular form; its length is 11,3 % of the total length. The ventral fins are short (almost of the same length as the space between the eyes) and placed very close to one another.

Of scales no trace can be observed; whether this naked condition is a constant feature or only due to the small size of the specimen, can naturally not be decided with certainty, but the scaly covering is generally far advanced in development at a length of ca. 150 mm. in the Lycodes which are on the whole provided with scales, so that the first alternative is the most probable.

The ventral branch of the lateral line is only distinct in its course down towards the anus. It begins on the neck, forms a small arch over the free flap of the gill-cover and inclines thereafter down towards the anus, but becomes already indistinct over the anus. Along the median line of the side a tolerably distinct line with not a few pores is to be seen under the lens; the pores are somewhat far apart in front but closer together posteriorly.

The colour is uniformly a ruddy brown-gray, the fins and underside of the head lighter, dirty gray; the dark peritoneum shows through the belly.

Distribution. A single specimen (♂) was taken by the Ingolf Expedition in 1896 between Jan Mayen and Iceland (St. 119), where the depth was 1010 fathoms and bottom-temperature — 1°0 C.

Relation of the species to *Lycodes frigidus* Coll.

L. platyrhinus was placed with *L. frigidus* Coll. by Lütken, and it certainly presents some resemblance with this species in appearance, namely, in its uniform, ruddy brown-gray colour; but a more thorough comparison will at once show important differences of which the following may be emphasized.

L. frigidus has a less elongated body-form, the height over the anus, in a specimen of similar length, being 10 % or somewhat more of the total length; the tail especially is quite different in appearance when seen from the side, as it becomes pointed posteriorly somewhat quickly in *L. frigidus*. Again, the head is larger in *L. frigidus*, its length being 22 % or more of the total length. *L. frigidus* has more rays in the pectoral fins, namely 19—21. Lastly, the scaly covering in *L. frigidus* is far advanced at the total length of the present species, and its lateral line is single (ventral).

Lycodes microcephalus Jensen.

Tab. I, fig. 1. Fig. 6—8 in text.

1901. *Lycodes microcephalus* Jensen, Vidensk. Medd. Naturh. Foren. Kbhvn., p. 206.

The height over the anus is 8 % of the total length. The head is small, its length being only 17,3 % of the total length. The tail is much longer than the head and trunk together, the distance from the snout to the anus being 38,3 % of the total length. The colour is a uniform yellowish white, without bands or spots, blue-black on the belly. Lateral line mediolateral (?), only apparent on the trunk. The scales extend to the point of the pectoral fin, but naked spots occur here and there, especially on the tail posteriorly; incipient scale-formation on the unpaired fins. Size 81 mm.

D. 92. A. 76. P. 15.

Distribution. Northern Atlantic Ocean S.W. from Iceland, 799 fathoms.

Only one specimen is present for examination. Its most important proportions are the following:

Total length	81 mm.
Length of the head	14 —
Distance between the snout and the anus	31
Height over the anus	6,5

The form of the body is somewhat elongated; the greatest height lies over the belly a little in front of the anus and goes 10 times in the length. The trunk itself is almost of even height, but lessens at the anus, its height here going $12^1/_2$ times in the total length; the tail tapers slowly and fairly evenly towards the point. The greatest thickness lies across the cheeks and is but little less than the greatest height of the body; the trunk is a little smaller, and the tail becomes more and more compressed towards the tip. The anus lies a long distance in front of the middle of the length of the body, its distance from the snout being 38,3 % of the total length.

The head is less than in some of the Lycodes species here treated of, its length being only 17,3 % of the total length. For the rest it has a thick and plump appearance; seen from the side, the upper and lower edges converge slightly forwards, and the end is blunt; seen from above it narrows a little towards the broad rounded end of the snout. The eyes are placed so high up that their upper margin projects a little in front of the forehead; their longitudinal diameter is 5½ times in the length of the head; seen from above, the distance between the eyes is equal to the diameter of the eye. The length of the snout to the eye, is about 3⅘ times in the length of the head. The lower jaw extends almost as far forward as the upper, whose posterior angle lies under the anterior third of the eye. The lips are thick. The tubular nostrils are well-developed. Of large, cup-shaped pits there is a no small number: 1 behind the eye, towards the upper side, 5 under and in front of the eye, 1 behind and 1 in front of the nostril, 8 on the preoperculum and mandible, lastly 1 on the neck

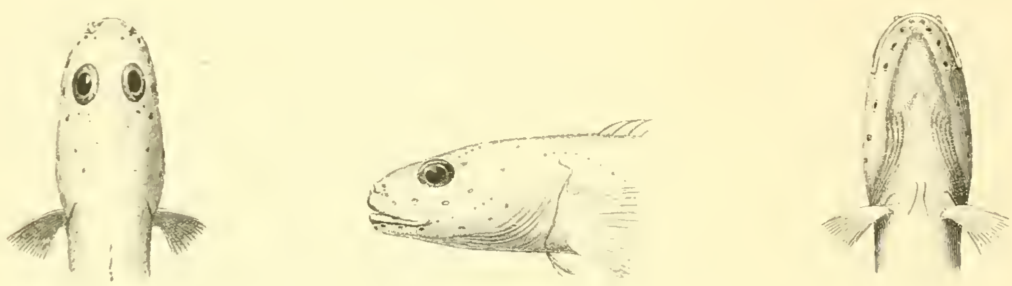


Fig. 6—8. Head of *Lycodes microcephalus*, seen from above, the side and from underneath. × 2.

a little in front of the origin of the lateral line. Further, there is a number of fine lateral line pores on the top of the head, the operculum and preoperculum.

The dorsal fin begins relatively far forward, namely, at a distance from the snout which is equal to 21,6 % of the total length; it contains ca. 92 rays, the anal fin ca. 76 rays (half the tail fin being reckoned with each). The ventral fins are relatively long (3,5 mm.), but very thin. The pectorals are 8,5 mm. long and contain 15 rays, the lowermost of which extend at their points beyond the covering skin.

The scales already show a tolerably wide distribution, namely, forward to the tip of the pectoral fin when laid backwards. They are not yet very close together, here and there also are some naked spots, especially on the hindmost portion of the tail, and in front the scaly covering projects forwards in the shape of a wedge leaving the belly and back bare. Further, the scales show signs of going to spread out on to the unpaired fins.

The lateral line seems to be mediolateral. It begins over the upper notch of the gill-cover, forms a slight arch over the flap of the latter, and can then be followed along the median line of the trunk as far as the vertical line through the anus; the pores are tolerably distant from one another and only number 21 on the whole distance mentioned. Possibly there is likewise a ventral branch, as on the one side there seem to be 2—3 pores on the belly in front of the anus.

The colour is a uniform brownish yellow without any signs of stripes. The belly shows blue-black owing to the peritoneum shining through. In the journal of the Expedition it is written concerning the fresh fish: almost without colour, a little bluish gray in tone; the top of the head slightly reddish; the side of the trunk and belly (over the peritoneum) dark blue .

An unpaired sexual organ is present. No pyloric appendages to be seen.

Distribution. The single specimen taken in 1896 by the Ingolf Expedition[1] was obtained S.W. from Iceland, were the depth was 799 fathoms and the bottom-temperature 4 5 C. (St. 78).

This new species does not seem to stand anyway near any of the other Lycodes; *L. atlanticus* mihi, to which one might be inclined to relegate it as the young, has a relatively greater head and more numerous rays in the pectorals (23).

Lycodes rossi Malmgren.

Tab. VII, Fig. 1 a, b, c, d, e, f, g.

1828.(?) *Blennius polaris* Ross (vix Sabine) in Parry, Narrative of an attempt to reach the North Pole, p. 200.
1864. *Lycodes rossi* Malmgren, Om Spetsbergens Fiskfauna; Öfvers. Kgl. Sv. Vet. Akad. Förhandl., p. 516.
1880. *L. rossi* Collett, The Norwegian North-Atlantic Expedition, Fishes, p. 106.
1886. *L. reticulatus* Rhdt. (?) jun., Lütken, Kara-Havets Fiske; Dijmphna-Togtets zoologisk-botaniske Udbytte, p. 136, Tab. XVII, Fig. 4—5.
1886. *L. Lütkenii* Lütken, ibid. p. 128 (partim), Tab. XVI, Fig. 1 (nec Fig. 2 6).
1895. *L. reticulatus* Smitt, Skandinaviens Fiskar, II, p. 612 (partim), Fig. 148.
1899. *L. rossi* Collett, Vidensk. Selsk. Skr. Chria., No. 6, p. 8 (cum fig.).
1901. *L. reticulatus* Reinh. (?), Knipowitsch, Ann. Musée Zool. l'Acad. Imp. St. Pétersbourg, T. VI, p. 25.
1901. *L. reticulatus* forma *reticulata* Smitt, Bih. K. Sv. Vet.-Akad. Handl. Bd. 27, Afd. IV, No. 4, p. 33 (partim), No. 23 & 27.
1901. *L. reticulatus* forma *seminuda* Smitt, ibid. p. 32 (partim), No. 16.
1901. *L. celatus* Jensen, Vidensk. Medd. Naturhist. Foren. Kbhvn., p. 208.
1901. *L. rossii* Jensen, ibid. p. 213 (partim).

Of the total length the height over the anus is (8,5) 9,4—11,7 %, the length of the head 22,4—25,3 %, the longitudinal diameter of the eye 3,6—4 %, the distance between the snout and the anus 43,1—49,3 %, the length of the pectorals 13,1—13,6 %. The young have dark cross-bands on a light ground, the bands relatively light in the centre, but with a very dark margin (on the dorsal fin, blackish); a light band across the neck. In larger individuals the dark (6—10) cross-bands on the side of the body are partly confluent below, so that the light interspaces partly show as saddle-shaped markings from the free edge of the dorsal fin down towards the lateral line; the light neck-band frequently divides up into several spots. The scaly covering in the older individuals reaches forward to a point, which lies almost under the beginning of the dorsal fin, and is wedge-shaped in front so that the

[1] The specimen was overlooked and not included in The Ichthyological Results .

anterior part of the back and belly are free of scales, likewise the head and fins. The lateral line is mediolateral. Pyloric appendages 2. Size 223 mm.

D. 91—96. A. 71—76. P. (17) 18—19 (20).

Distribution. Spitzbergen, 5—75 fathoms; Kara Sea, 46—100 fathoms; Porsanger Fjord (East Finmark), 30—50 fathoms.

Remarks on the Synonymy.

In 1828, Ross referred a fish taken by the Parry North Pole Expedition north of Spitzbergen at a depth of 80 fathoms, to the *Blennius polaris* described by Sabine from arctic America, though Ross at the same time noted some differences between them. From the description, it is quite clear that Ross' specimen was a species of the genus *Lycodes*.

In 1861, a Swedish Expedition to Spitzbergen obtained two small Lycodes, which Malmgren took — and probably rightly — to be identical as species with Ross' specimen. But M. rejected the reference of this Lycodes to Sabine's *Blennius polaris*, and after likewise rejecting the possibility of its identity with either of the *L. perspicillum* and *L. nebulosus* from Greenland established by Kroyer, gave it the name *L. rossi*, the diagnosis of which is based on a single 32 mm. long specimen (the second specimen seems to have been lost).

The next reference to *L. rossi* is by Collett in 1880. After examining Malmgren's type-specimen Collett came to the conclusion that *L. rossi* was really the same as *L. perspicillum* Kr., and again that *L. gracilis* M. Sars, which was only known from a young specimen from Christiania Fjord, was identical with *L. rossi*. Further, Collett explains: »it is probable that all these are only young stages either of *L. reticulatus* alone, or also of a second nearly related species, perhaps *L. lütkenii*« (l. c. p. 105).

In his great work on Scandinavian Fishes Prof. F. A. Smitt likewise expresses the opinion that *L. rossi* is the young of *L. reticulatus* Reinh., but with this he unites not only *L. perspicillum* Kr., but also *L. seminudus* Reinh. and *L. lütkenii* Coll. of the European-Greenland forms.

In his monograph on *L. gracilis* (1899) Collett again takes up the question of the position of *L. rossi*. He declares that in certain features *L. rossi* differs from *L. gracilis*, but he is still inclined to consider them identical; on the other hand, he now considers the transference of *L. perspicillum* to this species as problematical, and there is no further talk of bringing *L. gracilis-rossi* under *L. reticulatus*.

In my preliminary report on the Lycodes of the Ingolf Expedition I was of the opinion that I had again found *L. rossi* in two small specimens from the seas south of Jan Mayen, and that these united *L. rossi* with *L. lütkenii* Coll. In this however, I made an error. Later, in the material of the Kolthoff Expedition, I have seen so many specimens identical with the form from Jan Mayen, that with this increased knowledge, I must refer them to *L. seminudus* (cf. this species). And after I had the opportunity, through the favour of Prof. F. A. Smitt, of examining Malmgren's type-specimen of *L. rossi*, I think it certain that this form is a very young stage of the species *L. celatus* mihi.

This specific name I had employed for three small Lycodes from the Kara Sea; they were considered by Lütken, though with some doubt, as the young of *L. reticulatus* Reinh. I could not agree with this author on this point and formed the species *L. celatus*. To this I further referred two small Lycodes taken by Russian Expeditions in the Stor Fjord at Spitzbergen. Prof. N. Knipowitsch had identified these specimens as Lütken's *L. reticulatus* jun.? and with right, as I could judge from a direct comparison which Prof. K. kindly enabled me to make; through some differences in the most important proportions however, I felt obliged to distinguish it as a distinct variety: *spitsbergensis*.

But, as said, after I had seen the type-specimen of *L. rossi* Malmgr., I came to the conclusion that my *L. celatus* must be somewhat larger specimens of the same species.

Later, I got to know *L. rossi* closer through a whole series of specimens, old and young, which Dr. Johan Hjort had taken in 1901 in the Ise Fjord at Spitzbergen. And for use in this treatise, Prof. R. Collett has lent me a series of specimens, which kindness I appreciate the more as Prof. Collett had intended to work them out. With the help of this excellent material, I discovered that the largest of the specimens, which Lütken in his report on the fishes of the Kara Sea had referred to *L. lütkenii* Coll., belonged to *L. rossi*[1]. Lastly, I became convinced that two Lycodes must also be referred to *L. rossi*, which were taken at Spitzbergen (Ise Fjord and W. from Cape Mitra) by the Kolthoff Expedition of 1900 and ascribed to *L. reticulatus* by Prof. Smitt (l. c.).

Description.

Altogether I have had 19 specimens for investigation; they are enumerated below with the most important proportions:

[1] The remaining (27) specimens, on the other hand, form a new species belonging to the scaleless Lycodes, which I have named *Lycodes agnostus* (cf. p. 79—80).

		Spitzbergen, 1861 *L. rossi* Malmgr. sp. orig.	Spitzbergen, 1901	Spitzbergen, 1901	Kara Sea	Spitzbergen, 1900	Spitzbergen, 1900	Spitzbergen, 1899	Spitzbergen, 1901	Spitzbergen, 1901	Spitzbergen, 1901	Spitzbergen, 1901	Kara Sea	Kara Sea	Spitzbergen, 1901	Spitzbergen, 190	♀ Spitzbergen, 1901	♂ Spitzbergen, 1901	♀ Spitzbergen, 1901	♀ Kara Sea
Total length	in mm.	32	54,5	60,5	65	68,2	75,5	75,8	85	86	88,5	92,5	94	105	114	118	163	191	205	223
Length of the head	—	7,5	12,5	14	15,5	17,25	18,25	18,5	20,2	21,2	21	22,5	22	23,5	28	28,5	40	47,5	50	55
Distance from snout to anus	—	14,5	24,2	27,5	28	32	34	34,5	37	39	39,5	42	42	47	53	53,5	78	92	101	110
Height over the anus	—	3	5,2	6	6,5	7	8	7,75	9	9	9	9,5	8	10	12	11,25	16,5	21	24	24,5

The form is moderately elongated, the height over the anus being $8^{1}/_{2}$—$10^{1}/_{3}$ times (in young individuals sometimes almost 12) in the total length. As in other Lycodes species the head is somewhat depressed, whilst the somewhat compressed trunk passes evenly into the strongly compressed tail. The head is a little broader than the trunk; its greatest thickness lies over the cheeks and is ca. $1^{1}/_{10}$—$1^{2}/_{10}$ greater than the greatest height of the trunk. In adult specimens the anus lies almost at the middle of the body, as its distance from the snout is 47,8—49,3 % of the total length; younger specimens (under 120 mm.) have relatively longer tails, the distance of the anus from the snout in them being 43,1—47 % of the total length.

The head is relatively small, its length being only 22,4—25,3 % of the total length. The eyes are situated high up, so that their upper margins project forward over the forehead, and the space between them is somewhat hollow; their longitudinal diameter (in specimens of 118—223 mm.) is 6—6,9 times in the length of the head or 4—3,6 % of the total length; they are thus relatively small. The length of the snout, reckoned to the eye, is 2,9—3,7 times in the length of the head or 7,6—8,6 % of the total length. The upper-jaw extends to the vertical line through the middle of the eye; the end of the snout projects a certain distance in front of the underjaw. The lips are thick; the underlip has a dependant fold on each side, and the fold of skin along the underjaw's lower edge is overlapping on the chin. The tube-shaped nostrils are well-developed. Along the upper and under-jaws are shallow pits for the lateral line. The strong teeth are placed in a single row on the intermaxillaries (10—15), on the palatals (9—14) and on the mandible (10—15); on the foremost part of the jaws (especially on the under-jaw) they form however a double row; further, there is a small group (4—5) on the portion of the vomer lying between the anterior ends of the palatals.

The dorsal fin begins at a distance from the snout equal to 30—31,7 % of the total length; it contains 91—96 rays, the anal 71—76. The ventral fins are small (of a length almost equal to the breadth of the forehead between the eyes). The length of the pectorals is 13,1—13,6 % of the total length, i. e. almost equal to the distance between the posterior margin of the eye and the edge of the gill-cover; they contain most frequently 18—19, more rarely 17 or 20 rays, of which the lower ones project at their points beyond the covering skin.

The scales in the larger specimens (163—223 mm., Tab. VII, fig. 1 f & g) cover the sides of the tail almost completely, but on its foremost part are already somewhat distant from the dorsal fin and continue forward from thence on the side of the trunk as a broad wedge, ending a little behind, or at a point opposite to, the beginning of the dorsal fin; the head, anterior part of the back, the belly and fins are thus quite free of scales. The two smallest specimens (32 and 54,5 mm., Tab. VII, fig. 1 a & b) are naked, but scales have already begun to show on the 60,5 mm. specimen, on the foremost part of the tail and on the trunk to the point of the closed pectoral fin, mainly above the median line of the side. In the 65 mm. long specimen, only some few scales can be observed on the boundary between the trunk and the tail, up towards the back, but in three young specimens of 68,2, 75 and 75,8 mm. (Tab. VII, fig. 1 c & d) a distinct strip of scales is seen on the side of the body, in front to the middle of the pectoral when laid backwards and posteriorly an almost equal distance behind the anus. In the 85 mm. long specimen, the scaly covering is relatively very early developed, as it has here essentially the same distribution as in the adults, only the end of the tail is naked (which may also occur in part in much larger specimens); the individuals of 114 and 118 mm. are in a similar condition, but one of 105 mm. is much less advanced: in this the scales are only on the foremost three fifths of the tail and on the trunk to a little distance behind the tip of the pectoral, and for the most part they only extend from the back more or less to near the middle line of the side; only on a small portion do they reach below this. These examples should sufficiently illustrate the variations in the distribution of the scales in young and medium-sized specimens.

The lateral line is single, mediolateral, arises at the upper end of the gill-opening, forms a slight arch on the shoulder and courses along the dorsal aspect of the trunk but more in the median line on the tail. Over the first obliquely descending part of this lateral line there is a horizontal row of 4 to 5 pores, placed somewhat remote from one another, and there is a similar row between the posterior part of the head and the front end of the dorsal fin.

Colour. I shall begin with a description of the smallest specimen but 32 mm. long (type-specimen of *L. rossi* Malmgr.). As fig. 1 a of Tab. VII in natural size shows, this has 8 broad, dark bands on the body, and also a dark spot at the end of the caudal fin. The first of these bands reaches from behind the head to the front end of the dorsal fin, the second band lies under and a little beyond the posterior portion of the pectoral, the third has its anterior border lying over the anus, the most posterior (eighth) covers the end of the tail. All the bands reach down over the linear depression along the middle of the side of the body; the fifth extends to near the anal fin, the sixth, seventh and eighth extend on to this fin. Above, they all extend on to the dorsal fin. The ground-colour is yellow white (that is, on the specimen now much bleached; Malmgren wrote: dilute fulvo flavus), and the bands which are saddle-shaped, have a small, dark margin with lighter centre. The first band is separated from the dark posterior margin of the head by a light stripe across the neck. There is a dark streak on each side of the head, from the snout on to the gill cover[1]. — The next smallest specimen (54,5 mm.), represented in fig. 1 b of Tab. VII, is very similar to the foregoing in colour-markings, but the bands are broader and their number is only 7. Then comes the 60,5 mm. specimen whose colouration agrees completely with that of the type-specimen. The 65 mm. specimen from the Kara Sea displays a certain difference as a small, dark-brown spot appears in the lighter centre of the

[1]) The figure in F. A. Smitt (l. c. 1895) show a light spot behind the eye, towards the upper side, but I think the artist has depicted the brain showing through the skull; Malmgren says expressly (concerning the specimens at hand, two this time): in the Spitzbergen specimens the light spots on the dark crown characteristic for the last-named (i. e. *L. perspicillum* Kr.) are moreover wanting».

bands (see fig. 5, Tab. XVII of Lütken l. c. 1886); this specimen has 9 dark cross-bands (besides the dark spot on the point of the tail), but it does not stand alone, as in my fig. 1 e, Tab. VII a specimen with 10 cross-bands will be seen, whilst on the other hand, the number of bands in a specimen 114 mm. long is reduced to 6. — In specimens not quite young the sharp boundary between the dark cross-bands on the side of the body gradually disappear, dark colour-material being here deposited; the light interspaces between the bands then assume the form of saddle-shaped markings, which extend from the free edge of the dorsal fin down towards the lateral line, but they may be traced especially on the posterior part of the tail right across the body (cf. the two largest figures on Tab. VII). — The light dark-margined band, which extends across the neck and down on to the free fold of the gill-cover, is frequently divided in part or entirely, into three light spots by a dark longitudinal streak on each side, sometimes even into four spots by another dark streak on the middle line of the neck; rarely it is represented only by a light spot on and over the gill-cover.

In all the 3 females the eggs are small, at the most with a diameter of 1,5 mm. (in the 205 mm. female, taken the 26th of July 1901).

Distribution. *L. rossi* is a high arctic fish, hitherto only found in the Kara Sea, in Porsanger Fjord and at Spitzbergen.

At Spitzbergen, it has been taken at several places. First by a Swedish expedition of 1861 in Treurenberg Bay, at 5 fathoms depth, and at Fosters Islands in Hinlopen Straits, in each case a quite small specimen; next, by the Russian expeditions of 1899 and 1900 in the Stor Fjord, where the depth was 39—75 fathoms and bottom-temperature — 0,7 to — 1,6 C., a small specimen at each place. The Kolthoff Expedition of 1900 took one specimen 163 mm. long in Ise Fjord (Coal Bay) at 100 meters depth, and another of 87 mm., W. from C. Mitra (79° 10′ N. L. 11° E. L.) at 100 meters. Lastly, Dr. Johan Hjort in 1901 took a number of specimens (54,5—205 mm. long) in Green Harbour (an arm of Ise Fjord), where the depth was 75 fathoms.

In the Kara Sea the Dijmphna Expedition of 1882—83 obtained four specimens (65—223 mm. long) at 46—100 fathoms depth.

Finally, Dr. Hjort during the 1900 cruise of the "Michael Sars", obtained it in one of the fjords of East Finmark, namely in the innermost part of the Porsanger Fjord (the so-called Ostpol) where the depth was 30—50 fathoms and the bottom-temperature — 1,2° C.

Relation to allied Species.

L. rossi stands very close to the Greenland *L. reticulatus* Reinh.; it has however a more slender form, and on the whole fewer rays in the pectoral fin (|17| 18—19 |20| against |19| 20 |21|), and its colouration does not change over with age into the network-formation (reticulate). Concerning its relation to *L. reticulatus* var. *macrocephalus* see p. 70.

L. lütkenii Coll. is also a closely allied form (cf. p. 61).

Lycodes lütkenii Collett.

1878. *Lycodes reticulatus* Collett (nec Reinhardt), Fiske fra Nordhavs-Expeditionens sidste Togt; Forh. Vidensk. Selsk. Chria. 1878, No. 14, p. 59.

1880. *L. lütkenii* Collett, The Norwegian North-Atlantic Expedition, Fishes, p. 103, Pl. III, Fig. 25.

In relation to the total length, the length of the head is 25,7 %, the distance between the snout and the anus 47,3 %, the height over the anus 12,7 %, the longitudinal diameter of the eye 3,3 %, the length of the pectoral 16,8 %. The colour is gray-brown with 7 broad, dark cross-bands; a light band across the neck. The scales extend to a point under the anterior end of the dorsal fin. The lateral line is mediolateral. Pyloric appendages 2. The size (of the single specimen, a female), 370 mm.

D. 94. A. 76. P. 23.

Distribution. W. from North Spitzbergen, 459 fathoms.

Remarks on the Synonymy.

L. lütkenii was established in 1880 by R. Collett for a species, a single specimen of which, 370 mm. long, was taken by the North-Atlantic Expedition W. from North Spitzbergen, where the depth was 459 fathoms and the bottom-temperature — 1° C.; it was previously described by the same author in 1878 under the name *L. reticulatus* Reinhardt, an error that Collett himself corrected in the interval after he had examined the real *L. reticulatus* in the Zoological Museum of Copenhagen.

Later, *L. lütkenii* was reported, on the authority of Lütken, to have been again found in numbers both by the Dijmphna and Ingolf Expeditions. In 1886 he referred no less than 28 specimens from the Kara Sea to *L. lütkenii*: I have come to the conclusion however, that the largest of these specimens must be referred to *L. rossi* Malmgr., and that the others constitute a new species, belonging to the scaleless Lycodes: *Lycodes agnostus* (cf. p. 79). In 1898 further, Lütken mentioned quite briefly that the Ingolf had taken 6 *L. lütkenii* S. from Jan Mayen. Five of these however, are a colour-variety of *Lycodes pallidus* Coll. var. *similis* mihi (cf. p. 46). The sixth specimen was rightly determined according to my earlier opinion, as expressed in my preliminary report on the Lycodes of the Ingolf Expedition (l. c.), but after examining a whole series of similar specimens in the Stockholm Riks-Museum, brought from East Greenland by the Nathorst-Kolthoff Expeditions, I have come to a different conclusion, namely: that we have here a form which cannot be separated from *L. seminudus* Reinhardt, and must be considered as a colour-variety of this species (see further p. 72).

On *Lycodes lütkenii* Coll. (nec Lütken).

This form has been described in detail and well illustrated by Collett in his work on the fishes of the North-Atlantic Expedition. After I had learnt, through the kindness of Prof. Collett, to know it for myself, I became quite at one with him in believing it to be a distinct species from *L. reticulatus* Reinh. as C. has well shown (l. c. p. 104). In certain respects, *L. lütkenii* is nearly related to *L. seminudus*, as we now know it with the banded colour-markings, and I shall therefore briefly discuss the mutual relations of these forms.

If the single female specimen of *L. lütkenii* is compared with a specimen of *L. seminudus* of the same sex and similar size, they agree essentially in the most important proportions of the body; yet *L. lütkenii* is a less slender form, as will be seen:

		L. seminudus ♀	*L. lütkenii* ♀
Total length in mm.		335	370
Length of the head	in % of total length	25,1	25,7
Distance from snout to anus		46,9	47,3
Height over the anus		10,2	12,7

The head is of similar form as in *L. seminudus*, but seems to be less broad-snouted. The eyes seem relatively a little smaller, their longitudinal diameter being 3,3 % of the total length (against 3,7 % in the above specimen of *L. seminudus*), and the flap of the gill-cover is not bent upwards. The number of teeth is somewhat less than in *L. seminudus*; on the intermaxillary I have counted 15 in series, 15 on the palatines, 5 on the vomer, and on the mandible 15 in series (cf. p. 78).

The dorsal fin begins at a distance from the snout, which is equal to 30 % of the total length. The number of rays in the unpaired fins falls within that in *L. seminudus*. The pectorals, on the other hand, show a very important difference, being of a much greater size, their length being 16,8 % of the total length; in none of the 18 specimens of *L. seminudus* does the length of the pectorals exceed 11,8 % of the total length.

The scales extend further forward than in the most scaled specimen of *L. seminudus*, namely to a point under the anterior end of the dorsal fin, but at the same time both the belly and anterior portion of the back are naked.

The colouration agrees on the whole with that in the banded forms of *L. seminudus*; that the dark bands are rather indistinct (except on the dorsal fin) comes probably from the advanced size of the specimen.

The differences mentioned, especially the less slender form of the body, and the large pectorals, seem to me so important, that *L. lütkenii* Coll. ought to be held distinct from *L. seminudus* Reinh.

(Later. *L. lütkenii* presents even greater resemblance to *L. rossi* Malmgr., whose appearance in the adult condition is now known. Of important differences I can only mention, that in *L. rossi* the pectoral fins are shorter (their length being 13,1—13,6 % of the total length) and contain fewer rays, namely 17—20. All the same, I think it best to keep these forms separate so long as transitional forms are not found).

Lycodes reticulatus Reinhardt.

Tab. II, Fig. 2. Fig. 9—10 in text.

1835. *Lycodes reticulatus* Reinhardt, Overs. Kgl. D. Vidensk. Selsk. Forh. 1834—35, p. 77.
1838. *L. reticulatus* Reinhardt, Kgl. D. Vidensk. Selsk. Skr. VII, p. 167, Tab. 6.
1880. *L. reticulatus* Lütken, Vidensk. Medd. Naturh. Foren. Kbhvn., p. 318 (partim).
1895. *L. reticulatus* Smitt, Skandinaviens Fiskar II, p. 611 (partim).
1897. *L. reticulatus* Vanhöffen, Grönland-Expedition der Gesellschaft für Erdkunde zu Berlin, II, 1, p. 101.

The height over the anus amounts to 11,3—14,2 % of the total length. The length of the head in males is 25,1—26,5 %, in females 22,4—24,4 %, and the longitudinal diameter of the eye 4—2,7 % of the total length. The distance between the snout and the anus in males is 46,7—49,7 % of the total length, in females 46,2—47,4 %. The length of the pectoral is 13—14,2 % of the total length. Young specimens have 7—9 dark cross-bands on the trunk and tail, which (all or essentially only the foremost) form network markings in the older; a light band across over the neck and dark lines of network on the sides of the head. The scaly covering reaches to a point under or a little in front of the anterior end of the dorsal fin, but the belly and the anterior part of the back as well as the fins are naked. The lateral line is medio-lateral. Pyloric appendages 2. Size up to 380 mm.

D. 92—93. A. 75. P. 19—21. Vert. 93 (21—22 + 72—71).

Distribution. West Greenland, ca. 100 fathoms.

Remarks on the Synonymy.

Of the 10 specimens referred by Lütken (l. c.) to *L. reticulatus* Reinh., I think we must reject the following: Nr. 18 must be brought under *L. seminudus* Reinh.; Nr. 24 and Nr. 25, now prepared skeletons, I am unable to determine with perfect certainty, but in all probability they likewise belong to *L. seminudus* Reinh. Further reasons for this separation will be found under *L. seminudus* (cf. p. 71 and p. 75).

Lastly, it cannot be considered absolutely certain, that Nr. 23, type-specimen to *L. perspicillum* Kroyer, is the young form of the present species; it is better therefore, to discuss it separately with some young specimens of similar appearance which have appeared later (cf. p. 64—66).

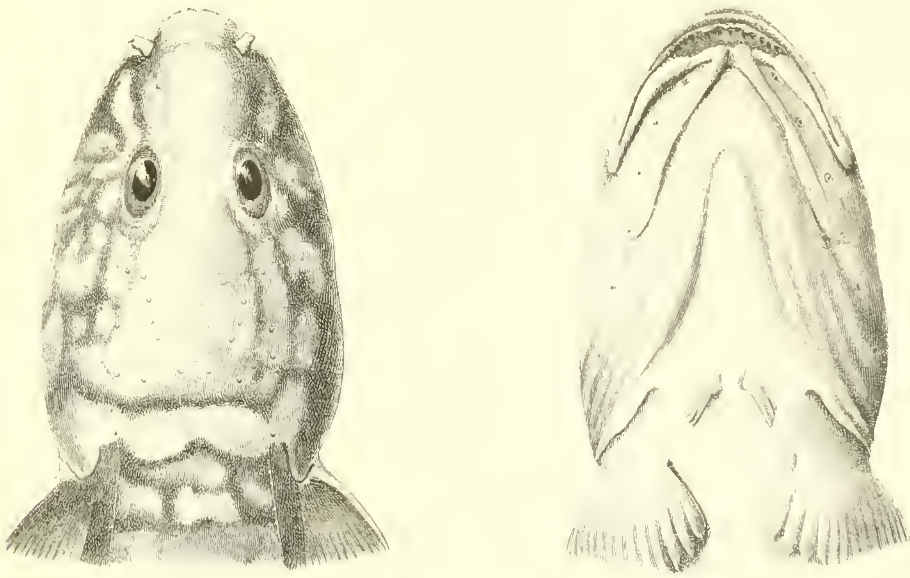
Description.

After separating out the foreign elements as mentioned above, our knowledge of *L. reticulatus* rests upon 6 specimens preserved in the Museum here. Their proportions are given below along with those of a seventh (255 mm. long) which was taken later by Dr. E. Vanhöffen and preserved in the Berlin Museum, from which I have had it for inspection.

		♀	♂	♀	♀	♂	♂	♂
Total length	in mm.	225	255	270	286	345	370	380
Length of the head		55	64	62	64	90	98	97
Distance from snout to anus		106	119	128	132	161	184	184
Height over the anus		25,5	32	37	33	49	47	?

The form is therefore somewhat elongated, the height over the anus going 7—8,8 times in the total length. The greatest breadth lies as usual forward on the cheeks, and is ca. $1^1/_3$ times greater than the height at the same place; the trunk is somewhat compressed, the height half way along being $1^1/_2$ times greater than its thickness, and the tail posteriorly becomes gradually more and more compressed. The tail has a slight advantage in length over the rest of the body, the distance between the snout and anus being in males 46,7—49,7 % of the total length, in females 46,2—47,4 %.

The length of the head amounts in the males to 25,1—26,5 %, in the females to 22,4—24,4 % of the total length. Seen from the side the upper and lower margins each form a slightly bent line, seen from above (fig. 9 in text) the outline approaches an oval form. The head above is somewhat arched, and rounded towards the sides, which again are convex; the under surface is also slightly arched. The eyes are rather small and as usual relatively the smallest in full-grown specimens, so that their longitudinal diameter is 6—10 times in the length of the head or 4—2,7 % of the total length; the distance between the two eyes is almost equal to the longitudinal diameter of the eye. The length of the snout to the eye is 7,8—9 % of the total length. The upper jaw reaches to the perpendicular line through the centre or the posterior third of the eye, and extends anteriorly a little in front of the lower jaw. The lips are particularly fleshy; the underlip has an overhanging fold on each side, and the fold of skin along the underjaw's lower margin droops like a flap on the chin (see fig. 10 in text). The teeth are curved, conical or almost cylindrical; on the intermaxillary in front there is a double row, and on the underjaw 3 rows in front, but otherwise they are in a single



9 10

Fig. 9—10. Head of *Lycodes reticulatus*, seen from above and below. × 1.
From a 255 mm. long specimen (♂) from the innermost parts of Umanak Fjord (West Greenland), 190 m. Drygalski Expedition (Dr. E. Vanhöffen), 27. 3. 1893.

row; I have counted 9—14 teeth in a row on the intermaxillary, on the palatines 9—13, on the vomer 2—5 and on the underjaw 8—15 in a row.

The dorsal fin begins at a distance from the snout which is equal to 30—31,8 % of the total length; it contains 92—93 rays, the anal fin 75 rays. The ventral fins are small, almost of the same length as the diameter of the pupil. The length of the pectorals amounts to 13—14,2 % of the total length; they contain (19) 20 (21) rays.

The scales in all the present specimens (225—380 mm. long) reach to a point which lies under or a little in front of the anterior end of the dorsal fin, yet a part under the dorsal fin anteriorly and the belly to the anus (likewise a little behind this) are naked. In the smallest specimen the scaly covering ceases at some distance (23 mm.) from the end of the tail, but in the others it extends very close or even to the root of the tail. The fins are free of scales.

The lateral line begins on the back of the head over the gill-cover, curves down with a slight arch towards the median line, along which it then continues to the point of the tail. A few pores are to be seen forward on the trunk above this mediolateral lateral line.

The colouration is somewhat speckled (Tab. II, fig. 2 and fig. 9 in text). I cannot give a better notion of it than by citing Lütken's description, which says concerning the males: The colour-markings are as a rule in the form of a network on the trunk and tail, i. e. composed of an irregular network of brown bands and lines of various breadth, which separate spots more or less large of a lighter ground-colour; but it is clear as a rule — and noticeable in all cases, if one seeks for it, in younger specimens — that the foundation for this network lies or has been in a system of 7—9 dark and especially dark-margined cross-bands, which extend from the trunk and tail out on to the dorsal fin where they are usually very distinct; between these bands, which extend down almost to the median line, are light parts or spots (often with a darker spot again in the light). Especially constant is such a dark margined light spot or cross-band across over the neck from the one gill-opening to the other, and also some light dark-bordered spots or sinuous markings posterior to and over the eyes, as well as on the sides of the head under the eyes as far the nostrils». And of the females it is said at the same place: «The two larger specimens have plainly the reticulate markings characteristic of the species in general; these extend out on to the dorsal fin and the posterior part of the anal fin as more or less distinct bands, and on the head like the markings already described above for the males; the smallest has also these on the whole, specific and very characteristic markings on the head, but on the trunk and tail on the other hand there are only 8 dark-margined cross-bands on the back and dorsal fin».

Distribution.

L. reticulatus is distributed along the southern parts of West Greenland. During the last century 7 specimens are known to have been taken there, at Julianehaab, Fiskenæs, Godthaab and Umanak. Only of one of these specimens is there the further information (by Dr. Vanhöffen) that it was taken in the innermost parts of Umanak Fjord (Karajak Fjord) in a trap at 190 metres depth.

According to Goode & Bean[1]) the species has been taken at several places on the east coast of the United States at 17—140 fathoms depth, but one cannot tell with certainty if these authors have had the true *L. reticulatus* before them; their figures (Pl. 78, fig. 273 and Pl. 81, fig. 281 a—b) indicate so however.

Relation to allied forms.

L. reticulatus stands very close to the form from East Greenland I have called *L. reticulatus* var. *macrocephalus*; on p. 70 I give the reasons for holding them partly separate for the time.

Concerning the relation of this species to *L. seminudus* see p. 78 and to *L. rossi* p. 59.

Young forms of *L. reticulatus* (*L. perspicillum* Krøyer, Tab. II, fig. 3).

The specimens certainly *L. reticulatus* sent here from Greenland are medium-sized to large (225—380 mm.). Concerning the appearance of the young we have only conjectures, Prof. Collett in 1878 expressing the supposition that the small Lycodes described long ago by Krøyer under the name *L. perspicillum* was the young of *L. reticulatus*[2]). With this view Lütken agreed. In my preliminary report on the European-Greenland Lycodes I differed from this opinion and made *L. perspicillum* a distinct species without giving particular reasons for this step however; certain know-

[1]) Goode & Bean: Oceanic Ichthyology, p. 305; Mem. of the Museum af Comp. Zoology at Harvard College, vol. XXII, 1896.
[2]) Vidensk. Selsk. Forh. Chria. 1878, No. 14, p. 61.

ledge gained in the interval has brought me however to the position that Collett was probably right, and in that case the synonymy-list for *L. reticulatus* must be augmented by the following names:

1844. *Lycodes perspicillum* Krøyer, Overs. Kgl. D. Vidensk. Selsk. Forh. p. 140.

(1845). *L. perspicillum* Krøyer, in Gaimard: Voyages en Scandinavie, en Laponie etc., Zoologie. Poissons, Pl. 7.

1862. *L. perspicillum* Krøyer, Naturhist. Tidsskr. 3. R., 1. B., p. 289.

1880. *L. perspicillum* Lütken, Vidensk. Medd. Naturh. Foren. Kbhvn. p. 321.

1898. *L. perspicillum* Lütken, The Danish Ingolf Expedition, II, 1, p. 22, Tab. IV, Fig. 5.

1899. *L. Lütkenii* Holmquist (nec Collett), Ann. Mag. Nat. History (7), vol. 3, p. 221 (partim).

1901. *L. reticulatus* forma *frigida* Smitt, Bih. K. Sv. Vet.-Akad. Handl. Bd. 27, Afd. IV, No. 4, p. 29 (partim), No. 1.

1901. *L. perspicillum* Jensen, Vidensk. Medd. Naturh. Foren. Kbhvn., p. 213.

This form is known by 3 specimens from West Greenland. One of these is the 65 mm. long specimen[1]) described in detail by Krøyer and figured in Gaimard's Voyages (Pl. 7, fig. A[2]). A second specimen, 43 mm. long, was taken by the Ingolf Expedition of 1895 off Sukkertoppen (63° 24' N.L.) at 68 fathoms depth; the figure cited, painted from the living fish, gives an idea of its appearance. Lastly, Dr. A. Ohlin who was with the Peary Auxiliary Expedition as Zoologist, also obtained a 43 mm. long specimen in Murchison Sound (between 77—78° N.L.) at 45 fathoms depth; it is the one of the two specimens which Holmquist (l. c.) has determined as *L. lütkenii* Coll.; F. A. Smitt has later referred it to *L. reticulatus* forma *frigida*; of the incorrectness of both determinations I have been able to convince myself by an examination of the specimen itself, which is preserved in the Riks-Museum at Stockholm.

The most important proportions of these 3 specimens[3]) are as follows:

Total length	in mm.	43	43	65
Length of the head		10	10	15
Distance from snout to anus		18,75	18,75	28
Height over the anus		4,25	4,5	6,5

The length of the head is therefore 23,1—23,3 %, the distance between the snout and the anus 43—43,6 %, the height over the anus 10—10,5 % of the total length. It is clear therefore, that these young forms are relatively long-tailed in comparison with the adult *L. reticulatus*, but this is no absolute objection to their being referred to the named species, because in other Lycodes I have observed an approximately similar disagreement between the young and adult individuals (cf. e. g. *L. rossi*, p. 57).

1) Krøyer mentions and figures (Pl. 7, fig. B) still another specimen, ca. 40 mm. long, but that has been disposed of long since.

2) The figure is not entirely successful, showing amongst other things not the slightest trace of scales.

3) Lütken mentions and figures still a fourth *L. perspicillum?*, 69 mm. long, in Dijmphna-Togtets zoologisk-botaniske Udbytte, 1886, p. 137—138, Tab. 17, fig. 6. This specimen was from Greenland (Disko Bay); it must have been lost as I cannot find it in our collection. Concerning the other *L. perspicillum?* from Kara Sea mentioned at the same place, see *L. rossi* Malmgr. (p. 56).

The colouration (cf. Tab. II, fig. 3, representing Kroyer's type-specimen) consists of 9—11 dark saddle-shaped cross-bands on the trunk and tail, the most posterior on the outermost point of the tail; each of these bands is bordered by a very dark, sharply outlined margin; the most anterior band is separated from the dark upper surface of the head by a light cross-stripe (neck-band); the head is encircled by a dark-brown O-shaped stripe, extending from the snout to the front margin of the eye, from the posterior margin of the eye to the gill-cover's edge and from there on to the neck in front of the light neck-band; further an oval spot, light-coloured but surrounded by a brown ring is observed behind the eye towards the upper edge of the head. — This regular banded marking seemed to me previously to tell against these individuals being considered the young of the network-marked *L. reticulatus*; but after I had seen in a series of specimens of the nearly allied *L. reticulatus* var. *macrocephalus*, just such a similar change in colouration, occuring with age (cf. p. 68—69 and Tab. VIII), I think it very probable that *L. perspicillum* can change in a similar manner to *L. reticulatus*.

The scales in the largest specimen show on the middle third of the body, namely on the portion from a point under the anterior end of the dorsal fin, to the middle of the tail; in the smallest specimen of *L. reticulatus* the scales also cease at some distance from the end of the tail.

Taking all in all, it seems to me extremely probable, that *L. perspicillum* Kroyer is the young stage of *L. reticulatus* Reinhardt, as Collett was the first to remark. Complete certainty, of course, will not be arrived at until the transition stages are found.

I may just add, that according to Goode & Bean (Oceanic Ichthyology, 1895, p. 307), the Albatross has taken specimens of *L. perspicillum* Kr. off the east coast of North America (45° 24½' —47° 29' N.L.), at 59—86 fathoms depth; the figures given (Pl. 80, fig. 278 & 278 a) suggest that these author's *L. perspicillum*, which they consider a separate species, is identical with Kroyer's; it agrees well therefore, that there should be a form on the east coast of North America which is probably the same as *L. reticulatus* Reinhardt (cf. p. 64).

var. **macrocephalus** m.

Tab. VIII, Fig. 1 a, b, c, d, e, f.

1886. *Lycodes reticulatus* Steindachner, Die Österr. Polarst. Jan Mayen (Internat. Polarforsch. 1882—83), 3. Bd., p. 107.

1901. *L. reticulatus* forma *reticulata* Smitt, Bih. K. Sv. Vet.-Akad. Handl. Bd. 27, Afd. IV, No. 4, p. 33 (partim), No. 26 & 28—36, Fig. 4—5.

1901. *L. reticulatus* forma *seminuda* Smitt, ibid. p. 31 (partim), No. 13.

In proportions of the total length, the height over the anus is 10—12,2 %, the length of the head in males 26,2—28,6 %, in females and young 25—26,6 %, the longitudinal diameter of the eye 4,3—4,8 %, the distance between the snout and the anus 46,2—50,6 %, the length of the pectorals 13—14,4 %. The young have 7—9 dark and dark-bordered cross-bands on a light ground, and in addition a dark spot on the end of the caudal fin; a light band across over the neck, and often a dark longitudinal streak on the sides of the head. In older specimens a more or less distinct network-marking is developed from the dark borders of the bands, especially on the front portion of the body. The scaly covering in older individuals extends from a little behind the root of the pectorals to the end of the tail or ceases somewhat in front of this, but the belly and the anterior part of the back are naked; there are no scales on the fins. The lateral line is mediolateral. Pyloric appendages 2. Size 245 mm.

D. 91—96. A. 72—78. P. (19) 20—21.

Distribution. Northern East Greenland, ca. 50—150 fathoms; Jan Mayen, ca. 40—100 fathoms.

Of this form, which I have thought it best to consider as a variety of the foregoing species, there is a number (14) of specimens, presenting a special interest as they show transition stages in markings from the young with sharply marked black cross-bands to a network formation in the adults (cf. Tab. VIII), reminding one quite of that in *L. reticulatus*. For this reason Prof. Smitt (l. c.) has referred (the most of) these specimens to the West-Greenland species; I cannot but think however that the differences are important, and I must for the time being hold them in part distinct. Eleven specimens were taken at northern East Greenland by Swedish expeditions; two were taken at Jan Mayen in 1900 by the steamer Michael Sars and kindly handed over to me for examination by Prof. Collett; one was likewise taken at Jan Mayen by Dr. Fischer and has been placed at my disposal by Prof. F. Steindachner.

Description.

The most important proportions of all 14 specimens are as follows:

		East-Greenland 1900	Jan Mayen 1900	East-Greenland 1900	Jan Mayen 1883	East-Greenland 1900	East-Greenland 1899	East-Greenland 1900		Jan Mayen 1900	East-Greenland 1900				
							♀	♂	♂		♀		♂	♂	♂
Total length	in mm.	61	83	86	87	88	113	115	116	119	120	133	156	195	245
Length of the head	—	16	20,75	22,2	22,75	22,5	28,2	29,2	30,5	30	30,5	34	42	53	70
Distance from snout to anus	—	29	39,5	41,5	41,25	42	53	52,5	54,5	58	56,5	61,5	76	94	124
Height over the anus	—	6	9	9	9,5	8,8	11,5	12	12,5	14	13	14	16	20	30

The form is moderately elongated, the height over the anus going 8—10 times in the total length. The greatest thickness lies forward on the cheeks and is ca. $1\frac{1}{3}$ times greater than the height at the same place; the trunk is already somewhat compressed, as its thickness a little in front of the end of the pectoral goes about 1,4 times in the height, and the tail becomes gradually more and more compressed. The anus lies almost at the middle of the body, its distance from the snout being 46,2—50,6 % of the total length.

The length of the head is 26,2—28,6 % of the total length in males, 25—26,2 % in young females and small specimens. Seen from the side, its upper and lower margins each form a slightly curved line, seen from above the outline is somewhat oval. The top of the head is slightly arched. The eyes are placed high up, so that their upper margins project forward over the forehead; their longitudinal diameter is contained 5,4—6,7 times in the length of the head, or is 4,3—4,8% of the total length; the distance between the two eyes is a little smaller than the longitudinal diameter of the eye. The length of the snout, measured to the eye, is contained 2,7—3,3 times in the length of the head or is 8—9,8% of the total length. The upper jaw reaches to the vertical line through the middle or anterior third of the eye, and anteriorly extends a little way in front of the under jaw. The lips are thick; the underlip has a dependant fold on each side, and the fold of skin along the lower margin of the lower jaw is spread out like a flap on the chin. The nasal tubes are well-developed. Along the upper and lower jaws there are shallow pits for the lateral line. The teeth are short but strong; I have counted 8—11 teeth in a row on the intermaxillary, 8—10 on the palatine, 1—5 on the vomer, 9—14 in a row on the mandible; forward on the intermaxillary and mandible there is further a posterior row of teeth.

The dorsal fin begins at a distance from the snout which is equal to 29,2—32,3% of the total length; it contains 91—96 rays, the anal fin 72—78 rays. The ventral fins are short (almost of the same length as the longitudinal diameter of the eye). The length of the pectoral is almost equal to the distance from the snout to the posterior margin of the eye and amounts to 13—14,4% of the total length; they contain 20—21 rays (only in one specimen — that of 113 mm. — have I found 19 rays).

Scales. The smallest of the present specimens, which is 61 mm. long, lacks any trace of scales. In the 83 mm. specimen (Tab. VIII, fig. 1 c) scales have begun to appear as a small strip round the lateral line, forward to the middle of the posteriorly extended pectoral and posteriorly almost the same distance behind the anus. The further development of the scaly covering consists essentially in the appearance of scales on the posterior part of the tail also, and at the same time the rows are increased in a vertical direction. Some variation exists however. Thus, the scaly covering in a 133 mm. long specimen (Tab. VIII, fig. 1 d) does not have any greater extension relatively than in that of 83 mm., whilst in another only 116 mm. long, it approaches distinctly nearer to the root of the tail. In some of the largest specimens the scales extend from a little behind the base of the pectoral to, or nearly to, the beginning of the caudal fin, but they are less close together at the root of the tail fin, and the belly as also a stretch on the back anteriorly are naked; in other specimens just as large the end of the tail is however still naked, and that holds also for a narrow stretch along the base of the dorsal and anal fins (Tab. VIII, fig. 1 e & f). No scales are to be seen on the unpaired fins.

The lateral line begins over the operculum, forms a slight arch on the shoulder and from there courses along the median line of the body. A shorter or longer series of pores, with wide interspaces and without the character of a true lateral line, is often to be seen on the anterior portion of the back above this mediolateral lateral line.

Colour. The young have 7—9 dark cross-bands on a light ground, and in addition a dark spot on the end of the tail; the bands again are bordered by a more or less marked edge of darker, almost blackish colour; the hindmost 2—5 bands extend out on to the anal fin as darkish streaks in line with those on the dorsal fin where the bands end; further forward the bands extend more or less down below the median line of the side. Across over the neck and on to the operculum extends a light band which is most frequently divided in part or entirely into three light spots by a dark streak on each side, which crosses from the dark edge bordering the neck-band in front and behind.

On the side of the head, from the snout to under the eye and out on to the gill-cover, a dark streak often runs. The central part of the cross-bands becomes lighter and lighter with age, or several light spots appear in each band, retaining the dark border, so that a reticulate marking is formed, as is seen in fig. 1 e, Tab. VIII. The distinct network-marking does not occur equally early or strong in all specimens. The largest of those present (245 mm. long) is essentially at the same stage as that of 195 mm. represented in fig. 1 f, whereas the specimen only 156 mm. long represented in fig. 1 e, Tab. VIII, presents a very distinct reticulate marking. Of the specimens from Jan Mayen a somewhat distinct reticulate marking is already seen in that of 119 mm. (Tab. VIII, fig. 1 b), and even in the specimen 87 mm. long such a marking has already begun to form in the foremost band; in the specimen 83 mm. long (Tab. VIII, fig. 1 c) an oval spot, light and surrounded by a dark ring, is present behind the eye towards the upper side.

Concerning the reproduction, but little can be elucidated, as none of the females are more than 120 mm. long. In a female of this size, taken on the 7th of July 1900 at East Greenland (72° 25' N.L.), the eggs measure scarcely 0,5 mm. in diameter. In the largest of the males (245 mm. long) the testes are well-developed, 16,5 mm. long.

Distribution. *L. reticulatus* var. *macrocephalus* is a high-arctic fish, only known from northern East Greenland and Jan Mayen.

At East Greenland 11 specimens, whose size lay between 61 and 245 mm., were taken between 72° 25' and 74° 35' N.L. The several localities are distributed as follows:

72° 25' N.B.	17° 56' W.L.	300 metres	6 specimens	Kolthoff Expedition	1900.
73° 32' —	24° 38' —	100—110 -	1 —	Nathorst —	1899.
73° 55' —	19° 20' —	150 -	3 —	Kolthoff —	1900.
74° 35' —	18° 15' —	150 -	1 —	— —	—

At Jan Mayen the Austrian Polar station in 1882—83 took a small specimen (87 mm.) at a depth of 100 fathoms, and the "Michael Sars" 2 specimens (83—119 mm.) at a depth of 60—75 m. on the 8th of August 1900.

Appendix.

Two small Lycodes, taken during the cruise of the "Fylla" in 1886 by the botanist Th. Holm at northern West Greenland, namely in Baffins Bay, at 92 fathoms, may perhaps be referred to *L. reticulatus* Reinh. var. *macrocephalus*. These specimens measure:

Total length	in mm.	45,5	47,5
Length of the head		11,5	12
Distance from snout to anus		21	22
Height over the anus		5,25	5,5

The height over the anus is therefore 11,3—11,6 %, the length of the head 25,3 %, the distance between the snout and the anus 46,2—46,3 % of the total length. In respect to the most important proportions they thus stand very close to the above-described young *L. reticulatus* var. *macrocephalus*, but the tail is relatively a little longer and the height over the anus a little greater. The coloration is also very similar: 7 saddle-shaped bands, bordered by a dark margin, break the light ground-colour; between the foremost band and the dark-coloured neck there is a light cross-stripe. In addition, a brown stripe is present on the head, extending from the snout under the eye on to the gill-covers; further, there is a light oval spot but surrounded by a dark margin, behind the eye towards the upper side. The pectorals count 20—21 rays; in one specimen there are 92 rays in the dorsal fin, 73 rays in the anal.

One of these specimens is represented in fig. 1 a on Tab. VIII.

Comparison with *Lycodes reticulatus.*

The present form displays no slight resemblance to *L. reticulatus* Reinh. from West Greenland, mainly in respect to colouration, as both in the older stages have the dark cross-bands transformed to a more or less distinct network-formation; further, they have a mediolateral lateral line; nor do the numbers of rays in the fins present any differentiating character. On the other hand, it seems as if the variety *macrocephalus* was a form with relatively large head and large eye, which will appear from the following comparison between two male specimens of almost equal size:

		L. reticulatus forma *typica* ♂	*L. reticulatus* var. *macrocephalus* ♂
Total length	in mm.	255	245
Length of the head	in % of total length	25,1	28,6
Longitudinal diameter of the eye	—	3,5	4,3

Further comparison between almost equally large adult specimens is unfortunately not possible for the time being, as *L. reticulatus* is not present in smaller nor var. *macrocephalus* in larger male specimens than those given, and there is also a great gap in size between the females at hand. I must provisionally suggest that the differences noted cannot be overlooked without further investigation and that two varieties are to be reckoned with.

If we bring *L. perspicillum* Kr., the supposed young of *L. reticulatus*, into the comparison, we see that the young of the latter have likewise a smaller head as well as a relatively longer tail:

		L. reticulatus juv.? (*L. perspicillum* Kr.)			*L. reticulatus* var. *macrocephalus*				
Total length	in mm.	43	43	65	61	83	86	87	88
Length of the head	in % of total length	23,3	23,3	23,1	26,2	25	25,8	26,1	25,6
Distance from snout to anus	— —	43,6	43	43,1	47,5	47,6	48,3	47,4	47,7

L. rossi Malmgr. (from Spitzbergen and the Kara Sea) is also near to the present form, but it has a smaller head (length, 22,4—25,3 % of the total length) and relatively small eyes (longitudinal diameter, 3,6—4 % of the total length). In addition, *L. rossi* has on the average fewer rays in the pectorals, namely (17) 18—19 (20), and the marking does not change over into the reticulate.

Lycodes seminudus Reinhardt.

Tab. IX, Fig. 1 a, b, c, d, e & Tab. X, Fig. 1 a, b. Fig. 11—14 in text.

1838. *Lycodes seminudus* Reinhardt, Kgl. D. Vidensk. Selsk. Skr. VII, p. 223.

1878. *L. seminudus* Collett, Fiske fra Nordhavs-Expeditionens sidste Togt, Sommeren 1878; Forh. Vidensk. Selsk. Chria. 1878, No. 14, p. 67.

1880. *L. seminudus* Lütken, Vidensk. Medd. Naturh. Foren. Kbhvn., p. 325.

1880. *L. reticulatus* Lütken, ibid. p. 318 (partim).

1880. *L. seminudus* Collett, The Norwegian North-Atlantic Expedition, Fishes, p. 113, Pl. IV, Fig. 28.

1895. *L. reticulatus* Smitt, Skandinaviens Fiskar, II, p. 611 (partim).

1897. *L. seminudus* Vanhöffen, Grönland-Expedition der Gesellschaft für Erdkunde zu Berlin, II, 1, p. 100.

1898. *L. Lütkenii* Lütken, The Danish Ingolf-Expedition, II, 1, p. 22 (partim).

1901. *L. reticulatus* forma *seminuda* Smitt, Bih. K. Sv. Vet.-Akad. Handl. Bd. 27, Afd. IV, No. 4, p. 31 (partim), No. 14—15, 17—18 & 20—22.

The height over the anus is 9—10,6 % of the total length. The length of the head in males is 27—30 %, in females 25—28 % of the total length. The longitudinal diameter of the eye is 5,3—3 % of the total length. The distance between the snout and the anus is 44,6—50,6 % of the total length. The length of the pectoral is 9,6—11,8 % of the total length. The colour is a uniform gray-brown, or there are indistinct dark cross-bands on the trunk and tail, or distinct dark cross-bands (7—9) and as a rule a light neck-band. The scales as a rule reach forward only to a point a little behind, over or a little in front of the anus (seldom to the tip of the flattened-out pectoral). Lateral line mediolateral. Pyloric appendages 2. The size ca. 500 mm.

D. 91—97. A. 73—78. P. (19) 20—22.

Distribution. West Greenland, ca. 100 fathoms; East-Greenland, ca. 100—400 fathoms; Jan Mayen, 370 fathoms; off the Norway-Shetland Slope, 600 fathoms; Spitzbergen, 260 fathoms; Kara Sea, 92 fathoms.

Remarks on the Synonymy.

The species *L. seminudus* was formed in 1838 by Prof. Reinhardt sen. for a Lycodes almost 1½ feet long, taken at Umanak in West Greenland. From *L. reticulatus* Reinh. to which it stood near in several ways, it was distinguished at the first glance in that the body was uniformly coloured and naked from the snout to the vertical line through the anterior end of the anal fin; in his detailed description however, R. laid less weight on these characters, rightly paying attention especially to other more important structural features (number of the teeth, shortness of the pectorals etc.).

The same specimen was dealt with by Lütken in his treatise of 1880. L. came to the conclusion, after some acquaintance with larger males of *L. reticulatus* had been gained in the interval, that there was nothing else on which a specific difference between *L. reticulatus* and *L. seminudus* could be based, than the distinctly less extension of the scaly covering in the latter. This impression in my opinion was due to an erroneous division of the material which Lütken had. So far as I can see, namely, Nr. 18 (l. c. p. 332) of the specimens referred by Lütken to *L. reticulatus* belongs to the present species; this individual, whose length is 365 mm., possesses certainly a weakly banded marking and a somewhat widely distributed scaly covering, but in more important characters it seems to agree with *L. seminudus*. In all probability also, the specimens Nr. 24 and Nr. 25 (l. c. p. 332) referred by Lütken to *L. reticulatus* belong to *L. seminudus*; perfect certainty, however, cannot be attained as they are now unfortunately prepared skeletons[1].

[1]) Lütken says of these specimens, that the colouration was not at all and the scaly covering only partly recognisable. The moderate condition of these individuals has naturally brought it about that a failure in determination could more easily take place.

In later years 2 further specimens of *L. seminudus* have been taken at West Greenland. One of these, a uniformly coloured female of 335 mm., was taken 1893 by Dr. E. Vanhöffen in Umanak Fjord; it was kindly handed over to me for investigation by the Berlin Museum. The other was sent to our Zoological Museum in 1901 by P. Müller of Jakobshavn, governor of the colony; it is only 180 mm. long and of special interest, as in agreement with the above mentioned specimen it shows a not very distinct, yet clearly recognisable, banded marking.

Apart from West Greenland *L. seminudus* was again found at Spitzbergen by the Norwegian North-Atlantic Expedition, as a single, uniformly coloured specimen only 128 mm. long; Prof. Collett has kindly handed it to me for study and I can confirm the correctness of his determination.

In addition to the uniformly coloured or weakly banded form, *L. seminudus* may however also appear with very distinct cross-bands and with a light band across over the neck. In the Riks-Museum of Stockholm I have had the opportunity, through the kindness of Prof. Smitt, to see no less than 7 specimens (129—280 mm. long) from East Greenland (Nathorst and Kolthoff Expeditions of 1899 and 1900) of a form, which only differs from the typical *L. seminudus* by the pronounced, livelier marking. In his treatise of 1901 F. A. Smitt had rightly referred these specimens to Reinhardt's *L. seminudus*, but in this species he sees only a form of *L. reticulatus*, an opinion I cannot agree with.

A similar specimen (180 mm. long) had also been taken by the Ingolf Expedition south from Jan Mayen. In my preliminary notice on the Lycodes of this expedition (l. c. p. 213), I have referred it to *L. lütkenii* Coll., which again I identified with *L. rossi* Malmgr. from Spitzbergen, as a small specimen (67 mm. long) from the Ingolf Expedition seemed to me a transition-form between *L. rossi* and the larger specimen from the same expedition referred to *L. lütkenii*. This position I have meanwhile been obliged to give up. *L. rossi* Malmgr. is without doubt the young stage of *L. celatus* established by myself (cf. further p. 56). And since both the specimen of the Ingolf Expedition (that of 180 mm.) and the above-mentioned 7 specimens of the Nathorst-Kolthoff Expeditions seem constantly to have very short pectorals, whereas *L. lütkenii* Coll. is characterized specially by large pectoral fins, I consider it best to keep the last named separate from *L. seminudus*. And the small specimen referred to (from the Ingolf Expedition), which I had erroneously taken for a connecting-link with *L. rossi*, becomes the young form of *L. seminudus* (cf. further p. 76—77).

Description.

Proportions of the uniformly coloured or indistinctly banded form:

		♀[1]	♀	♀	♂	♂
Total length	in mm.	128	180	335	365	445
Length of the head	—	32	46	84	100	127
Distance from snout to anus	—	57	82,5	157	184	225
Height over the anus	—	12,5	18,75	34	38,5	50

Proportions of the distinctly banded form:

		♂	♂	♀[2]	♂	♀	♀	♂	♂
Total length	in mm.	129	161	180	180	197	218	250	280
Length of the head	—	36	43,5	48,5	49	52,5	61	67,5	77
Distance from snout to anus	—	61,5	77	88	83	94	106	116	130
Height over the anus	—	12	16	19	16	18	22	25,5	28

The form is elongated, the height over the anus going ca. $9\frac{1}{2}$—11 times in the total length. The greatest thickness lies forward on the cheeks and is equal to or somewhat greater than the height at the same place; the trunk is tolerably compressed, its height midway being $1\frac{1}{2}$ greater than the thickness, and the tail becomes more and more slender posteriorly. The anus in the males lies at, or a little in front of, the middle of the body, its distance from the snout being 46,1—50,6 % of the total length; in females its distance from the snout is 44,6—48,3 % of the total length.

[1]) The specimen is from Spitzbergen (North-Atlantic Expedition), the others from West Greenland.

[2]) This specimen is from Jan Mayen (Ingolf Expedition), the others from East Greenland (Nathorst and Kolthoff Expeditions).

The length of the head in males is 27—28,5 %, in females 25—28 % of the total length. Seen from the side, the upper margin is almost horizontal at the neck, and from there slopes gradually, evenly and almost in a straight line down towards the snout, which is low; the under margin rises up slightly only in front; seen from above, the head decreases but little in breadth towards the anterior end of the snout, which is broadly rounded off so that the outline of the head forms an elongated oval. The crown is flat, the cheeks almost perpendicular or only slightly convex; taken with the depressed and broad, somewhat flat snout, this gives the head a characteristic appearance, reminding one somewhat of a pike. The eyes are situated high up, so that their upper border juts forward over the forehead; the size decreases a good deal relatively with age, their longitudinal diameter going 4,8—9,4 times in the length of the head, i. e. 5,3—3 % of the total length; the distance

11

12

Fig. 11—12. The head of *Lycodes seminudus*, seen from above and underneath. × $^3/_4$.
From a 335 mm. long specimen (♀) from the innermost parts of the Umanak Fjord (West Greenland), 200 m. Drygalski Expedition (Dr. E. Vanhöffen), 17.3.1893.

between the two eyes is almost equal to $^2/_3$ rds of the longitudinal diameter of the eye (in old specimens quite equal to this). The length of the snout to the eye, is 3,5—2,9 times in the length of the head or 7,5—10 % of the total length. The upper jaw reaches to a perpendicular line through the centre or anterior third of the eye, and anteriorly it extends a little in front of the lower jaw. The lips are rather fleshy along the upper jaw and on the sides of the lower, but somewhat thin in front on the latter; the fold of skin along the under margin of the latter is relatively little developed the whole way (see fig. 12 in text). The free flap of the gill-cover is relatively long and bent up at the corner. There is a number of shallow grooves for the lateral line along the upper and under jaws. The teeth are truncate and conical or almost cylindrical, in a double row on the intermaxillary anteriorly, in three rows (2 in young specimens) on the mandible anteriorly, but otherwise form a single row; in larger specimens I have counted 17—24 teeth in a row on the intermaxillary, 16—24 on the palatines, 3—6 on the vomer and 17—26 in a row on the mandible.

The dorsal fin begins at a distance from the snout equal to 29,6—33,7 % of the total length; it contains 91—97 rays, the anal fin 73—78 rays. The ventral fins are small (almost of the same length as or even shorter than the longitudinal diameter of the pupil). The pectorals are relatively broad but short, their length being 9,6—11 % of the total length or always less than the distance between the snout and the posterior margin of the eye; they contain (19) 20—22 rays, of which the lower project at their points from the connecting skin.

The scales extend from the end of the tail more or less far forward on the sides of the body; the covering tends to a point in front like a wedge, leaving the side of the back and belly naked for some distance; there are no scales on the fins, or in any case only on the posterior half of the dorsal fin, along the base. In the uniformly coloured or weakly banded form, the scaly covering is subject to great variation in regard to distribution in part independently of the age of the individuals, it seems. In the type-specimen, which is 445 mm. long, the scaly covering extends forward scarcely to a point which lies directly over the origin of the anal fin. In the second largest (365 mm.) on the other hand, the scales reach to a point at the tip of the flattened pectoral and have thus attained the greatest extension known as yet for the species. In the 335 mm. specimen (Tab. X, fig. 1 b) and that of 180 mm. (Tab. X, fig. 1 a) the scaly covering extends forward a little in front of the anus, in Collett's specimen from Spitzbergen (128 mm. long) just a trifle in front of the anus. The specimens present of the distinctly banded variety have a much more regular distribution of the scales (Tab. IX, fig. 1 b, c, d, e). In 3 specimens of 280, 218 and 180 mm. the scaly covering extends forward like a wedge to a point, which lies directly over the anus, whilst in 5 specimens of 250, 197, 180, 161 and 129 mm. it stops at a short distance behind the anus.

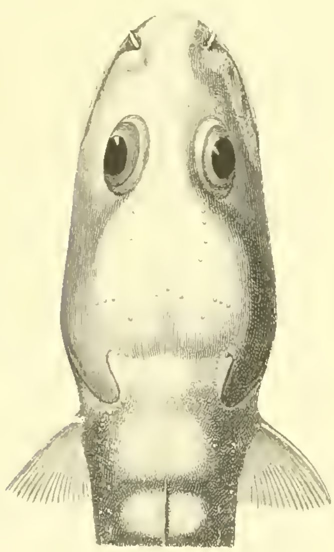


Fig. 13. The head of *Lycodes seminudus*, of the variety with distinct cross-bands. × 3/4. From a 280 mm. long specimen (♂) from northern East Greenland (Franz Joseph's Fjord) 760 m. Nathorst Exped., 14.8.1899.

The lateral line begins over the gill-cover, forms an arch over the shoulder and courses from there along the middle of the body. On the foremost part of the trunk in well-preserved specimens, a shorter or longer series of pores is present above the lateral line, with wide interspaces and without forming any true lateral line.

Colour. The present species occurs in two colour-varieties, it seems, namely, one uniformly coloured or with slightly marked cross-bands, the other with distinct cross-bands. — Those entirely uniform of a gray-brown are: Reinhardt's type-specimen (445 mm. ♂) from Umanak; Vanhöffen's specimen (335 mm. ♀) from Umanak Fjord (Tab. X, fig. 1 b)[1]; Collett's specimen (128 mm. ♀) from Spitzbergen. A weak banded marking is seen in: the specimen (365 mm. ♂) from Godthaab, referred to *L. reticulatus* by Lütken, also the specimen (180 mm. ♀) recently sent from Jakobshavn. In the first of these, there are above the median line 7 dark bands, 2 on the trunk and 5 on the tail, which again are somewhat lighter in the centre; in the small specimen, a similar number of somewhat more apparent bands are seen (Tab. X, fig. 1 a). —

[1]) By very favourable light, exceedingly weak traces of a faded, banded marking may perhaps be detected in this specimen.

The specimens from East Greenland and Jan Mayen all show a livelier colouration, as is seen in Fig. 1 b, c, d, e of Tab. IX and Fig. 13 & 14 in the text. They have distinctly 2 dark bands on the trunk and 5—7 on the tail; in addition, the end of the tail (fin) is dark-coloured; the dark bands are especially distinct on the dorsal fin and the upper part of the body, lower down they may disappear in the general darkish ground-colour, but they are often also, especially on the tail posteriorly, separated by light interspaces right across, the light may even separate the bands forward on the body and constitute an important part of the colouration. The dark bands are light in the centre, often so light that the margins show as a distinct, dark-brown frame, or that an originally single band dissolves into two; sometimes the light in the band is partly limited to a rounded-off spot (see Fig. 1 e of Tab. IX). Right across the neck, from gill-cover to gill-cover stretches a light, dark-bordered stripe, which sometimes however can be limited to a rounded-off light spot on the centre of the neck or very rarely may disappear almost entirely.

As already mentioned, I am much inclined to refer Nr. 24 and Nr. 25 among Lütken's *L. reticulatus* (l. c. p. 332) to *L. seminudus*. Full certainty cannot be attained as the specimens are now skeletons, but the considerable length of the head (28,5—29,5 % of the total length), the rich provision of teeth (on the intermaxillary 17—18 teeth in a row, 5—7 on the vomer and 20 in a row on the mandible), as also the shortness of the pectorals (10 % of the total length) seem to point certainly in this direction. The number of the vertebræ is 95—96 (23—24 + 72).

[Later addition. During my participation in the summer cruise of the "Michael Sars" in 1902, a specimen of *L. seminudus* was taken on the 26th of June at 62° 58' N.L. 1° 56' E.L., and at c. 600 fathoms; the place lies in the "cold area" off western Norway.

It is a ♂ with all the known characters of the species; its most important proportions are as follows:

Total length	268	mm.
Length of the head	73	—
Distance from snout to anus	128	—
Height over the anus	28	—

In proportions of the total length, the length of the head is therefore 27,2 %, the distance between the snout and the anus 47,8 %, the height over the anus 10,4 %; of the same length the distance between the snout and the anterior end of the dorsal fin is 32,1 %, the length of the pectoral 10,6 %; the latter fin contains 21—22 rays.

The scaly covering reaches from the end of the tail forward to a point, which lies an eye's length behind the point of the pectoral, being wedge-shaped in front; the scales extend out on to the basis of the posterior part of the dorsal fin. The body is without markings.

Further, our Museum has recently received through Mr. H. Kraul, director of the Upernivik colony in West Greenland, 4 very large *L. seminudus* (400—497 mm. long), all males, which are remarkable for their relatively large head (its length being 27,6—30 % of the total length). The pectorals, which count (19) 20 rays, amount in length to 11,1—11,8 % of the total length. The scaly wedge in one specimen extends forward slightly in front of the vertical line through the anterior end of the anal fin, in the three others it ceases a little behind this point. The colouration has almost vanished, yet traces of dark cross-bands and light interspaces may be detected, especially on the dorsal fin.]

On an early and a young stage of *Lycodes seminudus*.

Amongst the material brought home by the Ingolf Expedition is a small, 67 mm. long Lycodes which I take to be an early stage of *L. seminudus;* it remained undetermined and is not mentioned in the report on the ichthyological results of the expedition.

This specimen was taken at St. 116 (south from Jan Mayen, 371 fathoms), at the same place therefore, where the 180 mm. long specimen of *L. seminudus*, mentioned previously, was taken — a circumstance that might at once make one think of the possible specific identity of these specimens.

The proportions of this little specimen are as follows:

Total length	67 mm.
Length of the head	18
Distance from snout to anus	31 —
Height over the anus	6 —

Putting these figures into percentage, one finds that the length of the head is 26,9 %, the distance between the snout and the anus 46,3 %, the height over the anus 9 % of the total length.

As is shown in Fig. 1 a of Tab. IX, which represents this young specimen natural size, it has 8 broad, dark bands over the body. The first band extends from the back of the head to the beginning of the dorsal fin, the second lies over the tip of the pectoral, the anterior margin of the third lies over the anus, the eighth (last) band covers the end of the tail. All the bands reach from the outer border of the dorsal fin across the back and traverse the linear depression running along the middle of the body; the fifth reaches to near the anal fin, the sixth to the basis of this fin, the seventh and the eighth extend a little on to it. The ground-colour of the body is yellowish white, except on the belly, which is coloured blue-black on account of the peritoneum shining through; the cross-bands have chestnut-brown borders and a somewhat lighter centre. Lastly, one can discern an indication of a neck-band, namely a light spot in the centre line of the neck, beyond the upper notch of the gill-openings. Scales are wanting and a lateral line is not yet apparent. The dorsal fin contains 95 rays, the anal 77, and the pectoral 22.

If we now compare this young individual with the specimen of *L. seminudus*, 180 mm. long, from the same Ingolf station, we find such a great agreement between them that their specific identity cannot be doubted. Figure 14 below shows this larger specimen, natural size.

The length of the head is 27 %, the distance between the snout and the anus 49 % of the total length (180 mm.). The head has thus relatively the same length as in the younger specimen, whereas the tail has less preponderance in length over the rest of the body. It must be added that it is a female with very small eggs in the ovary.

On the trunk are again the two broad bands, although at the first glance they are not recognised as corresponding to the dark bands of the younger specimen; the central part namely has become very light and takes up also such a large part of the band that only its borders stand out as dark cross-stripes. The tail has only 5 dark bands. None of the bands show, as in the younger stage, any sharp boundaries below, as the ground colour has here become dark, but they stand out clearly against the yellow-white colour of the back and dorsal fin. The neck-band is more strongly developed than in the younger individual and extends from gill-cover to gill-cover as a narrow, light band.

The number of rays in the fins is in tolerably close agreement with that in the younger specimen, namely 94 in the dorsal fin, 75 in the anal and 21 in the pectoral.

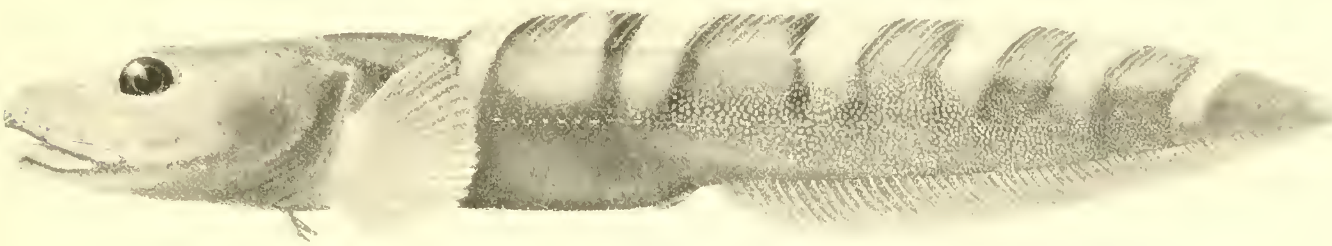


Fig. 14. *Lycodes seminudus* Reinh. (♀). × 1. S. from Jan Mayen, 371 fathoms. Ingolf Expedition 1896.

Lastly, amongst the specimens from the Kara Sea labelled by Lütken *L. pallidus*, I have found a young Lycodes which undoubtedly belongs to the species *L. seminudus*; this specimen is not named with the other *L. pallidus* in Lütken's report on the fishes of the Dijmphna Expedition, so that L. has probably regarded the determination as less certain.

Its proportions are as follows:

Total length	87 mm.
Length of the head	22,5 —
Distance from snout to anus	40 —
Height over the anus	8 —

The length of the head is thus 25,9 %, the distance between the snout and the anus 46 %, the height over the anus 9,2 % of the total length, which numbers fall within those found in *L. seminudus*. Just as certain a mark of recognition lies in the small pectorals whose length is only 10,3 % of the total length; they contain 19 rays.

Although the specimen is somewhat bleached, one can readily see that the colouration in the main has been the same as in the smaller specimen just described, namely 8 broad, dark and dark-bordered cross-bands, 2 on the body and 6 on the tail, in addition a dark spot at the end of the caudal fin; on the neck one can detect signs of a light cross-band. Scales have begun to appear on the tail, at some distance behind the anus.

It was taken by the Dijmphna Expedition in the Kara Sea at 92 fathoms depth.

Distribution.

A specimen was taken at West Greenland at each of the following localities: Godthaab, Jakobshavn, Karajak Fjord (in the innermost part of Umanak Fjord, 200 meters depth) and Umanak, also 4 specimens at Upernivik. At East Greenland the Nathorst Expedition of 1899 took a specimen as far up as 74° 52′ N.L. 17° 16′ W.L. (S. from Shannon Island), 350 meters, and 2 specimens in

Franz Joseph's Fjord, 760 meters, whilst the Kolthoff Expedition of 1900 took 4 specimens at various places in Franz Joseph's Fjord, 200—300 meters. The specimen of the North-Atlantic Expedition was taken on the north coast of Spitzbergen, where the depth was 260 fathoms and bottom-temperature of — 1,1° C. The Dijmphna Expedition took the above-mentioned, but 87 mm. long, specimen in the Kara Sea at 92 fathoms depth. The 2 specimens of the Ingolf Expedition were caught south from Jan Mayen, where the depth was 371 fathoms and the bottom-temperature — 0°,4 C. Lastly, the Michael Sars in 1902 took a specimen in the cold area off the west coast of Norway, at 62° 58′ N.L. 1° 56′ E.L., 600 fathoms.

Comparison between *Lycodes seminudus* and *L. reticulatus.*

As it has often been doubted that these names represent two different species, it may be of use to go over the most important differences between them, so far as they are limited in this treatise.

The form of the body is more slender in *L. seminudus* than in *L. reticulatus*, so that the height over the anus is 9—10,6 % of the total length in the former against 11,3—14,2 % in the latter.

The head is relatively larger in *L. seminudus* than in *L. reticulatus;* in the first-named namely, the length in the males is 27—30 %, in the females 25—28 % of the total length, whereas in the latter the numbers are respectively 25,1—26,5 % and 22,4—24,4 %. The form also is somewhat different: seen from the side, the head in *L. seminudus* is more pointed forward, which arises from the snout being much compressed in this species by comparison with *L. reticulatus;* the flat crown and the almost vertical cheeks in *L. seminudus* are also in contrast to the convex cheeks and the somewhat arched crown of *L. reticulatus.* Next, *L. seminudus* has larger eyes, their longitudinal diameter being 5,3—3 % of the total length, whilst the same proportion sinks with age from 4—2,7 % of the total length in *L. reticulatus.* The lips in *L. seminudus* are less fleshy than in *L. reticulatus*, and the double fold of skin hanging down from the chin in the latter (see fig. 10 in text) is very little developed in *L. seminudus* (see fig. 12 in text). Further, the bones of the mouth in *L. seminudus* have a greater equipment of teeth than those of *L. reticulatus;* thus in *L. reticulatus*, I have counted 9—14 teeth in a row on the intermaxillary, 8—15 in a row on the mandible, 9—13 on the palatine; in *L. seminudus* on the other hand, 17—24 teeth in a row on the intermaxillary, 17—26 on the mandible, 16—24 on the palatine. Lastly may be mentioned, that the free flap of the gill-cover is relatively long in *L. seminudus*, and that in this species the distance between the gill-openings across the belly is much less than in *L. reticulatus* (cf. fig. 12 with fig. 10 in text).

A very evident difference is shown in the size of the pectorals, as their length in *L. reticulatus* is 13—14,2 % of the total length, but only 9,6—11,8 % in *L. seminudus.*

The scaly covering has on the whole a greater extension in *L. reticulatus* than in *L. seminudus*, so far as we yet know. In all the specimens of *L. reticulatus* to hand, whose lengths lie between 225—380 mm., not only the tail, but also most of the trunk is covered with scales, as these reach forward to a point which lies under, or indeed somewhat in front of, the anterior end of the dorsal fin. In a single specimen of *L. seminudus*, that of 365 mm. namely, the scaly covering extends forward to a point at the end of the flattened-out pectoral fin, and in all the remaining (17) specimens whose lengths are from 129—497 mm., it does not once extend so far, but ceases a little in front of the anus, over the anus or a little behind this.

Lastly, as regards colouration, none of the present specimens of *L. seminudus*, not even the distinctly banded, show signs of assuming the network markings so characteristic of *L. reticulatus*.

Taking all together, the differentiating characters seem to me so important, that the reference of these two forms to one species would be quite unnatural.

If we take *L. reticulatus* var. *macrocephalus* into the comparison, the boundaries between the two species are certainly reduced, so far as the relative sizes of the head and eyes are concerned, but the other distinguishing characters (length of the pectorals, distribution of the scales etc.) still hold good.

Lycodes agnostus Jensen.

Tab. VI, Fig. 1 a, b.

1886. *Lycodes Lütkenii* Lütken, Kara-Havets Fiske; Dijmphna-Togtets zoologisk-botaniske Udbytte, p. 128 (partim), Tab. XVI, Fig. 2—6.

1895. *L. reticulatus* Smitt, Skandinaviens Fiskar, II, p. 611 (partim), Fig. 147.

1901. *L. reticulatus* forma *seminuda* Smitt, Bih. K. Sv. Vet.-Akad. Handl. Bd. 27, Afd. IV, No. 4, p. 32 (partim), No. 19.

1901. *L. agnostus* Jensen, Vidensk. Medd. Naturh. Foren. Kbhvn., p. 209.

In proportions of the total length, the height over the anus is 9,3—12 %, the length of the head 22—24,8 %, the distance from the snout to the anus 46—52 %, the longitudinal diameter of the eye in larger individuals 3,4—2,7 %, the length of the pectorals 10—12,5 %. 9—12 cross-bands, dark with lighter central part; a light stripe across the neck above. Scales wanting. Lateral line mediolateral[1]). Pyloric appendages 2. Size 233 mm.

D. 90—93. A. 70—75. P. 16—17.

Distribution. Kara Sea, 46—100 fathoms; Arctic Sea of Siberia (Chatanga Bay), 15 fathoms.

In the report on the fishes of the Kara Sea, Lütken referred 28 specimens of a Lycodes to the *L. lütkenii* described by Collett from the deep water at Spitzbergen. From an examination of these specimens however, I discovered that Lütken had mixed two species together under his "*L. lütkenii*", as I shall now explain.

The largest specimen, which is 223 mm. long[2]), has scales on the tail and a great part of the trunk, whereas the remaining 27 specimens are completely wanting in scales, although amongst them there are specimens up to 186 mm. in length. This alone at the beginning would counsel great caution in bringing these individuals together under one species; certainly one may find in the present treatise many examples to show that variation may occur within one and the same species of the genus

[1]) In well-preserved specimens further, a whole series of dorsal pores can be seen.

[2]) Lütken gives the length to 225 mm.

Lycodes with respect to the development of the scaly covering, but such a sudden jump as Lütken here makes possible, would be quite singular.

Again, the 27 specimens in comparison with the 28th belong to a relatively small-eyed form, the longitudinal diameter of the eye (in specimens of over 100 mm.'s length) amounting to only 3,4—2,7 % of the total length; in the two largest specimens (185—186 mm.) the horizontal diameter of the eye is thus 3—2,7 % of the total length, but in the 223 mm. long specimen 3,6 % of the total length, although in consequence of its greater size it should have had relatively still smaller eyes than the two named, if we had to do with the same species.

Further, the number of rays in the pectorals shows a very considerable difference: the 27 specimens have only 16—17 rays, whereas the 28th has 19. Lütken indeed, has remarked this difference, but he endeavoured to explain it away by supposing that the number undergoes some increase with age.

Although the colouration may seem quite similar on a cursory view, when rightly seen there is the difference that the 27 specimens have more numerous dark cross-bands, namely 9—12 (cf. Lütken l. c. Tab. XVI, fig. 2—6), whilst the 28th has only 8 (ibid. fig. 1).

From all these important differences I drew the conclusion that the 223 mm. long specimen must be specifically distinct from the others, and I was successful later in identifying it with *L. rossi* Malmgr. (cf. p. 56).

The remaining 27 specimens seemed to me to belong to a form which retained its naked condition throughout its whole life; in my preliminary report (l. c.) I gave it the name *Lycodes agnostus*.

Later I gained a welcome confirmation that I had judged rightly, as I found a specimen in the Stockholm Riks-Museum, which in all respects agreed with the form from the Kara Sea, also in that it was perfectly naked even though its total length was still greater than that of the specimens in my hands. F. A. Smitt in his great work on the Scandinavian Fishes gives a figure of it (fig. 147) under the name *L. reticulatus*, *Turnerii*, and in his later treatise On the genus *Lycodes* (l. c. 1901) he has mentioned it under the name *L. reticulatus* forma *seminuda*. Its most important proportions are as follows:

Total length	233 mm.
Length of the head	56,5
Distance from snout to anus	117 —
Height over the anus	22,5 —

In proportions of the total length, the length of the head is thus 24,3 %, the distance between the snout and the anus 50,2 %, and the height over the anus 9,7 %. The eyes are small, their longitudinal diameter being only 2,7 % of the total length. The body, as already mentioned, is quite free of scales. The lateral line is mediolateral. The colouration has now disappeared so that I cannot decide if the figure in Smitt has struck the right proportion between the light and dark bands. The pectorals contain 16 rays, the dorsal fin ca. 90 and the anal ca. 70 rays.

The specimen, which is a male with well-developed testes (33 mm. long), was taken on the 24th of August 1878 by the Vega Expedition on the east side of the Taimur peninsula, namely in the mouth of Chatanga Bay (75° N.L. 113° 30' E.L.), where the depth was 15 fathoms and the bottom-temperature 0,8° C.

The specimens of the Dijmphna Expedition were taken in the Kara Sea at a depth of 46—100 fathoms. I give below the proportions of 11 specimens chosen according to size:

								♀		♂	♀	♀
Total length	in mm.	66	70	94	105	116	135	138	147	155	185	186
Length of the head	—	16	16,5	23	26	28	33	34	35	37	45	41
Distance from snout to anus		31	32	44	52	58	68	67	70	77	97	90
Height over the anus	—	6,5	6,5	9	10	11	13,5	14	15	15	22	16

In the 185 mm. long female the eggs are of a considerable size, namely 4,5 mm. in diameter; the date of the catch is not forthcoming.

Comparison with allied forms.

A scaleless Lycodes has not been known hitherto from the European-Greenland coasts. From Arctic North America however, 2 species were known, which are described as perfectly naked, and set up by Bleeker therefore as a separate genus: *Lycodalepis*, namely *L. turnerii* Bean (Alaska, Bering Straits) and *L. mucosus* Richardson (Northumberland Sound, Cumberland Gulf). The scaleless Lycodes from the Kara Sea presents great similarity to *L. turnerii* amongst these, the latter's proportions according to Bean[1] being as follows:

Total length			330 mm.
Length of the head	in % of the total length		23
Longitudinal diameter of the eye	—	—	2,5
Distance of the anal fin from the snout	—	—	51

But *L. turnerii* has 18 rays in the pectorals, 85 in the dorsal fin, and 67 in the anal; and these data can scarcely be regarded as resting on wrong counting, since Scofield[2] in a second specimen has found: P. 18, D. 86, A. 67. Nor does the colouration agree, so far as I can discern from the figure which Jordan & Evermann[3] have given of Bean's type-specimen.

Until further information is forthcoming, I must therefore consider the scaleless Lycodes from the Kara Sea and Chatanga Bay a separate species. The European Lycodes-fauna is thus enriched by an interesting form which has hitherto been misunderstood. I cannot find however, any sufficient ground for adopting the genus-name *Lycodalepis* proposed by Bleeker, since we know forms which, in their weak development of the scaly covering (e. g. *L. seminudus*), present transitions between entirely naked and perfectly scaled species; and other characters do not exist which might be the basis for a generic separation of the naked species, so far as I can see (cf. for the rest p. 5, with remarks on the likewise scaleless *L. platyrhinus* mihi).

[1] Proc. U. S. Nat. Mus. 1878, p. 463.

[2] List of fishes obtained in the waters of Arctic Alaska. The Fur Seals and Fur-Seal Islands of the North Pacific Ocean, Part III, 1899, p. 505.

[3] Fishes of North and Middle America, IV, Pl. 350, Fig. 858. Bull. U. S. Nat. Mus. 1900.

Lycenchelys Gill.

Lycenchelys Gill, Proc. Acad. Nat. Sci. Philad., 1884, p. 180 (*muræna*).

The body is very elongated (anguilliform), the height over the anus going ca. 16—24 times in the total length. Teeth on the intermaxillary and mandible, vomer and palatines. Lower jaw without barbules. Scales small. Lateral line ventral or mediolateral, or both ventral and mediolateral. Branchiostegal rays 6.

From the waters of North America 3 species of this genus have been described, namely: *Lycenchelys verrillii* Goode & Bean, off the east coast of the United States (34° 39' 40"—42° 33' N.L. 68° 22'—75° 14' 40" W.L.), 75—603 fathoms; *Lycenchelys paxillus* Goode & Bean, off the east coast of the United States (35° 45' 30"—42° 48' N.L. 63° 07'—74° 48' W.L.), 263—904 fathoms; *Lycenchelys porifer* Gilbert, off Lower California, 857 fathoms[1]).

From the European and Greenland waters are at present known 4 species, distinguished from one another in the following manner:

I. 7 pits for the lateral line along the upper jaw and under the eye.
  A. Distance of the dorsal fin from the snout is less than 20% of the total length.
    a. Length of the head is less than 14% of the total length. Colour uniform. (The cold area off west Norway, east Iceland, and in the Færoe Channel; 340—620 fathoms). *L. muræna* Coll.; p. 82.
    b. Length of the head is more than 14% of the total length. Dark spotted colouration. (Northern East Greenland; ca. 160 fathoms). *L. kolthoffi* Jensen; p. 88.
  B. Distance of the dorsal fin from the snout is 21% or more of the total length. (Skager Rak, south and west Norway; 70—300 fathoms). *L. sarsii* Coll.; p. 86.
II. 8 (larger) pits for the lateral line along the upper jaw and under the eye. (Davis Straits; 393 fathoms). *L. ingolfianus* Jensen; p. 90.

Lycenchelys muræna Collett.

Fig. 15—19 in text.

1878. *Lycodes muræna* Collett, Fiske fra den Norske Nordhavs-Exped. 1876—77; Forh. Vidensk. Selsk. Chria. 1878, No. 4, p. 15.

1878. *L. muræna* Collett, Fiske fra Nordhavs-Expeditionen 1878; Forh. Vidensk. Selsk. Chria. 1878, No. 14, p. 74 (partim).

1880. *L. muræna* Collett, The Norwegian North-Atlantic Expedition, Fishes, p. 116 (partim), Pl. IV, Fig. 30 (nec Fig. 29 & 31).

1891. *L. muræna* Lilljeborg, Sveriges och Norges Fiskar, II, p. 25 (partim).

1895. *L. muræna* Smitt, Skandinaviens Fiskar, II, p. 616 (partim) (non Fig. 152).

1901. *Lycenchelys muræna* Jensen, Vidensk. Medd. Naturh. Foren. Kbhvn., p. 214.

[1]) Concerning these species, see Goode & Bean: Oceanic Ichthyology, 1895, p. 309—312; also Jordan & Evermann: The Fishes of North and Middle America, Part III, 1898, p. 2470.

The height over the anus is 4,1—5 % of the total length. The head, whose length is 12,9—13,3 % of the total length, is not particularly broad, the trunk is somewhat compressed; the tail becomes much compressed and loses gradually in height towards the end. The lower jaw extends almost to the end of the upper. 7 pits for the lateral line along the upper jaw and under the eye. The distance between the snout and the anus is 27,6—30,4 % of the total length. The distance of the dorsal fin from the snout is 17,6—18,2 % of the total length. The colour uniform yellow-brown. The scales are distributed over the tail and trunk, whilst the head and fins are naked. Lateral line double, divided into a ventral and mediolateral branch, the latter however frequently indistinct. Pyloric appendages not developed. Size 181 mm.

D. 118—126. A. 100—104[1]. P. 13—15.

Distribution. The cold area off west Norway, east from Iceland, and in the Færoe Channel; 340—620 fathoms.

Remarks on the Synonymy.

Lycodes muræna was established by Collett for a 140 mm. long specimen of an elongated Lycodes, which the North-Atlantic Expedition of 1877 took in the ice-cold waters off Helgeland in Norway, at 350 fathoms depth. In 1878, off Bear Island and Spitzbergen in ice-cold water and from depths of 459—658 fathoms, the North-Atlantic Expedition got 3 other specimens (112—198 mm.) likewise of a very elongated Lycode, which Collett referred to the same species, as he considered certain differences as less essential and a sign of the variability of the species. From a study of the figures 29, 30 and 31 of the chief publication of the North-Atlantic Expedition's Fishes I got however the impression that — if the figures were correct — they could not belong to one and the same species: figs. 29 and 31 must represent another species than fig. 30, which formed the type-specimen from the 1877 cruise of the North-Atlantic Expedition.

After I had had the opportunity, through the kindness of Prof. Collett, to examine 2 of the specimens of the North-Atlantic Expedition, namely the type-specimen from 1877 and one of the specimens (not figured) from 1878, my presupposition became a certainty: the specimens from the 1878 cruise of the North-Atlantic Expedition ought to form a species by themselves, belonging to the genus *Lycodonus* Goode & Bean (cf. p. 95) and this I proposed to name *L. flagellicauda*. To this form further are to be referred, the specimens obtained by the English expeditions of the "Knight Errant" and "Triton" in the Færoe Channel, and which Günther referred to *Lycodes muræna* Coll. (the figures in Chall. Report leave no doubt about the matter), and also the specimens from the Ingolf Expedition referred to *L. muræna* Coll., which were taken north of the Iceland-Færoe ridge[2]. Of the true "*Lycodes muræna*", which ought to be referred to the genus *Lycenchelys* Gill, only the type-specimen was known until a short time ago, but during the revision of my manuscript I have further been able to study 2 specimens, taken by the "Michael Sars", the one (145 mm. long) in 1900 E. from Iceland, the other (181 mm. long) in 1902 in the Færoe Channel.

A detailed comparison will vindicate the necessity of the intended separation.

Comparison between *Lycenchelys muræna* Coll. and *Lycodonus flagellicauda* m.

The form of the body is throughout more elongated in *L. flagellicauda*: in *L. muræna* namely, the height over the anus is 4,1—5 % of the total length, in specimens of *L. flagellicauda* of similar size 3,4—4,4 %. In other regards also the form is essentially different. *L. muræna* is a compressed form: the trunk is already (if not distended by sexual products) somewhat thinner than high, and the tail quickly becomes strongly compressed; close behind the anus, the thickness is to the height

[1] According to Collett D. 118, A. 100; according to my observations in another specimen D. 126, A. 104.

[2] But not the large specimen from Davis Straits, because it forms a distinct species both from *L. muræna* and from *L. flagellicauda*: *Lycenchelys ingolfianus* (see p. 90). Nor the young specimen from the Atlantic S. from Iceland; though it stands very close to *L. flagellicauda*, it represents in my opinion quite a separate species: *Lycodonus ophidium* (cf. p. 97).

in the relation of about 1 : 2 (sometimes 2 : 3), and thereafter the tail becomes narrower towards the root of the caudal fin. *L. flagellicauda* on the other hand has a much broader body: the trunk is round; at the beginning of the anal fin the body is almost as thick as high, and the tail has almost the same thickness relatively in the greatest part of its length, only near the end does it become compressed. Seen from above, *L. murœna* (fig. 16) with its compressed tail looks therefore rather different by the side of the round-tailed *L. flagellicauda* (fig. 30). The difference is most apparent indeed, if the animals are viewed from the side: in *L. murœna* (fig. 15) the tail displays a gradual decrease in height, whereas in *L. flagellicauda* (fig. 29) the tail becomes directly remarkably low, as the lower edge immediately behind the anus rises upwards with a rapid slope; by its specially slender, whip-like tail, *L. flagellicauda* stands on the whole quite isolated amongst the

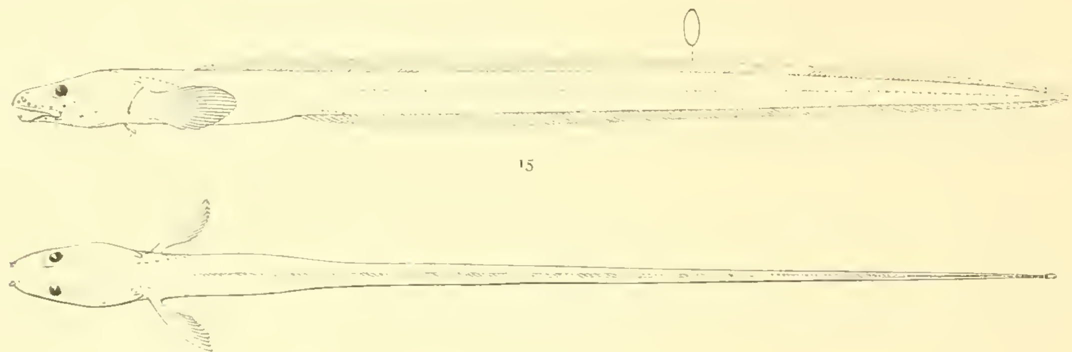


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Fig. 15—16. *Lycenchelys murœna,* seen from the side and from above. × 1.
The scales are omitted. The oval ring over the upper figure shows the form of a cross-section at the place indicated. — The figures are drawn from Collett's type-specimen of *Lycodes murœna* from the Norwegian North-Atlantic Expedition of 1877.

Lycodes known to me. — The distance between the snout and the anus in *L. murœna* is 27,6—30,4 % of the total length, in specimens of *L. flagellicauda* (of similar size) 24,2—28 %, i. e. on the whole is greater in *L. murœna.*

17 18 19

Fig. 17—19. Head of *Lycenchelys murœna,* seen from above, the side and below. × 2/1.
Drawn from Collett's type-specimen from the Norwegian North-Atlantic Expedition of 1877.

The head has about the same relative length in the two species; in the specimens at hand of *L. murœna* the length of the head namely is 12,9—13,3 % of the total length, in adult specimens of

L. flagellicauda 12,7—14,2 %. But for the rest, there are apparent differences. The head in *L. flagellicauda* (fig. 31) is much broader than in *L. murœna* (fig. 17). In *L. murœna* the underjaw, seen from below, forms a tolerably steep arch, and its end reaches almost as far forward as the upper jaw (fig. 19); in *L. flagellicauda* on the other hand, the under jaw forms a flat arch, and its anterior end lies a good way behind the point of the upper jaw (fig. 33), so that the mouth always „stands open". As a result of the breadth of the head, the eyes in *L. flagellicauda* are more upturned than in *L. murœna*, in which they look more out to the side. Teeth are found in both species on the jaws, palatines and vomer, but they are relatively long in *L. murœna*. The number of branchiostegal rays is 6 in *L. murœna*, only 5 in *L. flagellicauda*. The lateral line's deep, cup-shaped grooves along the upper and lower jaws, reminding one of the suckers of the octopus, adorn the head of *L. flagellicauda* in a characteristic manner; also, the number in the row on the upper jaw is a little different, being 8 in *L. flagellicauda* against 7 in *L. murœna* (cf. fig. 32 and 18).

The dorsal fin begins, as Collett has also remarked, a little further forward relatively in *L. murœna*, as its distance from the snout in this species is 17,6—18,2 % of the total length, whilst its distance in 12 specimens of *L. flagellicauda* amounts to 18,8—20,6 %. As I could not count the rays in the dorsal and anal fins of *L. murœna* with certainty, I am unable to say if any distinguishing character can be obtained therefrom; according to Collett the numbers (*L. murœna* sens. strict.: D. 118, A. 100[1]); *L. flagellicauda:* D. 101—108, A. 97—103) would indicate not. On the other hand, *L. murœna* has certainly a fewer number of rays throughout in the pectorals, viz. 13—15; in 12 specimens of *L. flagellicauda* I have counted 15—17 rays, and Collett gives for his two large specimens likewise 15—17 rays, only a quite small specimen appears to have 13—14.

The scales are evidently laid down earlier in *L. murœna* than in *L. flagellicauda*. The smallest specimen present, 140 mm. long, of *L. murœna* s. str. is already covered with scales on the tail and the trunk, and the larger specimens (145 and 181 mm. long) are similarly covered; only the middle of the belly (in front of the anus) is naked. *L. flagellicauda* shows some irregularity with regard to the time of appearance of the scales. Of the specimens from the Ingolf Expedition, the largest, whose total length is 204 mm., shows but quite solitary scales on the posterior portion of the tail. The next largest, 200 mm. long, is much more richly provided with scales; it has the posterior portion of the tail densely covered, but further forward on the tail the scales are more spread out and none are to be seen on the trunk. In a 183 mm. long specimen, the scaly covering has a similar distribution as in the foregoing, but the scales are on the whole less close. Lastly, two specimens of respectively 184 and 170 mm. are perfectly naked. These specimens all come from one and the same place (Ingolf St. 104). The remaining specimens (110—188 mm. long) are either quite naked or show only weak traces of scales. Of Collett's two large specimens, the one (217 mm. long) was at the same stage as the Ingolf's 204 mm. specimen, whereas the second, 198 mm. long, is much more richly covered with scales than any other specimen of this species as yet known, not only the tail but also the trunk itself being provided with scales[2]). — Altogether, one may say, that the scales are laid down earlier in

[1]) In a specimen obtained later (from the „Michael Sars") I have found: D. 126, A. 104.

[2]) In one of 3 specimens I have seen later („Michael Sars" 1902), the scales also extended relatively far forward, namely to the vertical line through the anterior end of the dorsal fin, though they were much scattered; the length of this specimen was 203 mm.

L. muræna sens. str., and have a greater distribution in relation to the total length of the fish, than in *L. flagellicauda*.

The lateral line is double in both species, mediolateral and ventral; the mediolateral branch may sometimes be particularly distinct in *L. muræna* (see fig. 15), but in *L. flagellicauda* it is always very indistinct, as even in the most favourable cases only single pores can be seen[1]). For the rest, the ventral branch in both species may be rather difficult to follow, or not at all traced, beyond the anus.

The colour in both species is uniform, without bands or spots. *L. muræna* is brownish above, below the median line yellowish; the anal fin and pectorals are grayish-white, the dorsal fin dark-gray; on the belly, the black peritoneum shines through; the scales stand out lighter than the ground-colour of the body. *L. flagellicauda* tends most often to be more gray-brown.

In conclusion I may give the most important proportions of the three *L. muræna* present:

		♀		♀
Total length	in mm.	140	145	181
Length of the head	—	18	19,25	24
Distance from snout to anus	—	39	40	55
Height over the anus	—	5,75	7	9
Distance of dorsal fin from snout	—	25	25,5	33

Distribution. With the limitation here given to *Lycenchelys muræna* Coll., the species is only known from 3 specimens. The first of these (140 mm. long) was taken by the Norwegian North-Atlantic Expedition in June 1877 off Helgeland in Norway, 325 kilom. W.S.W. from Bodo (66° 41′ N.L. 6° 59′ E.L.), where the depth was 350 fathoms and temperature of the bottom — 0°9 C. The second specimen (145 mm. long) was caught in July 1900 by the steamer Michael Sars E. from Iceland (64° 53′ N.L. 10° W.L.) where the depth was 340 fathoms and bottom-temperature – 0°69 C. Lastly, the third specimen (181 mm. long) was taken in 1902, likewise by the Michael Sars , in the Færoe Channel (60° 19′ N.L. 5° 39′ W.L.), where the depth was 620 fathoms and bottom-temperature under 0° C.

Lycenchelys sarsii Collett.

Fig. 20–22 in text.

1871. *Lycodes sarsii* Collett, Forh. Vidensk. Selsk. Chria., p. 62, c. tab.
1874. *L. sarsii* Collett, Norges Fiske; Tillægsh. til Forh. Vidensk. Selsk. Chria. 1874, p. 102.
1884. *L. sarsii* Collett, Meddelelser om Norges Fiske i Aarene 1879—83; Nyt Magaz. f. Naturvidensk. 29 Bd., p. 78, Pl. I, Fig. 3–4.
1891. *L. sarsii* Lilljeborg, Sveriges och Norges Fiskar, II, p. 23.
1895. *L. sarsii* Smitt, Skandinaviens Fiskar, II, p. 616, Fig. 151.
1898. *L. sarsii* Collett, Vidensk. Selsk. Skr. Chria. No. 1, Pl. I—II.
1901. *Lycenchelys sarsii* Jensen, Vidensk. Medd. Naturh. Foren. Kbhvn., p. 214.

[1]) Such is the case at any rate in my present specimens. Fig. 31 in the Fishes of the North-Atlantic Expedition shows however, a whole row of pores along the linear median furrow of the side; such a condition I have not seen.

The height over the anus (in medium-sized and adult individuals) is 5,2—5,9 % of the total length. The head is tolerably broad, the trunk a little compressed, the tail gradually becoming more strongly compressed and losing slowly in height. The length of the head in males is 14,1—15 %, in females 13,7—14,2 %[1]) of the total length. The lower jaw reaches almost to the end of the upper. 7 pits for the lateral line along the upper jaw and under the eye. The distance between the snout and the anus is in males 27,2—28,6 %, in females 26,2—27,7 % of the total length[2]). The distance of the dorsal fin from the snout is 21—24,7 % of the total length. Small specimens uniformly gray-brown along the back, yellow-white on the underside, somewhat larger specimens similar but with irregular, brown to black cross-markings and shades over the back and tail, and with a dark stripe between the eye and the snout; older individuals uniformly yellowish brown with indistinct shadings down the sides. The scales in developed specimens reach to the head and partly out on to the unpaired fins. The lateral line ventral, indistinct. Pyloric appendages rudimentary. The size up to 184 mm.

D. ca. 123. A. ca. 117. P. 15—16.

Distribution. Western and southern Norway; Skager Rak; 70—300 fathoms[3]).

20 21 22

Fig. 20—22. Head of *Lycenchelys sarsii*, seen from above, the side and below.

Prof. Collett has recently (1898) given so detailed and careful information concerning this species, a relatively considerable number of specimens of which has been brought to light by the practical fisheries investigations of Dr. Petersen and Dr. Hjort, that there is no need to treat of it anew. As supplementary information I shall only state the proportions of the 8 specimens from the Skager Rak at my disposal, mentioning the sex; it will thus appear that the differences in proportions are not great in adult individuals (cf. Diagnosis).

1) In small specimens (44—62 mm. long) 14,9—17,5 %, according to Collett.

2) " " " " 29,8—32,8 %.

3) Concerning the separate localities where the species was taken, cf. Collett l. c. 1898 and C. G. Joh. Petersen. Beretning IX fra den biologiske Station, p. 17, 21 & 22 (Fiskeri-Beretning for Finansaaret 1898—99, Kjobenhavn 1900). How far the form from North Atlantic, in 180 fathoms, which Günther formerly referred to *Anguilla kieneri*, and Day corrected to *Lycodes kieneri* and Günther finally to *L. sarsii* (cf. Voy. Challenger, Rep. Deep-Sea Fishes, XXII, 1887, p. 80), is really a *L. sarsii*, I shall leave unanswered as I have not seen the specimen; if the accompanying figure in Chall. Rep. (Fig. 3) purports to be more than a sketch, it would indicate indeed that the form was not identical with *L. sarsii*.

			♀	♂	♀	♀	♂	♂	♂
Total length	in mm.	89	128	140	146	151	152	169	184
Length of the head		12,5	18	21	20	21,5	21,5	24	27.5
Distance from snout to anus		24.5	35.5	40	39.5	39.5	42	46	51
Height over the anus		5	7	8	7.5	7.5	9	9.5	10

Lycenchelys muræna Coll. is the European Lycode with which the present species might most easily be confused. The following distinguishing characters however, are sufficient to separate them:

L. muræna is a more elongated species than *L. sarsii*, the height over the anus being only 4,1—5 % of the total length.

In *L. muræna* the dorsal fin begins further forward than in *L. sarsii*, its distance from the snout being only 17,6—18,2 % of the total length.

L. muræna has fewer rays in the pectorals, namely 13—15.

Lycodonus flagellicauda Jensen is likewise a more elongated species, the height over the anus being only 3,4—4,4 % of the total length, and is immediately distinguished from the present by its particularly slender, whip-like tail.

Lycenchelys kolthoffi n. sp.

Tab. X, Fig. 2. Fig. 23—25 in text.

1901. *Lycodes Verrillii* Smitt (nec Goode & Bean), Bih. K. Sv. Vet.-Akad. Handl. Bd. 27, Afd. IV, No. 4, p. 22, Fig 1—3.

The height over the anus amounts to 4,9—5,2 % of the total length. The head, whose length is 14,3—14,8 % of the total length, is tolerably broad and flat, the

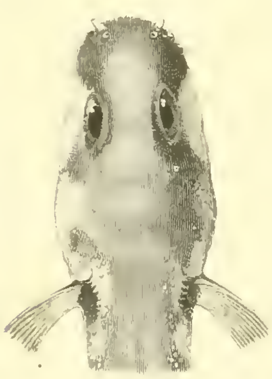
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Fig. 23—25. Head of *Lycenchelys kolthoffi*, seen from above, the side and below. × 2.

trunk is approximately cylindrical; the tail is of a low, very elongated form, not much compressed, except near the end. The anterior point of the lower jaw lies a good bit behind the end of the upper jaw. 7 pits for the lateral line along the upper jaw and under the eye. The distance between the snout and the anus is

27,8—28,4 % of the total length. The distance of the dorsal fin from the snout is 18,6—18,9 % of the total length. The colour yellow-white, with many brown spots, which on the tail posteriorly, adorn both the unpaired fins and the body between them, but on the foremost part of the tail and on the trunk are mainly on the dorsal fin, the back and the upper part of the side; a dark-brown spot above at the shoulder, and a dark arched band across over the pectoral, on the skin between the rays; top of the head brown, the sides and under surface whitish; a dark band from the snout to the eye, a dark spot behind the eye and one on the gill-cover. The scales extend from the end of the tail to, or a little beyond, the anterior end of the dorsal fin, but the belly and the under part of the trunk (in front of the anus) are naked; no scales on the fins. The lateral line double, rather distinct from the flap of the gill-cover down towards the anus (the ventral branch); in addition, isolated pores are present along the median line (the mediolateral branch). Pyloric appendages not developed. The size (of the two males to hand) ca. 130 mm.

D. ca. 124. A. ca. 110. P. 14—15.

Distribution. Northern East-Greenland, ca. 160 fathoms.

Of this new species the Kolthoff Expedition took 2 specimens (♂♂) off the east coast of northern Greenland (72° 25' N.L. 17° 56' W.L.) on the 30th of July 1900; the depth was 300 meters, and the bottom stony and sandy.

The most important proportions of these specimens are as follows:

		♂	♂
Total length	in mm.	128,5	131,5
Length of the head	—	19	18,75
Distance from snout to anus	—	36,5	36,5
Height over the anus	—	6,75	6,5
Distance from snout to dorsal fin	—	24,25	24,5
Length of the pectoral	—	14,5	13,5
Length of the snout	—	6,3	6,4
Longitudinal diameter of the eye	—	3,25	3,25

The North American *Lycodes Verrillii* Goode & Bean (Oceanic Ichthyology, 1895, p. 309, Fig. 277), with which F. A. Smitt (l. c.) had identified the present form, is quite a different species, as will appear from the following measurements of 2 specimens, presented to the Copenhagen Zoological Museum from the Smithsonian Institution.

L. verrillii Goode & Bean:

		♂	♀
Total length	in mm.	135	138
Length of the head	—	26	22
Distance from snout to anus	—	45	44
Height over the anus	—	7,25	8,5
Distance from snout to dorsal fin	—	35	32
Length of the pectoral	—	12	10,5
Longitudinal diameter of the eye		5	5,5

Compared with *L. verrillii* Goode & Bean, therefore, we have in *L. kolthoffi*:

The body is more slender, the height over the anus being 4,9—5,2 % of the total length (against 5,5—6,2 % in *L. verrillii*).

The anus lies further forward, its distance from the snout being 27,8—28,4 % of the total length (against 31,9—33,3 % in *L. verrillii*).

The head is relatively shorter, its length being 14,3—14,8 % of the total length (against 19,3 [in ♀ 16] % in *L. verrillii*).

The dorsal fin begins relatively further forward, its distance from the snout being 18,6—18,9 % of the total length (against 23,2—25,9 % in *L. verrillii*).

The pectorals are larger, their length being 10,3—11,3 % of the total length (against 8,3—8,9 % in *L. verrillii*).

The eyes are relatively smaller, their longitudinal diameter being 2,5 % of the total length (against 3,7—4 % in *L. verrillii*).

In addition, the dark colouration is marbled in *L. kolthoffi*, but in regular cross-bands in *L. verrillii*.

L. kolthoffi stands much nearer to *L. sarsii* Coll., from which however it can be easily distinguished in that the eyes are relatively a little smaller, that the pectorals are larger, and that the dorsal fin begins further forward; thus in a 140 mm. long *L. sarsii* ♂, the longitudinal diameter of the eye is 2,9 %, the length of the pectoral 7,9 %, the distance of the dorsal fin from the snout 22,2 % of the total length. In addition, the colouration is quite different; the present species is strongly spotted, whilst adult *L. sarsii* are more uniform, with only indistinct shadings down on the sides.

Lycenchelys ingolfianus Jensen.

Tab. X, Fig. 3. Fig. 26—28 in text.

1898. *Lycodes muræna* Lütken, The Danish Ingolf-Expedition, II, 1, p. 20 (partim).

1901. *Lycenchelys ingolfianus* Jensen, Vidensk. Medd. Naturh. Foren., p. 210.

The height over the anus is 5,1 % of the total length. The head tolerably broad, the body almost round, the tail gradually compressed and losing very slowly in height. The length of the head is 12,4 % of the total length. The anterior end of the lower jaw lies a good bit behind the point of the upper. 8 large pores for the lateral line along the upper jaw and under the eye. The distance between the snout and the anus amounts to 27,6 % of the total length. The distance of the dorsal fin from the snout is 20 % of the total length. The colour uniformly yellow-brown. Scales cover the tail and the trunk as also the unpaired fins towards their margin. Lateral line double, divided into a ventral and a mediolateral branch. Pyloric appendages very small. The size (of the only known specimen) 275 mm.

D. 128. A. 116. P. 17.

Distribution. Davis Straits, 393 fathoms.

The single specimen to hand of this new species, which Lütken had referred to *L. murœna* Coll., though with some hesitation, is a female with small eggs in the ovary; the most important proportions are as follows:

Total length	275 mm.
Length of the head	34 —
Distance from snout to anus	76 —
Height over the anus	14 —
Distance of dorsal fin from snout	55 —

The form of the body is more elongated than in most of the species of the genus, the height over the anus being 5,1 % of the total length. The greatest height of the body lies over the anus; from this the height remains almost unaltered towards the head, and posteriorly decreases very slowly and evenly towards the tail. The trunk itself approximates to the cylindrical, its thickness being only $1^{1}/_{5}$—$1^{1}/_{4}$ times in the height, but the tail becomes gradually more strongly compressed. The anus lies far forward, its distance from the snout being 27,6 % of the total length.


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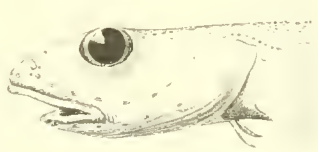
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Fig. 26—28. Head of *Lycenchelys ingolfianus*, seen from above, the side and below. × 1.

The head is relatively short, its length being 12,4 % of the total length. It is tolerably broad, especially on the cheeks, where the breadth indeed is a little greater than the height. Seen from the side, the height remains the same from the neck to near the eye, where the orbit shows a little convexity; from the anterior margin of the eye the snout descends somewhat sharply, yet so that the slope forms a weak arch, and at the same time the lower surface rises up. Seen from above, it is a little bent out over the cheeks, and the point of the snout is broadly rounded off. The upper surface is flat on the crown, slightly arched on the snout but has a depression between the eyes. The eyes are large, their longitudinal diameter being $^{1}/_{4}$ of the length of the head; seen from the side, the upper margin projects forward over the forehead; seen from above, there is an eye's diameter between the two eyes; they are almost circular. The length of the snout to the eye is ca. $3^{1}/_{3}$ times in the whole head. The lower jaw is much shorter than the upper and reaches only to the vertical line through the tube-shaped nostrils. The upper lip is swollen, the lower lip tolerably thin it the middle, but thick at the sides and provided as usual with a dependant fold. The teeth are small, truncate and conical. On the intermaxillary there are two rows, the first of which is much the longest and consists of 15 teeth on each side, decreasing in size towards the angle of the mouth; the second row has 5 teeth. On each palatal bone there is a tolerably short row of teeth; the vomer is also sparingly provided with teeth. The lower jaw has several irregular rows of teeth in the centre, a single row towards the sides.

The dorsal fin begins almost over the point of the flattened-out pectoral, at a distance from the snout equal to 20 % of the total length. It contains, so far as I have been able to count, 128 rays, the anal 116 rays; in both numbers half the tail fin is as usual reckoned. The pectorals, which contain 17 rays, are of a broad oval form; their length is 7,4 % of the total length or equal to the distance from the end of the opercular flap to the middle of the lens of the eye. The ventral fins are small (about $^{2}/_{3}$ rds the diameter of the eye) and thin.

The head and the paired fins are naked; the rest of the body is covered with small scales which on the unpaired fins reach to near the margins.

The lateral line is double, divided into a mediolateral and a ventral branch, but for the greatest part of its course it is only discernible under a lens. It begins on the neck, a little above and in front of the posterior corner of the gill-cover, and inclines obliquely therefrom towards the belly, which it reaches at a distance of about $^{1}/_{3}$ rd of the length of the trunk from the base of the pectoral; this descending portion of the lateral line is relatively distinct with pores close together. From there it continues almost on the boundary between the side and the belly and can be followed a good distance on the tail as an extremely fine light strip with very small, but rather closely-placed pores. The mediolateral branch can be followed right out to the base of the caudal fin; its pores are less close to one another than in the ventral branch, so that there are 2—3 scales between two successive pores against 1—2 scales in the latter.

On the head, the lateral line opens into a number of distinct pores. From the snout to under the eye there is a row of 8 large pores, from the tip of the lower jaw to the preoperculum's lower and posterior corner there is another row of 7 similar pores. Between the posterior margin of the eye and the neck is a row of 8 fine pores, whose 5th pair is connected by a cross line of 2 pores. Between the eye and the upper posterior corner of the preoperculum there are 3 pores and on the preoperculum itself another 3 pores.

The colour is a uniform yellow-brown on the back, yellowish or grayish on the belly; of markings only a dark border is seen along the free edge of the gill-cover, and the tube-shaped nostrils are coloured black. The scales appear as light points.

Distribution. A single specimen (♀) was taken by the Ingolf Expedition of 1895 (St. 27) in Davis Straits off the coast between the colonies Godthaab and Sukkertoppen (64° 54' N.L., 55° 10' W.L.), where the depth was 393 fathoms and bottom-temperature + 3°8 C.

Relation to allied species. Of these, *L. murœna* Coll. is the one which is most remote from the present species. *L. murœna* is namely a still more elongated form, the height over the anus being 4,1—5 °/₀ of the total length, and it has a more compressed tail; further, its underjaw reaches almost to the tip of the upper, its dorsal fin begins further forward (the distance from the snout is = 17,6—18,2 °/₀ of the total length), and it has fewer rays in the pectorals, namely 13—15.

L. sarsii Coll. is distinctly nearer to the present species, but its head is somewhat longer (the length in the two females at my disposal being 13,7—14,2 °/₀ of the total length), and flatter, and the lower jaw reaches almost as far forward as the upper (see Fig. 21 & 22 in text). In addition, it has fewer rays in the pectorals, namely 15—16.

On the other hand, there might be some doubt, whether the present species is not identical with the *L. paxillus* Goode & Bean[1]) taken on the east coast of North America in deep water (263—904 fathoms). As I am not myself acquainted with *L. paxillus*, I shall only indicate that this species appears to be less elongated, the height going 16 times in the total length (whereas in *L. ingolfianus* it is almost 20 times); further, *L. paxillus* seems to have only 16 rays in the pectorals, 118 in the dorsal and 110 in the anal fin; lastly, the lateral line is given as being single (mediolateral).

Lycodonus Goode & Bean.

Lycodonus Goode & Bean, Bull. Mus. Comp. Zool., X, No. 5, 1883, p. 208 *(mirabilis)*.

The body very elongated (anguilliform), the height over the anus going ca. 21—30 times in the length. Teeth on the intermaxillary, mandible, vomer and palatines. Lower jaw without barbules. Scales small. Lateral line mediolateral or both mediolateral and ventral. Along the bases of the dorsal and anal fins a row of small bony plates (lateral out-growths of the upper ends of the interspinous rays), on which the rays are superimposed. Branchiostegal rays 5.

This genus, which in relation to the other anguilliform *Lycodinæ* is specially characterized by the structure of the interspinous bones and by only having 5 branchiostegal rays, consists now of 3 species from deep water: *Lycodonus mirabilis* Goode & Bean, off the east coast of the United States (35° 45' 23"—41° 53' N.L. 65° 21' 50"—74° 34' 45" W.L.), 721—1309 fathoms; *L. ophidium* Jensen, North Atlantic Ocean S. from Iceland, 1089 fathoms; *L. flagellicauda* Jensen, the polar depths from Spitzbergen down towards Iceland and the Færoes, 459—1003 fathoms.

The American species lacks fin-rays on the anterior (9—11) plates on the back, whereas all the plates bear fin-rays in the European species. The two last species can be distinguished from one another by the following characters:

[1]) *Lycodes paxillus* Goode & Bean, Proc. U. S. Nat. Mus. 1879, p. 44. *L. paxilloides* Goode & Bean, Bull. Mus. Comp. Zool., X, 1883, p. 207. *Lycenchelys paxillus* Goode & Bean, Oceanic Ichthyology, 1895, p. 311, Fig. 279 & 282; Jordan & Evermann, Fishes of North America, III, 1898, p. 2471.

a. The distance between the snout and the anus is 24,1—28 % of the total length, the distance of the dorsal fin from the snout, 18,2—20,6 %. *L. flagellicauda* Jensen; p. 94.

b. The distance between the snout and the anus is 21,6 % of the total length, the distance of the dorsal fin from the snout 15,3 %. *L. ophidium* Jensen; p. 97.

Lycodonus flagellicauda Jensen.

Fig. 29—33 in text.

1878. *Lycodes muræna* Collett, Fiske fra Nordhavs-Expeditionen 1878; Forh. Vidensk. Selsk. Chria., 1878, No. 14, p. 74 (partim).

1880. *L. muræna* Collett, The Norwegian North-Atlantic Expedition, Fishes, p. 116 (partim), Pl. IV, Fig. 29 & 31.

1887. *L. muræna* Günther, The Voyage of H. M. S. Challenger, vol. XXII, Report on the Deep-Sea Fishes, p. 79, Pl. XII, Fig. A.

1891. *L. muræna* Lilljeborg, Sveriges och Norges Fiskar, II, p. 25 (partim).

1895. *L. muræna* Smitt, Skandinaviens Fiskar, II, p. 616 (partim), Fig. 152.

1898. *L. muræna* Lütken, The Danish Ingolf-Expedition, II, 1, p. 20 (partim).

1901. *Lycenchelys flagellicauda* Jensen, Vidensk. Medd. Naturh. Foren. Kbhvn., p. 210.

The height over the anus is 3,4—4,4 % of the total length. The head, whose length is 12,7—14,5 %[1]) of the total length, is broad and flat, the trunk round; the tail becomes very low immediately behind the anus and is of a round whip-shaped form, only becoming compressed near the end. The front of the lower jaw lies a good bit behind the tip of the upper. 8 pits for the lateral line along the upper jaw and under the eye. The distance between the snout and the anus is 24,1—28 % of the total length[2]). The distance between the snout and the dorsal fin is 18,2—20,6 % of the total length. The colour uniformly gray-brown. The scales may extend to the head, when the total length of the fish is ca. 200 mm., but usually they are much less advanced at this (or a still greater) total length. The lateral line double, divided into a ventral and a mediolateral branch, but of the latter only isolated pores are usually to be seen along the median line of the side[3]). Pyloric appendages not developed. The size up to 217 mm.

D. 101—109[4]). A. 97—103[4]). P. (13—14) 15—17.

Distribution. The polar depths from Spitzbergen down towards Iceland and the Færoes, 459—1003 fathoms.

[1]) In 4 males 13,3—14,2 %, in 8 females 12,7—13,8 %, in 2 young specimens 14,1—14,5 %.

[2]) In 4 males 25—26,8 %, in 8 females 24,4—28 %, in 2 young specimens 24,1—25,4 %.

[3]) Figure 31 in Collett (N. North-Atlantic Exped., Fishes) shows a whole row of pores along the middle of the side, but I have not seen anything similar.

[4]) According to Collett: D. 101—108; A. 97—103. In two specimens I have found: D. 108—109; A. 98—102.

Under *Lycenchelys muræna* (p. 83—86) I have described this form in detail and indicated its independence from *L. muræna*.

In my preliminary notice on the *Lycodinæ* of the Ingolf Expedition (l. c.) the present form is given as a *Lycenchelys*, with the addition however that it would seem most natural to remove it and

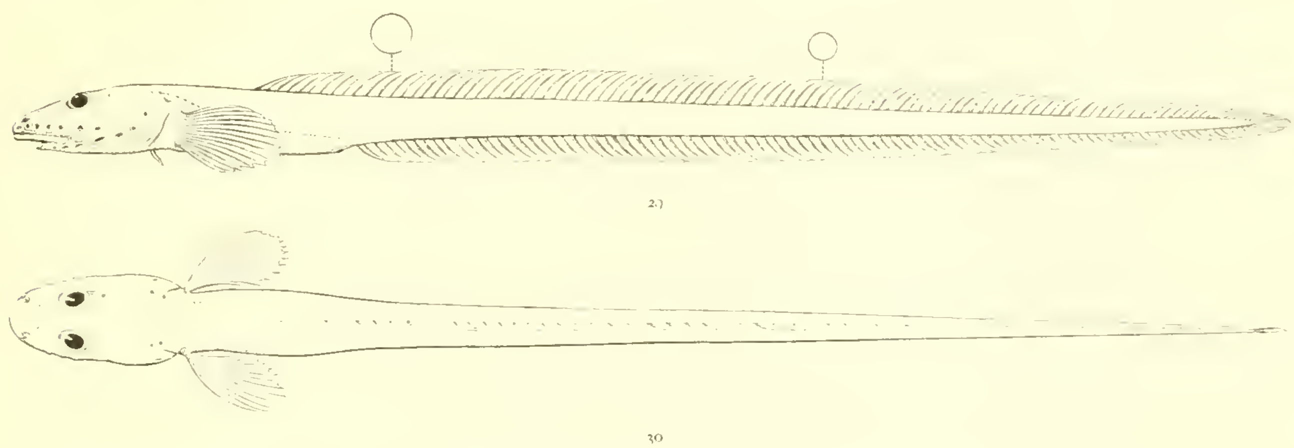


Fig. 29—30. *Lycodonus flagellicauda*, seen from the side and above. × 1.
Scales are omitted, likewise the small bony plates along the bases of the unpaired fins. The two rings over the upper figure represent the form of a cross-section at the place indicated.

Fig. 31—33. Head of *Lycodonus flagellicauda*, seen from above, the side and below. × 5/3.

make it into a separate genus. On further research I find this supposition strengthened: *Lycenchelys flagellicauda* (and the following species, *L. ophidium*) are of one genus with *Lycodonus* Goode & Bean.

The genus *Lycodonus* was founded in 1883 by the American ichthyologists Goode & Bean (Bull. Mus. Comp. Zool. X, No. 5, p. 208) with a single species: *L. mirabilis*. In 1895, when this fish was again mentioned by the same authors in their work Oceanic Ichthyology (p. 312), a considerable number of specimens had been taken off the coast of New England, in deep water (721—1309 fathoms). Our Museum possesses two specimens presented by the Smithsonian Institution, so that I can judge of it from personal observation.

The two most important peculiarities, which in my opinion, specially characterise the genus *Lycodonus*, are shared in common by this species and *L. flagellicauda* (and the succeeding *L. ophidium*): first and foremost, the number of the branchiostegal rays, which is only 5 on each side (in *Lycenchelys* on the other hand, 6); and next, a peculiarity in the structure of the dorsal and anal fin: along the bases of these fins there is a row of small bony shields, on which the fin-rays are superimposed, one on each plate; these bony plates are especially apparent in *L. mirabilis*, in lesser degree in *L. flagellicauda*, because it is quite a small fish, but one can observe them easily under a lens, especially if the skin is allowed to dry a little; Goode & Bean designate these plates as ectodermal scutes or plates , but on dissection they prove to be lateral outgrowths of the outer ends of the interspinous rays (or perhaps more correctly of the small bones fused with the outer part of the interspinous rays).

For the rest, the genera *Lycenchelys* and *Lycodonus* agree so far as I can see. Goode & Bean certainly mentioned another peculiarity in the latter, namely: caudal distinct not fully connect with dorsal and anal , but in the two specimens of *L. mirabilis* at my disposal the unpaired fins join into one, just as in *L. flagellicauda*.

Concerning *Lycodonus mirabilis*, Goode & Bean remark: The first 10 or 11 scutes do not support rays, but whether rays were originally present or not cannot be ascertained . In the two specimens at my disposal fin-rays are wanting on the first 9—11 plates, and there is no sign that the rays have been torn off, so that it must be a normal condition. In *L. flagellicauda* (and *L. ophidium*) on the other hand, all the plates bear fin-rays. This difference seems to me indeed of subordinate importance, in any case not so important, that it should prevent the three species being placed within the same genus.

For the sake of completeness, I add here the most important proportions of 14 *Lycodonus flagellicauda* which I have investigated (those of 185, 197 and 203 mm. are from the 1902 cruise of the Michael Sars , the others from the Ingolf Expedition of 1896).

				♂	♀	♀	♀	♀	♂	♀	♀	♀	♂	♂	♀
Total length .	in mm.	110	114	141	162	170	181	183	184	185	188	197	200	203	204
Length of the head	—	15,5	16,5	20	20,5	22	24,25	23,5	24,5	25,5	25	27	26,5	28	28
Distance from snout to anus	—	26,5	29	35,5	39,5	43	46,5	45	46,5	50,5	48,25	55	50	54,5	54
Height over the anus	—	3,75	4	5,5	5,5	6,5	6,75	6,75	6,5	7	8	7,5	8,25	7,75	9
Distance of dorsal fin from the snout	—	20	22	28,5	31	35	36,5	34,5	35,5	36	38	39,5	40	40,25	41

Distribution.

The Norwegian North-Atlantic Expedition took 2 specimens W. from Spitzbergen, where the depth was 459 fathoms and bottom-temperature — 1° C., and a small individual W. from Bear Island, where the depth was 658 fathoms and bottom-temperature — 1°2 C. The English Expeditions of 1880 and 1882 with the Knight Errant and Triton obtained many specimens in the Færoe Channel, where the depths were 540 and 608 fathoms, bottom-temperature 29°2—30° F.; in the same channel (at 60° 19′ N.L. 5° 39′ W.L.) the Michael Sars in the summer of 1902 took 3 specimens where the depth was 620 fathoms and bottom-temp. under 0° C. Further, the Ingolf Expedition took it in 1896 at the following places:

St. 117.	South from Jan Mayen...	1003 fathoms	÷ 1 C.	1 specimen
- 125.	North from Iceland	729 —	÷ 0,8 -	1 —
- 102.	East from Iceland........	750 —	÷ 0,9 -	1 —
- 104.	— — —	957 —	÷ 1,1 -	5 —
- 105.	— — —	762 —	÷ 0,8 -	2 —
- 139.	North from Færoes.......	702 —	÷ 0,6 -	1 —

Lycodonus flagellicauda is thus widely distributed over the deeper parts of the "cold area", from Spitzbergen down to Iceland and the Færoe Channel.

Lycodonus ophidium Jensen.

1898. *Lycodes muræna* Lütken, The Danish Ingolf-Expedition, II, 1, p. 20 (partim).
1901. *Lycenchelys ophidium* Jensen, Vidensk. Medd Naturh. Foren. Kbhvn., p. 212.

The single specimen present, a young individual of 118 mm., stands very near to *Lycodonus flagellicauda*, but in proportion to the total length, the length of the head is 12 %, the distance between the snout and the anus 21,6 % and the distance of the dorsal fin from the snout 15,3 %. P. 15.

Distribution. North Atlantic Ocean S. from Iceland, 1089 fathoms.

As there is but a single and young specimen to hand, only the above preliminary characterisation of the species can be given.

This specimen has in the main the same characteristic appearance as the young *L. flagellicauda* and is hardly to be distinguished from these on superficial observation. But the measurements show that the head is shorter, that the anus lies further forward and that the dorsal fin begins nearer the head. These features will appear on comparison with three *L. flagellicauda* of similar length:

	Lycodonus flagellicauda			*L. ophidium*
	Totall. 110 mm.	Totall.[1] 112 mm.	Totall. 114 mm.	Totall. 118 mm.
In percentage of the total length:				
Length of the head	14,1 %	14,3 %	14,5 %	12 %
Distance from snout to anus	24,1 %	26,8 %	25,4 %	21,6 %
Distance of dorsal fin from the snout	18,2 %	19,6 %	19,3 %	15,3 %

The specimen was taken by the Ingolf Expedition of 1896 in the North Atlantic S. from Iceland (St. 65), where the depth was 1089 fathoms and bottom-temperature 3° C. In Lütkens report on the ichthyological results of the expedition it is referred to *L. muræna* Coll.

[1] From Colletts measurements of a specimen from the North-Atlantic Expedition; the two other specimens are from the Ingolf Expedition.

APPENDIX.

On some new discoveries of Lycodes.

Dr. phil. Joh. Schmidt, who conducted the zoological investigations of the Danish steamer »Thor» at Iceland during 1903, has had the goodness to show me the Lycodes taken during this cruise. Of special interest were the following:

Lycodes vahlii Reinh. This species occurs, in addition to what has been stated previously (p. 21) at west, north and east Iceland, also at south Iceland, as the »Thor» took 3 young specimens at 63° 15' N.L. 20° 4' W.L., at a depth of 326—216 m.

Lycodes frigidus Coll. 1 specimen was taken in the polar depths off north-east Iceland (66° 19' N.L. 10° 45' W.L.) where the depth was 1440 m., bottom-temp. — 0°92 C.

Lycodes pallidus Coll. 1 specimen was taken in the polar depths off north-east Iceland (66° 2' N.L. 11° 5' W.L.), where the depth was 1040—900 m., bottom-temp. — 0°58 C.

Lycodes seminudus Reinh. 3 specimens (2 ♂♂, 31—36 cm. long, 1 ♀, 33 cm. long, all uniformly coloured) were taken in the polar depths off north-east Iceland (66° 2' N.L. 11° 5' W.L.) where the depth was 1040—900 m., bottom-temp. — 0°58 C.

Literature published (or coming into the hands of the author)
after the end of the year 1902.

Römer und Schaudinn: Fauna Arctica. II, 1, 1901. Die Fische von E. Ehrenbaum.

In this general treatise (p. 123) Prof. Ehrenbaum mentions that Römer and Schaudinn in 1898 took a small Lycodes (67 mm. long) N.W. from Ross Island at a depth of 85 m.; this specimen E. refers to *L. reticulatus* Reinhardt (in the synonymy-list including with others, *L. rossi* Malmgr.); further, that the Olga-Expedition took 2 specimens of *Lycodes* (180 and 250 mm. long) at the entrance to Green Harbour in 145—180 m. depth, both of which had to be referred to the *reticulatus*-group.

All these 3 specimens belong without doubt to *Lycodes rossi* Malmgren.

R. Collett: Om tre for Norges Fauna nye Fiske. Arch. f. Math. og Naturvidensk. B. XXV. Nr. 2. 1903.

On p. 14—26, Collett discusses the *Lycodes rossi* Malmgr. taken by the »Michael Sars» in Porsanger Fjord and at Spitzbergen, and mentions also a specimen from the bank south from Bear Island, depth 130 m., bottom-temp. ÷ 0°5 C.[1]). Concerning the delimiting of the species Prof. C. has a similar opinion to my own, being however inclined to consider *L. lütkenii* Coll. as the fully grown stage of *L. rossii*; I have set forth my own views, on this point on p. 61.

[1]) When Collett (p. 26) also gives *L. rossi* as from East Greenland, that is incorrect, but the fault lies entirely with myself, as I at a certain time considered the East Greenland Lycode, which I have named *L. reticulatus* Reinh. var. *macrocephalus* in the present work, to be identical with *L. rossi* and had informed Prof. C. of this.

N. Knipowitsch: Zool. Ergebn. d. Russ. Exped. nach Spitzbergen. Fische. Nachtrag. Ann. Musée Zool. de l'Acad. Imp. d. Sci. St.-Pétersbourg, T. VIII, 1903.

In this treatise Prof. Knipowitsch corrects the *Lycodes esmarki* Coll. and *L. reticulatus* Reinh. (?) previously described by him from Spitzbergen to: *L. eudipleurostictus* Jensen and *L. rossi* Malmgr. A new discovery is further mentioned (1901): *Lycodes pallidus* Coll., a 70,8 mm. long specimen taken in Stor Fjord, depth 102½ m., bottom-temp. — 1°8 C.; *L. rossi* Malmgr., a 42 mm. long specimen taken in Stor Fjord, Genevra Bay, depth 42 m., bottom-temperature + 2°3 C.

R. Collett: Meddelelser om Norges Fiske i Aarene 1884—1901. II. Chria. Vidensk.-Selsk. Forhandl. 1903, No. 9.

On p. 3—18, Prof. Collett discusses in detail the 4 Lycodes occurring in Norway: *Lycodes vahlii* Reinh., *gracilis* M. Sars, *L. rossi* Malmgr., *L. esmarkii* Coll. and *Lycenchelys (Lycodes) sarsii* Coll.

With regard to *Lycodes vahlii* Reinh., *gracilis* M. Sars, Prof. Collett agrees with the view set forth by me that *L. gracilis* M. Sars is a form of *L. vahlii* Reinh. It is common at relatively shallow depths along the whole coast-line of the land, and penetrates far into the large fjords, such as Trondhjem and Christiania Fjords . . . it is taken tolerably frequently by the fishermen during the fishing for the so called deep-water prawn *(Pandalus borealis)*, which has been carried on within recent years in various fjords and bays on the south coast. This fishing takes place in the mouths of the Christiania Fjord at about 30 to 60 fathoms as a rule . From Finmark, in addition to the specimen from Baads Fjord mentioned in the present work (p. 21), C. mentions 3 others, 179—220 mm. long, taken by the Michael Sars during 1901 in Varanger Fjord at ca. 100 fathoms depth.

Lycodes esmarkii Coll. Since 1884 Prof. C. has again been able to examine a considerable number (almost 50) of adult individuals (the largest 745 mm. long), all taken on lines at the same localities in Finmark as before: Ox Fjord, Vardo and Varanger Fjord.

Lycenchelys sarsii Coll. Since C.'s latest report on this species (1898) only two new specimens have been found, from Trondhjem Fjord, 150 fathoms and from Nordfold in Salten, 280 fathoms. The 19 certain specimens hitherto known were taken within the waters lying between the Skager Rak and the Polar Circle .

Ad. S. Jensen: The Fishes of East-Greenland. Meddelelser om Grønland, vol. XXIX, 1904.

Contains a report on the Lycodes taken by Swedish expeditions at northern East-Greenland: *Lycodes pallidus* Coll. (p. 256), *L. eudipleurostictus* Jensen (p. 257), *L. reticulatus* Reinh. var n. *macrocephalus* (p. 258; Pl. XIII, fig. 2 a & b), *L. seminudus* Reinh. (p. 260) and *Lycenchelys kolthoffi* n. sp. (p. 261; Pl. XIII, fig. 1).

Tab. I.

Tab. I.

Fig. 1. *Lycodes microcephalus* Jensen; p. 53.

The only specimen, 81 mm. long; nat. size.

S.W. from Iceland, 799 fathoms. Ingolf Expedition, 1896.

Fig. 2. *Lycodes vahlii* Reinh., *typica*; p. 14.

2 a. A young specimen, 143 mm. long, with distinct banded markings, mentioned p. 15; nat. size.
Southerly West-Greenland, 88 fathoms. Ingolf Expedition, 1895.

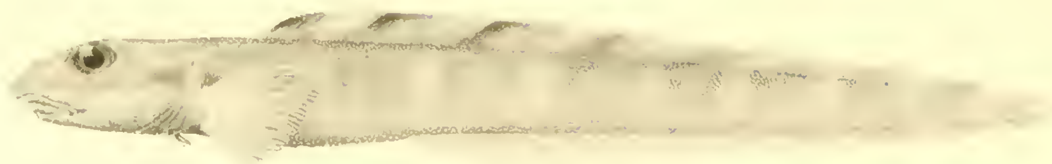
2 b. An adult female, 310 mm. long, still with traces of the dark bands; reduced to 3/4 nat. size.
Southerly West-Greenland (Sukkertoppen). Copenhagen Museum.

2 c. An adult male, 410 mm. long, where the banded markings have almost disappeared; reduced to ca. 5/8 nat. size.

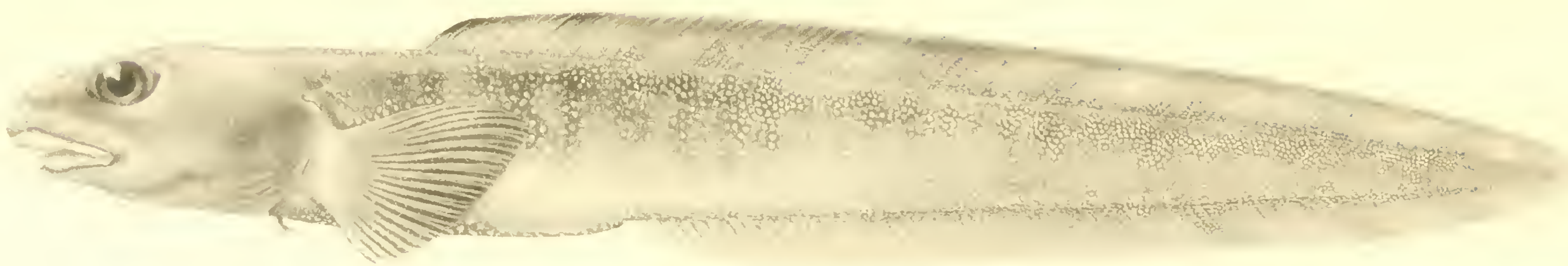
Southerly West-Greenland (Sukkertoppen). Copenhagen Museum.

1

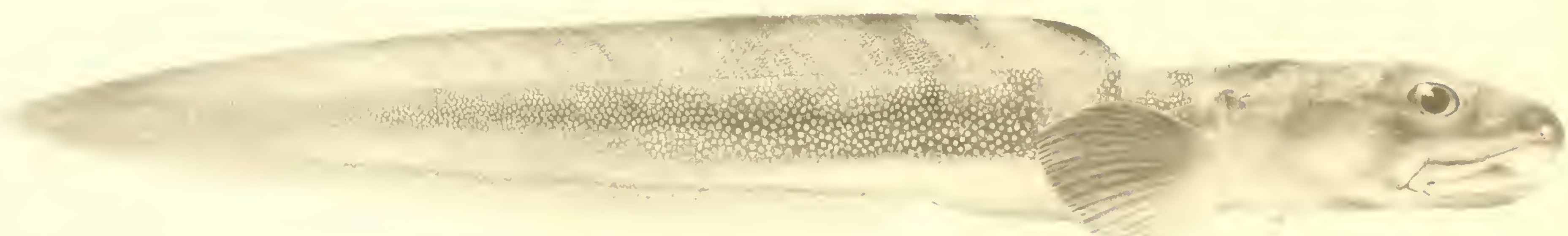
2 a



2 b



2 c



Pacht & Crone Phototyp.

Tab. II.

Tab. II.

Fig. 1. *Lycodes vahlii* Reinh., *lugubris* Lütk.; p. 16.

1 a. An adult male specimen, 300 mm. long, where the dark bands have disappeared; with characteristic dark spot in the anterior corner of the dorsal fin; reduced to $^{11}/_{15}$ nat. size. North-west Iceland (Arnar Fjord). Copenhagen Museum.

1 b. An adult female, 210 mm. long, similar to the foregoing specimen; nat. size. East Iceland (Seydis Fjord). Copenhagen Museum.

Fig. 2. *Lycodes reticulatus* Reinh.; p. 61.

An adult male, 255 mm. long; a little reduced.

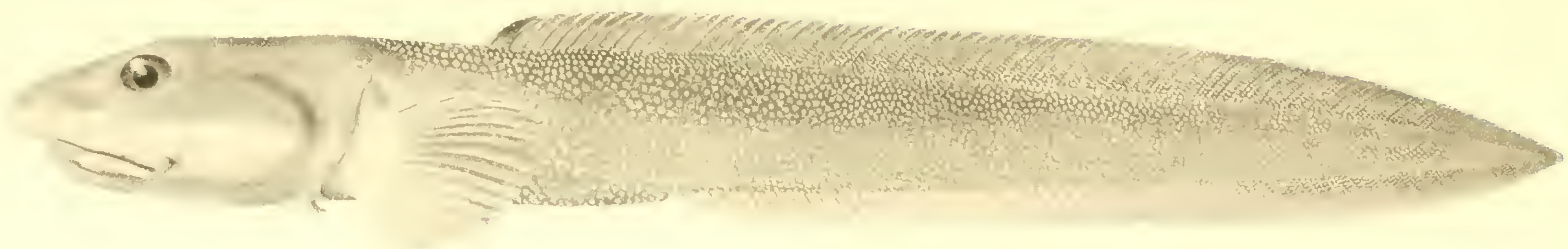
West Greenland (Umanak Fjord). Drygalski Expedition, 1893.

Fig. 3. *Lycodes reticulatus* Reinh. (?), juv.; p. 64.

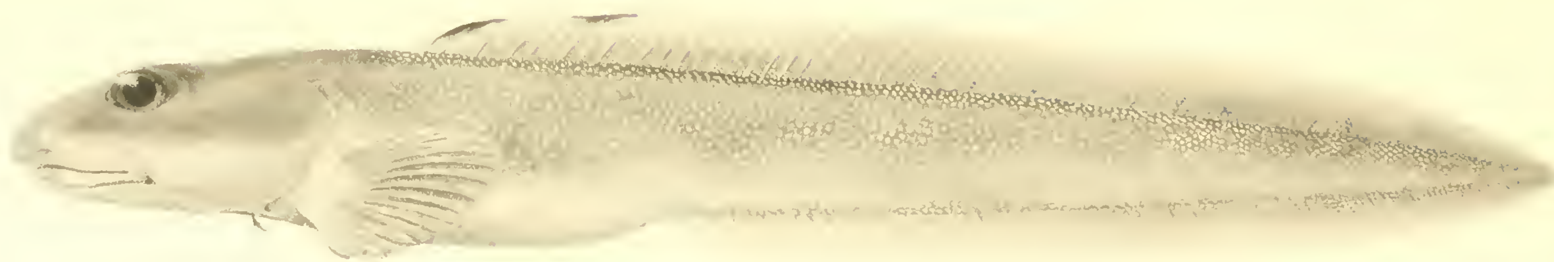
Type-specimen of *Lycodes perspicillum* Kroyer; nat. size.

West Greenland. Copenhagen Museum.

1 a



1 b



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2

Pacht & Crone phototyp.

Tab. III.

Tab. III.

Fig. 1. *Lycodes eudipleurostictus* Jensen; p. 33.

1 a. An adult female, 260 mm. long; a little reduced.

N.W. from the Færoes, 471 fathoms. Ingolf Expedition, 1896.

1 b. A young specimen, 75 mm. long; nat. size.

Off the Norway-Shetland «Slope», 360 fathoms. «Michael Sars», 1902.

Fig. 2. *Lycodes esmarkii* Coll.; p. 27.

2 a. A young specimen, 192 mm. long, with ⅄-shaped, light bands (cf. p. 28); almost nat. size.

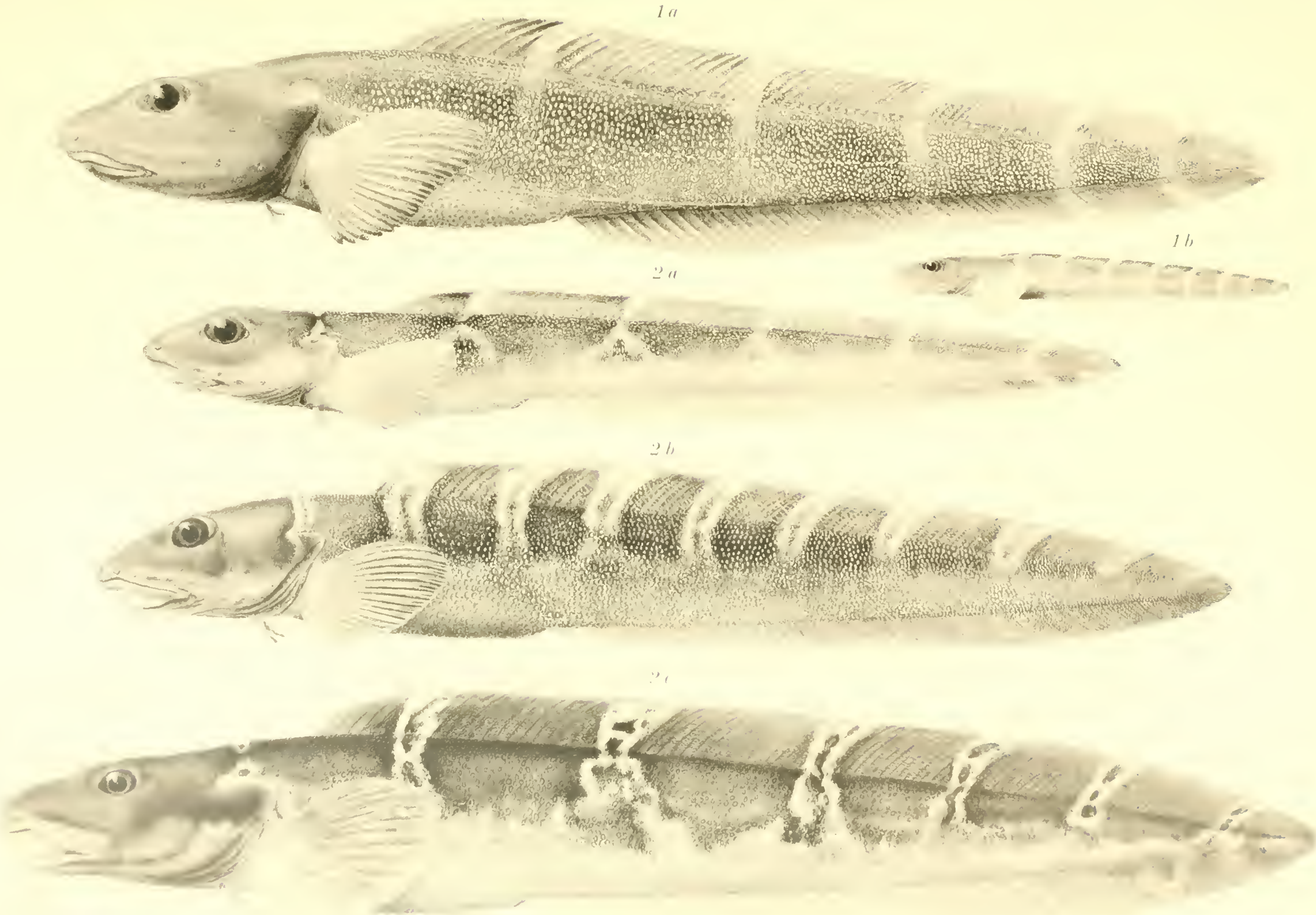
Between Norway and Bear Island, 410 metres. Nathorst Expedition, 1898.

2 b. A somewhat larger specimen, 371 mm. long, with dark stripes and spots in the light bands (cf. p. 31); reduced to $^3/_5$ nat. size.

Norway-Shetland «Slope», 275 fathoms. «Michael Sars», 1902.

2 c. An adult (♂) specimen, 552 mm. long, colouration in the final stage, the light bands being dissolved into festoon-shaped markings; reduced to $^5/_{11}$ nat. size.

E. from the Færoes, 228 fathoms. «Michael Sars», 1902.


1 a
1 b
2 a
2 b
2 c

Tab. IV.

Tab. IV.

Fig. 1. *Lycodes pallidus* Coll., *typica;* p. 38 & 40.

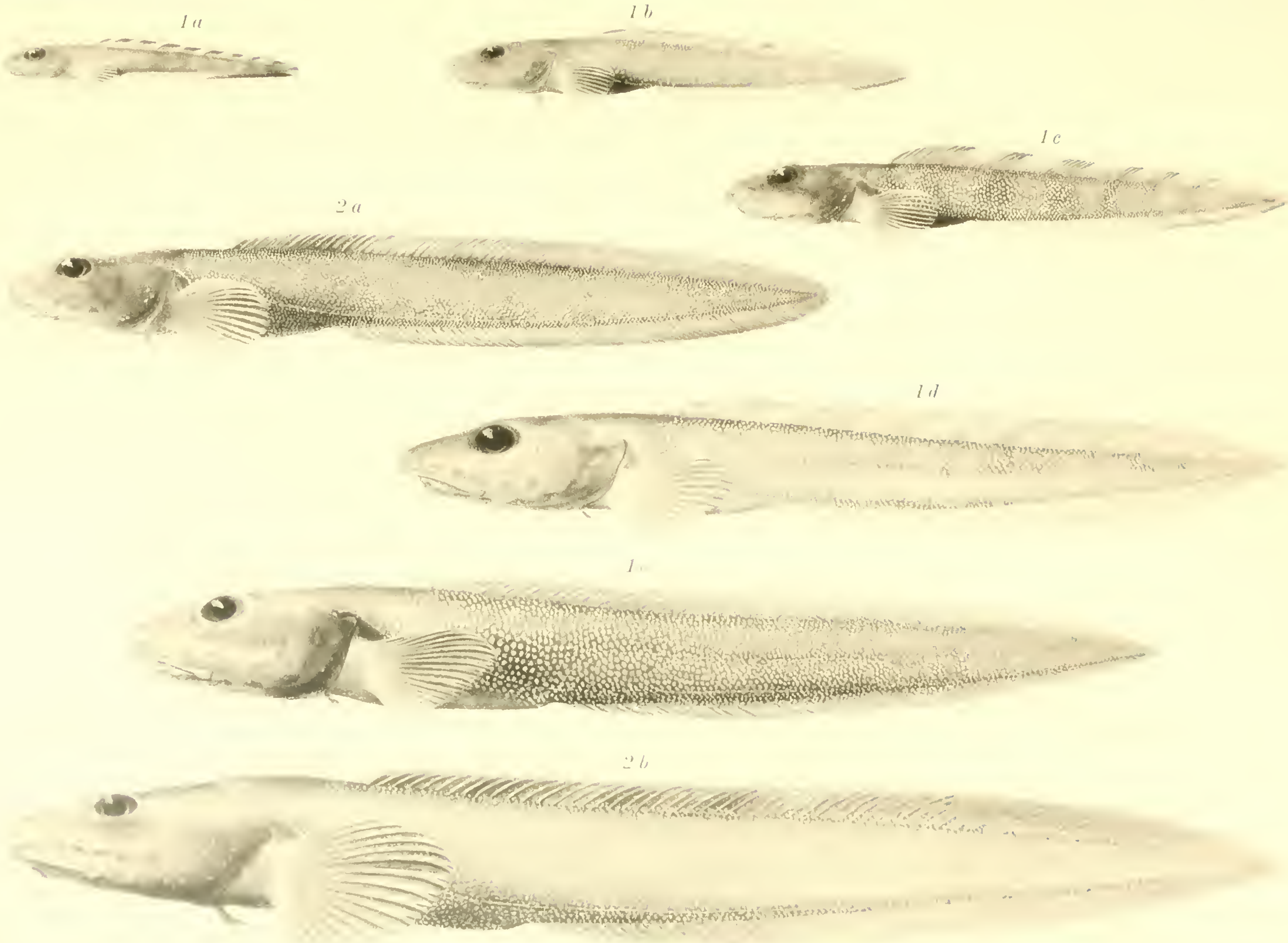
1 a, b, c, d og e. A series of specimens showing the varying colouration from the young's distinct banded markings to the adult's uniform colour; nat. size.

N. from the Færoes and N. from Iceland, 293—495 fathoms. Ingolf Expedition, 1896.

Fig. 2 a, b. *Lycodes pallidus* Coll., var. *squamiventer* m.; p. 39 & 48.

The scales are seen to be more widely distributed, both on the belly and back, than in the typical form; nat. size.

E. from Iceland and N. from Færoes, 679—957 fathoms. Ingolf Expedition, 1896.



Pacht & Crone phototyp.

Tab. V.

Tab. V.

Fig. 1. *Lycodes frigidus* Coll.; p. 22.

1 a. A medium-sized specimen, 232 mm. long; nat. size.

S. from Jan Mayen, 1003 fathoms. Ingolf Expedition, 1896.

1 b. A very young specimen, 50,5 mm. long; nat. size.

N.E. from Iceland, 860 fathoms. Ingolf Expedition, 1896.

Fig. 2. *Lycodes pallidus* Coll., var. *similis* m.; p. 39 & 46.

2 a, b, c and d. A series of specimens in which the dark bands become indistinct with age; nat. size.

S. from Jan Mayen, 371 fathoms. Ingolf Expedition, 1896.

Pacht & [illegible] phototyp

Tab. VI.

Tab. VI.

Fig. 1. *Lycodes agnostus* Jensen; p. 79.

1 a. A medium-sized specimen, 147 mm. long; nat. size.

The Kara Sea, 46—100 fathoms. Dijmphna Expedition, 1882—83.

1 b. A young specimen, 62 mm. long; nat. size.

The Kara Sea, 46—100 fathoms. Dijmphna Expedition, 1882—83.

Fig. 2. *Lycodes platyrhinus* Jensen; p. 51.

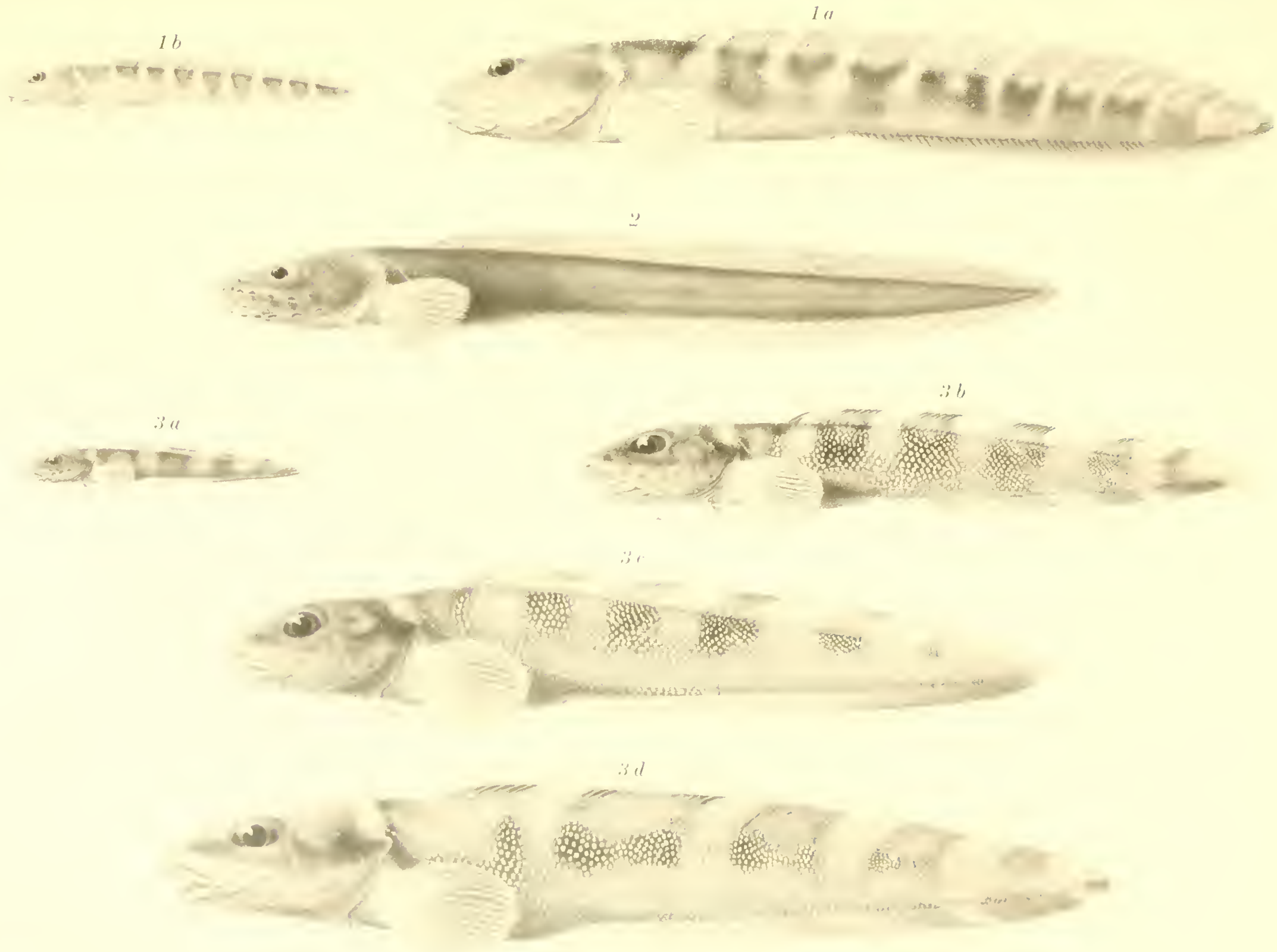
The only specimen, 148,5 mm. long; nat. size.

Between Jan Mayen and Iceland, 1010 fathoms. Ingolf Expedition, 1896.

Fig. 3. *Lycodes pallidus* Coll., var. *similis* m.; p. 39 & 46.

3 a, b, c and d. A series of specimens in which the dark bands remain distinct; nat. size.

S. from Jan Mayen, 371 fathoms. Ingolf Expedition, 1896.


1 a
1 b
2
3 a
3 b
3 c
3 d

Tab. VII.

Tab. VII.

Lycodes rossi Malmgr.; p. 55.

1 a. Type-specimen of *L. rossi* Malmgr.
Spitzbergen, Treurenberg Bay, 5 fathoms. Stockholm Museum.

1 b. Specimen, 54,5 mm. long.
Spitzbergen, Green Harbour, 75 fathoms. »Michael Sars«, 1901.

1 c. Specimen, 68,2 mm. long.
Spitzbergen, Stor Fjord, 39 fathoms. St. Petersburg Museum.

1 d. Specimen, 75,8 mm. long.
Spitzbergen, Stor Fjord, 75 fathoms. St. Petersburg Museum.

1 e. Specimen, 118 mm. long.
Spitzbergen, Green Harbour, 75 fathoms. »Michael Sars«, 1901.

1 f. Specimen, 163 mm. long (♀).
Spitzbergen, Ise Fjord, 100 metres. Kolthoff Expedition, 1900.

1 g. Specimen, 205 mm. long (♀).
Spitzbergen, Green Harbour, 75 fathoms. »Michael Sars«, 1901.

All natural size.

Pacht & [illegible] phototyp

Tab. VIII.

Tab. VIII.

Lycodes reticulatus Reinh. var. *macrocephalus* m.; p. 66.

1 a. A specimen, 45,5 mm. long, doubtfully of the present species (cf. p. 69).

Baffins Bay, 92 fathoms. Copenhagen Museum.

1 b & c. Two specimens, 119 and 83 mm. long; in the largest the bands have already begun to assume the net-form.

Jan Mayen, 60—75 metres. Michael Sars , 1900.

1 d, e and f. Three specimens, 133, 156 and 195 mm. long; the intermediate shows very distinct reticulate markings, which is far from being the case in the larger last specimen.

Northern East-Greenland (1 d from 74° 35′ N.L. 18° 15′ W.L., 150 metres; 1 e and f from 72° 25′ N.L. 17° 56′ W.L., 300 metres). Kolthoff Expedition, 1900.

All natural size.

1a 1b 1c 1d 1e 1f

Pacht & [illegible] phototyp.

Tab. IX.

Tab. IX.

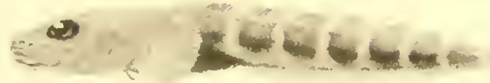
Lycodes seminudus Reinh.; p. 71.

1 a. A very young specimen, 67 mm. long, still naked, with distinct dark bands; cf. p. 76.
S. from Jan Mayen, 371 fathoms. Ingolf Expedition, 1896.

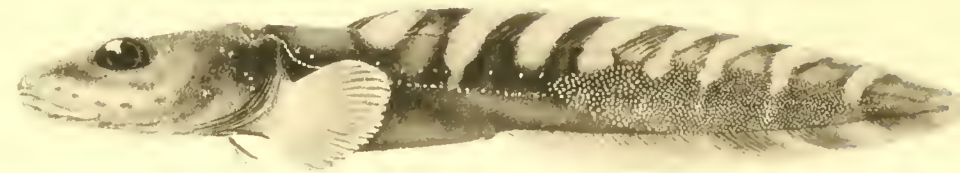
1 b, c, d and e. Four specimens, 129 (♂), 161 (♂), 218 (♀) and 280 (♂) mm. long, belonging to the variety with a distinct banded marking (cf. p. 74—75).
Northern East-Greenland (1 b and d from the mouth of Franz Joseph Fjord, 200—300 metres; 1 c from outer part of Myskoxe Bay, 200 metres; 1 e from Franz Joseph Fjord, 760 metres). Nathorst Expedition, 1899 and Kolthoff Expedition, 1900.

All natural size, except 1 e which is slightly reduced.

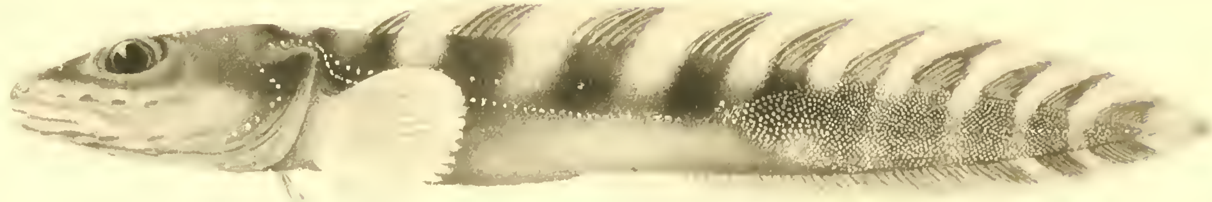
1 a



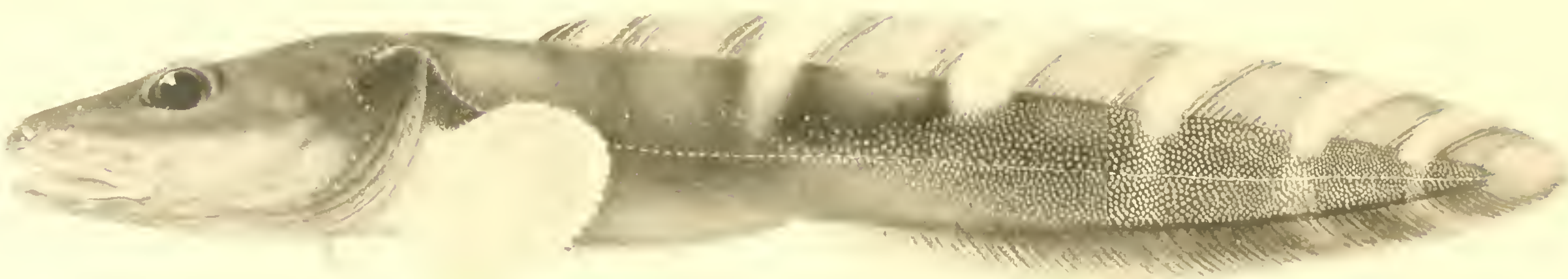
1 b



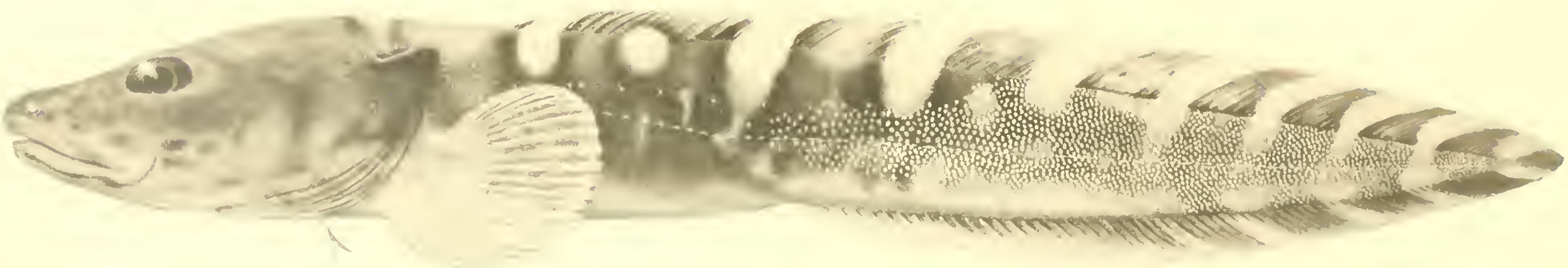
1 c



1 d



1 e



Pacht & Crone phototyp.

Tab. X.

Tab. X.

Fig. 1 a. *Lycodes seminudus* Reinh.; p. 71.

Specimen, 180 mm. long (♀), with less distinct banded marking; cf. p. 74; nat. size.

West Greenland (Jakobshavn). Copenhagen Museum.

Fig. 1 b. *Lycodes seminudus* Reinh.; p. 71.

Specimen, 335 mm. long (♀), of the uniformly coloured variety; cf. p. 74; reduced to 3/4 nat. size.

West Greenland (Umanak Fjord). Drygalski Expedition, 1893.

Fig. 2. *Lycenchelys kolthoffi* Jensen; p. 88.

Specimen, 131,5 mm. long (♂); nat. size.

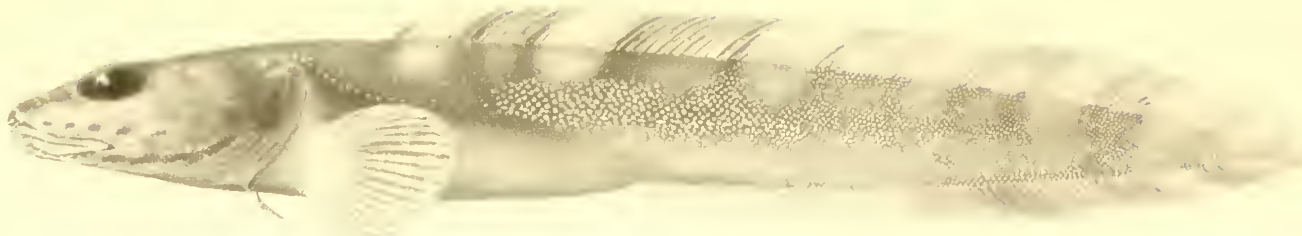
Northern East-Greenland (72° 25′ N.L. 17° 56′ W.L.), 300 metres. Kolthoff Expedition, 1900.

Fig. 3. *Lycenchelys ingolfianus* Jensen; p. 90.

The only specimen, 275 mm. long (♀); slightly reduced.

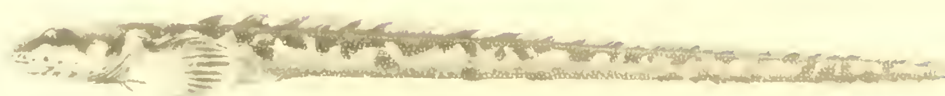
Davis Straits (64° 54′ N.L. 55° 10′ W.L.), 393 fathoms. Ingolf Expedition, 1895.

1 a

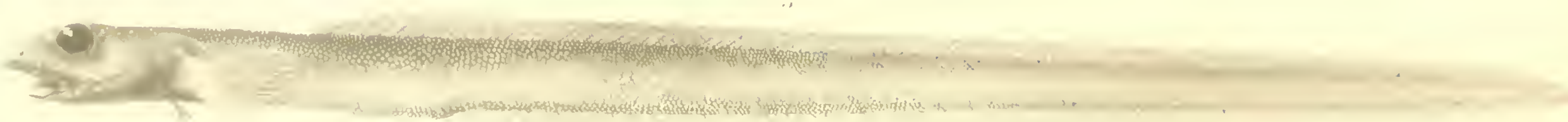


1 b

2



3



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THE DANISH INGOLF-EXPEDITION.

VOLUME II.

5.

LAMELLIBRANCHIATA.

(PART I.)

BY

AD. S. JENSEN.

WITH 4 PLATES AND 5 FIGURES IN THE TEXT.

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CONTENTS.

Lamellibranchiata, Part I.

Introduction.

The Danish Ingolf-Expedition of 1895—96 brought home a very considerable material of Mollusca from the waters round the Færoes, Iceland and South Greenland. The Expedition was planned on the lines of a deep-sea investigation and the greater part of the material collected comes therefore from great depths; of the 144 stations investigated no less than 125 have depths of over 100 fathoms.

This material is naturally of great interest; the area investigated was but little known before and an extension of our knowledge of the deep-sea fauna must be classed among the relatively rare occurrences.

Whilst working up this material I felt appreciably the lack of information regarding the distribution of the Mollusca in the coastal regions round a great part of the area. This does not apply however to Greenland; on the west coast of that country collections have been made for many years and the material has been worked up by H. J. Posselt, and from the east coast the gatherings of the expeditions of recent years have been worked up by Posselt, R. Hägg, Ad. S. Jensen and J. Grieg. From Iceland and the Færoes, on the other hand, we had, just as previously for Greenland, but incomplete and short lists of the species and, as these, mainly drawn up by O. A. L. Mörch.

This deplorable absence of material from the coastal region of Iceland and the Færoes has now been made good. In 1892 and 1893 already Mag. scient. Will. Lundbeck had collected a great number of Mollusca in the north-western fjords of Iceland during his voyage with the fishing-cutter "Prinsesse Marie" and in recent years a number of the younger naturalists, who have visited the Færoes and Iceland, have willingly met my wishes and made a special effort to collect the Molluscs of those regions.

I may thus mention in particular, that in the summers of 1898, 1899 and 1901 Mag. sc. R. Hörring made considerable collections at the Færoes and along the east and south-west coasts of Iceland during his cruises with the fishery-inspection ship the "Diana"; further, that Dr. A. C. Johansen in 1900 brought home a large collection from the east and south coasts of Iceland, also made during a summer cruise with the cruiser "Diana". In 1902 Mag. scient. A. Ditlevsen was sent out with the "Diana", in 1903 Mag. scient. C. V. Otterström with the new inspection-ship "Beskytteren", in 1904 Cand. magist. H. J. Gemzöe ("Beskytteren"), in 1905 Cand. F. Johansen ("Beskytteren") and in 1907 Cand. magist. O. Börup ("Beskytteren"); all of these brought home collections, which helped to throw light on the Molluscan fauna of the Færoes and Iceland.

Information with regard to the Molluscan fauna of our North Atlantic islands was also obtained from another side. The Icelandic botanist, Dr. Helgi Jónsson, who was dredging for algae at the Færoes and Iceland during the years 1897, 1898 and 1901, in response to my request, preserved the Molluscs collected at the same time and with great liberality presented them to the Zoological Museum of Copenhagen University. His countryman, the zoologist Bjarni Sæmundsson, has also assisted me, among other ways, by lending material from the Natural History Collection at Reykjavik.

A very considerable collection has been brought home from the Færoes by Dr. Th. Mortensen, who in 1899 carried out a series of dredgings from the gunboat "Guldborgsund" partly in the fjords, partly on the banks down to a depth of ca. 150 fm.

Lastly, Dr. Johs. Schmidt, the leader of the cruises with the research-steamer "Thor", has during several years made collections at the Færoes and Iceland and brought home a considerable and very valuable material, from the littoral right down to the abyssal region, which he has preserved for science by presenting it to the Zoological Museum of Copenhagen.

For the sake of completeness I may further mention, that during my participation in the 1902 cruise of the research-steamer "Michael Sars" under the direction of Dr. Johan Hjort, I was given the opportunity of collecting a quantity of Mollusca on the banks round about the Færoes, on the east coast of Iceland as well as north and south of the Wyville Thomson Ridge. During my voyages in West-Greenland in 1906, 1908 and 1909 I also collected a great number of Molluscs.

The present part of the work on the entire material will show, that my endeavours have been directed first and foremost to the disentanglement of the species. The determinations have been made as carefully as possible; that we can not be sufficiently critical regarding the determinations made by our predecessors, even of common and apparently well-known species, I have already shown in my small papers on *Mya* and *Tellina*.

With respect to Greenland, I have restricted myself to give a brief review of the distribution, as the works of Posselt and others have already discussed the details. For Iceland and the Færoes, on the other hand, each single place of occurrence has been mentioned, as there is a need here for all the information we can obtain — better to have too much detail than the reverse.

With regard to the synonymy lists I may remark here, that they have been intentionally divided into two sections, the first referring to the most necessary, systematic literature, whilst the second contains references to the principal, local fauna-lists.

The region dealt with here — the "bridge" between Europe and America across the North Atlantic Ocean and the slopes down to two deep-sea basins very different in hydrographical regards — offers more than ordinary interest, and many and varied problems have presented themselves for discussion as the work advanced. But the treatment of these and other conditions I shall postpone meantime, until the systematic elaboration of the material is completed.

Copenhagen, Zoological Museum,
October 1911.

Ad. S. Jensen.

Lamellibranchiata.

Part I.

Anomiidae.

Anomia.

The genus *Anomia* is represented by 2 species at the Færoes and Iceland: *Anomia squamula* L. and *Anomia patelliformis* L.

As regard the former, I am unable to agree with the prevailing view that *A. squamula* is a variety of *A. ephippium*. The latter is considerably larger and easily distinguished from the fact, that the upper (free) valve of the shell has 3 muscular impressions (one of the adductor, two of the byssus musculature; comp. Pl. I, fig. 3), whilst the upper valve in *A. squamula* only shows two muscular impressions (one of the adductor, one of the byssus muscle).

Anomia aculeata Müller (Pl. I, fig. 2 d) I take to be a variety of *A. squamula*, as there are all transitions between smooth and spinous specimens and they agree exactly in other regards, e. g. in the byssus musculature. G. O. Sars has observed correctly in so far that he only found two muscular impressions in the upper valve of *A. aculeata* and was consequently disinclined to refer *A. aculeata* as a variety to *A. ephippium*, where there are three muscular imprints[1]) on the upper valve. But Sars has not noticed at the same time, that *A. squamula* also has only two muscular impressions (Pl. I, fig. 2 c) and consequently cannot be a variety of *A. ephippium* either.

I have sought in vain for the true *A. ephippium* in my material from the Færoes and Iceland. Nor have I found this species among the material which has been collected in the course of years in the Danish waters. It is perhaps even doubtful, if *A. ephippium* occurs at Norway; I do not think it altogether inconceivable that G. O. Sars, starting from the anticipated view that *A. squamula* is a variety of *A. ephippium*, has ascribed to *A. ephippium* a distribution in Norway on this erroneous basis[2]).

Again, it is difficult enough to distinguish *Anomia patelliformis* from *A. squamula* — and probably not always with certainty; the upper valve shows only two muscular impressions in both species (comp. Pl. I, fig. 1 c with fig. 2 c). The best distinguishing marks are, that the notch in the lower valve is large, almost triangular in *A. patelliformis* (Pl. I, fig. 1 b) and the umbo a little way from the margin (Pl. 1, fig. 1 a), whereas in *A. squamula* the notch in the lower valve is small, oval (Pl. I, fig. 2 b) and the umbo entirely or almost on the margin (Pl. I, fig. 2 a).

[1]) It is not quite fortunate, when Sars describes the adductor imprint as being bi- or tripartite.

[2]) Linné also has his two species geographically separated, the main region for *A. ephippium* being given as the Mediterranean, whilst *A. squamula* lives "in Oceano Sveceo". Syst. Nat. ed 12, I, 2, 1767, p 1150 and 1151.

Anomia patelliformis Linné.

Pl. I, figs. 1 a—c.

Anomia patelliformis Linné, Syst. Nat. ed. 12, I, 2, 1767, p. 1151; Jeffreys, Brit. Conch. II, 1863, p. 34, pl. 20, fig. 2; Sars, Moll. Reg. Arct. Norv., 1878, p. 15.

Anomia patelliformis Mörch, Vidensk. Medd. Naturhist. Foren. 1867, p. 99.

Iceland.

At this island, from which it has not been known earlier, the species has been taken in recent years mostly on the south coast, rarely on the southernmost part of the west coast, from the beach down to a depth of ca. 70 fm.

West Iceland:

64°45.8′ N. L., 23°55.2′ W. L., 30 fm.	1 valve.
64°11′–64°18.5′ N. L., 22°30.5′–22°46′ W. L., 14–29 fm.	1 —
Reykjavik	1 spec.

South Iceland:

Grindavik	2 valves.
Vestmannaeyjar, shore	2 spec.
— 10—20 fm.	2 —
— ca. 20 fm.	1 —
— 30 fm., gravel with shells	12 valves.
— Heimaey, shore	13 —
63°30′ N. L., 20°14′ W. L., 42 fm.	6 —
63°21′ — , 17°31′ — , 69 fm., black sand	1 spec.
63°21′ — , 17°15′ — , 58 fm.	1 valve.
63°30′ — , 17° — , 57 fm.	1 spec. (from stomach of a cod).

The largest specimen has a length of 47 mm.

The Færoes.

When Mörch published his list of the molluscan fauna of the Færoes, only one specimen was known, locality not stated; during the latest years it has been taken at the following places:

62°29′ N. L., 7°37′ W. L., 60 fm., sand and shells	1 spec.
Ejde, 5–6 fm., coarse black sand	1 valve.
Skaalefjord, 4—10 fm.	2 —
Solmunde, on *Serpula* tubes	5 —
Kongshavn, 12—16 fm.	9 —
Vestmanhavn, 10—30 fm	1 —
5 miles N. of east point of Myggenæs, 50 fm.	1 spec. & 1 valve.
7 miles N. by E. of east point of Myggenæs, 57 fm.	2 valves.
61°40′ N. L., 7°40′ W. L., 135 fm.	1 valve.
Akralejte in N. 57 W. 12 miles, ca. 150 fm.	1 —
Færoe Bank, 58 fm.	2 valves.
61° N. L., 8°52′ W. L., 90 fm.	1 spec.

The largest specimen measures 35 mm. Among a number of specimens collected at an earlier date, the locality not stated more precise than "the Faeroes", the largest measures 40 mm. The greatest depth at which an adult specimen has been taken is 60 fm.[1]).

Distribution. Apart from South-West and South Iceland and the Faeroes, *Anomia patelliformis* occurs along the Norwegian coast from Lofoten southwards (0—40 fm.), and rarely in the northern and eastern Kattegat (10—25 fm.). It is found on all the British coasts (10—86 fm.), north and west coast of France, at Spain and Portugal, in the Mediterranean and Adriatic.

Anomia squamula Linné.

Pl. I, figs. 2 a—d.

Anomia squamula Linné, Syst. Nat. ed. 12, I, 2, 1767, p. 1151. — *Anomia ephippium* Forbes & Hanley, Brit. Moll. II, 1853, p. 325 (partim); Jeffreys, Brit. Conch. II, 1863, p. 30 (partim); Sars, Moll. Reg. Arct. Norv., 1878, p. 14 (partim?). — *Anomia aculeata* Müller, Zool. Dan. Prodrom., 1776, p. 249; Sars, Moll. Reg. Arct. Norv., 1878, p. 15, Pl. 19, fig. 1.

Anomia squamula Mörch, Vidensk. Medd. Naturhistorisk Foren. 1867, p. 98; ibid. 1868, p. 226. *Anomia ephippium* Mörch, ibid. 1867, p. 99.

The Ingolf-Expedition has taken this species at:

			Bottom-temp.	
St. 51.	E. of Iceland	68 fm.	7°32 C.	5 spec. (on *Bugula*).
- 127.	N. - —	44 -	5°6 -	8 — (on *Hornera* and *Bugula*).
- 129.	N.W. of Iceland	117 -	6°5 -	1 —
- 16.	W. - —	250 -	6°1 -	7 — (on *Serpula*, *Tubularia* and *Cidaris* spines).
- 86.	— - — (Brede Bugt)	76 -		Several hundred valves and 1 spec. on a Hydroid.
- 87.	— - — —	110 -		Several hundred valves and 3 spec. on *Arcturus Baffini* and 7 spec. on *Tubularia*.
- 98.	— - —	138 -	5°9 -	Several hundred valves and 1 spec.
- 89.	— - —	310 -	8°4 -	2 spec. (on Brachiopod and *Cidaris* spine).
- 11.	— - —	1300 -	1°6 -	3 valves (apparently old).
- 9.	— - —	295 -	5°8 -	1 spec. and 1 valve.
- 8.	S.W. - —	136 -	6°0 -	1 —
- 85.	— - —	170 -		3 valves.
- 67.	S. - —	975 -	3°0 -	1 spec., with 3 others on it.
- 54.	S. E. - —	691 -	3°9 -	1 —
- 55.	— - —	316 -	5°9 -	4 — (on *Oculina* and on *Cidaris* spine).
- 6.	— - —	90 -	7°0 -	6 — and 7 valves.
- 1.	W. of the Færoes	132 -	7°2 -	5 — (on *Cidaris* spines and on shell of *Pecten septemradiatus*).

The greatest depth at which any living specimen was taken was 975 fm., but they may have been attached to two large pieces of timber brought up in the trawl; otherwise the greatest depth was 691 fm.; the other depths lie between 44 and 316 fm.

[1]) The specimen from 90 fm. is very small, 5 mm. long.

The specimens from deep water are more or less thin-shelled and of small dimensions; of those from 170 fm. and more the largest specimen is 11.5^{mm} long. Some of the many shells from St. 86, 87 and 98 belong to the variety *aculeata*.

Besides, the tendency of the species to vary is shown in a remarkable power of changing sculpture and form according to the substratum, possessed not only by the valve which is closely adherent to the substratum but also by the free, upper valve. Thus a specimen on *Retepora* has a pitted surface on the upper valve, where the pits correspond to the openings in the network of the Bryozoa; a second specimen shows spinous ribs corresponding to the costæ of the *Pecten septemradiatus* to which it is attached; a third on a spine of a *Cidaris* shows folds or wrinkles corresponding to the longitudinal ribs of the spine; a fourth specimen attached crossways on a *Serpula* tube has sharp ridges opposite the rings of the tube, and so on. The contour of the shell is as a rule circular, but sometimes the length is considerably greater than the breadth or the reverse or the contour becomes very irregular according as the substratum restricts the growth in the one or other direction.

Iceland.

In addition to the specimens from the "Ingolf" stations, *Anomia squamula* has been taken at Iceland in recent years at other places, east, north, west and south, as is shown by the following list.

East Iceland:

Myre Bugt	26 fm.	7 spec. and 10 valves.
— —	36 -	1 —
Lónsvik	40 - , mud and clay.	1 valve.
64°27′ N. L., 13°27′ W. L.	84 -	Many spec. on *Balanus Hameri*.
The Horn N. 74 E. 9 miles	38 -	2 spec.
64°58′ N. L., 13°25′ W. L.	40 -	3 valves.
Faskrudsfjördr	50–20 - , blue clay.	1 —
Reydarfjördr	14 -	2 spec.
Vidfjördr	8–12 -	6 valves.
Nordfjördr	40 -	1 —
Seydisfjördr at Skulavig	6 -	1 spec. and 18 valves.
— — —	30 -	3 —
Bakkafjördr	12–15 - , black sand.	1 valve.
—	20–28 - , sand and clay.	1 spec.
—	32–25 - , sand and clay vith shells.	3 valves.

The largest specimen measures 15.5^{mm}.

North Iceland:

66°32′ N. L., 15°15′ W. L.	75 fm.	1 spec. and 2 valves.
Thistil Fjördr	10 -	2 — on algæ, 3 spec. on *Cyprina* and 9 spec.
— —	50 - , clay vith stones.	1 valve.

Thorshöfn	6 fm.		35 valves.
Vidarvik	11 -		2 —
—	$13^{1}/_{2}$ -	, black sand.	6 spec. and 4 valves.
Haganesvik	$3^{1}/_{2}$—4 -		5 valves.
Axafjördr	22 -	, mud.	3 spec. (1 on *Pecten islandicus*) and 7 valves.
—	30 -	, sand and stones.	18 valves.
Grjótnes	12—15 -		2 —
Skjálfandi Bugt	31 -	, fine, black sand.	1 spec. and 2 valves.
Ófjord S. of Hrisey	18 -	, clay.	1 —
— - - —	17—20 -	, stones and mud.	2 valves.
Hedinsfjördr	13 -		1 —
66°17′ N. L., 18°13′ W. L.	52 -		8 spec.
Kollafjördr	5 -		1 —
Skagastrand			15 —
Prestbakki	3—4 -		2 —
66°17′ N. L., 21°14′ W. L.	95 -		1 — (on *Bugula*)
66°36′ — , 21°57′ —	32—37 -		11 —

The largest specimen measures 20.5 mm. A few belong to the variety *aculeata*.

West Iceland:

Höfnvik	9—10 fm.		2 spec. and 3 valves.
Adalvik	6— 9 -		3 —
Isafjardardjup	60—63 -		23 —
Skutulsfjördr	2— 4 -		1 —
Arnarnes	5— 7 -		1 —
Önundarfjördr	11 -		1 —
66°8′ N. L., 24°21′ W. L.	47 -		2 — and 3 valves.
Dyrafjördr, inside Thingnæs	$10^{1}/_{2}$-$12^{1}/_{2}$ -	, ooze and small stones.	15 valves.
—	$19^{1}/_{2}$ -		2 spec.
65°52′ N. L., 23°58′ W. L.	33 -		1 valve.
Arnarfjördr	10 -		2 spec.
64°45.8′ N. L., 23°55.2′ W. L.	30 -		10 — (2 on *Hyas*).
Tálknafjördr	15 -		2 —
Stykkishólmr	6—9 -		14 —
Hvalfjördr	24 -		1 — and 25 valves.
Krossvik	8 -	, shell-gravel, blue clay, stones.	12 valves.
Faxafjördr	$14^{1}/_{2}$ -		2 spec. and 2 valves.
—	17 -	, coarse shell-sand.	ca. 100 valves.
—	14—29 -		- 13 —

Faxafjördr, ca. 3 miles N. 59 W. from Grótta lighthouse . . 25 fm.		8 valves.
—, off Kollafjördr . . 8—11½ -	mud and stones.	5 spec. and 2 valves.
—, mouth of Kollafjördr . . . . 9½—11 -	fine, black sand and mud.	12 valves.
—, off Kollafjördr . . . . 10 -		17 —
—, Keflavik . . . . . . 15—16 -	fine, black sand.	8 —
—, ca. 2 miles N. E. of Keflavik . . . . . . 19½—20½ -		10 —
—, 1 mile W. of Helgasker Vager . . . . 13—16 -		4 —
—, 1 mile W. of Helgasker Vager . . . . 14½ -		1 — (on *Pecten islandicus*).
—, E. of Videy . . . . 9—10 -	fine sand and mud.	5 —
—, 7 miles N. N. E. of Skagens light . . . 17—20½ -	sand and shells.	1 —
Reykjavik, on *Laminaria* driven on land.		ca. 80 spec.
—, at low-water mark		1 spec.
— . . . . 1½ fm.	stony bottom.	9 —
— . . . . 1½ -	gravel —	1 —
— . . . . 2—3 -	on *Laminaria hyperborea*.	15 —
— . . . . 8 -		2 —
— (Engey) . . . . 7—8½ -	mud.	1 spec. and 3 valves.
Hafnarfjördr, on the beach		10 —
— . . . . 4 fm.	sand and mud.	1 valve.
— . . . . 25 -	fine, black sand and mud.	10 —
Skagi . . . . 21 -		13 —

The largest specimen is 22 mm long. A number of specimens belong to the variety *aculeata*.

South Iceland:

63° 15' N. L., 22° 23' W. L. . . . . 170—114 fm.		2 spec. and 20 valves.
63° 18' — , 21° 30' — . . . . . . 94 -		5 valves.
63° 30' — , 20° 14' — . . . . . . 42 -		1 spec.
63° 05' — , 20° 7' — . . . . . . 293 -		3 valves.
Vestmannaeyjar, beach		14 —
— . . . . 10 fm.		2 spec. and 4 valves.
— . . . . 15—20 -		8 —
— . . . . 30 -	shell-gravel.	2 valves.
— . . . . 49 -	clay with a little mud.	ca. 100 valves.
— Heimaey, beach		70 —
62° 57' N. L., 19° 58' W. L. . . . . . . 500 fm.		2 —

63°17½' N. L., 17°39' W. L.	87 fm., black sand w. shells and stones.	3 spec. and 1 valve.
63°21' — , 17°31' —	69 - , black sand with shells.	2 —
63°21' — , 17°15' —	58 - , sand, stones and shell-gravel.	3 spec. and 25 valves.
63°24' — , 17° 5' —	70 - , black sand w. stones and shells.	4 valves.
63°30' — , 17° —	57 -	4 spec. (from stomach of cod).
63°21' — , 16°22' — . . 263—295 -		2 —

The largest specimen is 21 mm; some are of the variety *aculeata*.

The Færoes.

Anomia squamula has been frequently taken at the Færoes during recent years, from the shore down to a depth of 475 fm. The localities are the following:

Viderejde.		1 valve.
Svinö		9 spec.
Klaksvig.	10—15 fm.	25 valves.
—	11 - , on Laminaria.	32 spec.
Arnefjord	0—15 - , hard bottom.	12 —
Bordövig	7—10 - , black sand, small stones, Laminaria.	ca. 100 valves.
—	7—15 - , sand with Laminaria.	2 spec.
—	10 -	9 valves.
Ejde.	5—6 - , coarse, black sand.	72 —
Fundingsfjord.	12— ca. 20 - , coarse sand and clay.	Some spec. and many valves.
Andefjord	16—23 -	3 spec. (on *Modiola modiolus*).
Solmunde	, on *Serpula* tubes.	7 spec.
Kongshavn	12—16 fm.	5 —
Vestmanhavn	3½ - fine black sand.	8 valves.
—	4 - , sand.	1 spec.
—	4—5 -	2 —
—	5—6 - , fine, black sand.	10 valves.
—	10—30 -	Some specimens and ca. 100 valves.
Vestmansund	ca. 70 -	8 valves.
Sandevaag	on Laminaria.	10 spec.
Sörvaag	14—16½ fm., mud.	6 valves
Midvaag	7—11 -	3 —
Kalbakfjord		3 spec.
Thorshavn, outer harbour . .	12—16 fm.	3 — and 5 valves.
Glivursnæs at Thorshavn		2 —
Nolsö, beach		8 valves.
— deep hole at north end, ca. 100 fm.		Many spec. (on *Modiola modiolus*).
Sandsvaag.	, on Laminaria.	5 spec.

Kvalbö			1 valve.
Trangisvaag	6–8 fm.,	mud and clay.	4 —
—	20 - ,	on Laminaria.	40 spec.
62°29′ N. L., 7°37′ W. L.	60 - ,	sand and shells.	7 —
5 miles N. of east point of Myggenæs	50 -		80 valves.
7 miles N. by E. of east point of Myggenæs	57 -		3 —
13 miles S. of Myggenæsholm	70 -		2 —
61°40′ N. L., 7°40′ W. L.	135 -		19 spec. and 22 valves.
61°15′ — 9°35′ —	ca. 475 -		3 — — 67 —
61°7′ — 9°30′	440 -		30 valves.
61°06′ — 8°30′	61 -		2 spec.
61 — 8°52′	90 -		4 —
60°55′ — 8°56′	ca. 75 -		20 — (on Balani).
9 miles E. S. E. of Bispen	ca. 70 -		12 valves.
5 — S. S. E. —	50 -		3 —
6 — N. by W. of Kalsö	60 -		12 spec.
1½—2 miles off mouth of Bordövig	20—30 -		27 — and 5 valves.
Bordönæs in N. 75 W., 1¾ miles	30 -		60 — (on *Modiola modiolus*).
16 miles E. by S. of south point of Nolsö	80 -		5 spec. and 6 valves.
Akralejte in N. 57 W. 12 miles	150 -		2 — — 7 —
13 miles W. by S. of Munken	ca. 150 -		ca. 100 valves.
61°35′ N. L., 4°39′ W. L.	210 -		4 —

The largest specimen measures 23.5 ^{mm}. A number belong to the variety *aculeata*. The specimens from the deep localities (210—475 fm.) are thin-shelled and small (none over 11 ^{mm}.). The shells may also be very thin however in the littoral belt.

Distribution. *Anomia squamula* with the variety *aculeata* has its northern boundary in the "warm area" of the White Sea (Knipowitsch) and Murman Coast (Herzenstein). It is distributed along the whole of the Norwegian coast, from the shore down to 400 fm. (G. O. Sars), and goes through the Kattegat down to the northern part of the Great Belt and the Sound (C. G. Joh. Petersen). Towards the west it is distributed, as shown above, as far as the Færoes and round the whole of Iceland. In the Zoological Museum of Copenhagen specimens occur on *Cidaris papillata* spikes from the sea between Orkney and the Shetlands (135 fm.) and from 60°39′ N. L., 3°09′ W. L. (203 fm.) as also from many localities in the North Sea, down to a depth of 65 fm. It occurs on all the British coasts. Where the southern boundary of its distribution lies, I am unable to say, as the authors have confused this species with the more southerly *Anomia ephippium* (comp. p. 3), but it goes at least to the Bay of Biscay, where the Danish research-steamer "Thor" has taken some specimens at great depths

(43°37' N. L., 2°08' W. L.; 250—790 fm.). On the western side of the Atlantic it is distributed from Hatteras to the southernmost part of Labrador[1]).

Ostreidæ.

Ostrea edulis Linné.

[Iceland.]

In "Brit. Conchol." vol. II, 1863, p. 40 Jeffreys gives Iceland as the northern boundary for the distribution of the oyster[2]) and Mohr as his authority. If we look up the work of the latter: "Forsog til en Islandsk Naturhistorie", 1786, we find *Ostrea edulis* mentioned (p. 130), it is true, but with the addition, that it "is said to occur in Hvalfjorden" according to E. Olafsen. But in the work of Eggert Olafsen and Biarne Povelsen: "Reise igjennem Island" (2nd part, 1772, p. 1010) the record cited is followed by the remark "but we have not seen it." As no other naturalist has found the oyster at Iceland since that time, it may be deleted from the fauna.

[The Færoes.]

From here the collection of the Zoological Museum possesses quite a small oyster (length 8 mm., height 10 mm.) attached to a shell of *Modiola modiolus* and still containing the dried-up soft parts; the specimen was sent in by Sysselmand Müller in 1873.

So far as I know, this is the only evidence we have, that the oyster may occur at the Færoes[3]). It is hardly credible, however, that *adult* oysters occur at the islands, as they would scarcely have escaped attention. Nor can the small specimen referred to be considered to have been transported here as larva by oceanic currents, as no current runs from the English or other European coasts to the Færoes[4]). But experiments have perhaps at some time been made to "introduce" oysters at the Færoes.

Pectinidæ.

Pecten pusio Linné.

Ostrea pusio Linné, Syst. Nat. ed. 12, 1, 2, 1767, p. 1146. — *Pecten pusio* Jeffreys, Brit. Conchol. II, 1863, p. 51, Pl. 22, fig. 1.

Pecten (Hinnites) distortus Mörch, Vidensk. Medd. naturhist. Forening 1867, p. 98.

[1]) In a geologically very late (postglacial) period *Anomia squamula* was distributed to West Greenland, where it is now extinct; cf. Ad. S. Jensen: On the fossil quaternary Mollusc-Fauna of Greenland (Medd. om Grönland, XXIX, 1900, p. 293); and Ad. S. Jensen and P. Harder: Post-glacial changes of climate in arctic regions as revealed by investigations on marine deposits (Postglaziale Klimaveränderungen, Stockholm 1910, p. 399).

[2]) The same statement is repeated in Proc. Zool. Society, 1879, p. 555.

[3]) In his "Fauuula Moll. Insul. Færoënsium" (p. 99) Mörch cites the following passage from Landt: "it (i. e. *Anomia squamula*) is attached to small stones on the bottom at the same place as "the small oyster, *Ostrea minuta*", which he has fished up from the bottom of Vestmanhavnsfjorden close to the Vaagö side" and adds to this: "what we are to understand by Landt's *Ostrea minuta* is not clear; Landt has perhaps overlooked the hole in the shell of an *Anomia*, or he may even have meant a distorted *Saxicava*".

[4]) The Færoes are washed by the Gulf Stream, but it is improbable that the pelagic life of the oyster is of such long duration, that the larvæ could be carried the long distance across the Atlantic. Further, the specimen in question belongs to the European oyster (*Ostrea edulis*), as the muscular impression is white, not dark as in the American *Ostrea virginica* (cf. Whiteaves, Catal. of the marine Invertebrata of Eastern Canada, 1901, p. 116).

The "Ingolf" has taken this species at:

St. 87. West Iceland (Brede Bugt)	110 fm.	1 valve (height 4 mm.).

Further, *Pecten pusio* has been taken during recent years at several places on South-West and South **Iceland**, namely:

South-West Iceland:

Brede Bugt, off Hellissandur ...	20 fm.	1 valve (small).
Faxafjördr	17 - , coarse shell-sand.	10 — —
— mouth of Kollafjördr	$9^{1}/_{2}$-11 - , fine black sand and mud.	1 fragment.
Hafnarfjördr, 1 mile W. $^{3}/_{4}$ N. of Helgasker Vager	$14^{1}/_{2}$ fm.	1 spec.
Skagi	21 -	2 valves.

South Iceland:

Grindavik		1 valve.
Vestmannaeyjar	10—20 fm.	1 spec. and 1 valve.
—	30 - , gravel with many shells.	4 valves.
—	49 - , clay.	Numerous valves.
— Heimaey	shore.	17 valves.

The largest specimens are from the Vestmannaeyjar and measure:

length .... 30 mm., height .... 35 mm.

— .... 33.5 - — .... 36 -

The largest specimen from the west coast (that from Hafnarfjördr, $14^{1}/_{2}$ fm.) measures:

length .... 15 mm., height .... 18.5 mm.

The fragment from Faxafjördr, $9^{1}/_{2}$—11 fm., however, has been of considerably larger dimensions.

The Færoes.

When Mörch wrote his "Faunula Molluscorum Insularum Færöensium" he knew a specimen and a valve from the Færoes, but the locality is not stated; the specimen, which contains the remains of the soft parts, is 32 mm. high and 27 mm. long; the valve is 38 mm. high. In recent years *Pecten pusio* has been taken with the dredge at the following places:

Ejde	5—6 fm., coarse, black sand.	1 valve (small).
Vestmanhavn	10—30 -	2 —
Nolsö, deep hole at north end	ca. 100 -	2 —
7 miles N. by E. of east point of Myggenæs	57 -	1 —
5 miles N. of east point of Myggenæs	50 -	1 —
13 miles W. by S. of Munken	ca. 150 -	4 —
Færoe Bank	58 -	1 —

The largest of these valves is 36 mm. high and 26 mm. long.

Among the specimens from Iceland are some down to a size of scarcely 2 mm. The prodissoconch is smooth; immediately under it are radiating ribs, which are more or less spinous and tuberculous. Small specimens are difficult to recognize as belonging to this species, as they are relatively elongated, with the two dimensions of the shell almost the same, and the ears extremely well-developed; they might easily be confused, for example, with the young of *Pecten varius*. Medium-sized specimens still free are higher than long and of regular form. Later, the growth becomes irregular owing to the sedentary mode of life.

Distribution. In addition to South-West and South Iceland and the Færoes, *P. pusio* occurs at Southern Norway, but it has not been found living in the Danish waters inside the Skaw (a few dead, probably fossil, valves have been taken in the Eastern Kattegat). It also occurs at the British coasts ("on every rocky coast from Shetland to Cornwall"), along the coast of France and the Liberian Peninsula, through the whole of the Mediterranean right to Asia Minor. It is further distributed as far as Madeira, Canary Isles, Azores and Liberia, according to Dunker even to the Cape of Good Hope.

The vertical distribution extends at Norway from 0 to 90 fm., according to G. O. Sars, and at the British Isles from 0 to 85 fm., according to Jeffreys. Nevertheless, the latter author records the species as taken by the "Lightning" N. of the Hebrides in 530 fm. and by the "Porcupine" off the west coast of Ireland in 808 fm. Other authors also record it from great depths, thus Dautzenberg and Fischer[1]) from 1360 m. and 1494 m. at the Azores, and A. Locard[2]) from 896—2285 m. in the Bay of Biscay and north coast of Spain, as also from 1200 m. W. of the Soudan. Is it not possible that these records are based on mistakes? Or were they only dead shells which occurred at the great depths?

Remarks. *Pecten pusio* is here taken *sensu latiore*. The French malacologist A. Locard definitely maintains that the "*P. pusio*" of the authors covers two distinct species, namely: (1) a free-living species for the whole of its life, of regular form (*Pecten multistriatus* Poli); (2) a species permanently attached in adult condition, always of irregular form (*P. distortus* da Costa); the first species belongs to the Mediterranean, though exceptionally occurring in the Atlantic as far as the Bay of Biscay and coast of Liberia, whereas the latter species is exclusively an oceanic form, with a distribution from the Azores to Norway[3]). It seems to me, however, that Locard's mode of reasoning is not conclusive in the matter. Bucquoy, Dautzenberg and Dollfus seem likewise most inclined to consider *P. distortus* and *P. multistriatus* as one and the same species, *inter alia*, because both forms may be found as members of the same "colony" and thus in all probability of the same origin.[4])

Pecten opercularis Linné.

Ostrea opercularis Linné, Syst. Nat. ed. 12, 1, 2, 1767, p. 1147. — *Pecten opercularis* Jeffreys, Brit. Conch. II, 1863, p. 59, Pl. 22, fig. 3.

Pecten opercularis Mörch, Vidensk. Medd. Naturhist. Foren. 1867, p. 98.

[1]) Mém. Soc. Zool. de France, X, 1897, p. 193.

[2]) Expéd. scient. Travailleur-Talisman, Moll. Test. II, 1898, p 379.

[3]) A. Locard: Contrib. à la faune malacol Française. XI Monographie. Pecten, 1888, p. 38; idem. Exped. scient. Travailleur-Talisman, Moll. Test. II, 1898, p 377—79.

[4]) Mollusques marins du Roussillon, II, 1887—98, p. 106.

The Færoes:

Mörch's list gives this species from Kollefjord (on Strömö)[1]) and from "Fiskebanken" W. of the Færoes. In recent years *Pecten opercularis* has been dredged at the following places:

Klaksvig	10—15 fm.		1 valve.
Andefjord	16—23 -		1 —
Fundingsfjord	12—ca. 20 -	, coarse sand and clay.	1 spec. & 5 valves.
Ejde	5—6 -	, coarse black sand.	2 valves.
Vestmanhavn	5—6 -	, fine black sand.	1 spec.
—	5—13 -	mud and black sand.	1 —
—	10—30 -		1 valve.
Nolso, deep hole at north end	ca. 100 -		2 spec. & 1 valve.
Trangisvaag	1—12 -		1 spec.
62°29′ N. L., 7°37′ W. L.	60 -	, sand and shells.	1 valve & 1 fragment.
62°16.5′ — , 6°6′ —	50—60 -		10 valves.
62°16 — , 5°54′ —	50—60 -		1 valve.
5 miles N. of east point of Myggenæs	50 -		2 fragments.
7 — N. by E. of east point of Myggenæs	57 -		9 valves.
61°56′ N. L., 7°04′ W. L.	30 -		1 valve.
61°40′ — 7°40′ —	135 -		1 —
61° — 8°52′ —	90 -		2 spec. and 1 valve.
60°55′ — 8°56′ —	69 -		4 valves and some fragments.
9 miles E. S. E. of Bispen	ca. 70 -		3 valves.
6 — N. by W. of Kalsö	60 -		7 spec.
$1^1/_2$—2 miles off mouth of Bordovig	20—30 -		1 spec. and 1 valve.
16 miles E. by S. of south point of Nolso	ca. 80 -		4 spec.
13 miles W. by S. of Munken	- 150 -		7 valves.

It should be emphasized, that all the specimens taken in the fjords and at the coast itself are small, at most 24.5 mm. In the open sea round about the Færoes, on the contrary, many large individuals have been taken; the largest living specimen measures 65 mm., the largest of the empty shells 80 mm.

The specimens vary somewhat in regard to colour and sculpture, just as at other places.

Distribution. *Pecten opercularis* occurs at the Canary Isles, Madeira and the Azores. It is common in the Mediterranean (including the Aegean) and along the coasts of Europe to Southern

[1]) It is probably these specimens (collected by Iap. Steenstrup) to which Jeffreys refers, when he writes (l. c. p. 60): "Steenstrup informs me that he has found it *(P. opercularis)* in Iceland", the Færoese locality being confused with Kollafjördr in Iceland. *Pecten opercularis* has never been found at Iceland.

Norway; its northern boundary, according to Sparre Schneider, is reached in Norway at 67° N.L. It enters the Kattegat, in the southern part of which it is common, as also into the Sound to the island Hveen. In the west, as shown above, it ranges to the Færoes.

Jeffreys estimates the vertical distribution of the species at 0—180 fm., and at Norway according to Sars, it only goes down to 100 fm. and at the Færoes to 100 (150?) fm. Nevertheless, Jeffreys states that the "Lightning" and "Porcupine" Exped. have taken it N. of the Hebrides at 530 fm., W. of Ireland at 808 fm. and off the Channel at 257—690 fm., as well as off Portugal at 361 fm., but it is not stated whether these were living specimens or empty shells; from the Azores also it is given by Fischer and Dautzenberg from a depth of 1360 m.

Pecten islandicus Müller.

Pl. I, figs. 4a—b and c—d (young).

Pecten islandicus Müller, Zool. Dan. Prodrom., 1776, p. 248; Sars, Moll. Reg. Arct. Norv., 1878, p. 16, Pl. 2, fig. 2; Verrill, Trans. Conn. Acad., X, 1899, p. 72, Pl. XVI, figs. 2—5. — *Pecten Fabricii* Philippi, Abb. u. Beschreib. neuer oder wenig gekannter Conchyl., I, 1845, p. 101, Pecten Tab. 1, fig. 5.

Pecten islandicus Fabricius, Fauna groenl., 1780, p. 415; Møller, Index Moll. Groenl., 1842, p. 16; Mörch, Rink's Grönland, 1857, p. 94; Vidensk. Medd. Naturh. Foren. 1868, p. 225; Arctic Manual, 1875, p. 133; Rink's Dan. Greenland, 1877, p. 442; Becher, Österr. Polarstat. Jan Mayen III, 1886, p. 68; Posselt, Medd. om Grønland, XXIII, 1898, p. 14.

This species has been taken by the Ingolf-Expedition at the following places:

St. 31.	Davis Strait	88 fm.	1°6 C.	1 spec. (small).
- 26.	— —	34 -	0°6 -	1 —
- 127.	N. of Iceland	44 -	5°6 -	4 valves (1 with remains of soft parts).
- 87.	W. - — (Brede Bugt)	110 -		2 —, ancient in appearance.
- 86.	— - — — —	76 -		1 small spec. and several valves, ancient in appearance.
- 6.	E. - —	90 -	7°6 -	1 young spec.

West Greenland.

Very common from the southernmost parts and as far north as zoological investigations have been made, namely to Ivsugigsok (76° N. L.). The largest specimen I have seen is from Egedesminde and measures 105 mm. It occurs most frequently at depths of 15—50 fm. and prefers hard bottom. At some of the colonies (Holstensborg, Egedesminde) the Danes frequently send out men to dredge for it on the "banks", where it flourishes in quantity, especially when they have guests to whom they wish to offer this Greenland delicacy; its large adductor muscle has a very good taste and it even seemed to the malacologist H. P. C. Møller "more tender and finer in the flesh than *Ostrea edulis*". The same author states, in a manuscript, that *P. islandicus* "moves very rapidly by firm beats of the valves and can thus spring almost a foot each time; I have never seen it use the foot".

East Greenland.

Whole valves, still less living specimens, have not been found; on the other hand, some fragments have been taken in the dredge off Angmagsalik in 140 fm. (a fragment) and in Forsblads Fjord in 50—90 fm. (fragments of a larger and a smaller valve). Further, a shell fragment has been found at Rolige Bræ in the inner part of Scoresby Sound[1].

Jan Mayen.

The Austrian Expedition of 1882—83 found numerous specimens on the north side of the island, 75—95 fm. The Danish Expedition of 1900 obtained 9 living specimens and various valves on muddy bottom at a depth of 55 fm.; the largest was 86mm in height.

Iceland.

Pecten islandicus has not been found at all on the south coast but it is common on the other coasts of the island. The specimens, which are preserved in the Zoological Museum, come from the following localities:

East Iceland:

64°27' N. L., 13°27' W. L.	84 fm.	1 valve (fossil perhaps).
64°58' — , 13°25' —	40 -	1 —
Faskrudsfjördr	50—20 -	3 spec. (small).
Outer Reydarfjördr	60—80 -	2 —
Reydarfjördr	86 -	1 —
Nordfjördrs Flóin	35—55 -	1 —
Mjófifjördr	40—52 -	1 —
Seydisfjördr	10 -	1 —
— at Skulavig	6 -	1 —
Bakkafjördr	20—28 -	1 —
—	25—32 -	10 —
—	52—43 -	11 — (small)

The largest specimen is 78mm high.

North Iceland:

Haganesvik	$3^1/_2$—4 fm.	3 valves.
Axafjördr	22 -	3 spec.
—	30 -	2 valves.
Ofjord	2—3 -	1 spec.
—	11 -	2 —
66°17' N. L., 18°13' W. L.	52 -	1 —
Kollafjördr	5 -	1 —
—	10 -	1 — & 3 valves.
Veidileysafjördr	21—25 -	3 —

[1]) Cf. Ad. S. Jensen, Medd. om Grønland, XXIX, 1909, pp. 301—2 and 333.

It is naturally due to chance that all the shells brought home are small in size, none over 60^{mm}; in reality very large specimens occur at North Iceland and in extremely large quantities at places.

West Iceland:

Hesteyrarfjördr	15—17½ fm.		2 spec.
Dyrafjördr, inside Thingnæs	10—12½ -	, mud and small stones.	15 valves.
—	18 -		7 spec.
—	20 -		1 —
Bildudalr	5—7 -		1 —
Fossfjördr	44 -		2 valves.
Tálknafjördr	14 -		10 spec.
—	ca. 24 -		1 —
N.W. of Tálkni			1 — & 2 valves.
Patreksfjördr	drag-net on beach		1 —
65°17.5′ N.L., 23°24′ W.L.	28 fm.		3 —
Hvalfjördr	24 -		Several spec.
Faxafjördr, Keflavik	15—16 -	, fine, black sand.	1 fragment.
— , ca. 2 miles N.E. of Keflavik	19½—20½ -	, ooze.	1 —
— , ca. 3 miles N. 59 W. of Grótta Light	25 -		1 valve.
Reykjavik Roads			1 spec.
— — near Engey			1 —
— , Engey	7—8½ -	, ooze.	8 —
Hafnarfjördr	4—7 -		1 —
— , 1 mile E.N.E. of Helgasker Vager	11½ -	, bottom-temp. 9.3°C. (August).	6 —
— , 1 mile W.¾N. of Helgasker Vager	14½ -		4 —

Even at the southern boundary of its occurrence at Iceland the species attains a considerable size; the specimens from Hvalfjördr reach a size of up to 80^{mm}, from Reykjavik up to 95^{mm} and from Hafnarfjördr up to 78^{mm}. Outside the fjords however, it has not been taken further south than in Brede Bugt, and the living specimens from there are only 20—25^{mm}.

[The Færoes.]

In recent years a number of shells of *P. islandicus*, all large (72—90^{mm}) and with a "fossilized" appearance, have been taken with the dredge at various places out to sea round about the islands, namely:

S. of Myggenæs	from the line-fishing	1 valve	
Akralejte in N. 57 W. 12 miles	150 fm.	3	, fragments.
61°10′ N.L., 5°46′ W.L.	150—160 -	1 —	
61°21′ N.L., 5°12′ W.L.	210 -	1 —	

As no living specimens were forthcoming, it may probably be taken as fairly certain, that *Pecten islandicus* no longer lives at the islands.

Remarks. The radiating ribs of the shell begin to appear in the young immediately below the prodissoconch. In the beginning the shell is provided with very dense, concentric lines (Pl. I, figs. 4 c and d), which in the spaces between the longitudinal ribs give way later to a very characteristic rasp-like structure (distinct under the lens) (Pl. I, fig. 4a). The longitudinal ribs themselves are often smooth, but not rarely rough from down-turned spines or scales. The rasp-like sculpture is almost always present, if the shell is not too much rubbed; it may be difficult to see or has disappeared only in the cases, when the radiating ribs lie very closely and are covered with scales, but even on such specimens it can as a rule be observed on the older parts of the shell (Pl. I, fig. 4b). Curiously enough authors do not seem to have attached any weight to this good distinguishing character, and Verrill has even recently established a special variety *insculpta* (l. c., p. 73, fig. 5) for specimens with such structure; in my experience this is practically never wanting, when carefully sought for under a lens.

Some few of the Greenland and Iceland specimens belong to the variety, which Chemnitz has described and figured in Conchyl. Cabinet VII, 1784, p. 318, Tab. 65, fig. 616: the shell is thrown into undulating, radial folds. I have also a similar variety from Jan Mayen.

Distribution. *Pecten islandicus* is an arctic species, but whether it is circumpolar, as is generally stated, seems to me more than doubtful. It has been taken, it is true, at Labrador, West Greenland, Iceland and Spitzbergen, in the Barents Sea and at the entrance to the Kara Sea, but it has not been found in the Kara Sea nor in the Polar Sea of Siberia [1]); then it appears again in the Bering Sea, but it has not been met with in the Polar Sea north of arctic America [2]), any more than at the high-arctic East Greenland. In the Atlantic to the south it reaches to Cape Cod and West Norway [3]), in the Pacific to Korea and North Japan [4]). — Its vertical distribution extends in general from 5 to 50 fathoms, but sometimes it goes deeper down.

Shells ancient in appearance have been taken at many places, where it is certain the species no longer lives, e. g. at Bohuslän (Malm), in the Kattegat (C. G. Joh. Petersen), in the North Sea (Metzger), at the British coasts (Forbes & Hanley) and off the west coast of Ireland ("Porcupine").

1) The Dijmphna-Exped., which made many dredgings in the Kara Sea, only got a single small specimen, and it was not taken in the Kara Sea itself, but in the entrance (Jugor Strait). Nor was it found by the Vega-Exped. in the Polar Sea of Siberia.

2) Under the distribution of *P. islandicus*, Posselt (l. c., p. 15) notes "Wellington Channel" and Belcher as his authority. But on looking up Belcher: "The last of the Arctic voyages" (1855), where *P. islandicus* is certainly noted among the Molluscs collected by the Expedition and determined by Lovell Reeve (Vol. II, p. 396), we find the locality given as "Lievely, Greenland", i. e. Godhavn on Disko Isl. in W. Greenland, which was touched at by the Expedition both on the outward and homeward voyage. "Lievely" is the name given by the English whalers to Godhavn.

3) The southern boundary lies right down about 59° N. L., where Dr. O. Nordgaard in 1902 took a specimen off the mouth of Lysefjord (Bergens Museums Aarbog 1903, No. 8, p. 36); Dr. Nordgaard kindly permitted me to see this specimen, which was 45 mm. high and taken at a depth of ca. 24 fm. At Bergen already, where M. Sars found it, though only as small, dwarf-like specimens (50 mm. high), *P. islandicus* is rare, as it is not mentioned in Friele's or Norman's lists of the Molluscan fauna of Bergen Fjord. I have had the opportunity of seeing two specimens from the immediate neighbourhood of Bergen, taken by Dr. Nordgaard, the one in Radosund at a depth of ca. 50 fm. (height of specimen 29.5 mm.), the other, of the same size, in Alværstrommen at a depth of 16 fm. along with *Pecten opercularis*.

4) From Engineer Schönau of the Great Northern Telegraph Co., our Museum has received a specimen from the coast of Korea and one from the waters S. of Wladiwostock (42°15′ N. L., 130°43′ E. L.).

Nor can I believe, that the shells of this species stated to have been taken off the west coast of France, 748—1262 m. ("Princesse Alice") and in the Bay of Biscay, 400 m. ("Caudan") were "fresh" — unfortunately, the authors say nothing as to the condition of the shells — though Locard makes the following statement regarding *P. islandicus:* "C'est, comme on le sait, une espèce particulièrement septentrionale, qui ne vient jusque dans nos régions qu'á la condition de se propager en eaux profondes".[1])

Pecten islandicus is not a particularly high-arctic species; it lives in greatest quantity, forming whole banks of shells, at Finmarken, North Iceland and South-West Greenland as well as on the fishing banks of Nova Scotia and Newfoundland, whereas it occurs much more sparsely at Spitzbergen[2]). Mörch also remarks, that it does not grow so large in the high north[3]). As mentioned, it attains a considerable size even so far south as S. W. Iceland, where the bottom-temperature in August amounted to 9.3° C.

Pecten aratus Gmelin.

Pl. I, figs. 5a—e.

Pecten aratus Gmelin, Linn. Syst. Nat. ed. 13, 1788, p. 3327. — *Pecten sulcatus* Jeffreys, Brit. Conchol. II, 1863, p. 64; Proc. Zool. Soc., 1879, p. 557. — *Pecten aratus* Sars, Moll. Reg. Arct. Norv. 1878, p. 17, Tab. 2, fig. 3.

The "Ingolf" Expedition has taken this species at:

St. 98.	W. of Iceland	138 fm.	5.9° C.	A number of valves.
- 97.	- - —	450 -	5.5° -	1 right valve.
- 89.	- - —	310 -	8.4° -	1 spec. & 1 left valve.
- 9.	S.W. - —	295 -	5.8° -	11 valves.
- 10.	- - —	788 -	3.5° -	1 small spec. (height 6mm).
- 85.	- - —	170 -		2 valves.
- 55.	S. E. - —	316 -	5.9° -	2 spec.

At **Iceland** and the **Færoes** — where it has not been known hitherto — it has also been taken at the following places by Danish expeditions:

64°42′ N. L.,	27°43′ W. L.	426 fm.	6° C.	1 spec.
63°15′ —	22°23′ —	170—114 -		1 —
63°05′ —	20°7′ —	293 -		2 — & 13 valves.
63°12.5′ —	20°06′ —	268 -		ca. 20 spec.
61°15′ —	9°35′ —	ca. 475 -		1 spec.

The specimens to hand are rather variable both in form and sculpture. As a rule the height is somewhat greater than the length, but the two dimensions may be almost equal. In consequence of this the circumference is variable, the lower contour forming sometimes a part of an oblique oval, sometimes an almost perfect arc of a circle. The number of the primary, stronger ribs is extremely variable

1) Campagne du "Caudan", par R. Koehler, 1896, p. 207.
2) Torell: Spitsbergens Molluskfauna, 1859, p. 124.
3) Catal. des Moll. du Spitzberg, p. 27. Ann. Soc. Mal. de Belgique, IV, 1869.

e. g. 6, 8 (Pl. I, figs. 5a & b), 10 and 12. Sometimes the intermediate ribs are almost as well developed as the primary, so that the difference is not appreciable, and the sculpture then assumes a certain resemblance to that in *Pecten islandicus;* it lacks however the characteristic intercostal, rasp-like structure of the latter (Pl. I, figs. 5c & d). Each primary rib again is composed of a varying number of small ribs, which may be smooth but are usually rough (at least towards the periphery) from the presence of small, erect scales (Pl. 1, fig. 5e). All the specimens to hand are grayish-yellow to straw- or orange-yellow (elsewhere the colour is described as purple-red or rose-red). The largest specimens measured:

Length	Height	Breadth
29.5 mm	30 mm	7.5 mm
29.5 -	29.5 -	8 -
28.5 -	29 -	7 -
24.5 -	27 -	7 -

Distribution. *Pecten aratus* ranges from Morea through the Mediterranean to the Atlantic off Soudan ("Talisman"), Pyrenean Peninsula, France and Ireland, as also north of Shetland [1]); further, it occurs from Bohuslän along the coast of Norway to Lofoten [2]). Lastly, the Danish investigations have shown that it goes south of the Færoes and south of Iceland and a good way up into the Denmark Strait. Its vertical distribution is placed by Jeffreys at from 20 to 530 fm.; the "Ingolf" however has taken a living (though small) specimen at a depth of even 788 fm. (St. 10).

Among the synonyms of this species Jeffreys gives *Pecten bruci* Payraudeau, but French and Italian authors do not agree with him here. After examining a specimen of *P. bruci* (from Corsica) sent to our Zoological Museum by Marchese di Monterosato, I consider there is no doubt, that Jeffreys is right; this means at the same time that *P. aratus* is distributed in the Mediterranean.

Pecten septemradiatus Müller.

Pl. I, figs. 6a—c (var. *scaber*).

Ostrea septemradiata Müller, Zool. Dan. Prodr., 1776, p. 248. — *Pecten septemradiatus* Jeffreys, Brit. Conchol. II, 1863, p. 62, Pl. 23, fig. 1.

This species has been taken by the "Ingolf" at the following stations:

St. 98.	W. of Iceland	138 fm.	5.9° C.	Fragments of numerous valves.
- 89.	- - —	310 -	8.4° -	1 spec.
- 9.	S.W. - —	295 -	5.8° -	1 spec. and 8 valves.
- 8.	- - —	136 -	6.0° -	Fragments of 4 —
- 85.	- - —	170 -		— - 7 —
- 55.	S. E. - —	316 -	5.9° -	1 spec.
- 6.	- - —	90 -	7.0° -	2 valves.
- 1.	N.W. of the Færoes	132 -	7.2° -	7 spec.

1) During my participation in the cruise of the "Michael Sars" in 1902, I obtained a specimen at 60°21.5' N.L., 3° 55' W.L., 148 fm.

2) Noman's record of its occurrence right up at 71° 12' 30" N.L., 20° 30' 30" E.L., 135 fm. seems hardly credible and is based in all probability on an erroneous determination (Niederländ. Arch. f. Zoologie, Suppl. Bd. 1, 1881—83, No. 10 p. 3).

In recent years, further, it has been taken at other places at Iceland and the Færoes, namely:

Iceland.

63°15′ N. L., 22°23′ W. L. .... 170—114 fm.	2 spec. and 23 valves.
63°18′ — 21°30′ — .... 94 -	1 fragment.
63°05′ — 20°07′ — .... 293 -	11 valves.
63°12.5′ — 20°06′ — .... 268 -	1 valve.

Færoes.

62°29′ N. L., 5°17′ W. L. .... 191 fm.	2 valves.
61°40′ — 7°40′ — .... 135 -	ca. 25 valves.
61°15′ — 9°35′ — ...... ca. 475 -	3 valves.
61°09′ — 7°54′ — .... 180 -	2 spec. and 5 valves.
61°07′ — 9°30′ — .... 440 -	1 valve.
61°06′ — 9°21′ — .... 210 -	1 —
Akralejte in N. 57 W. 12 miles ca. 150 -	9 spec. & numerous valves.
13 miles W. by S. of Munken - 150 -	1 valve.

Pecten semptemradiatus is thus quite common round the Færoes and the south and south-west of Iceland, which has not been known hitherto. It does not enter the fjords, however, occurring only in the open sea. It has been taken at depths of 90—475 fm. (living specimens however only from 132—316 fm.).

The specimens to hand from Iceland and the Færoes show no small variation with regard to the sculpture of the shells. Compared with typical specimens (from the Kattegat) they have on the whole more numerous folds (8—13) (Pl. I, figs. 6a—b) and are very distinctly radially striated on the left shell. Some specimens are smooth, in others again the radiating stripes of the left shell are rough from the presence of small, down-turned scales; lastly, the specimens from stations 9 and 89 of the "Ingolf" have not only the stripes on the left valve densely beset with such sharp scales (Pl. I, fig. 6c), but likewise have the stripes which lie between the radiating folds of the right valve provided with small spines. Had transitions not been present, one might have been tempted to consider the last-named specimens as belonging to an independent species; it will now be most correct to call this, the most strongly spined form, by the name of var. *scaber*.

At the Færoes and Iceland the species attains to a considerable size; the largest specimens measure:

Length 55 mm	Height 52 mm	Breadth 13 mm
— 55 -	— 55 -	13.5 -

Distribution. According to Locard[1]) *Pecten septemradiatus* does not live in the Mediterranean, but is an oceanic species occurring off West Africa (Sahara), at the Canaries, the French Atlantic coast and in the Channel. At the northern parts of the British Isles, as also in the southern Skager Rak

[1]) A. Locard: Contrib. à la faune malacol. française, XI, Monogr. Pecten, 1888, p. 90; idem: Rés. scient. de la camp. du "Caudan", 1896, p. 211. English authors are said to have confused with *P. septemradiatus* the more southerly *P. flexuosus* Poli (= *P. inflexa* Poli; *P. Dumasii* Payraudeau). Cf. also Bucquoy, Dautzenberg et Dollfus: Les Moll. marins du Roussillon, II, 1887—98, pp. 69—70; cf. also, however, the record of the occurrence of *P. septemradiatus* at Bouches du Rhône, p. 802.

and in the eastern Kattegat (its southern boundary lies in the Sound at Hveen Island). Further it is very common along the Norwegian coast, right up to Varanger Fjord (70° N.L.) and, as shown above, our knowledge of its distribution has been extended to embrace also the Atlantic at the Færoes and at south and south-west Iceland. — The bathymetric distribution extends from 15 to over 300 fm.

M. Sars considered *P. septemradiatus* (*P. danicus* Chemn.) as an arctic species[1]), and G. O. Sars inclines to the same view, as his father has found the same species very common in the fossil condition in the older glacial marl. As will have been seen from the above list, the "Ingolf" has only taken this bivalve at localities with fairly high temperature; nor has the species been found elsewhere, where the conditions are "arctic" in the hydrographical sense of the word. As it is inconceivable, that the above authors could have made an erroneous determination of this easily recognized species, I venture to conclude that *P. septemradiatus* belongs to a layer, which has been deposited under milder climatic conditions. I notice also, that W. C. Brogger has put forward quite the same view. He writes namely[2]): "When we see, what a considerable size this species attains to in the Isocardia-clay (up to more than 62 mm), there is no reason for believing it to be originally an arctic species, the less so, as it does not occur at all in the living or fossil, high arctic fauna. It is therefore undoubtedly a typically boreal species".

Pecten tigrinus Müller.

Pecten tig(e)rinus Müller, Zool. Dan. II, 1788, p. 26, Tab. 60, figs. 6—8; Jeffreys, Brit. Conchol. II, 1863, p. 65, Pl. 23, fig. 2.

Pecten tigerinus Mörch, Vidensk. Meddel. Naturh. Foren. 1868, p. 226 and p. 229.

The "Ingolf" has taken this species at:

St. 86. W. of Iceland (Brede Bugt) 76 fm. 9 valves (fragments).

Iceland.

Jeffreys gives "Iceland" as the home of this pretty species, as also Mörch, who mentions Torell as his authority. In addition to the above locality from the "Ingolf", *P. tigrinus* has been taken in recent years at the following places at South Iceland:

63°15′ N.L., 22°23′ W.L.	170—114 fm.		1 valve.
63°30′ — , 20 14′ —	42 -		1 —
Vestmannaeyjar	30 -	gravel with shells.	3 —
—	49 -	clay with a little mud.	5 —
63°21′ N.L., 17°31′ W.L.	69 -	black sand.	2 —
63°21′ — , 17°15′ —	58 -	sand, stones, shell-gravel.	15 —
63°24′ — , 17° 5′ —	70 -	black sand w. stones and shells.	1 spec. and 9 valves.

The largest of these shells measures: length 21.5 mm, height 22 mm.

[1]) M. Sars: Fossile Dyrelevninger fra Quartærperioden, 1865, p. 127.

[2]) W. C. Brogger: Om de senglaciale og postglaciale nivåforandringer i Kristianiafeltet, 1900—1901, p. 469.

Færoes.

In an appendix to "Faunula Moll. Insul. Færöensium" Mörch (l. c.) has added *P. tigrinus* to the fauna of the islands, without however stating the locality. In recent years it has been taken at many places round the islands at depths of 20—150 fm., as will appear from the following list:

Vestmanhavn	10—30 fm.	1 valve.
Nolso, deep hole at north end	ca. 100 -	1 spec. and 1 valve.
62°29′ N.L., 7°37′ W.L.	60 -	2 valves.
62 16′ — , 5°54′ —	50—60 -	5 —
5 miles N.E. of east point of Myggenæs	50 -	2 —
7 — N.by E. - - — - —	ca. 57 -	1 —
13 — S. of Myggenæsholm	ca. 70 -	28 —
61°40′ N.L., 7°40′ W.L.	135 -	6 —
61°06′ — , 8°30′ —	61 -	2 —
60°55′ — , 8°56′ —	69 -	1 —
5 miles S.S.E. of Bispen	50 -	1 —
9 — E.S.E. - —	ca. 70 -	22 —
6 — N.by W. - Kalsö	60 -	2 —
1 1/2—2 miles off mouth of Bordövig	20—30 -	1 spec.
16 miles E.by S. of S. point of Nolsö	ca. 80 -	4 valves.
Akralejte in N.57 W. 12 miles	ca. 150 -	1 spec. and 10 valves.
13 miles W.by S. of Munken	ca. 150 -	1 — - 90 —

The largest of these shells measures: length 32^{mm}., height 31.5^{mm}.

These shells from Iceland and the Færoes vary greatly in regard to form, sculpture and colour. Forbes and Hanley have given the following description which agrees well with our shells: "Sometimes the surface is otherwise smooth, sometimes there is a marginal belt of narrow and very closely disposed depressed radiating costellæ; occasionally these latter extend over the whole shell with or without the presence of about five principal radiating ribs, which are rounded, generally broad, and variable in amount of elevation (var. *costata* Jeffreys)".[1] In the last variety the margin of the shell is sometimes inflexed.

Distribution. *P. tigrinus* is distributed along the west coast of Europe from the north of Spain to West Finmarken, also over the Færoes to South and South-West Iceland; it goes further into the Kattegat. The vertical distribution is given by Jeffreys as 5—180 fm.

Remarks on *P. tigrinus* and *P. striatus*.

Pecten tigrinus and *P. striatus* are as a rule most readily distinguished from one another by the hindmost ears in the former being almost rudimentary, but well-developed in the latter; further, the radiating ribs in *P. striatus* are beset with short vaulted spines or prickles, whereas these are lacking in *P. tigrinus*. Sometimes, however, it is not at all easy to separate them, as the posterior

[1]) Forbes and Hanley: A history of British Mollusca, II, 1853, p. 286

ears in *P. tigrinus* may be fairly large, and the hindmost part of the shell may show a trace of being echinated; on the other hand, the number of the spined ribs in *P. striatus* may be limited to two, even to one along the anterior edge of the shell, whilst the whole of the remaining part of the shell in form and sculpture agrees with *P. tigrinus*.

Pecten striatus Müller.

Pecten striatus Müller, Zool. Dan. II, 1788, p. 26, Tab. 60, figs. 3—5; Jeffreys Brit. Conchol. II, 1863, p. 69, Pl. 23, fig. 4.

Pecten striatus Mörch, Vidensk. Meddel. Naturh. Foren. 1867, p. 98.

At **Iceland** the "Ingolf" Expedition took this fragile species at:

St. 98.	W. of Iceland (Brede Bugt)	138 fm.	5.9° C.	4 valves.
- 86.	- - — — —	76 -		8 —
- 87.	- - — — —	110 -		3 —
- 6.	S.S.E. of —	90 -	7° C.	3 spec. & 1 valve.
- 51.	— - —	68 -	7.32° -	1 — - 1 —

It has later been taken at Iceland at the following places:

63°15′ N. L., 22°23′ W. L.	170—114 fm.	1 spec. and 12 valves.
63°21′ — 17°31′ —	69 -	3 valves.
63°21′ — 17°15′ —	58 -	1 valve.

The largest of these shells is 20 mm. high.

At the **Færoes**, where it had already been noted by Mörch, *P. striatus* has been taken at the following places:

Thorshavn, outer roads	12—16 fm.	1 valve.
Nolso, deep hole at north end	ca. 100 -	1 spec.
61°40′ N. L., 7°40′ W. L.	135 -	1 valve.
16 miles E. by S. of south point of Nolso	- 80 -	7 spec. and 1 valve.
Akralejte in N. 57 W., 12 miles	- 150 -	5 valves.
13 miles W. by S. of Munken	- 150 -	3 —

The largest of these shells is 22.5 mm. high.

Distribution. *P. striatus* occurs in the Western Mediterranean (from Sicily) and ranges along the west of Europe to West Finmarken in Norway; it goes over the Færoes to South and South-West Iceland[1]). It enters the Kattegat as far as Hellebæk and Samso. The vertical distribution is given by Jeffreys to be from 5 to 180 fm.

Regarding its relation to *P. tigrinus*, see notes under the latter.

[1]) The record given by Becher, that the Austrian Expedition has taken the species on the north side of Jan Mayen, 140—180 m. (Österr. Polarstat. Jan Mayen, 1886, III, p. 68) is undoubtedly based on an erroneous determination.

Pecten imbrifer Lovén.

Pl. II, fig. 1 (var. *major*) & fig. 2 (var. *minor*).

Pecten imbrifer Lovén, Index Moll. Scand., 1846, p. 31; Dall, Bull. Mus. Comp. Zool. Harvard Coll. XII 1886, p. 220, Pl. IV, fig. 4; Friele & Grieg, Norw. North-Atlantic Exped., Mollusca III, 1901, p. 8. — *Pecten mamillatus* M. Sars, Christ. Vid. Selsk. Forh. 1873, p. 12. — *Pecten Hoskynsi* G. O. Sars, Moll. Reg. Arct. Norv., 1878, p. 20, Pl. 2, fig. 1; var. *major* Leche, K. Sv. Vetensk. Akad. Handl. 16, No. 2, 1878, p. 35; Collin, Dijmphna-Togtets zool.-bot. Udbytte, 1886, p. 453; var. *pustulosus* Verrill, Trans. Conn. Acad. V, 1882, p. 581, Pl. 42, fig. 22. — *Cyclopecten pustulosus* Verrill, Trans. Conn. Acad. X, 1899, p. 70, fig. 1 & p. 83, Pl. 19, figs. 3, 4; Verrill & Bush, Proc. Unit. Stat. Nat. Mus. XX, 1898, p. 839, Pl. 85, figs. 5, 6, 10, 11. — *Cyclopecten subimbrifer* Verrill & Bush, Trans. Conn. Acad. X, 1899, p. 84; Proc. Unit. Stat. Nat. Mus. XX, 1898, p. 840, Pl. 85, figs. 8, 9. — *Pecten lucidus* Nomann, Niederländ. Arch. f. Zool., Suppl. Bd. I, 1881–82, No. 10, p. 2, Pl. 1, figs. 5, 6, 7, 8.

Pecten Hoskynsi Friele, Nyt Mag. f. Naturvidensk. 24 Bd., 1879, p. 222; Becher, Österr. Polarst. Jan Mayen, 1886, III, p. 68. — *Pecten imbrifer* Posselt, Medd. om Grønland, XIX, 1895, p. 66; ibid. XXIII, 1898, p. 12; Jensen, ibid. XXIX, 1905 (1909), p. 332; Hägg; Arkiv för Zoologi, Bd. 2. 1904, No. 2, p. 30; var. *lamellosa* Posselt, Medd. om Grønland, XXIII, 1898, p. 13, Pl. 1, fig. 1.

Pecten imbrifer has been taken by the "Ingolf" at:

St. 115.	S. of Jan Mayen	86 fm.	0.1° C.	1 valve.
- 116.	- - —	371 -	—0.4° -	3 spec. and a number of valves.
- 98.	W. of Iceland	138 -	5.9° -	ca. 35 spec.
- 97.	- - —	450 -	5.5° -	1 spec. and 3 valves.
- 87.	- - —	110 -		1 valve.
- 90.	- - —	568 -	4.4° -	3 valves (fragments).
- 9.	- - —	295 -	5.8° -	1 valve.
- 85.	S.W. - —	170 -		7 valves.
- 81.	- - —	485 -	6.1° -	ca. 65 spec.
- 54.	S. - —	691 -	3.9° -	2 valves.
- 59.	E. - —	310 -	—0.1° -	3 —
- 143.	N. of the Faeroes	388 -	—0.4° -	1 spec.

West Greenland.

During my cruise with the "Tjalfe" I took *P. imbrifer* in Davis Strait at:

66° 22′ N. L., 57° 16′ W. L. .... 360 fm. 6 spec.

The Swedish Expedition of 1871 found it in Umanak Fjord at 397 fm. and in Baffins Bay at 227 fm.

East Greenland.

Danish Expeditions have taken *P. imbrifer* at the following places:

Off Scoresby Sound	167 fm.	1 valve.
Forsblads Fjord	50 -	1 —
— —	50—90 -	ca. 125 spec.

The Swedish Expedition of 1900 took *P. imbrifer* at:

S. E. of Pendulum Island (74°35' N. L.)	79 fm.	1 spec.

Jan Mayen.

In addition to at the above stations of the "Ingolf", *P. imbrifer* has been taken by the Norwegian North-Atlantic Exped. at a depth of 263 fm. (bottom-temp. — 0.3° C.) and by the Austrian Exped. at a depth of 75—95 fm.

Iceland.

In addition to at the 8 "Ingolf" stations, *P. imbrifer* has been taken by the "Thor" at:

63°05' N. L., 20°7' W. L.	293 fm	1 spec. and 10 valves.
62°57' — 19°58' —	500 - .	1 — - 9 —

The Færoes.

As well as N. of the Færoes, as noted above, *P. imbrifer* has been taken (by the "Thor") S. W. of the Færoes, at:

61°15' N. L., 9°35' W. L.	ca. 475 fm.	12 spec. and 25 valves.

Remarks. The specimens to hand of *Pecten imbrifer* from East Greenland and from Jan Mayen differ from the Atlantic specimens (W., S. W. and S. of Iceland, as well as S. W. of the Færoes) in attaining to a greater size, namely 15—22 mm. for full-grown specimens, against 10—12 mm. in the Atlantic, as also in the fact, that the posterior ears of the shell are relatively large (cf. in Pl. II figs. 1 a, b, c, d, e and f with figs. 2 a and b).

On the whole the Polar Sea form probably reaches a greater size than the Atlantic. The specimens brought home by the Dijmphna Exped. from the Kara Sea measure up to 21 mm., and Leche records the maximum size from the Kara Sea as 22 mm.[1]); Friele and Grieg give 20 mm. as being not uncommon for high-arctic specimens, whereas the species does not become more than 11 mm. at the Norwegian coast. Leche for his specimens found it convenient to set up a var. *major*; I quite agree with this and propose therefore to call the southern, smaller form var. *minor*. So far as my experience goes, the variety *major* also differs from the more southerly form by having as a rule the posterior ears of the shell relatively large (comp. in Pl. II figs. 1 a—f (var. *major*) with figs. 2 a—b (var. *minor*)). I am of opinion, therefore, that the forms *major* and *minor* represent geographical subspecies, connected respectively with the "cold" (or transitional belt to this) and the "warm" area in the deeper regions.[2])

Within each of these subspecies there are numerous modifications in regard to the sculpture of the left valve. Posselt (l. c.) has some pertinent remarks on this point. Whilst Posselt received his impressions from "a consideration of the figures cited", I have been able to observe the transitions on the material before me and I may take the opportunity of illustrating these not uninteresting conditions by some figures.

[1]) In the Vega-Exped. Vetensk. Iakttagelser III, 1883, p. 452 Leche records the species from the Bering Sea with an even greater size, namely 30 mm., but the specimens in question I have had the opportunity of seeing in the Riks-Museum at Stockholm, do not belong to this species.

[2]) The specimens from St. 59 and St. 143 of the Ingolf, with negative temperatures, are small but seem, to judge fom the relatively large, posterior ears of the shell, to be the young of var. *major*.

The lines of growth on the right valve appear as numerous, low and sharp folds, whilst the left valve, in addition to similar folds, bears in general radially arranged, pored, small vesicles (Pl. II, figs. 1 g—h), the number of which increases towards the periphery, new ones arising regularly in the interspaces.

Closer consideration shows, that the vesicles have the lower edge free and that they are simply outgrowths of the concentric lamellæ. Thus, we may find some specimens, in which the left valve in regard to sculpture only differs in the main from the right by some few, distant rows of very small, pocket-like outgrowths (Pl. II, fig. 1 a), but generally their number is large (fig. 1 b). Other specimens have larger and fewer, rather vaulted outgrowths (fig. 1 c). In others again the vesicles are so broad and flat, that they almost meet one another (fig. 1 e). Lastly, we find in the variety *lamellosa* Posselt (fig. 1 f) a form where the vesicles are fused together to concentric, porous wrinkles, formed of projecting, down-turned lamellæ, which at their lower free margin reach to and rest on the next wrinkle; the lamellæ are in general interrupted and broken, so that only remnants of them remain as sharp combs. The vesicular outgrowths are also broken off more or less and their position is then shown as a concavity in the line of growth; sometimes almost all the vesicles are rubbed off, so that the lines of growth appear like the cogs on a cog-wheel (fig. 1 d & 1 i). Among other variations it may further be mentioned, that the upper part of the shell may be almost completely smooth and the outgrowths appear only towards the margin, as shown in fig. 2 a; lastly, fig. 2 b represents a specimen in which the left valve is almost quite smooth.

I would not have entered so much into detail on these points had not Prof. A. E. Verrill and Miss Katherine Bush raised these variations to the rank of species; their *Pecten pustulosus* and *P. subimbrifer* are in fact based on specimens such as are represented in my figures 1 c and 1 d.

Distribution. The form *major* is an arctic, deep-water form (30—400 fm., perhaps even deeper, 650 fm.[1]), occurring at East Greenland, Jan Mayen and Spitzbergen, in the Barents Sea and the Kara Sea[2]). The form *minor* is an Atlantic, deep-water form, which occurs in Davis Strait and off the east coast of the United States of North America, down to ca. 40° N. L., along West and South Iceland, S. of the Færoes and at the western and northern coasts of Norway. The "Thor" has taken it S. E. of the Færoes (61°25′ N. L., 4°39′ W. L., 210 fm.) and in the North Sea (58°32′ N. L., 4°18′ E. L., 147 fm.). How far the species goes southwards along the west coast of Europe cannot be stated[3]), as *P. imbrifer* is said not to be identical — as assumed earlier — with the Mediterranean-Atlantic *P. Hoskynsi* Forb.[4]).

Pecten vitreus Chemnitz.

Pallium vitreum Chemnitz, Conch. Cab. VII, 1784, p. 335, Pl. 67, Fig. 637 a. — *Pecten vitreus* G. O. Sars, Moll. Reg. Arct. Norv., 1878, p. 21, Pl. 2, fig. 5; Jeffreys, Proc. Zool. Soc. 1879, p. 561; Smith, Chall. Rep. XIII, 1885, p. 303. — *Palliolum vitreum* Verrill, Trans. Conn. Acad. X,

1) St. 192 of the Norweg. North-Atlantic Exped. lies at 69°46′ N. L., 16°15′ E. L., with a depth of 649 fm. and bottom-temp. of —0.7° C., but I have not seen specimens from here.

2) Leche's record of its occurrence in the Bering Sea is due to an erroneous determination, as shown on p. 26 note 1.

3) Dautzenberg & Fischer record it right down at the Azores (Dragages effectués par l'Hirondelle et par la Princesse Alice; Mém. Soc. Zool. France 1897, T. 10, p. 192).

4) Cf. Dall, Bull. Mus. Comp. Zoology, XII, 1886, pp. 214 and 220.

1899, p. 66, Pl. 18, figs. 6—13. — *Pecten abyssorum* (Lovén M. S.) G. O. Sars, Moll. Reg. Arct. Norv., 1878, p. 22, Pl. 2, fig. 6. — *Chlamys Chaperi* Dautzenberg & Fischer, Mém. Soc. Zool. France X, 1897, p. 190, Pl. 5, figs. 5—8.

Pecten vitreus Posselt, Medd. om Grønland, XXIII, 1898, p. 11.

This species has been taken by the "Ingolf" Expedition at:

St. 28.	Davis Strait	420 fm.	3.5° C.	3 spec.
- 25.	—	582 -	3.3° -	3 — and 1 valve.
- 98.	W. of Iceland	138 -	5.9° -	1 — - 4 valves.
- 90.	—	568 -	4.4° -	3 valves.
- 10.	—	788 -	3.5° -	7 spec. and 1 valve.
- 9.	—	295 -	5.8° -	2 — - 1 —
- 8.	S. W. of Iceland	136 -	6 ° -	3 valves.
- 80.	—	935 -	4 ° -	1 valve.
- 78.	—	799 -	4.5° -	2 spec. and 32 valves.
- 73.	—	486 -	5.5° -	2 —
- 69.	S. of Iceland	589 -	3.9° -	1 — and 6 valves.
- 68.	—	843 -	3.4° -	3 —
- 39.	—	865 -	2.9° -	7 —
- 67.	—	975 -	3 ° -	6 — and 3 valves.
- 40.	—	845 -	3.3° -	16 —
- 7.	—	600 -	4.5° -	1 —
- 46.	W. of the Færoes	720 -	2.4° -	1 —

The largest of these specimens (from St. 25) measures: length 25 mm., height 25.5 mm., breadth 8 mm.; the second largest (from St. 40): length 19 mm., height 19.5 mm., breadth 7 mm.

Further, *P. vitreus* has been taken by the "Thor" at the following places:

Iceland.

63°05' N. L.,	20°7' W. L.	293 fm.	1 spec. and 5 valves.
63°12.5' —	20°06' —	268 -	7 — - 1 valve.
62°57' —	19°58' —	500 -	1 — - 40 valves.
62°10.5' —	19°36' —	ca. 1000 -	3 —
63°21' —	16°22' —	263—295 -	3 —

Færoes.

61°8' N. L.,	9°46' W. L.	450 fm.	1 spec. (on spine of *Cidaris*).
61°15' —	9°35' —	ca. 475 -	6 — and 17 valves.

Remarks. Examination of the numerous specimens at hand has led me to the same view as that held by Jeffreys, Norman, Verrill, Friele and Grieg, namely that *P. abyssorum* (Lovén)

Sars is only a variety of *P. vitreus* Chemn.[1]) On the one hand, there are all transitions from the densely scaled to the perfectly smooth specimens; on the other, we find specimens which have just as thin valves and just as small ears as *P. abyssorum* in combination with a sculpture such as we find in *P. vitreus*.

Distribution. The investigations of the "Ingolf" show that *Pecten vitreus* does not enter into the "cold" area, but keeps to places with positive bottom-temperature (2.4°—6° C.) in the southern part of the Davis and Denmark Straits, also south round Iceland over to the Færoes, in 136 to 975 fm.[2]) On the European side the species ranges from Lofoten along the Norwegian coast, 50—650 fm. (Sars), into the northern part of the North Sea, ca. 150 fm. ("Thor") and down into the Skager Rak, ca. 240—350 fm. ("Thor"). Further, it occurs between the Færoes and Hebrides, 229—650 fm. ("Lightning"), off the west coast of Ireland, France and the Pyrenean Peninsula, 90—994 fm. ("Porcupine"), in the Bay of Biscay, ca. 340—895 fm. ("Caudan"), N. of the Azores, 2240 fm. ("Travailleur-Talisman"), at the Azores, ca. 445—840 fm. ("Princesse Alice")[3]), at the Canaries and W. of Morocco and Soudan, ca. 85—1100 fm. ("Travailleur-Talisman"), Sargasso Sea, 1650 fm. (id.) as also in the Mediterranean (to Sicily). In the Western Atlantic it occurs off Nova Scotia and Newfoundland, 57—400 fm. and further south as far as Florida, going down to a depth of 1537 fm. off Chesapeake Bay (Verrill). It has also been taken off the west coast of Patagonia, 140—400 fm., at the Philippines, 100—700 fm. and at the south of Japan, 345 fm. ("Challenger").

Pecten similis Laskey.

Pecten similis Laskey, Mem. Wern. Soc. I, 1811, p. 387, pl. 8, fig. 8; Jeffreys, Brit. Conchol. II, 1863, p. 71, Pl. 23, fig. 5.

At **Iceland** the "Ingolf" has taken this species at:

St. 98. W. of Iceland.	138 fm.	5.9° C.	8 valves
- 86. - - — (Brede Bugt)	76 -		6 —
- 87. - - — —	110 -		1 —
- 85. S.W. - —	170 -		1 spec. and 15 valves.
- 6. S.E. - —	90 -	7.0° C.	3 -

The largest of these specimens (St. 98) measure: length 7mm, height 6.25mm.

Further, *P. similis* has been taken S. of Iceland at

63° 15′ N. L., 22° 23′ W. L.	170—114 fm.		Numerous spec.

as well as at the following places at the **Færoes**:

Klaksvig.	10—15 fm.		2 valves.
Fundingsfjord	12—ca. 20 -	coarse sand	23 —
Vestmanhavn	5—6 -	fine black sand	2 —
61° 40′ N. L., 7° 40′ W. L.	135 -		5 —

[1]) In his great work on the Mollusca from the "Expéd. scient. du Travailleur et du Talisman" (T. II, 1898, p. 398) A. Locard maintains the opposite view.

[2]) Posselt records a specimen from Sukkertoppen (almost in the same latitude as St. 28 of the "Ingolf") at 15—20 fm., but the specimen has certainly not been living at this shallow depth.

[3]) It can be seen from the figures, that *Chlamys Chaperi* Dautzenberg and Fischer (l. c.) is identical with the present species.

13 miles S. of Myggenæsholm	ca. 70 fm.	85 valves.
9 - E. S. E. of Bispen	- 70 -	ca. 100 valves.
6 - N. by W. of Kalsö	60 -	1 spec.
16 - E. by S. of south point of Nolso	80 -	1 valve.
13 - W. by S. of Munken	- 150 -	24 —

This pretty little Pecten was not known earlier from Iceland or from the Færoes.

Distribution. *Pecten similis* ranges from the Gulf of Aegina through the Mediterranean, from Madeira along Europe to West Finmarken and into the eastern Kattegat; over the Færoes it reaches to South and South-West Iceland. According to Jeffreys it is also said to occur at Jamaica and Korea. The same author gives its vertical distribution at from 2 to 300 fm.

Pecten groenlandicus Sowerby.

Pecten vitreus (non Chemnitz) Gray, Parry's first voyage, 1820, Suppl. to App. p. 245. — *Pecten groenlandicus* Sowerby, Thes. Conch. II, 1842, p. 57, Pl. 13, fig. 40; Sars, Moll. Reg. Arct. Norv. 1878, p. 23, Pl. 2, fig. 4. — *Camptonectes groenlandica* Verrill, Proc. Unit. Stat. Nat. Mus., XX, 1898, p. 837, Pl. 85, fig. 7.

Pecten grönlandicus Mörch, Rink's Grønland, 1857, p. 94; Medd. Naturh. Foren. 1868, p. 226; Arctic Manual, 1875, p. 133; Rink's Dan. Greenland, 1877, p. 442; Friele, Nyt Mag. f. Naturvidensk., 24 Bd., 1879, p. 222; Becher, Österr. Polarst. Jan Mayen, III, 1886, p. 69; Posselt, Medd. om Grönland, XIX, 1895, p. 65; ibid. XXIII, 1898, p. 9; Hägg, Ark. f. Zoologi, 1904, Bd. 2, No. 2, p. 28; Jensen, Medd. om Grønland XXIX, 1905 (1909), p. 331.

The "Ingolf" has taken this species at:

St. 24.	Davis Strait	1199 fm.	2.4° C.	2 valves.
- 115.	S. of Jan Mayen....	86 -	0.1° -	Numerous spec.
- 116.	— - -	371 -	−0.4° -	1 valve.
- 126.	N. of Iceland......	293 -	−0.5° -	3 —
- 128.	— -	194 -	0.6° -	17 —
- 127.	— -	44 -	5.6° -	3 —
- 85.	S.W. of -	170 -		20 —
- 18.	- - -	1135 -	3° -	1 —
- 81.	- - -	485 -	6.1° -	4 spec.
- 69.	S. - -	589 -	3.9° -	6 valves.
- 40.	- - -	845 -	3.3° -	1 —
- 4.	E. - -	237 -	2.5° -	2 —
- 58.	- - -	211 -	0.8° -	3 spec. and a number of valves.
- 59.	- - -	310 -	−0.1° -	1 spec.

West Greenland.

At the northern part *Pecten groenlandicus* has been taken by Swedish Expeditions in Umanak Fjord and in Baffins Bay, 12—227 fm., by the Fox Exped. in Melville Bay and at Cape York. On the American side it is known right up to 81°41' N. L. (Discovery Bay).

East Greenland.

Here *P. groenlandicus* has been taken both by Danish and by Swedish Expeditions at the following places:

Off Angmagsalik	25—40 fm.	clay.	15 spec.
Tasiusak	30—50 -		9 —
Odesund	5—15 -	stones with algæ.	2 —
Cape Dalton	9—11 -	clay with small stones.	1 fragment.
Off Henry Land	ca. 20 -	stones.	1 valve.
Turner Sound	ca. 3 -		1 spec. and 1 valve.
Hekla Havn	3—11 -		ca. 20 spec.
Hurry Inlet	10 -	clay.	- 50 —
Fleming Inlet	118 -	red clay.	1 valve.
Mouth of Forsblads Fjord .	14— 3 -		ca. 70 spec.
Forsblads Fjord	90—50 -	clay with sharp stones.	6 spec.
Cape Borlase Warren	10 -	Laminaria.	1 —
Sabine Island.		—	4 —
S. E. of Hvalros Island . . .	42—53 -	mud and stones.	Numerous spec.
S. E. of Pendulum Island . .	79 -	- - -	2 spec.

It has thus been found at many places over the distance from 65°35' N. L. to 74°35' N. L. and reaches the considerable size of 28.5mm. (Forsblads Fjord).

Jan Mayen.

According to Friele *P. groenlandicus* is common at a depth of 30—100 fm.; the Danish Expedition of 1900 took over 300 living specimens at a depth of 55 fm. and on ooze bottom, and the "Ingolf", as mentioned, found numerous specimens at a depth of 86 fm. on muddy bottom; the Austrian Exped. also dredged up numerous specimens. It reaches a length of 22mm.

Iceland.

In addition to the "Ingolf" stations mentioned, *P. groenlandicus* has been taken at the following places by Danish Expeditions:

5 miles E. of Seydisfjördr (east coast)	135 fm.	1 spec.
6—7 miles N. of Borgarfjördr (N. W. coast)	85 -	1 —
N. E. of Lánganes (N. W. coast)	70 -	1 fragm. (on tube of *Onuphis*).

Also on the S. coast of Iceland at:

63°05' N. L., 20°7' W. L.	293 fm.	Numerous spec.
62°57' — 19°58' —	500 -	12 spec. & 23 valves.

Færoes.

P. groenlandicus has been taken off the islands at:

63°15' N. L., 9°35' W. L.	270 fm.	2 spec.
63°03' — 9°28' —	275 -	1 — & 4 valves.
61°15' — 9°35' —	ca. 475 -	ca. 150 spec.
61°7' — 9°30' —	440 -	10 spec. & 19 valves.

Distribution. *Pecten groenlandicus* occurs further at Spitzbergen (30–260 fm., Norweg. North-Atlantic Exped. and others), Finmarken (30—150 fm., Sars), in the Barents Sea (7—250 fm., "Will. Barents") and the Kara Sea (5—125 fm., "Dijmphna", Leche) as also in the Siberia Sea as far as to 116° E. L. (15—36 fm., "Vega"). It has not been met with in the Bering Sea, and it is therefore doubtfully circumpolar. On the other hand, it occurs in the arctic seas N. of America, in the western part of Davis Strait, as well as off Newfoundland (130—224 fm., Verrill). In high-northern seas it is one of the most frequent Molluscs and occurs in such incredible numbers, that the trawl can take it sometimes by hundredweights (cf. Krause, Mollusken von Ostspitzbergen, Zool. Jahrb. Abth. f. Syst. 6. Bd., p 341).

Apart from its arctic distribution *P. groenlandicus* has also another, in the Atlantic. As shown above, it has been taken in the Atlantic S. of Iceland and S. of the Færoes; Jeffreys records it from the waters N. of the Hebrides (542 fm.), W. and S. of Ireland (257—517 fm., "Lightning" and "Porcupine"); the "Thor" has taken it off the Channel (625–670 fm.), the "Caudan" in the Bay of Biscay (500 and 740 fm.), the "Travailleur" and "Talisman" also in the Bay of Biscay (365—610 fm.) and N. of Spain (570—625 fm.), the "Josephine" between the Azores and Gibraltar (550 fm.), the "Travailleur" and "Talisman" W. of Morocco and W. of Soudan (410—05 fm.).

Remarks. In high-northern regions *P. groenlandicus* reaches a considerable size; at E. Greenland, we have heard, it becomes up to 28.5 mm. long, at Jan Mayen 22 mm., in the Kara Sea 28 mm.[1]), at Spitzbergen even 32.5 mm.[2]). In comparison with these sizes all my specimens from the true Atlantic are very small; the largest is only 10.75 mm. I believe therefore, that the *P. groenlandicus* living in the Atlantic is a dwarf-form. With this agrees also Locard's remark regarding the specimens taken by the "Travailleur-Talisman", that they belong to a var. *minor*[3]) and Jeffreys' statement that the specimens taken by the "Porcupine" Exped. off the British Isles were "young only"[4]); I believe, that the species in the warm Atlantic is already full-grown at a size, which in the Polar Sea would still be considered young.

As it is still constantly stated, that the left valve is considerably larger than the right, I may say J. Collin is perfectly right when he writes (l. c., p. 452): "in most .... the valves are of the same

1) Collin has introduced the term var. *major* for specimens from the Kara Sea; Dijmphna-Togtets Zool.-bot. Udbytte, 1886, p. 452.

2) N. Knipowitsch: Zool. Ergebn. d. russ. Exped. nach Spitzbergen. Moll. und Brachiop. I, p. 79; Ann. Mus. Zool. St. Pétersbourg, T. VI, 1901.

3) Expéd. scient. du Travailleur et du Talisman; Moll. Test. II, 1898, p. 399.

4) Proc. Zool. Soc., 1879, p. 560.

size, only in a few does the margin of the left valve extend a trifle beyond that of the right, without however bending over it" and p. 453 (under *Pecten Hoskynsi* Forbes var. *major* Lech.): "in all very thin-shelled *Pecten*-forms the weakest valve gives way at the edge, when the animal retracts strongly on dying, thus producing the characteristic concavity, which runs concentrically with the margin of the shell, the sculpture markings on the right valve giving this a greater firmness".

In his diary written on the Danish East Greenland Expedition of 1900, the young zoologist Soren Jensen, since dead, entered the following observations regarding *P. groenlandicus*: ". . . . this small bivalve is able to swim when fully-developed. It opens and shuts the valves, beating the water out during the latter process with considerable force and thus moving backwards through the water. The specimens which lay on the bottom of a glass with water, could in this way "gape" their way right up to the surface".

Pecten frigidus Jensen.

Pl. I, figs. 7 a—f.

1876. *Pecten fragilis* Jeffreys, Ann. Mag. Nat. Hist. (4) XVIII, p. 424 (partim).
1877. *P. fragilis* Friele, Nyt Mag. f. Naturvidensk., 23 Bd., 1877, II, p. 2.
1879. *P. fragilis* Jeffreys, Proc. Zool. Soc. Lond., p. 561 (partim), Pl. 45, fig. 1 ad dextram.[1]
1879. *P. fragilis* Friele, Catal. d. auf d. norw. Nordmeerexped. bei Spitzbergen gef. Mollusken; Jahrb. Deutsch. Mal. Gesellsch. VI, p. 264.
1901. *P. fragilis* Friele & Grieg, The Norwegian North Atlantic Exped., Zool., Mollusca III, 1901. p. 8.
1902. *P. biscayensis* Friele (non Locard), Moll. d. ersten Nordmeerfahrt d. Fischereid. "Michael Sars" 1900; Bergens Museums Aarbog 1902, No. 3, pp. 3, 15 & 17.
1904. *P. frigidus* Jensen, Vidensk. Medd. fra den naturhist. Foren. i Kbhvn. 1904. p. 305 (cum fig.).
1904. *P. fragilis* Hägg, Arkiv för Zoologi, Bd. 2, 1904, No. 2, p. 30.
1905. *P. frigidus* Bavay, Mém. de la Soc. Zool. de France, T. XVII, 1905, p. 189, Pl. 17, fig. 4.

The shell a little higher than long, irregularly suborbicular, with the anterior and lower margins forming together a semicircle and the posterior margin sligthly arched or almost straight, compressed, the right valve flatter than the left, translucent silvery white. The valves very thin, fragile, with concentric folds, to the number of about 12 in the adult, broad in the middle of the shell, narrowing towards the lateral margins, with numerous fine, elevated, radiating striæ. The auricles small, unequal, the posterior the smallest, faintly marked off from the shell, the anterior distinctly marked off from the shell, the left triangular, the right with an acutely angulated sinus for the byssus. Hinge-margin straight, pit for the cartilage very small, triangular; the internal surface shining. Length 27^{mm}., height 29^{mm}., breadth 6.5^{mm}.

Distribution: The ice-cold depths of the Norwegian Sea, from Spitzbergen down towards Iceland, the Færoes and Shetland, 579—1539 fm.

[1] The figure to the left represents, so far as the contour is concerned, the same valve seen from the inside, but provided with a form and sculpture as if seen from the outside.

This species has been taken by the "Ingolf" at:

St. 125	729 fm.	—0.8° C.	Fragments of 2 valves.
- 113	1309 -	—1 ° -	8 spec. and some fragments.
- 117	1003 -	—1 ° -	6 spec. and ca. 14 valves.
- 118	1060 -	—1 ° -	10 spec. and ca. 50 valves.
- 112	1267 -	—1.1° -	Fragment of 1 valve.
- 119	1010 -	—1 ° -	25 spec. and ca. 20 valves.
- 111	860 -	—0.9° -	1 spec. and 14 valves.
- 120	885 -	—1 ° -	3 — - ca. 20 valves.
- 110	781 -	—0.8° -	4 —
- 102	750 -	—0.9° -	ca. 25 valves.
- 103	579 -	—0.6° -	1 spec.
- 104	957 -	—1.1° -	10 spec. and ca. 80 valves.
- 105	762 -	—0.8° -	3 — - 2 valves.

These 13 stations all lie between Jan Mayen, Iceland and the Færoes, with depths of 579—1309 fm. and bottom-temperature of —0.6°——1.1° C. According to Friele and Grieg (l. c.) it was taken at 12 of the stations of the Norweg. North-Atlantic Exped., from Spitzbergen down towards the Færoes and Shetland; the depths varied from 658—1539 fm., the bottom-temperature from —1°——1.6° C. It was also found again in 1900 by the "Michael Sars" N. of the Færoes, at a depth of ca. 1100 fm. and with a bottom-temperature of —1.12° C. (according to Friele, l. c. 1902), likewise in 1900 by the Nathorst Exped. between Greenland and Jan Mayen (72°42' N. L., 14°49' W. L.) and at depth of ca. 1050 fm. (19 spec.). Lastly, the "Thor" in 1903 took 3 shells off N.E. Iceland at 66°19' N. L., 10°45' W. L., 766 fm., bottom-temp. —0.95° C.

Pecten frigidus must be considered the most characteristic Bivalve of the ice-cold depths of the Norwegian Sea, both in regard to size of individuals and numbers.

The variation is fairly small, being confined to some changes in the strength of the radiating striæ and contour of the shell. As a rule the shell is a little higher than long (Pl. I, figs. 7a & b), sometimes the two dimensions are approximately equal (Pl. I, figs. 7c & d). The specimens figured measure:

Height	Length
28.5 mm.	26.5 mm.
27 -	26.5 -

Quite small specimens have the ears of the shell comparatively enormously large, as is shown in fig. 7f, which represents a specimen 2 mm. long. Even in the full-grown the ears of the shell may be of slightly different size (cf. figs. 7a & b with figs. 7c & d), but are yet on the whole comparatively very small, by which means the species is distinguished from the nearly related *P. pudicus* Smith and *P. undatus* Verrill and Smith (see p. 36).

P. frigidus, as indicated in the diagnosis, is not exactly symmetrical and it obviously rests on the flattest (right) valve, as this is always "clean", whereas the left valve is covered with Foraminifera, worm-tubes, Scalpellum etc.

Remarks on "*Pecten fragilis* Jeffreys" [1].

As I find myself able to clear up the obscurity which has hitherto rested over this species of Jeffreys, I take this opportunity of making a few remarks in this regard.

Pecten fragilis was founded by Jeffreys in 1876 (Ann. Mag. Nat. Hist. (4) 18, p. 424) for a species taken by the "Valorous" Expedition in the North Atlantic, between Ireland and South Greenland, at depths of 1450, 1750 and 1785 fm. At the same time Jeffreys reports, that the Norweg. North-Atlantic Exped. had taken the same species during its cruise of 1876, at 1000—1500 fm.; this latter information must have come through H. Friele (of Bergen), to whom the working up of the Mollusca of the Norwegian Expedition was entrusted, sending Jeffreys a specimen of this Pecten of the northern ocean, which the latter has identified as belonging to his North Atlantic species.

In 1879 Jeffreys again mentions *Pecten fragilis*, in the report on the Mollusca collected by the "Lightning" and "Porcupine" Expeditions (Proc. Zool. Soc. Lond. 1879, p. 561), a specimen having been taken by the "Porcupine" in 1869 off the west coast of Ireland in 420 fm. On this occasion two figures of the shell are given (l. c. Pl. 45, fig. 1).

In the same year Friele stated, that *P. fragilis* Jeffreys was common over the whole of the deep "cold area" from the Færoe-Shetland Channel to Spitzbergen.

On comparing the "fragile" Pecten found by the "Ingolf" Expedition in great depths in the "cold area" with the *P. fragilis* Jeffr. figured in the Proc. Zool. Soc. 1879, Pl. 45, fig. 1 *to the right*, it was evident to me, that it must be the same species, and that fig. 1 *to the left* on the same Plate must have arisen from the artist turning the right valve round and publishing it as left valve, as it has the auricular sinus (for the byssus) and is on the whole a copy of the right valve.

I had some doubts, however, as to how far the figure to the right had really been drawn from one of the original specimens of the "Valorous" Expedition, as it is stated regarding these in Jeffreys' paper of 1876: "Fragments only"; nor could I believe, that the specimen of the "Porcupine" Expedition had served as basis for the figure, as it is designated "young", whilst the figure in question represents a fairly large specimen. To still further increase the confusion, it is stated in Jeffreys' diagnosis of 1876: "the lower valve has a few slight concentric ribs, but no longitudinal striæ", which does not agree with my specimens from the depths of the Norwegian Sea (nor with Jeffreys' figure) and "ears .... equal in size", which does not agree either.

I had my suspicions, therefore, that the figure in the Proceedings of the Zool. Soc. had been drawn from a specimen from the deep arctic basin, sent to Jeffreys by Friele. I therefore asked Dr. A. C. Johansen, who was at that time studying at the British Museum in London, to examine into this matter, and through the friendly assistance of Mr. E. A. Smith, the Director of the Malacological Department, Dr. Johansen was able to send me the following information.

From the "Valorous" Expedition there were only rather poor fragments of "*Pecten fragilis*

[1]) These remarks are a translation from my earlier article, written in Danish, on *Pecten frigidus* l. c.).

Jeffreys", of which a couple of very small pieces show similar characteristic, concentric folds which mark the *Pecten* of the Norwegian Sea, whilst others and larger pieces obviously belong to another type. The specimen from the "Porcupine" Expedition is entire, but only ca. 10 mm. long. — Under the name of *P. fragilis*, further, there were found a right and a left valve from the waters of Spitzbergen, sent by H. Friele, but the left valve was in pieces; these valves proved to be completely identical with a specimen from the "Ingolf" Expedition, which I had sent Dr. Johansen for comparison.

The explanation of the matter is now quite clear; Jeffreys has identified the fragments from the "Valorous" Expedition with the deep-water *Pecten* taken by the Norwegian North-Atlantic Expedition a year later; the diagnosis has been based on the specimen from the deep basin of the Norwegian Sea, but as the left valve of this specimen was in pieces, Jeffreys has made use of the larger fragments from the "Valorous" Expedition; these belong, however, to quite a different type, obviously without striation, since they reminded Dr. Johansen of *P. groenlandicus* — from this has come the passage, which has caused so much trouble to authors: "the lower valve has .... no longitudinal striæ". Later, in the paper of 1879, Jeffreys' artist has replaced the fragmentary left valve in another way, namely, by placing the right valve on its convex side, taken its contour and furnishing it with a sculpture, as if it was seen from the outer side. I need not refer to the manner in which other authors have sought to explain the difficulties caused in this way.

It is not at all certain, therefore, that the fragile Pecten of the Norwegian Sea with concentric folds is identical with the North Atlantic *P. fragilis* Jeffreys from the "Valorous" Expedition; on the contrary, I feel convinced, that there are two species, nearly related yet distinct, and for the following reasons.

From the Western Atlantic off the United States (37°38'40" N. L., 73°16'30" W. L., 1423 fm.) Verrill and Smith have described a *Pecten undatus*, which agrees in all regards with the *Pecten* of the Norwegian Sea except that *the ears of the shell* are *considerably larger*, for which reason it must be considered a different species from the arctic deep-water form. It is more reasonable to conclude, therefore, that the fragments of the Atlantic *P. fragilis* Jeffr. from the "Valorous" Expedition and the small specimen from the "Porcupine" belong to the same species as *P. undatus* Verrill & Smith than to the species living in the deep water of the Norwegian Sea under quite different physical conditions. For this reason I have given the form from the Norwegian North-Atlantic and "Ingolf" Expeditions a new name: *frigidus*, meaning, that it lives at temperatures which are constantly under 0° C.

In the same year (1885) in which *P. undatus* was founded, E. A. Smith described a *Pecten pudicus* from the Southern Ocean E. of Marion Island (46°46' S. L., 45°31' E. L., 1375 fm.), which likewise shows a great resemblance to my form from the northern cold area, but has in common with *P. undatus* the relatively large ears and will perhaps on direct comparison prove to be identical with the latter.

Pecten (Hyalopecten) dilectus Verrill & Bush from the east coast of North America, 1813 fm., will also probably prove to belong to *P. undatus* as its younger developmental stage.

If these suppositions prove to be well-founded, the synonymy of the Atlantic form will then be as follows:

Pecten undatus Verrill & Smith[1].

1876. *Pecten fragilis* Jeffreys, Ann. Mag. Nat. Hist. (4) XVIII, p. 424 (partim). — Northern Atlantic (between Ireland and Greenland), 1450—1785 fm.

1879. *P. fragilis* Jeffreys, Proc. Zool. Soc. Lond. p. 561 (partim) (non Pl. 45, fig. 1). — W. of Ireland, 420 fm.

1885. *P. undatus* Verrill & Smith, Trans. Conn. Acad. VI, p. 444, Pl. 44, fig. 21. — Off Virginia, 1423 fm.

1885. *P. pudicus* E. A. Smith, Chall. Rep., XIII, Lamellibranchiata, p. 302, Pl. 21, fig. 8. — Southern Ocean E. of Marion Island, 1375 fm.

1888. *P. biscayensis* Locard, Contrib. à la faune malacologique française, XI Monogr. des esp. app. au Genre Pecten, p. 144. — Bay of Biscay, "zones profondes".

1897. *Chlamys (Pseudamussium) pudica* Dautzenberg & Fischer, Mém. Soc. Zool. de France, 10, p. 191. — Azores, 1846 fm.

1898. *Pecten Biscayensis* Locard, Expéd. scient. du Travailleur et du Talisman, Moll. Test. II, p. 400. — N. of Spain, 1353 m.; off Santander, 1960 m.; W. of Soudan, 2635 m.

1898. *Hyalopecten dilectus* Verrill & Bush, Proc. Unit. Stat. Nat. Mus., 20, p. 836, Pl. 97, fig. 9. — Off Marthas Vineyard, 1813 fm.

1899. *H. dilectus* Verrill & Bush, Trans. Conn. Acad., X, p. 90.

1899. *H. undatus* Verrill & Bush, ibid., Pl. 18, fig. 5.

To this species I refer a fragment of a left valve, taken by the "Ingolf" at

St. 18. Entrance to the Denmark Strait........... 1135 fm. 3.0° C.

Pecten maximus Linné.

Ostrea maxima Linné, Syst. Nat. ed. 12, 1, 2, 1767, p. 1144. — *Pecten maximus* Jeffreys, Brit Conchol. II, 1863, p. 73, Pl. 24.

A fragment, ancient in appearance, of a large valve (the ventricose right valve) was obtained by me in the dredge on **Færoe Bank** (60°55' N. L., 8°56' W. L.) at a depth of 69 fm.

Distribution. The Western Mediterranean[2]) and along Europe from the Canary Isles and Madeira to Scotland, Southern Norway, Skager Rak and Bohuslän.

Amussium lucidum Jeffreys.

Pl. II, figs. 3a—c.

Pleuronectia lucida Jeffreys, in Wyville Thomson's Depths of the Sea, 1873, p. 464, fig. 78.[3]) — *Amussium lucidum* Jeffreys, Ann. Mag. Nat. Hist. (4) XVIII, 1876, p. 425; Jeffreys, Proc.

[1]) The name *Pecten fragilis* Jeffreys cannot be taken into consideration, as on the one hand, as shown, it embraces heterogenous forms, on the other it has been used, as Locard has shown, both by Chemnitz and by Montagu for other species. More doubtful is the question between the names *undatus* and *pudicus*, as they were brought into use in the same year.

[2]) Cf. Monterosato: Revision de quelques Pecten des mers d'Europe (Journ. de Conchyliologie, 1899, Nr. 3, p. 1).

[3]) Dall is of opinion, that only the figure to the left represents *A. lucidum*, whereas the figure to the right (b) is of another species, namely *A. Pourtalesianum*; Bull. Mus. Comp. Zool., vol. XII, No. 6, p. 211.

Zool. Soc. 1879, p. 562; Smith, Challenger Report XIII, Lamellibranchiata, 1885, p. 317, Pl. 24, fig. 2; Fischer & Dautzenberg, Mém. Soc. Zool. de France, 10, 1897, p. 193; Locard, Expéd. scient. du Travailleur et du Talisman, Moll. Test. II, 1898, p. 406.

The shell slightly oblong-orbicular, the anterior margin more strongly curved outwards than the posterior, which slopes fairly steeply down towards the ventral margin, compressed, the right valve flatter than the left, somewhat translucent, glistening. The valves thin, the left almost smooth or only with the margin provided with more distinct, concentric lines, the right valve on the other hand with strong, rather dense, slightly elevated, concentric striæ. Beaks small, little prominent, least on the right valve. The ears well-developed, the posterior a little smaller than the anterior, with lamellæ-like lines of growth; the anterior ear on the right valve with a small sinus at the base. The hinge-margin straight, cartilage-pit small, triangular. The internal surface shining, with 10—15 elevated radiating ribs, translucent on the outer side as milk-white stripes. Height 8.5 mm., length 9 mm., breadth 2.3 mm.

It has been taken by the "Ingolf" Expedition at

St. 10. Denmark Strait............. 788 fm. 3.5° C............. 1 spec. and 10 valves.

The above diagnosis, which is based on the specimens of the "Ingolf" Expedition, agrees on the whole with that given by Jeffreys in Ann. Mag. Nat. Hist. (1876). A couple of small differences, I believe, can be satisfactorily explained. For example, Jeffreys gives the number of radiating ribs as 9, but the figure in Thomson's book shows 10; further, Edg. Smith found 11 on two shells preserved in the British Museum and 14 usually on the "Challenger" specimens. Jeffreys says nothing as to a byssal sinus in the anterior ear of the right valve, but that such is present can be seen in the figure given by Edg. Smith.

Distribution. *Amussium lucidum* has a wide distribution within the northern and tropical Atlantic[1]: off the entrance to the Denmark Strait, 1450 fm. ("Valorous"); 49°27′ N. L., 13°33′ W. L., ca. 1100 fm. ("Thor"); N. and W. of Spain, 580—1100 fm. and N. of the Azores, 2240 fm. ("Travailleur", "Talisman"); the Azores 1000 fm. and 725—1010 fm. ("Challenger", "Princesse Alice"); W. of Morocco and W. of Soudan, 500—1385 fm. ("Travailleur", "Talisman"); off Pernambuco in Brazil, 675 fm. ("Challenger").

Limidae.

Lima loscombii Sowerby.

Lima loscombii Sowerby, Genera .... of shells, 1820—24, Lima, fig. 4; Jeffreys, Brit. Conchol. II, 1863, p. 85, Pl. 25, fig. 4.

At the **Færoes**, where it has not been known earlier, the species has been taken in recent years at the following places:

16 miles E. by S. of south point of Nolso.......	ca. 80 fm.	1 valve.
13 — W. by S. of Munken................	- 150 -	1 —
60°55′ N. L., 8°56′ W. L.........................	69 -	1 —

[1] The form from the Southern Ocean referred by Jeffreys (l. c. 1879) to *A. lucidum* as a variety *(striata)* has been separated by Edg. Smith (l. c., p. 316) as an independent species: *A. meridionale*.

The largest of these shells (from the last-mentioned locality) measures 17 mm.

Its **distribution** extends from Lofoten along Europe and Africa as far as the west coast of Soudan, also into the Mediterranean to the Aegean. From the Skager Rak it goes into the south-eastern Kattegat.

G. O. Sars gives its vertical distribution as from 5—100 fm., Jeffreys from 5—205 fm. Yet it is stated, that the "Porcupine" has taken it at great depths (4, 5 and 6 hundred fm. on the line Falmouth-Gibraltar, in the Mediterranean even at 1456 fm.).

Lima excavata Fabricius.

Ostrea excavata Fabricius, in Schröter's Naturgeschichte, II, 1780, p. 117. — *Excavata Fabricii* Chemnitz, Conch. Cab., VII, 1784, p. 355, Pl. 68, fig. 654. — *Lima excavata* Jeffreys, Proc. Zool. Soc., 1879, p. 564, Sars, Moll. Reg. Arct. Norv. 1878, p. 24, Pl. 3, fig. 1; Locard, Expéd. scient. du Travailleur et du Talisman, Moll. Test. II, 1898, p. 409. — *Radula (Acesta) excavata* Dautzenberg & Fischer, Mém. Soc. Zool. de France, X, 1897, p. 186.

This beautiful species has been taken by the "Thor" at 3 places **S. of Iceland**, namely at:

63°05′ N. L., 20°7′ W. L.	293 fm.	1 valve and some fragments.
63°12.5′ N. L., 20°06′ W. L.	268 -	4 spec. and 7 valves (height 27.5—87 mm.), along with a quantity of *Oculina*.
63°21′ N. L., 16°22′ W. L.	263—295 -	1 spec. (height 56 mm.), along with living *Oculina (Lophelia) prolifera*.

Although these specimens attain to a very considerable size (87 mm.) they are yet far from the maximum size of the species; Sars gives the size of Norwegian specimens as "almost equal to a palm of the hand", and our Zoological Museum possesses specimens from the Trondhjems Fjord up to a size of 160 mm.

Distribution. *Lima excavata* is best known from Norway, especially from Hardanger Fjord. G. O. Sars (l. c.) ascribes to it the following distribution: West Finmarken, Lofoten and West Norway, 150—400 fm.; to this O. Nordgaard adds the following remark: "On our coast the species is limited to the great fiord depths with their particularly constant temperature and salinity (6—7° C., about 35 ‰). As the Vest Fiord is the most northern of the principal fiords where these physical conditions prevail, I am inclined to think that the mention of this species from Finmark must be a mistake. The northern limit should be looked upon as Lofoten, until there is definite information that it is distributed still further northwards." [1])

Lovén [2]) records it from Bohuslän, without stating however whether living specimens were obtained.

Further information regarding this species is given by Jeffreys (l. c.); the "Lightning" took it N. of the Hebrides, 189 fm. ("A hinge and a part of the valves, quite fresh and united by the cartilage. Perhaps taken by a fish on the Norwegian coast, and carried out to sea" (!), and the "Porcupine"

[1]) Nordgaard: Hydrogr. and biolog. investig. Norwegian Fiords, 1905, p. 175.

[2]) Öfvers. Kgl. Vetensk.-Akad. Förh. 3, 1846, p. 186.

obtained it at three stations off the S. W. coast of Portugal, 292—718 fm. ("Fragments of old and young specimens. Semifossil?").

Next, it is mentioned by Dautzenberg and Fischer (l. c.) from the Azores, 595—900 fm. and by Locard (l. c.) W. of Soudan, 335—1380 fm.[1])

It is found as postglacial fossil in Norway, up to a size of 160 mm.[2])

Lima gwyni Sykes.

Pl. II, figs. 4a—c.

Lima elliptica Jeffreys, Brit. Conch., II, 1863, p. 81; V, 1869, p. 169, Pl. 25, fig. 2; Proc. Zool. Soc. 1879, p. 563; Locard, Expéd. scient. du Travailleur et du Talisman, Moll. Test. II, 1898, p. 418. — *Lima gwyni* Sykes, Journ. of Malacol., X, 1903, p. 104.

The "Ingolf" has taken this species at:

St. 6.	S. of Iceland	90 fm.	1 valve.
- 81.	S. W. of Iceland	485 -	1 —

Further, it has been taken at **Iceland** at the following places:

63°15' N. L., 22°23' W. L.	114—170 fm.		11 valves.
63°18' — 21°30' —	94 -		1 valve.
Vestmannaeyjar	68—70 -		2 valves.
63°17½' N. L., 17°39' W. L.	87 -	black sand with shells and stones.	1 valve.

These localities all lie off the south coast. The largest shell measures 13.5 mm. One of the shells from Vestmannaeyjar comes near to the variety *leviuscula*, the ribs being almost lacking.

At the **Færoes** it has been taken at:

61°9' N. L., 7°54' W. L.	180 fm.	2 valves.

The largest of these valves is 11 mm. high.

Distribution. This species reaches from Lofoten along the west coast of Europe into the Mediterranean to the Aegean; according to Jeffreys it is also said to have been found at Newfoundland and the northern Japan; the same author gives its vertical distribution as from 6—400 fm.

Lima gwyni has not earlier been recorded from Danish waters; in reality however it has been taken in the Kattegat, namely, a specimen at Trindelen as also a specimen and a valve in the neighbourhood of Fladen, 13½—29 fm., but an erroneous determination placed it under *L. subauriculata* Mtg.[3])

Synonymy. With regard to the designation of the species the following information may be quoted from Sykes[4]): "In 1863 Jeffreys described (Brit. Conch. vol. II, p. 81) a shell from the British

[1]) At the place cited Jeffreys also ascribes it a distribution to Patagonia and Japan, but in Zool. Chall. Exp., Part XXXV, 1885, p. 290, E. A. Smith refers the specimens in question to the nearly related species *Lima goliath* Sow.

[2]) P. A. Øyen, in Archiv f. Math. og Naturvidensk. Bd. XXX, Nr. 3, 1909, pp. 33—37.

[3]) C. G. Joh. Petersen: Om de skalbærende Molluskers Udbredningsforhold i de danske Have indenfor Skagen, 1888, p. 122, and: Det vidensk. Udbytte af Kanonbaaden "Hauch"'s Togter, 1893, p. 66. — Only one of the shells mentioned, namely that from No 39, belongs to *L. subauriculata*.

[4]) E. R. Sykes: On the Name *Lima elliptica*. The Journ. of Malacology, vol. X, 1903, p. 104.

Seas under this name *[L. elliptica]*. Unfortunately the name had been used in August 1861, by Whiteaves (Ann. Nat. Hist. ser. 3, vol. VIII, p. 146) for a fossil from the "Corallian Oolithes of Oxford". Under these circumstances, as I am unable to trace any other name applicable to the recent shell, I propose to name it *Lima gwyni*, nom. nov."

Lima hyperborea Jensen.

Pl. II, figs. 5a—e.

Limatula hyperborea Jensen, Medd. om Grønland, XXIX, 1909, p. 329, figs. 1a-d.

The shell oval or elliptical, extremely tumid, white or yellowish white with a faint lustre. The valve is thin, slightly oblique, with the anterior margin forming a slight, regular curve, the posterior margin somewhat more strongly curved outwards above, with ca. 24—36 fine, but distinctly elevated, sharp radiating ribs, disappearing outwards towards the sides, two of the central ones as a rule stronger and with larger interspace than the others, thus producing a fairly well-marked furrow, lying almost medially or a little to the anterior side of a line through the middle of the valve (sometimes however only one prominent median rib); the concentric striation extremely fine; the beaks prominent; the hinge-margin relatively long, almost straight, passing into the lateral margins at an obtuse angle; the cartilage-pit triangular; the inner side glistening silvery white or of a pearly lustre. Height 15 mm., length 9.5 mm., breadth 9 mm.

The "Ingolf" has taken this species at:

St. 116	S. of Jan Mayen	371 fm.	÷0.4° C.	1 spec. and fragments of 2 valves.
- 139.	N. of the Færoes	702 -	—0.6° -	2 spec.

Whilst the specimen from St. 116 is 20 mm. high, the largest from St. 139 is only 4.5 mm.

Lima hyperborea was originally described by me from **East Greenland,** where it was taken by the Danish Exped. of 1900 at the following places:

Fleming Inlet........................	118 fm.	clay.	1 spec.
Forsblads Fjord	ca. 50 -	clay with stones.	1 —
Forsblads Fjord	90—50 -	clay with stones.	12 spec. and 14 valves.

The largest of these specimens measures: height 16.5 mm., length 10 mm.

Distribution. In addition to at E. Greenland *Lima hyperborea* lives at Jan Mayen and in the "cold area" N. of the Færoes, at Spitzbergen and in the Kara Sea (10—70 fm.)[1], from which I have seen specimens preserved in the Stockholm State-Museum. It also lives presumably in the Barents Sea and in the cold Norwegian Sea, where "*L. subovata* Jeffr." is said to have been taken at several places, according to Friele and Grieg[2], as confusion with the present species has probably occurred. The same also holds good probably with regard to the "*Lima elliptica* Jeffr." taken by the Dutch

[1] The specimens from the Kara Sea were referred by W. Leche to *Lima sulcata* (Leach) Lovén; Kongl. Sv. Vet. Akademiens Handl. Bd. 16, No. 2, 1878, p. 34.

[2] Norw. North-Atlantic Exped. Zool., Mollusca III, 1901, p. 7.

Exped. in the Barents Sea (76°31′ N. L., 45°36′ E. L.) at 130 fm., bottom-temperature —1° C., as Nomann[1]) gives the maximum size to be 11 mm. in the length and 18 mm. in height, a size never reached by *L. elliptica* so far as I know, but which might well agree with the present species.

Remarks. From *Lima gwyni* Sykes (= *L. elliptica* Jeffr. (non Whiteaves)), with which the present species has some resemblance, it is distinguished by the following characters: the form of the shell is higher; the ventral margin forms a steeper curve with the lateral margins; the radiating ribs (fig. 5e) are sharp, not serrate. *L. subovata* Jeffr. is also a nearly related species, but it has more numerous (50—60) radiating ribs and is even more tumid.

Lima subauriculata Montagu.

Pl. II, figs. 6a—c.

Pecten subauriculata Montagu, Test. Brit., Suppl., 1808, p. 63, Pl. 29, fig. 2. — *Lima subauriculata* Jeffreys, Brit. Conchol. II, 1863, p. 82, Pl. 25, fig. 2.

Lima sulcata Möller, Index Moll. Groenl., 1842, p. 16. — *Lima conclusa* Beck, Amtl. Ber. 24 Vers. deutscher Naturf. und Aerzte in Kiel, 1847, p. 114. — *Limatula sulculus* Mörch, Rink's Grønland, 1857, p. 94. — *Lima (Limatula) subauriculata* Mörch, Vidensk. Medd. Naturh. Foren. 1867, p. 98; ibid. 1868, p. 226. — *Limatula sulculus* Mörch, Arctic Manual, 1875, p. 133; Rink's Dan. Greenland, 1877, p. 442. — *Limatula subauriculata* Posselt, Medd. om Grønland, XXIII, 1898, p. 17.

This species has been taken by the "Ingolf" at:

St. 87.	W. of Iceland (Brede Bugt)	110 fm.	2 valves.
- 86.	- - — — —	76 -	ca. 20 valves.

The largest of these shells measure 5.5 mm.

West Greenland.

Here *Lima subauriculata* is common, on hard bottom and at depths of 15—100 fm., from the southernmost part up to Upernivik (72°47′ N. L.). It reaches the considerable size of 11 mm.

Iceland.

At East Iceland *L. subauriculata* has been taken at:

64°58′ N. L., 13°25′ W. L.	40 fm.	23 spec. and 27 valves.
Reydarfjördr	68 -	1 valve.
Nordfjördr	40 -	2 valves.
Seydisfjördr, mouth	38—14 -	1 valve.
— —	ca. 40 - , from stomachs of haddock.	7 spec. and 7 valves.

At North Iceland:

Axafjördr	30 fm., stones and sand.	2 valves.

[1]) Niederländ. Arch. f. Zoologie, Suppl.-Bd. I, 1881—82, No. 10, p. 4.

At West Iceland, at the two stations in Brede Bugt (86 and 87) mentioned above, and at South Iceland:

Vestmannaeyjar	49 fm., clay with a little mud.	4 valves.
63°21' N. L., 17°31' W. L.	69 - , sand.	1 valve.

At East Iceland the species reaches the considerable size of 10 mm.; of the shells from the rest of Iceland none are over 5.5 mm.

Færoes.

Here *L. subauriculata* has been taken at the following places:

Bordövig	7—10 fm.,	black sand, small stones, Laminaria.	2 valves.
—	10 - ,	sand, Laminaria.	1 valve.
Ejde	5—6 - ,	coarse black sand.	9 valves.
Fundingsfjord	12—ca. 20 - ,	coarse sand and clay.	4 —
Vestmanhavn	$3^1/_2$—5 - ,	fine black sand.	1 spec. and 10 valves.
—	5—6 - ,	— — —	3 — - 35 —
—	10—30 -		3 valves.
Sörvaag	14—$16^1/_2$ -		1 valve.
13 miles S. of Myggenæsholm.....	ca. 70 -		4 valves.
9 — E. S. E. of Bispen	- 70 -		40 —
16 — E. by S. of south point of Nolso	80 -		4 —
13 — W. by S. of Munken.....	ca. 150 -		ca. 100 valves.

The maximum size of the shells taken inshore is 5 mm., of those taken further out to sea 6 mm.

Distribution. On the European side *L. subauriculata* ranges from West Finmarken[1]) to the Canary Isles, also in the Mediterranean to its eastern part; doubtfully living in the Kattegat at present.[2]) On the American side it reaches from the Strait of Florida to Labrador and the southern West Greenland; it is also said to occur on the west coast of North America, according to Jeffreys.

At Norway, the Færoes, Iceland and Greenland its vertical distribution is from 10—150 fm. On the other hand, Jeffreys gives its vertical distribution to extend from 10—1785 fm.[3]) and Locard also records it from great depths, down to 2200 m.[4]); but as the species of the genus *Lima* are very difficult to distinguish from one another, it is conceivable that erroneous determinations have given rise to the records of these enormous depths (cf. under *L. similis* n. sp.).

1) According to G. O. Sars it has not been found at East Finmarken, but it is recorded from the Murman Coast (Herzenstein: Beiträge zur Kenntnis der Fauna der Murmankuste und des Weissen Meeres I. Mollusca, 1885, p. 642). It is stated by W. Leche to occur at Nova Zembla and in the Kara Sea, but this comes from an erroneous determination, the specimens in question belonging to *Lima hyperborea* m. (cf. the latter).

2) Only a single shell namely has been found at "Fladen" (Eastern Kattegat); as the other specimens taken in the Kattegat (including one living), which were referred by C. G. Joh. Petersen to *L. subauriculata* (Det vidensk. Udb. af "Hauch"'s Togter, 1889, p. 66), do not belong to this species, but to *L. gwyni* Sykes (= *L. elliptica* Jeffreys, non Whiteaves).

3) Proc. Zool. Soc. London, 1879, p. 563.

4) Expéd. scient. Travailleur-Talisman, Moll. Test., II, 1898, p. 417.

Lima similis n. sp.

Pl. II, figs. 7a—c.

The shell oblong, nearly equilateral, tumid, silvery white. The valves thin, with ca. 34—38 radiating ribs, two of the middle ones stronger than the others, with an interstitial furrow, or only one prominent median rib; the concentric lines conspicuous and close set. The beaks fairly prominent, the hinge-margin almost straight. forming with the lateral margins an obtuse angle. The inside glistening silvery white. Height 7 mm., length 3.75 mm.

The "Ingolf" has not taken this species, but the "Thor" found it **S. of the Færoes,** namely at

61°7′ N. L., 9°30′ W. L.	440 fm.	5 valves.
61°15′ — 9°35′ —	ca. 475 -	10 —

Further, the "Thor" has dredged the same species in the Bay of Biscay at

43°37′ N. L., 2°08′ W. L.	250—790 fm.	8 spec. and 15 valves.

This species has a great resemblance to *Lima subauriculata*, but the umbones are less swollen, the radiating (fig. 7c) ribs finer and more numerous and the dorsal margin forms more distinct angles with the lateral margins than in the latter (comp. figs. 1 and 2). I imagine, that the records given by authors of *L. subauriculata* from very great depths are due to mistakes in determination, *L. similis* being concealed under the name of *L. subauriculata*.

Fig. 1. *Lima similis.* × 8.

Fig. 2. *Lima subauriculata.* × 8.

Lima subovata Jeffreys.

Pl. II, fig. 8a—c.

Lima subovata Jeffreys, Ann. Mag. Nat. Hist. (4) XVIII, 1876, p. 427; Proc. Zool. Soc., 1879, p. 563, Pl. 45, fig. 2; Smith, Challenger Report XIII, 1885, p. 292.

This species has been taken by the "Ingolf" at:

St. 24.	Davis Strait	1199 fm.	2.4° C.	1 spec.
- 36.	— —	1435 -	1.5° -	1 spec. and fragments of 10 valves.
- 38.	S. of Greenland	1870 -	1.3° -	3 spec. and 2 valves.
- 22.	- - —	1845 -	1.4° -	1 spec.
- 90.	Denmark Strait	568 -	4.4° -	15 valves.
- 10.	— —	788 -	3.5° -	10 — (mostly fragments).
- 80.	S. W. of Iceland	935 -	4 ° -	2 —
- 81.	- - - —	485 -	6.1° -	1 spec. and 1 valve.
- 69.	S. of Iceland	589 -	3.9° -	ca. 30 valves (mostly fragments).

Further, the "Thor" has taken *L. subovata* to the south of Iceland at the following places:

63°05′ N. L., 20°7′ W. L.	293 fm.	1 valve.
62°57′ — 19°58′ —	500 -	3 spec. and ca. 80 valves (many in fragments).

The largest of these shells measures: height 10.5 mm., length 6.5 mm., the second largest is 8 mm. high.

Specially characteristic of this species seems to me the large number of radiating ribs (fig. 8c); under the lens they are seen to extend right to the ears of the shell; Jeffreys has counted about 50 ribs, and on my specimens I have counted 60—70 ribs.

According to Jeffreys *L. subovata* has been taken in the Northern Atlantic off the entrance to the Denmark Strait, 1450 fm.; between the Hebrides and Faeroes, 542 fm.; off the west coast of Ireland, 420—1443 fm.; off the Azores, 1000 fm.; in the Western Mediterranean, 1456 fm.[1])

Lima ingolfiana n. sp.

Pl. II, figs. 9a—d.

The shell oval, somewhat oblique, moderately convex, silvery-white. The valves thin, with ca. 30—40 radiating ribs, the ridges of which are as a rule finely scaled or spined; the middlemost ribs (or rib) are stronger than the others, thus giving rise to a median furrow (or two furrows); the beaks prominent; the hinge-margin fairly short, slightly sloping, forming obtuse angles with the lateral margins; cartilage-pit triangular; the internal surface glistening silvery-white. Height 5.25 mm., length 3.5 mm.

The "Ingolf" has taken this small, elegant species at **Iceland** at:

St. 98.	W. of Iceland	138 fm.	5.9° C.	1 valve.
- 90.	- - —	568 -	4.4° -	30 valves.
- 78.	S.W. of —	799 -	4.5° -	1 spec. and 20 valves.

This species is well characterized by its somewhat oblique, more or less broadly oval contour, the postero-dorsal margin forming a blunt angle not only with the hinge-margin but also with the postero-median margin; as also by the rather well-marked sculpture of its finely scaled or spined radiating ribs (fig. 9d).

Lima jeffreysi Fischer.

Pl. II, figs. 10a—c.

Lima Jeffreysi P. Fischer, Ann. Mag. Nat. Hist. (5) VI, 1880, p. 315; Journ. Conch. XXX, 1882, p. 52; Locard, Expéd. Scient. Travailleur-Talisman, Moll. Test. II, 1898, p. 415, Pl. XV, figs. 20—23.

The "Ingolf" has taken this species at:

St. 18.	Off entrance to Denmark Strait.	1135 fm.	3.0° C.	1 valve.
- 90.	S.W. of Iceland	568 -	4.4 -	1 —
- 69.	S. - —	589 -	3.9° -	1

The largest of these shells (from St. 90) is 9.5 mm. high.

[1]) On the other hand, unlike Jefreys, I am unable to refer to this species the specimens of "*L. subovata*" taken by the Norwegian and the Dutch Exped. in the Norwegian and Barents Seas, as I believe, that they belong to my species *Lima hyperborea* (see the latter).

In addition *L. jeffreysi* has been taken by the "Thor" at the following places **south of Iceland**:

63°05' N. L., 20°7' W. L.	293 fm.	7 valves (mostly fragments).
62°57' — 19°58' —	500 -	ca. 80 valves (many fragments).

The largest of these shells is 12 mm. high.

This species is easily recognizable by its oblique shape, its squamular radiating ribs (fig. 10c) and its lack of a central furrow. The number of ribs is 20—25, and even in the middle of the shell their breadth is less than that of the intervening furrows.

L. Jeffreysi was only known earlier from the Bay of Biscay, 580 fm. ("Travailleur").

This species is nearly related to *L. confusa* E. A. Smith[1]) from the Azores, Sombrero Island and Pernambuco, 450—1000 fm.; this again is said to be identical with *L. ovata* Jeffreys (non Searles Wood[2]) from the North Atlantic, 1450 fm. *L. setifera* Dall[3]) from Havanna, Barbadoes and North Carolina, 52—450 fm., is also a nearly related species.

Lima sarsii Lovén.

Pl. II, figs. 11 a—d.

?*Lima crassa* Forbes, Rep. Brit. Assoc. Adv. Science, 1843, p. 193. — *Lim(e)a Sarsii* Lovén, Index Moll. Scand., 1846, p. 32; Jeffreys, Brit. Conchol. II, 1863, p. 78, Pl. 25, fig. 1. — *Limatula crassa* Sars, Moll. Reg. Arct. Norv. 1878, p. 26.

At **Iceland** this species has been taken by the "Ingolf" at:

St. 98. W. of Iceland	138 fm.	5.9° C.	1 valve.
- 85. S. W. of Iceland	170 -		1 —

The largest of these shells (St. 98) is 4 mm.

Further, *L. sarsii* has been taken at the **Færoes** at:

61° 15' N. L., 9° 35' W. L.	ca. 475 fm.	1 valve (height 4 mm.)
61° 35' - - 4° 39' - -	210 -	2 valves (max. height 3 mm.)

This species, which is readily recognizable from its solid, densely and coarsely scaled shell (fig. 11 d) and crenulated cardinal margin (fig. 11 c), was not known earlier from these regions of the Atlantic.

Its **distribution** extends from northernmost Norway (Varanger Fjord) along Europe and into the Mediterranean to the Aegean Sea[4]). It is not known in the Skager Rak or the seas within this.

G. O. Sars estimates the vertical distribution to be from 50—300 fm., Jeffreys from 80—300 fm. Nevertheless the latter records it from great depths (off Ireland and on the line from Falmouth-Gibraltar, 400, 500 and 600 fm., in the Mediterranean even 1456 fm.), and Locard records it from 2018 meters off Cape Finisterre.

[1]) Challenger Report, vol. XIII, 1885, Lamellibranchiata, p. 292, Pl. XXIV, fig. 6.

[2]) Ann. Mag. Nat. Hist. (4) vol. XVIII. 1876, p. 426.

[3]) Bull. Mus. Comp. Zool., XII, 1886, p. 225; Proc. U. S. Nat. Museum, XII, 1889, p. 250, Pl. XIV, fig. 10.

[4]) According to Locard it is said to have been found at St. Helena.

Mytilidae.

Mytilus edulis Linné.

Mytilus edulis Linné, Syst. Nat. ed. 12, 1, 2, 1767, p. 1157; Jeffreys, Brit. Conchol. II, 1863, p. 104, Pl. 27, fig. 1; Gould & Binney, Rep. Inv. Mass. 1870, p. 183, figs. 483—84.

Mytilus edulis Fabricius, Fauna groenl. 1780, p. 417; Möller, Index Moll. Groenl., 1842, p. 19; Mörch, Rink's Grönland, 1857, p. 94; Vidensk. Medd. Naturh. Foren. 1867, p. 97; ibid. 1868, p. 225; Arctic Manual, 1875, p. 133; Rink's Dan. Greenland, 1877, p. 442; Posselt, Medd. om Grönland XIX, 1895, p. 66; ibid. XXIII, 1898, p. 18; Jensen, ibid. XXIX, 1909, p. 322.

At **West Greenland** the edible mussel is common from the southernmost parts up to at least Umanak; further north it is said to have been taken by the "Fox" in Melville Bay. The largest specimen (from Disko Fjord) measures 110 mm., and specimens of 80—90 mm. are not rare.

Regarding the edible mussel at Greenland H. P. C. Möller writes in a posthumous manuscript: "The ordinary length is 64—77 mm., the largest specimen I possess is 105 mm. long and 50 mm. broad; it was found at Julianehaab. It occurs everywhere on the west coast of Danish Greenland in great quantities, both on the shores by the open sea and in the bays, among the stones and in craks and crevices of the rocks. It always lives at a depth corresponding with lowest ebb-tide. Gould (Rep. Inv. Mass.) states, that it keeps to places which are laid dry by the water during ebb, but in this country it keeps to the boundary of the lowest ebb, or a little below or outside this; if it went higher up, it would be enclosed by the ice from November to May. It is eaten by the Greenlanders, boiled, raw or pickled in train-oil. It is an even more common source of nourishment for the ravens, foxes, dogs and all the animals, which are forced to seek their food on the shore at ebb-tide". It may be remarked here, however, that I have often seen living mussels in Greenland on seaweed laid dry during ebb-tide, and that Dr. V. Nordmann likewise found living *Mytilus* in great numbers in Nordre Strömfjord, fixed among Fucus which was daily laid dry at low-water.

At **East Greenland** the edible mussel only lives on the southernmost parts; it is not rare in the Angmagsalik district, but the limit for its distribution lies not far north of this place, namely at ca. 66° 30′ N. L.[1]). It may reach a length of 84 mm. For the details of its occurrence I may refer to my paper: "On the Mollusca of East Greenland" (l. c.).

At **Iceland** it occurs in quantities round the whole island; the largest specimen I have seen is 85 mm. long.

At the **Færoes** it is found at many places and reaches a length of 93 mm.

The material at hand from Iceland and Greenland shows, that *Mytilus edulis* is just as variable in the north as in more southern regions; but without an exact knowledge of the conditions at the different localities, it will hardly repay to discuss the variation.

[1]) It is recorded in the literature (Posselt l. c.), that the Danish East Greenland Exped. of 1892 took a small edible mussel in the pelagic net out in the open sea between Spitzbergen and E. Greenland (75° 37′ N. L., 6° 4′ W. L.). It was 11 mm. long, thus long past the pelagic stage, and cannot have arrived here as floating larva. I imagine, that mussels have been attached by the byssus to the sides of the ship or algae growing there; by the rubbing of the ice against the ship the mussel has been torn off and come by chance into the net towed behind the ship. Cf. N. Hartz' report, that on the same Exped. he obtained numerous small algae in the net, especially when the ice was dense (Medd. om Grönland, XVII, 1896, p. 387, note).

Distribution. *Mytilus edulis* has a wide range within the temperate, in part also the arctic zone, both in the northern and southern hemispheres. In North America it occurs from North Carolina to Labrador; next, it occurs on the western and south-eastern coasts of Greenland, at Iceland and the Færoes; from the west coast of Nova Zembla its distribution extends along the whole coast of Europe, and also into the Mediterranean (var. *galloprovincialis* Lam.) to its easternmost end; through the Kattegat, decreasing in size, it reaches into the Baltic and up into the Gulf of Bothnia (to 62°6' N. L.). In the Pacific it ranges from Bering Sea to the Sea of Okotsk, Japan and Mexico. In the southern hemisphere the "Challenger" has taken it off Rio de la Plata, at the Falkland Islands, Kerguelen and New Zealand. — It belongs to the littoral belt; I have some young specimens, however, from greater depths, down to 50 fm.[1])

In high-arctic regions the dead shells of *Mytilus edulis* have been found at many places, where in spite of the keenest search not a single living specimen could be taken. In Europe it does not live north of Nova Zembla, yet dead shells occur in large numbers on Spitzbergen (both on the shore, at the beach and in raised deposits), on King Charles Land (Svenska Förlandet, 25 m. above the sea) and on Franz Josephs Land (3—6 m. above the sea). At East Greenland, as mentioned, it does not live N. of 66°30' N. L., but it has been found as fossil at ca. 73° N. L., namely at the mouth of Sophias Sound (25 m. above the sea) and in the innermost parts of Franz Josephs Fjord (10 m. above the sea). These discoveries of fossil (postglacial) *Mytilus edulis* indicate, that the high-arctic regions mentioned must have had a somewhat warmer marine climate than now at a not very remote geological period[2]).

Modiola modiolus Linné.

Pl. III, figs. 1 a—b (young).

Mytilus modiolus Linné, Syst. Nat. ed. 12, 1, 2, 1767, p. 1158; Jeffreys, Brit. Conchol. II, 1863, p. 11, Pl. 27, fig. 2; *(Modiola)* Gould & Binney, Rep. Inv. Mass. 1870, p. 186, fig. 485. — *Mytilus umbilicatus* Pennant, Brit. Zool., IV, 1767, p. 112.

Modiola umbilicata Mörch, Vidensk. Medd. Naturh. Foren. 1867, p. 96; ibid. 1868, p. 224.

The "Ingolf" has taken this species at:

St. 87. W. of Iceland (Brede Bugt) .... 110 fm. 1 spec. (empty).

[Greenland].

The species is recorded from here by G. O. Sars[3]) and by Dr. A. Krause[4]). I have no hesitation in refusing to admit the correctness of these records; a bivalve of such a size and so easy to get could not have escaped the attention of those, whose collections are preserved in the Copen-

[1]). N. Knipowitsch (Verhandl. Kais. Russ. Mineral. Gesellsch. Bd. 43, 1906, p 271) mentions a few cases where he has found living, full-grown *Myt. edulis* in great depths and at a constantly very low temperature but at the same time expresses agreement with a view I had put forward elsewhere (K. D. Vidensk. Selsk. Forhandl. 1904, p. 394), namely, that such is not the normal habitat of the species; the specimens in question must be considered to have been carried out into the deep, cold layers with seaweed, perhaps also with ice-floes (in the Kara Sea, for example, *M. edulis* has been found on drift-ice; cf. Jensen l. c.).

[2]) For further details see Ad. S. Jensen and Poul Harder: Post-Glacial changes of climate in Arctic regions as revealed by investigations on marine deposits (Postglaziale Klimaveränderungen. Stockholm, 1910, p. 399).

[3]) Sars: Moll. Reg. Arct. Norv., 1878, p. 387.

[4]) Krause, in Grönland-Expedition der Gesellsch. f. Erdkunde zu Berlin, II, 1, 1897, p. 185.

hagen Zoological Museum; here there is not and never has been any specimen of *M. modiolus* from Greenland [1]).

Iceland.

Dr. A. C. Johansen mentions *M. modiolus* among the Molluscs which occurred in the greatest abundance 2—3 meters below the high-water mark at the coasts of Iceland [2]). Further, G. Bardarson has made the following observation on the northern coast: "*M. modiolus* lives here at Húnaflói at a depth of 10—15 meters and is thrown up on the beach in a heavy sea, but in small quantity", and regarding the conditions on the west coast he writes as follows: "At Isafjördur and Breidifjördur .... it is found washed up at a few places in considerable quantity. At Faxaflói it is common .... still more frequent at Grindavík S. of Reykjanes, where thousands can be collected after a heavy sea. *M. modiolus* thus lives in shallower depths and is more frequently washed up, the further south we come along the west coast of Iceland". [3]) Lastly, the Icelandic naturalist Bj. Sæmundsson writes to me, that *M. modiolus* is often thrown up on the beach in autumn on the north coast.

I have made these preliminary remarks in order that the following lists may not give the impression, that *M. modiolus* is a rarity, for example, at East and North Iceland; its littoral occurrence and its considerable size have probably been the reasons why a comparatively small material of this species has been brought home.

East Iceland:

64°58′ N. L., 13°25′ W. L.	40 fm.	5 spec. and 1 valve.
Bakkafjördr	32—25 -	2 valves.

The shells last-mentioned reach a length of 105 mm.

North Iceland:

Husavik.	washed up with Laminaria rhizoids.	3 spec.
Skagastrand Bugt	33 fm.	1

The last specimen is small, the first up to 100 mm.

West Iceland:

66°6′ N. L., 23°59′ W. L.	23 fm.	1 spec.
Dyrafjördr	ca. 19 -	3
65°52′ N. L., 23°58′ W. L.	33 -	1 valve.
Arnarfjördr, beach		1 spec.
65°32′ N. L., 24°38′ W. L.	22 -	4
Grundarfjördr	$9^1/_2$ -	4 valves.
64°45.8′ N. L., 23°55.2′ W. L.	30 -	3 spec.
Hvalfjördr	21 -	1 and 1 valve.
Krossvik	8 - , shell-gravel, blue clay, stones.	1

1) G. O. Sars has also made the mistake in his "Tabulae distributionis" (op. cit.) of including Spitzbergen under its region of distribution.

2) Vidensk. Medd. Naturh. Foren. Kbhvn., 1902, p. 387.

3) Vidensk. Medd. Naturh. Foren. Kbhvn., 1910, p. 62.

Faxafjördr	25 fm.		Many valves.
—	$14^1/_2$ -		1 spec.
— Keflavik	15—16 -	, fine black sand.	3 fragments.
Reykjavik	beach, on Laminaria rhizoids		11 spec.
—	$1^1/_2$ fm.,	stony bottom.	2 spec.
—	8 -		4 —
Hafnarfjördr	beach		3 —
—	4 -		1 —
—	25 -	, fine black sand and ooze.	1 valve.
— 1 mile E.N.E. of Helgasker Vager	$11^1/_2$ -		2 valves.

It has thus been taken living even at a depth of 30 fm.; the specimen from the "Ingolf" St. 87, which also lies on the west coast of Iceland at a depth of 110 fm., was on the other hand empty and may possibly have been carried out with Laminaria, to the rhizoids of which *M. modiolus* is accustomed to attach itself by means of its byssus. The largest specimen is 146 mm. long.

South Iceland:

63°30' N. L., 20°14' W L.	42 fm.	3 valves.
Heymaey, Vestmannaeyjar	beach.	4 spec. & many valves.
Vestmannaeyjar	30 fm., shell-gravel.	3 valves.
—	49 - , clay with a little mud.	Fragments of 3 valves.

The specimens washed up on the beach at Heymaey are up to 95 mm. long.

The Færoes.

According to earlier authors (Svabo, Landt) *M. modiolus* occurs at many places at the Færoes; after a heavy sea it is often found washed into the bays, not rarely hanging to large tufts of seaweed under whose rhizoids it likes to live.

The largest specimens I have seen are 155 mm. long; large specimens are taken at a depth of even ca. 100 fm.

In recent years it has been taken at the following places at the Færoes:

Klaksvig	11 fm.,	on Laminaria rhizoids.	5 spec.
Fundings Fjord	12—ca. 20 -	, coarse sand and clay.	1 — and 16 valves.
Andefjord	16—23 -		1 —
Kongshavn	12—16 -		2 —
Vestmanhavn	$3^1/_2$—5 -	, fine black sand.	1 —
—	4 -	, sand.	1 —
—	4—5 -		1 —
—	ca. 10 -		2 —
—	10—30 -		10 —

Vestmansund	70 fm.		6 spec.
Sörvaag beach.			2 — and 3 valves.
—	14–16½ -	, ooze.	1
Thorshavn beach.			4
—	3–4 -		1 —
Nolso beach.			4 valves.
— deep hole at north end	ca. 100 -		30 spec. and many valves.
Trangisvaag Fjord, mouth	4–5 -	, among rhizoids of Laminaria.	1 — and 3 valves.
62°29′ N. L., 7°37′ W. L.	60 -		3 —
62°16.5′ N. L., 6°6′ —	50–60 -		5 —
5 miles N. by E. of east point of Myggenæs	50 -		2 —
7 — N. by E. of Myggenæs Point	57 -		6 —
6 — N. by W. of Kalso	60 -		14
1½—2 miles off mouth of Bordovig	20–30 -		1 —
Bordonæs in N. 57 W., 1¾ miles	30 -		15 & many valves.
9 miles E. of Nolso Light	ca. 30 -		2 —
16 — E. by S. of south point of Nolso	80 -		1 —

Distribution. On the European side *Modiola modiolus* ranges from the "warm area" of the White Sea[1]) to the British Isles and west of France (Loire)[2]) as also through the Kattegat into the Sound and Belts; next, over the Færoes to the coasts of Iceland. On the American side it is distributed from Labrador to North Carolina, and from Bering Sea to Japan and California. Jeffreys gives the vertical distribution to be from 0–100 fm., which agrees with the observations from the Færoes and Iceland (cf. above); its true habitat is the Laminaria region.

Modiola phaseolina Philippi.

Pl. III, figs. 2a—b.

Modiola phaseolina Philippi, Enum. Moll. Siciliae, II, 1844, p. 51, Pl. 15, fig. 14. — *Mytilus phaseolinus* Jeffreys, Brit. Conchol. II, 1863, p. 118, Pl. 27, fig. 5.

Modiola phaseolina Mörch, Vidensk. Medd. Naturh. Foren., 1868, p. 224.

[1]) According to Collin (Dijmphna-Togtets zool.-bot. Udbytte, 1886, p. 450) a very young specimen (19 mm. long) is said to have been taken in the Kara Sea at 53 fm., but this case is isolated, and I doubt whether the species really belongs to this Sea. N. Knipowitsch also reports, that he has once obtained *M. modiolus* from the deep part of the White Sea, where a very low temperature constantly prevails (the "cold area"), but he is of opinion, that it is not the normal home of the species, but that the specimens have probably been carried out there from the coastal region with seaweed or ice-floes (Verhandl. d. Kais. Russ. Min. Gesellsch. Bd. 43, 1906, p. 275). — The circumpolarity of *M. modiolus*, as maintained by some authors, is in any case a mistake; it has not been taken at Greenland (cf. antea p. 48), nor at Spitzbergen (cf Knipowitsch, Ann. Musée zool. de l'Acad. Imp. St.-Pétersbourg, VI, 1902, p. 119, note), nor on the north coast of Asia or in the waters N. of arctic America.

[2]) It has been forgotten by Locard in his list: Les coquilles marines des côtes de France (1892); in the same author's Prodrome de Malacologie Française, Mollusques marins (1886) numerous localities are given for it (p. 491).

This species has been taken by the "Ingolf" at:

St. 98.	W. of Iceland	138 fm.	5.9° C.	15 valves.
- 86.	- - — (Brede Bugt)	76 -		Numerous valves.
- 87.	- - — —	110 -		1 spec. & numerous valves.
- 54.	S. E. of Iceland	691 -	3.9° -	1 —
- 55.	— - —	316 -	5.9° -	3 —
- 6.	— - —	90 -	7° -	6 —
- 51.	— - —	68 -	7.32°-	1 — & 1 valve.
- 1.	N. W. of the Færoes	132 -	7.2° -	1 —

Previously *M. phascolina* was only known in these regions from Faxafjördr in West Iceland, where Iap. Steenstrup had taken 2 specimens (recorded in Jeffreys l. c.).

In addition to at the above stations of the "Ingolf", *M. phascolina* has in recent years been taken at many other places on the west, south and south-east coast of Iceland as well as at the Færoes, as will be seen from the following summary.

West Iceland:

66°8′ N. L., 24°21′ W. L.	47 fm.		1 spec.
Faxafjördr	13 -		1 —
—	17 -	, coarse shell-sand.	15 valves.
—	17—20½ -	, sand and shells.	3 —
Skagi	21 -		1 valve.

South Iceland:

63°15′ N. L., 22°23′ W. L.	170—114 fm.		7 valves.
63°18′ — 21°30′ —	94 -		1 valve.
Vestmannaeyjar	49 -	, clay with a little mud.	25 valves.
— Heymaey, on beach			18 —
63°17½′ N. L., 17°39′ W. L.	87 -	, black sand with shells and stones.	1 spec.
63°21′ — 17°31′ —	69 -		1 valve.
63°21′ — 17°15′ —	58 -	, sand, stones, shell-gravel.	9 spec. and 12 valves.
Ingolfshöfdi in N. by E. ½ E., 9½ miles	53 -		1 —

South-East Iceland:

64°3′ N. L., 15°40′ W. L.	35 fm.	5 spec.
Myre Bugt	36 -	1 spec. and 1 valve.
64°27′ N. L., 13°27′ W. L.	84 -	3 spec.

The Færoes:

Ejde	5—6 fm.	, coarse black sand.	6 valves.
13 miles S. of Myggenæsholm	ca. 70 -		2 —
61°56′ N. L., 7°04′ W. L.	30 -		1 spec.

61°40′ — 7°40′ —	135 fm.		1 spec. and 1 valve.
61°9′ — 7°54′ —	181 -	Temp. 8.42 C.	1 —
9 miles E. S. E. of Bispen	ca. 70 -		3 valves.
16 — E. by S. of south point of Nolso	80 -		4 spec. and 1 valve.
Akralejte in N. 57 W., 12 miles.........	- 150 -		1 —
13 miles W. by S. of Munken	- 150 -		ca. 100 valves.

At Iceland it reaches a length of 19 mm. in the shallower waters, whilst the specimen from 691 fm. (St. 54) is only 3.5 mm. long and the largest specimen from 316 fm. (St. 55) 7.5 mm. The largest of the specimens at hand from the Færoes is 16 mm. long.

Remarks. The numerous specimens to hand confirm in every respect the variation remarked upon by other authors; the form of the shell is sometimes elongated, sometimes very short, but with all transitions.

Modiola phaseolina is often confused with the young of *M. modiolus*, from which however it can be distinguished with certainty by means of the following combination of characteristics (cf. Pl. III, figs. 2a—b *(M. phaseolina)* with figs. 1a—b *(M. modiolus*, young):

The shell is more ventricose.

The anterior end under the umbo is less prominent.

The inner edge of the antero-dorsal margin is finely crenulated across, and the hinge-margin in from the beak is somewhat flattened and expanded and marked by minute transverse teeth.

The impression of the anterior closing muscle is bounded above by a ridge-like projection from the shell-margin.

The antero-dorsal margin rises more steeply and the dorsal margin is for some distance almost parallel with the ventral margin.

Distribution. *Modiola phaseolina* is distributed from northernmost Norway (Varanger Fjord) along Europe and into the Mediterranean as far as the Aegean Sea; it goes down into the Kattegat. To the west it reaches over the Færoes to the south-eastern, southern and western coasts of Iceland. — Jeffreys gives the vertical distribution to be from 0—3000 fm., though it is not apparent where he has obtained the record of this enormous depth from; the greatest depth noted by himself lies in the Mediterranean at 1415 fm[1]). At Norway, according to G. O. Sars, it reaches down to 300 fm., at the Færoes and Iceland to 691 fm., so that I am inclined to doubt the correctness of Jeffreys' record. Nor is the purely littoral occurrence quite certain, as it has not been taken living at less depths than 13 fm. at Iceland, the Færoes, Norway or Denmark. That it may be washed up on land is another matter; I have before me a number of apparently fresh shells, which had been washed up on the beach at Heymaey, Vestmannaeyjar on South Iceland (collected by Dr. A. C. Johansen).

Dacrydium vitreum Möller.

Modiola? vitrea "Holböll", Möller, Index Moll. Groenl., 1842, p. 19. *Dacrydium vitreum* Torell, Spitsbergens Molluskfauna, 1859, p. 139, Pl. 1, fig. 2; Sars, Moll. Reg. Arct. Norv., 1878, p. 28, Pl. 3, fig. 2; Verrill, Transact. Connecticut Acad., V, 1882, p. 579, Pl. 44, fig. 8.

1) Jeffreys, as usual, does not mention whether the shells were "dead" or contained the animal.

Modiolaria vitrea Mörch, Tillæg til Rink's Grönland, 1857, p. 94; Arctic Manual, 1875, p. 133; Rink's Dan. Greenland, 1877, p. 442. — *Dacrydium vitreum* Friele, Nyt. Mag. Naturvidensk., 1879, p. 22; Posselt, Medd. om Grönland, XIX, 1895, p. 66; idem, ibid. XXIII, 1898, p. 21; Jensen, Medd. om Grönland, XXIX, 1909, p. 325.

The "Ingolf" has taken this species at:

St. 32.	Davis Strait	318 fm.	3.9° C.	33 spec.	
- 28.	—	420 -	3.5° -	30 —	
- 35.	—	362 -	3.6° -	3 —	
- 24.	—	1199 -	2.4° -	5 —	
- 115.	S. of Jan Mayen	86 -	0.1° -	18 — and 25 valves.	
- 116.	—	371 -	—0.4° -	2 valves (corresponding).	
- 117.	—	1003 -	—1.0° -	1 spec.	
- 101.	N. E. of Iceland	537 -	—0.7° -	1 —	
- 124.	N. of Iceland	495 -	—0.6° -	1 —	
- 126.	—	293 -	—0.5° -	12 — and 12 valves.	
- 128.	—	194 -	0.6° -	27 — - 9 —	
- 87.	W. of Iceland (Brede Bugt)	110 -		4 — - 50 —	Quite small, maximum size 1 mm.
- 86.	— —	76 -		1 valve.	
- 98.	W. of Iceland	138 -	5.9° -	8 spec. and 25 valves.	
- 97.	- - —	450 -	5.5° -	1 —	
- 90.	- - —	568 -	4.4° -	2 — - 7 —	
- 85.	S.W. of —	170 -		5 —	
- 80.	— - —	935 -	4.0° -	1 — - 1 valve.	
- 78.	— - —	799 -	4.5° -	35 — - ca. 50 valves.	
- 58.	E. - —	211 -	0.8° -	1 valve.	
- 138.	N. of the Færoes	471 -	—0.6° -	10 spec.	

The largest shell, namely of 7 mm., is one from St. 58, E. of Iceland; in the Davis Strait a size of 5 mm. is attained (St. 28) and S. of Jan Mayen a size of 5 mm. (St. 115 and 116). From the stations west and south-west of Iceland the maximum size is 4 mm. From the two very deep stations, 24 and 117, the size is respectively only 3 mm. and 2.5 mm.

There is considerable variation in regard to the form and thickness of the shell[1]). The specimens from west and south-west of Iceland (St. 87, 86, 98, 97, 90, 85, 80 and 78) differ especially from the typical *D. vitreum* in having a relatively elongated form and a less convex dorsal line; they greatly resemble the *Dacrydium occidentale* of E. A. Smith[2]) (West Indies, 390 fm.), but I have not thought it right to separate these specimens as an independent species.

[1]) Cf. also A. Locard, who distinguishes between the following varieties: *minor*, *elongata*, *curta*, *incurvata*, *ventricosa* and *albida*; Expéd. scient. Travailleur-Talisman, Moll. Test., II, 1898, p. 364.

[2]) Zool. Chall. Exp., Part XXXV, 1885, p. 282, Pl. 17, fig. 1.

Elsewhere the following information may be given regarding the distribution of the species.

West Greenland.

In addition to the "Ingolf" stations in the Davis Strait, 318—1199 fm., *D. vitreum* has been taken at 7 localities from the southernmost (Julianehaab) to the northernmost part (72 4' N. L.) of Danish West Greenland, on clay bottom and at depths of 48—250 fm. The size is up to 5 mm.

East Greenland.

Here *D. vitreum* has been taken by Danish Expeditions at 9 localities from Cape Dalton to Sabine Island, or from $69\frac{1}{2}°$—$74\frac{1}{2}°$ N. L. and at depths of 10—127 fm. It reaches here a size of 6 mm.

Jan Mayen.

The Norweg. North-Atlantic Exped. took *D. vitreum* at 2 stations, with depths of 70—95 fm. The Danish Exped. of 1892 took 8 specimens S. of the island (70°32' N. L., 8°10' W. L.), at a depth of 470 fm.; the Danish Exped. of 1900 took 4 specimens and 2 valves at a depth of 55 fm., as also 3 specimens and 1 valve at a depth of 50—60 fm. Lastly, as shown above, the "Ingolf" Exped. found it at 2 stations at a depth of 86 and 371 fm., as also a specimen far to the south of the island (St. 117) at a depth of 1003 fm., but it is only 2.5 mm. long.

Iceland.

Apart from the stations of the "Ingolf" north-east, north, west, south-west and east of the island, *D. vitreum* has also been taken at the following places:

66°32' N. L., 15°15' W. L.	75 fm.		1 valve.
64°58' — 11°12' —	300 -	—0.38° C.	1 spec.

The Færoes.

Besides at the "Ingolf" station N. of the Færoes (St. 138, depth 471 fm.; maximum size of the specimens 4 mm.) *D. vitreum* has been taken at the following places:

63°14' N. L., 9°46' W. L.	260 fm.	18 spec.
63°03' — 9°28' —	275 -	1 valve.
5 miles N. by E. of east point of Myggenæs	50 -	2 valves.
61°40' N. L., 7°40' W. L.	135 -	1 valve.
61°15' — 9°35' —	ca. 475 -	2 spec. and 9 valves.
61°7' — 9°30' —	440 -	1 valve.
6 miles N. by W. of Kalso	60	2 valves.
13 — W. by S. of Munken	- 155 -	9 —

From the deepest of these places (475 fm.) the specimens have a size of 3.5 mm., from the other places still smaller (1—3 mm.).

Elsewhere *D. vitreum* ranges from the Kara Sea and Spitzbergen to the Mediterranean and the Azores; on the American side from the Gulf of St. Lawrence to Campeche. It is said to occur down to a depth of 2750 fm., and in arctic regions it reaches as high up as 10 fm. (cf. under East Greenland).

Idas argenteus Jeffreys.

Pl. III, figs. 3a—e.

Idas argenteus Jeffreys, Ann. Mag. Nat. Hist. (IV), vol. XVIII, 1876, p. 428; Proc. Zool. Soc. 1879, p. 570, Pl. 45, fig. 3; Proc. Zool. Soc., 1882, p. 683.

Shell having the shape of an irregular parallelogram (varying from rhomboidal to oblong), of a delicate texture, rather opaque, iridescent; it is covered with a pale brownish-yellow periostracum, which rises into fibrous excrescences on the posterior side; under the periostracum the shell is silvery white, except the beaks which are reddish brown; sculpture, very fine and close-set transverse striae and microscopic longitudinal striæ, radiating from the beaks; margins straight at the back and in front, rounded on the anterior and smaller side, and sloping from the back with a curved outline on the posterior side; beaks circular and incurved, placed near the anterior side; an internal and long cartilage covers the hinge; hinge-line nearly straight, but obtuse-angled at the hinge; hinge-plate narrow, minutely and closely denticulated on both sides of the hinge; inside polished and nacreous; edge plain; scars inconspicuous. Size of the largest specimens about 8 ^{mm}.

In 1876 Jeffreys described the species almost as above, the additions and changes made by himself in 1882, however, being added.

This small Mytilid was taken by the "Ingolf" at:

St. 67. S. of Iceland .... 975 fm. 3° C. ca. 260 spec.

The specimens of the "Ingolf"-Expedition agree extremely well with the descriptions of Jeffreys. A radiating striation however can hardly be seen and the hairy periostracum is often distributed over a greater part of the shell, mostly however on the posterior and dorsal surfaces.

Distribution. During the "Valorous" Cruise of 1875 one valve was taken in the North Atlantic (56°11' N. L., 37°41' W. L.) at 1450 fm. The "Porcupine" Expedition of 1869 also found a shell in the Bay of Biscay at a depth of 994 fm. Lastly, it was taken on the cruise of the "Triton" between the Hebrides and the Færoes at 516 fm., "inhabiting deserted tubes of *Teredo megotara* in a large water-logged piece of pine-wood, to which the *Idas* had fixed itself by a strong byssus". The specimens of the "Ingolf"-Exped. were taken south of Iceland (61°30' N. L., 22°30' W. L.) at 975 fm., under similar conditions to the last; the trawl brought up two large pieces of pine-wood, which had been pierced through and through by *Teredo;* in some of the *Teredo* tunnels were in addition mud and worm-tubes, further worms and small bivalves, namely *Idas argenteus.*

In 1882 Verrill mentions an "*Idas argenteus* Jeffreys var.? *lamellosus* Verrill (perhaps sp. nov.)", taken by the "Fish Hawk" in 1881 at New England off Martha's Vineyard (S. S. W. 1/4 W., 103 1/2 miles) at a depth of 335 fm.[1]). On this Jeffreys (l. c. 1882) makes the following comment:

[1]) E. A. Verrill: Catal. of Marine Mollusca added to the Fauna of New England; Trans. Conn. Acad. vol. V, 1882 (p. 579).

"*Idas argenteus* is probably the species of that name noticed by Verrill as var. *lamellosa*", and the added knowledge of *Idas argenteus* obtained in that year really disposed of the peculiarities of Verrill's *Idas*.

Modiolaria.

The 4 northern species of this genus may, according to my experience, most readily be distinguished from one another in the following manner:

<table>
<tr><td rowspan="4">The shell radially striated</td><td colspan="4">over the whole ....</td><td>M. faba.</td></tr>
<tr><td rowspan="3">only on anterior or also on the posterior area.</td><td rowspan="3">Central and posterior areas of shell</td><td colspan="2">not distinctly separated ....</td><td>M. nigra.</td></tr>
<tr><td rowspan="2">separated by a diagonal furrow.</td><td rowspan="2">Central area</td><td>smooth .... (cum var. lævigata et substriata).</td><td>M. discors</td></tr>
<tr><td>shagreen-like wrinkled .</td><td>M. corrugata.</td></tr>
</table>

Modiolaria discors Linné.

The true *Modiolaria discors* Linné does not occur at Greenland, Jan Mayen or Iceland. The species is represented here by "*Modiolaria lævigata* Gray" and "*Modiolaria substriata* Gray", which I do not consider separate species, but varieties of a species which also embraces "*Modiolaria discors* Linné". The last name has the prior right by age and must consequently have the advantage in the designation of the species.

var. *lævigata* Gray.

Pl. III, figs. 4a—b.

Modiola lævigata Gray, Parry's first voyage, Suppl. to App., 1824, p. 244. — *Crenella lævigata* Torell, Spitsbergens Molluskfauna, 1859, p. 133. — *Modiolaria discors* Gould & Binney, Rep. Invert. Mass., 1870, p. 192, fig. 489. — *Modiolaria lævigata* Sars, Moll. Reg. Arct. Norv., 1878, p. 29, Pl. 3, fig. 3; Leche, Vega-Exped. Vetensk. Arb. III, 1883, p. 450, Pl. 34, figs. 27—28.

Mytilus discors Fabricius, Fauna groenl., 1780, p. 418. — *Mytilus discors, arcticus* Fabricius (partim), K. D. Vidensk. Selsk. Skr. 1788, p. 453, figs. 1 & 4—6. — *Modiola discors* Møller, Index Moll. Groenl., 1842, p. 19. — *Modiolaria discors* Beck, in Gaimard, Voyage de la Recherche, Pl. 17, fig. 2a—h. — *Modiolaria lævis* Beck, ibid. Pl. 17, fig. 3f. — *Modiola discors* Beck, Amtl. Bericht 24. Versamml. deutsch. Naturf. in Kiel, 1847, p. 115. — *Modiolaria lævigata* Mörch, Rink's Grönland, 1857, p. 94; Vidensk. Medd. Naturh. Foren. 1868, p. 224; Arctic Manual, 1875, p. 133; Rink's Dan. Greenland, 1877, p. 442; Becher, Österr. Polarst. Jan Mayen III, 1886, p. 69; Posselt, Medd. om Grönland, XIX, 1895, p. 67; ibid. XXIII, 1898, p. 25; Jensen, ibid. XXIX, 1909, p. 326. — *Modiolaria corrugata* (non Stimpson) et *lævigata* Hägg, Ark. för Zoologi, Bd. 2, No. 2, 1904, p. 22 & 23.

var. *substriata* Gray.

Pl. III, figs. 5a—b.

Mytilus discors, arcticus Fabricius, K. D. Vidensk. Selsk. Skr. 1788, p. 453 (partim), figs. 2 & 3. — *Modiolaria lævis* Beck, in Gaimard, Voyage de la Recherche, Pl. 17, figs. 3a—c. — *Modiolaria discors* Mörch, Vidensk. Medd. Naturh. Foren. 1868, p. 224. — *Modiolaria lævigata* var. *substriata* Posselt, Medd. om Grönland, XIX, 1895, p. 67; ibid. XXIII, 1898, p. 26; Jensen, ibid. XXIX, 1909, p. 326. — *Modiolaria substriata* Hägg, Arch. för Zoologi, Bd. 2, No. 2, 1904, p. 25.

The "Ingolf" has taken this species at:

St. 33.	Davis Strait	35 fm.	0.8° C.	1 spec.	var.
- 34.	— —	55 -		1 — very young	*lævigata.*
- 119.	Norwegian Sea	1010 -		1 — young (empty),	var. *substriata.*

At **West Greenland** the species is very common from the southernmost part of the land as far northwards as the investigations extend, namely to N. W. of Cape York; on the American side it is still met with in Franklin Pierce-Bay at 79°25' N. L. It prefers shallow water, 0—30 fm., but it is said to live also in greater depths, down to 100 and 200 fm. The variety *substriata* is less common than *lævigata*. The largest specimens at my disposal of var. *lævigata* measure 46 mm., of var. *substriata* 30 mm.; O. Fabricius mentions specimens of up to 50 mm.

At **East Greenland** the species has been taken at many places, sometimes in large numbers, from Angmagssalik as far north as collections have been made (Shannon Island at 75—75½° N. L.). The depths noted are 0—30 fm. The variety *lævigata* is also by far the most abundant here; the largest specimen of this variety measures 36.5 mm., of *substriata* 32 mm.

Jan Mayen. The Austrian Expedition took 13 specimens up to 28 mm. long on the north side of the island, at a depth of 8—13 fm. The Danish Exped. of 1900 took some smaller specimens at 15 and 50—60 fm.

At **Iceland** the species is probably common all round the island, from lowest water[1]) and (in small specimens) out to 50—60 fm.; the localities mentioned below hardly give a correct picture of its distribution, as only few dredgings were made in very shallow water, where the species mainly lives. The variety *lævigata*, which is the most frequent, reaches a length of 48 mm., and among the var. *substriata* there is one of 52 mm.

East Iceland:

Lónsvik	8—10 fm.,	fine black sand.	1 spec.
Berufjördr, Djupivogr	3 - ,	on Laminaria rhizoids.	2 —
— —	6 - ,	mud with black sand.	1 —
— —	8 -		2 —
— —	10 -		3 —
Breiddalsvik	14 -		1 —

[1]) A. C. Johansen records *Modiolaria lævigata* among the Molluscs which occurred in the greatest abundance 2—3 meters below the high water mark at the coasts of Iceland. Vidensk. Medd. Naturh. Foren. 1902, p. 387.

Fáskrudsfjördr, Hafnarnes.	50—10 fm., blue clay		2 spec.
Reydarfjördr	60—80 -		1 -
—	70 -		1 -
Seydisfjördr at Skálanes		on Laminaria rhizoids.	7
— - —	6 -	, on Laminaria leaves.	1
— - —	7—8 -		2
— - Brimnes	8—4 -		1 —
Bakkafjördr	12—15 -		7 —
—	52—20 -		15
Finnafjördr, Gunolfsvik	12 -		1 —

All these are for the most part quite small specimens, due to chance naturally; the largest specimen is only 25 mm. long, but in the Stockholm Museum I have seen a specimen from Berufjördr, which was 48 mm. long. The variety *substriata* is rather frequent, comparatively speaking, in the material at hand.

North Iceland:

Thistilfjördr	10 fm., sand, coral.	1 spec.
Kollafjördr		7 —
—	10 -	1
— Húnaflói	5 -	1 —
Skagastrand		4 —
— Bugt	33 -	1 —
66°36′ N. L., 21°57′ W. L.	32—37 -	1 —

Though there happens to be only such a small material from this part of the coast, it nevertheless contains large specimens, of the variety *lævigata* up to 48 mm., and of the variety *substriata* of 52 mm.

West Iceland:

Höfnvik	10 fm.	1 spec.
Adalvik	6—9 -	3
Isafjördr		1 —
Önundarfjördr	1½—0 -	1 —
Dyrafjördr		1 —
65°52′ N. L., 23°58′ W. L.	33 -	1
65°17.5′ — 23°32′ —	7—12 -	1 —
Hvalfjördr	24 -	3 —
Faxe-Bugt		15
Reykjavik		20 —

All these specimens belong to the variety *lævigata*; the largest (from Önundarfjördr) is 45 mm., the second-largest (from Reykjavik) is 44.5 mm. long.

South Iceland:

Vestmannaeyjar	beach		1 valve.
—	....	10—15 fm.	1 spec.

These specimens belong to the variety *substriata* and reach a length of 18 mm.

[At the **Færoes** the species has *not been found*].

Remarks. At Iceland and Greenland the species occurs, as mentioned above, under two main forms:

a. *Modiolaria discors* L. var. *lævigata* Gray (Pl. III, figs. 4a—b): the shell somewhat compressed, posteriorly high, rounded-truncate; the posterior area without radiating striæ.

b. *Modiolaria discors* L. var. *substriata* Gray (Pl. III, figs. 5a—b): the shell ventricose, posteriorly low, rounded-pointed; the posterior area with radiating striæ.

But each of these forms again is subject to variation.

The typical *lævigata* is a high form, but even among the full-grown we meet with specimens which are much more elongated than is usually the case. The typical *lævigata* does not have the radiating striæ on the posterior area, but sometimes a faint striation may be seen here[1]).

In the typical *substriata* the postero-dorsal margin slopes rapidly downwards, but we also find specimens in which the slope of the posterior margin is less abrupt. The typical *substriata* has the posterior area distinctly striated radially, but sometimes the striation is not to be seen, even under a lens ("*Modiolaria lævis*" Beck l. c.).

The two forms frequently occur together and one is often at a loss to determine to which of the forms a given specimen has to be referred; in the case of small specimens it is often quite impossible.

Modiolaria lævigata-substriata are arctic and circumpolar forms, whose southern boundaries lie at Massachusetts, Lofoten and northern Japan. Viewed in a wider sense, including also *Modiolaria discors*, the species is distributed further along the rest of West Europe to Madeira, including the Kattegat-Baltic (to Kiel and Neustadter Bugt) and the Mediterranean[2]).

In opposition to G. O. Sars I must maintain, that *Modiolaria substriata* and *Mod. lævigata* are not distinct, but forms of one and the same species.

And I am most inclined to believe with Jeffreys, that *Modiolaria lævigata* Gray and *Modiolaria discors* Linné are specifically identical. Against this G. O. Sars has objected very definitely and I can in so far agree with this author, that there is not an excessively great resemblance between *Mod. discors* and an adult, typical *Mod. lævigata*; on the other hand, I certainly consider it as more than probable, that *Mod. discors* is nothing else but a southern[3]), pygmy[4]) and slightly altered form

[1]) I exclude here the fact, that all *lævigata* in the very young stages have the posterior area radially striated and in the adult condition retain this striation on the umbonal region; the striation is obviously a characteristic of the young stages.

[2]) Bucquoy, Dautzenberg and Dollfus however write in their oft-cited work, on the marine Mollusca of Roussillon, that the occurrence of *Mod. discors* in the Mediterranean requires to be confirmed; they mention various cases, in which *Mod. marmorata* Forb. has been confused with *Mod. discors*.

[3]) *Mod. discors* is certainly very commonly regarded as an arctic form, but the basis for this is undoubtedly a confusion with the form *substriata*; among many hundreds of specimens, which I have examined from arctic regions (Greenland, Iceland, Spitzbergen, Kara Sea), I have not found a single one of the true *discors*; this hardly goes further than northernmost Norway or Murman Coast, further east and north it is replaced by the *substriata* form. As mentioned by Sparre Schneider (Tromsösundets molluskfauna; Tromsö Museums Aarshefter VIII, 1886, p. 65) the form *substriata* ("*Mod. lævis* Beck") does not occur at Norway for the simple reason, in my opinion, that *Mod. discors* is its modification in boreal regions.

[4]) The maximum length of *Mod. discors* (at Denmark and Norway) is 20 mm., whereas *Mod. substriata* becomes over 50 mm. long.

of "*Mod. substriata*", so small is the difference between them[1]). *Mod. discors* (Pl. III, figs. 6a–b) is on the whole a more oblong form; this is the essential difference. But whilst maintaining, that *Mod. lævigata*, *Mod. substriata* and *Mod. discors* are identical specifically, I may yet emphasize that in their typical shape they are representatives for just as many special forms and must not be summarily thrown together.

Furthermore, the form *discors*, as I know it from Danish waters, is also not a little variable; frequently the posterior area is distinctly striated, but sometimes it appears almost smooth (cf. var. *semilævis* Jeffreys, Brit. Conchol. II, p. 127); I have even before me at this moment a specimen from the Great Belt (Svendborg), which combines a striation such as we find in *substriata* with the form of a typical *lævigata*, or on the whole shows a great resemblance to a very young *Mod. lævigata*.

In conclusion I may quote some little known observations regarding the biology of this species.

In his paper "Om Ueens-Muslingen" (i. e. *M. discors* var. *lævigata* and *substriata*) O. Fabricius[2] writes as follows: "This Bivalve I have found to be of common occurrence in Greenland, where it is called *Bibibiarsuk*; I do not know the certain origin of this word .... one might be inclined to think, that the Greenlanders have found this name suitable for the whistling or hissing noise, this Bivalve... produces when it has stood for a long time closed at ebb-tide for want of water and then with the coming of the flood begins to open again. It is attached by its fine silk (byssus) to large stones or rocks in the sea, the largest end sticking upwards, the open side turned towards the stone or foreign body, to which it is attached. It lives preferably so far from the land, that it does not become dry except at spring-tides when the greatest ebb occurs. On the blind rocks out to sea, therefore, it is most numerous .... When its silky hairs have been broken by the waves or other cause, I have seen it stretch out its foot, attaching it to the solid rock, elongating and contracting it, and thus push itself forwards .... the fattest and largest are found on clay bottom ...."

In a manuscript left by H. P. C. Møller we find: "It occurs everywhere in quantities on the coast of Danish West Greenland and especially where there is shallow water, partly on Laminaria, more rarely on Fucus, partly among the string-like algal forms and among stones, down to a depth of 20 fm. or still deeper, e. g. at Nennortalik, Godhavn; I have taken it in 30 fm. opposite Nepisene at a distance of 8 Danish miles from the coast."

And in a notice: "Ueber *Mytilus discors*" Iap. Steenstrup makes the following remarks on *Modiolaria discors* var. *lævigata* at Iceland: ". . . . Noch mehr zeichnet sich diese Muschel durch ihren sehr ausstreckbaren Fuss aus, welcher ihr erlaubt, die Byssusfäden nicht nur um die Seiten der Schalen, sondern auch über den Rücken derselben herumzuführen; dadurch kann sie sich ganz mit einer Byssushülle umgeben oder sich wie in einem Byssussack verstecken. Die Enden der äusseren Byssusfäden werden auf kleinen Steinchen, Muschelschalentrümmern und dergleichen festgeheftet, so dass der Byssussack ganz einem Steinhäufchen gleicht; die innere Wand der Byssushülle ist dagegen sehr glatt, aus dichtliegenden, sich kreuzenden Byssusfäden gebildet, und schliesst sich den Muschelschalen ziemlich dicht an. Nur das hintere Ende der Hülle hat eine Oeffnung, sonst ist sie ganz geschlossen. In seichten Meeresbusen, in welchen der Boden mit grobem Sande und Grande bedeckt war, hat S.

[1]) Leche has obviously been of the same opinion, as he writes (l. c. p. 151), that the *Mod. discors* from Kiel Bay, sent him by Möbius, cannot be specifically distinguished from *Mod. lævis* Beck; Leche refers to this in connection with the fact, that G. O. Sars had erroneously identified Möbius' *Mod. discors* with *Mod. corrugata* Stimpson.

[2]) Nye Samling af det Kgl. Danske Videnskabernes Selskabs Skrifter, 3. Deel, 1788, p. 153.

sehr oft bedeutende Flächen von den oben erwähnten Steinhäufchen eingenommen gesehen; in jedem derselben steckte eine lebende *Mytilus discors*-Muschel, ganz wie eine Puppe in ihrer Puppenhülle"[1]).

Modiolaria corrugata Stimpson.

Pl. III, figs. 7 a—d.

Modiola discors Gould (*non* Linné), Rep. Invert. Mass. 1841, p. 130, fig. 84. — *Mytilus corrugata* Stimpson, Shells of New England, 1851, p. 12. — *Modiolaria corrugata* Gould and Binney, Rep. Invert. Mass. 1870, p. 193, fig. 491; Sars, Moll. Reg. Arct. Norv. 1878, p. 30, Pl. 19, fig. 2.

Modiolaria corrugata Mörch, Rink's Grönland, 1857, p. 94; Arctic Manual, 1875, p. 133; Rink's Danish Greenland, 1877, p. 442; Posselt, Medd. om Grönland, XXIII, 1898, p. 23 (partim). — *Modiolaria nigra* Walker (*non* Gray), Journ. Roy. Dublin Soc., vol. 3, 1860, p. 70.

At **West Greenland** this species is not common according to Posselt. In this I can confirm Posselt and I even believe, that it is more rare than he thought, as he has in several cases confused *Modiolaria nigra* with the present species. Specimens which are certainly *M. corrugata* I have seen in the Copenhagen and Stockholm Zoological Museums from the following West Greenland localities: Fiskenæs, 70 fm., shell bottom; Godthaab, 50—60 fm.; Disco, Harungen, 160 fm., clay bottom; Godhavn, 70 fm., clay bottom; Umanak, 12 fm. and 25—35 fm., stony bottom; N. W. of Cape York, 5—12 fm., sand mixed with clay. From each locality there is only one or a couple of specimens. According to Jeffreys[2]), the so-called "*Modiolaria nigra*" taken by the "Fox" at Cape York and Port Kennedy belong to this species. — The largest Greenland specimen which I have seen is 15.75 mm. long.

[At **East Greenland** *M. corrugata* is stated to have been taken by the Swedish Exped. of 1900, according to R. Hägg[3]); I have had the opportunity of seeing the specimens in question and found, that they were in reality the two varieties *lævigata* Gray and *substriata* Gray of *Modiolaria discors* L. *M. corrugata* has thus not yet been found on the east coast of Greenland].

[On the north side of **Jan Mayen** the Austrian Polar Station is said to have taken 2 specimens, according to Becher[4]), but we do not know, whether the determination was correct].

[That *Mod. corrugata* occurs at **Iceland**, as stated by Verkrüzen[5]), I consider as more than doubtful; the species is not represented in the systematic collections made from the Danish side. I imagine, that the specimens Verkrüzen obtained at Reykjavik by dredging in July 1872, were *M. discors* var. *substriata*].

Distribution. In addition, we have more or less certain records that *Modiolaria corrugata* lives at Spitzbergen, ca. 3½—63 fm. (Torell, Knipowitsch) and at Finmarken, 20—50 fm. (Sars), in the Kara Sea, 20—78 fm. (Collin), in the Polar Sea of Siberia, 9—12 fm. (Leche), in the Bering Sea, 15—20 fm. (Krause) and on the north-east coast of America down to Cape Hatteras (Dall).

1) Amtl. Bericht über die 24. Versamml. Deutscher Naturf. und Aerzte in Kiel, 1847, p. 222.
2) Scient. Proceed. Roy. Dublin Soc., N. S., II, 1880, p. 128.
3) R. Hägg, Arkiv för Zoologi, Bd. 2, No. 2, 1904, p. 22.
4) Becher, Österr. Polarst. Jan Mayen, III, 1886, p. 69.
5) T. A. Verkrüzen: Dredging-Excursion to Iceland. Ann. Mag. Nat Hist. 4 ser. Vol. X, 1872, p. 372.

Remarks. Great uncertainty prevails among authors regarding *Modiolaria corrugata;* often it is called a "transitional form" to other arctic species of *Modiolaria*, and especially to *M. discors* L. var. *substriata* Gray ("*M. lævis* Beck"). From a close investigation I have come to the result, that *M. corrugata* is an exceedingly well defined species. *M. corrugata* certainly shows some resemblance in habit to *M. discors* var. *substriata*, but is readily distinguished from this by the middle area being not smooth or simply striated (cf. Pl. III, fig. 5e) but showing under the lens a shagreen-like wrinkling of the surface, as shown in fig. 7d on Pl. III (cf. also Krause: Ein Beitrag zur Kenntniss der Mollusken-Fauna des Beringsmeeres, p. 19)[1]. A similar kind of surface is also found, however, in *M. nigra;* but in the latter the posterior, striated area grades evenly over into the middle area, whereas in *M. corrugata* the middle area appears depressed along the boundary line towards the posterior area, as in *M. discors;* further, in *M. corrugata* the radial striation is coarser, the shell more ventricose (cf. measurements of *M. corrugata* with those of *M. nigra)* and with more prominent umbones. In regard to shape, moreover, *M. corrugata* is rather variable, as will be seen from the following measurements of a number of specimens:

Locality	Length of shell	Height of shell	Height / Length	Breadth of shell	Breadth / Length
Greenland	15.75 mm.	10 mm.	63.5 %	7.5 mm.	47.6 %
—	14.5 -	9.5 -	65.5 -	7.5 -	51.7 -
—	14.25 -	9 -	63.2 -	7.5 -	52.6 -
—	12.3 -	7.75 -	63 -	7 -	56.9 -
—	8 -	5.75 -	71.9 -	4.75 -	59.4 -
Spitzbergen............	26.5 -	17 -	64.2 -	11 -	41.5 -
—	24 -	15.75 -	65.6 -	10.25 -	42.7 -
—	22.5 -	14.75 -	65.6 -	10 -	44.4 -
—	18.75 -	12 -	64 -	8 -	42.7 -
—	13.75 -	8.75 -	63.6 -	5.75 -	41.8 -
—	13.25 -	8.8 -	66.4 -	5.75 -	43.4 -
—	13 -	8.75 -	67.3 -	5.5 -	42.3 -
—	8.5 -	6 -	70.6 -	4.75 -	55.9 -
—	8.25 -	5.75 -	69.7 -	4 -	48.5 -
Kara Sea	21.5 -	13 -	60.5 -	9 -	41.9 -

Modiolaria nigra Gray.

Modiola nigra Gray, Parry's first voyage, Suppl. to App., 1824, p. 244. — *Crenella nigra* Torell, Spitsbergens Molluskfauna, 1859, p. 130. — *Modiolaria nigra* Jeffreys, Brit. Conchol. II, 1863, p. 128, Pl. 28, fig. 4; Gould & Binney, Rep. Invert. Mass. 1870, p. 190, fig. 487 (juv.) & 488. *Modiola discrepans* Møller, Ind. Moll. Groenlandiæ, 1842, p. 10. — *Modiolaria striatula* Beck, in Gaimard, Voyage de la Recherche, Pl. 17, figs. 1 a—f; Amtl. Bericht 24. Versamml. deutsch. Naturf.

[1]) Archiv für Naturgeschichte, 1885.

in Kiel, 1847, p. 115. — *Modiolaria nigra* Mörch, Rink's Grönland, 1857, p. 93; Vidensk. Medd. Naturh. Foren. 1867, p. 96; ibid. 1868, p. 224; Arctic Manual, 1875, p. 132; Rink's Dan. Greenland, 1877, p. 442; Posselt, Medd. om Grönland, XXIII, 1898, p. 27; Hägg. Ark. för Zool., Bd. 2, No. 2, 1904, p. 26; Jensen, Medd. om Grönland, XXIX, 1909, p. 328.

West Greenland.

The species has been taken at many places from the southernmost part up to Proven (72° 23′ N. L.), and it will certainly prove to occur even further north, as it has been taken on the American side right up to 78°45′ N. L.[1]). The depths recorded lie between 10—200 fm. It attains to a very considerable size, up to 62 mm.

Regarding this species H. P. C. Møller writes in a manuscript preserved in the Museum here: "This bivalve is living along the whole coast of Danish West Greenland, but only solitary and where the sea is deep (30—60 fm.) and the bottom is clay. Young individuals are frequently to be met with; the adults on the other hand are rather seldom to be found, because they conceal themselves digging down deep in the clay."

East Greenland.

M. nigra has been taken at 6 localities between Angmagssalik (65°35′ N. L.) and Cape Borlase Warren (74°20′ N. L.), at depths of ca. 3—19 fm. The largest specimen is 45.5 mm. long.

Iceland.

M. nigra has been taken all round the island, at depths of ca. 6—50 fm. The largest specimen is not less than 67 mm. long, but as a general rule only small specimens are taken.

The various localities are shown in the following lists.

East Iceland:

Berufjördr, Djupivogr	6 fm.,	mud with black sand.	45 spec.
Faskrudsfjördr	50—20 -	, blue clay.	2 —
Reydarfjördr	44 -		1 —
Seydisfjördr at Skálanes	8—7 -		10 —
Bakkafjördr	ca. 10 -		2 —
—	12—15 -	, black sand.	1 —
—	52—43 -		Fragments of a large specimen.
Finnafjördr	18 -		3 spec.

The specimen from Reydarfjördr is 67 mm. long, the specimen from the greatest depth in Bakkafjördr has also been of considerable size, but the others are quite small specimens.

North Iceland:

Thórshöfn	6 fm.	1 valve.
Axafjördr	22 -	1 —
Öfjord at Svalbardseyri	10—20 -	4 spec.

These are small specimens.

[1]) Grieg: Rep. Sec. Norw. Arctic Exped. in the "Fram", No. 20, 1909, p. 9.

West Iceland:

Ritur Huk-Straumnæs	30 fm.,	in haddock.	2 spec.
Dyrafjördr, inside Thingnæs	10–12½ - ,	mud and small stones.	1 -
Hvalfjördr	24 -		1 —
Faxafjördr, off Kollafjördr	10 -		2 spec. & 2 valves.
— , - —	8–11½ - ,	ooze and stones.	1 -
— , ca. 2 miles N. E. of Keflavik	19½–20½ - ,	ooze.	3 -
— , 4.3 miles W. ¾ S. of Helgasker Vager	25 -		1 valve.

All these are quite small specimens; the largest (from the first locality) are only 12 mm. long.

South Iceland:

Medalland Bugt	47–37 fm.	5 spec.

These specimens reach a length of up to 33 mm.

The Færoes.

From earlier years we have several specimens of up to 53.5 mm. long, but the locality is merely given as "the Færoes". In recent years *M. nigra* has been taken at the following places:

Bordövig	7–10 fm.,	black sand, small stones, Laminaria.	18 spec.
—	10 - ,	sand with Laminaria.	5 —
Kongshavn	50 -		9 -
Vestmanhavn	3½–5 - ,	fine black sand.	1 —
—	5–6 - ,	fine black sand.	11 -
Trangisvaagfjord, head of	0–1 -		1 fragment.
9 miles E. S. E. of Bispen	ca. 70 -		4 spec.

Among the specimens from Kongshavn there are 2 which measure 39.5 and 43.5 mm.; the remainder are only small specimens.

The **distribution** is undoubtedly circumpolar; *Modiolaria nigra* has been taken at arctic America (Northumberland Sound and Wellington Channel, Jones Sound and Rice Strait), West and East Greenland and Spitzbergen, in the Kara Sea, Polar Sea of Siberia and Bering Sea; towards the south it reaches to Cape Hatteras, Dogger Bank and western part of the Baltic, Sea of Okotsk and North-West America. — The vertical distribution extends from ca. 3–200 fm.

Variation. *Modiolaria nigra* is subject to no small modification in regard to the form of the shell; as will be seen from the measurements below, the height of the shell in these 17 specimens alone varies from 48.3–58.1 % of the length of the shell and the breadth from 29.6–40.8 % of the length of the shell.

Locality	Length of shell	Height of shell	Height / Length	Breadth of shell	Breadth / Length
West Greenland (Nanortalik).	46.5 mm.	25 mm.	53.8 %	14.5 mm.	31.2 %
	32.5 -	18 -	55.4 -	11 -	33.8 -
East Greenland (Cape Dalton). .	40 -	22 -	55 -	14 -	35 -
	35.5 -	19.5 -	54.9 -	14.5 -	40.8 -
	35.5 -	20 -	56.3 -	12.5 -	35.2 -
	34.5 -	18.5 -	53.6 -	12.25 -	35.5 -
— — (Turner Sound).	44.5 -	21.5 -	48.3 -	16 -	36 -
	31 -	17 -	54.8 -	10.5 -	33.9 -
Iceland (Reydarfjördr)	67 -	33.5 -	50 -	20.5 -	30.6 -
The Færoes (Kongshavn)	43.5 -	22.5 -	51.7 -	14 -	32.2 -
	41.5 -	23 -	55.4 -		
	39.5 -	21.5 -	54.4 -	12.5 -	31.6 -
Denmark (Hellebæk)	51.5 -	29 -	56.3 -	16 -	31.1 -
	49 -	26 -	53.1 -	14.5 -	29.6 -
— (Hveen)	42 -	23 -	54.8 -	14.5 -	34.5 -
— (Kattegat)	41 -	21.5 -	52.4 -	14 -	34.1 -
	37 -	21.5 -	58.1 -	11.25 -	30.4 -

Modiolaria faba (Müller) Fabricius[1]).

Pl. III, figs. 8a—c.

Mytilus faba Müller, Prodr. Zool. Dan., 1776, p. 250; Fabricius, Fauna groenlandica, 1780, p. 419. — *Modiola arctica* Leach, in Ross, A voyage of discovery, 1819, App. II, p. 62. — *Modiola faba* Møller, Index Moll. Groenlandiæ, 1842, p. 19. — *Modiola fabus* Beck, Amtl. Ber. 24. Versamml. deutsch. Naturf. u. Aerzte in Kiel, 1847, p. 115. — *Crenella decussata* Walker *(non* Montagu), Journ. Roy. Dublin Soc. III, 1860, p. 72. — *Modiolaria faba* Beck, in Gaimard, Voyage de la Recherche, Pl. 17, figs. 4a—i; Packard, Mem. Boston Soc. Nat. Hist. I, 1867, p. 280; Mörch, in Rink, Dan. Greenland, 1877, p. 442[2]); Dall, Bull. U. S. Nat. Mus., XV, 1879, p. 146. — *Crenella faba* Jeffreys, Sc. Proc. Dublin Soc., N. S., II, 1880, p. 128; Bush, Proc. U. St. Nat. Mus. 1883, p. 244, Pl. 9, fig. 3; Dall, ibid., 1886, p. 207; Pfeffer, Jahrb. Hamb. wiss. Anst., 3. Jahrg., 1886, p. 44. — *Modiolaria faba* Posselt, Medd. om Grønland, XXIII, 1898, p. 22. — *Crenella faba* Grieg, Rep. Sec. Norw. Arct. Exped. in the "Fram", No. 20, 1909, p. 10, Pl. I, fig. 1.

The shell more or less ventricose, somewhat trapezoidal with a faint tendency to be oval, truncate in front, anterior margin rather curved, obliquely rounded posteriorly, ventral margin faintly

[1]) Of this little known species I give here a synonymy-list, which is complete, so far as I know; by far the most of references, however, are to *nomina nuda* only. — I think it doubtful whether *M. faba* is a *Modiolaria*, but it seems to me to stand further from the genus *Crenella*, and I retain the species under *Modiolaria*, therefore, to avoid founding a new genus on a single, northern species.

[2]) Mörch has forgotten to include the species in his earlier lists on the Mollusca of Greenland.

curved, dorsal side rissen in the middle and compressed, with the rather tumid and prominent umbones lying at the front end. The valves fairly thin but strong, with a brownish or yellowish, somewhat iridescent periostracum and provided over the whole with distinct, flatly rounded ribs, which to a number of ca. 50 radiate out from the umbones towards the circumference of the shell and are of the same breadth as or little broader than the intercostal furrows, but broadest towards the anterior end; the circular lines of growth very fine. Interior iridescent, usually pale-reddish or violet, crenulated at the margin; a crenulation of ca. 7 small teeth on the hinge-plate under and in front of the beak. Length up to 17.5 mm.

At **West Greenland** *Modiolaria faba* has been taken as far south as at Ivigtut (61°13' N. L.); it first appears in quantity at Godthaab (64°11' N. L.) and it is common further north, at least up to Melville Bay. It is met with most frequently in shallow water (0—15 fm., more seldom 20—30 fm.) and chiefly on stony, algae-covered clay bottom. — In Umanak Fjord I have found it attached by its byssus to sea-weed, which floated at the surface over very great depths.

Distribution. Elsewhere the species is only known on the American side, namely: Cape Sabine in Smith Sound (78°45' N. L.), 2—5 fm. and Havnefjord in Jones Sound (Grieg), Cumberland Sound on Baffin Land (Dall, Pfeffer), as also from Labrador southwards to 51°33' N. L., 0—15 fm. (Packard, Bush and Dall[1]).

Remarks. The numerous specimens at my disposal from Greenland show, that the form is variable to some extent, sometimes swollen and low, sometimes comparatively flat and high; to make this evident I have taken the measurements of the following specimens:

Length of shell	Height of shell	Height / Length	Breadth of shell	Breadth / Length
10 mm.	7.5 mm.	75 %	6.5 mm.	65 %
9 -	7 -	77.8 -	5.5 -	61.1 -
10 -	8 -	80 -	5 -	50 -
12 -	10 -	66.7 -	5 -	41.7 -

In a manuscript left by the author of the Index Moll. Groenlandiae, H. P. C. Møller, the following information is given regarding the animal: "The mantle is open in front for two-thirds of its extent; the posterior third is closed and forms a short conical tube, broad at the base. The hindmost part of the open mantle may extend a little out over the margin of the shell. The foot, when quite extended, is twice as long as the greatest length of the shell, otherwise quite similar in form to the foot in *M. lævigata;* extended whitish, contracted brownish, in young specimens yellowish."

Møller writes further on *M. faba:* "The colour of the shell is dark chestnut-brown; the quite small specimens are clear lilac; those I have taken here in deep water and in the open sea, were greenish and very light-coloured .... It occurs on Laminaria in great quantity at Godthaab and further north along the coast; but I have also obtained it at a depth of 30 fm., 8 Danish miles from the coast."

[1]) Mörch's record of its occurrence at the coasts of Denmark must be based on a mistake, as C. G. Joh. Petersen has already remarked (Om de skalb. Molluskers Udbredningsforhold, 1888, p. 128), as also Beck's statement that it lives at Iceland

Lastly, I may quote a remark by Jap. Steenstrup[1]) with regard to *Modiolaria faba:* "Eben dieselbe Lebensart (i. e. wie *Mod. lævigata,* cf. p. 61) muss auch eine andere Muschel aus derselben Abtheilung der Gattung *Modiolus*, nämlich der *Mytilus faba* Fabr. fn. grönl., führen, denn Prof. Steenstrup hatte mehrere in Spiritus aufbewahrte Exemplare aus Grönland in ähnlichen Byssushüllen gesehen; die Hüllen waren durch äussere Fäden theils an Sertularien- und Corallinen-Zweige geheftet und ganz mit denselben bedeckt, theils waren sie zwischen verschiedenen Ascidien eingewebt, zum Theil selbst von den letztgenannten überwachsen".

Crenella decussata Montagu.

Mytilus decussatus Montagu, Test. Brit. Suppl., 1808, p. 69. — *Crenella decussata* Jeffreys, Brit. Conchol. II, 1863, p. 133, Pl. 28, fig. 6; Sars, Moll. Reg. Arct. Norv., 1878, p. 31, Pl. 3, fig. 4.
Modiola? cicercula Møller, Ind. Moll. Groenlandiæ, 1842, p. 19. — *Crenella decussata* var. Mörch, Rink's Grønland, 1857, p. 94; Arctic Manual, 1875, p. 133; Rink's Dan. Greenland, 1877, p. 442. — *Crenella decussata* Posselt, Medd. om Grønland, XXIII, 1898, p. 19; Hägg, Ark. f. Zoologi, Bd. 2, Nr. 13, 1905, p. 113; Jensen, Medd. om Grønland, XXIX, 1909, p. 329.

The "Ingolf" has taken this species at:

St. 129.	N. W. of Iceland............	117 fm.	6.5° C.	1 valve.
- 86.	W. of Iceland (Brede Bugt)...	76 -		4 spec. & numerous valves.
- 87.	- - — —...	110 -		12 — & numerous valves.

The largest of these shells (St. 87) is 3.75 mm.

West Greenland.

Here *C. decussata* is common from the southernmost parts up to a least Upernivik (72°47' N. L.). It occurs on clay and sand and among fragments of shells, most frequently at 20—50 fm. but also goes higher up (10 fm.) as well as deeper down (200 fm.). The largest specimens measure 5.5 mm. — "It spins, but the threads are so fine, that they can scarcely be seen with the naked eye and even under the lens only in certain directions of the light" (H. P. C. Møller M. S.).

East Greenland.

A single specimen, 4.75 mm. high, has been taken on the southern part of the coast at Tiningnekelak (65 56' N. L.); according to Hägg (l. c.) a Swedish Expedition is said to have taken a very small specimen in Franz Josephs Fjord, the outer part of Myskokse Fjord, at $116^1/_2$ fm.

Iceland.

When Mörch wrote his review of the Mollusca of Iceland he did not himself know *Crenella decussata* from the island, but was only able to report, that Jeffreys had seen a single specimen

[1]) Extract in: Amtl. Bericht über die 24. Versamml. Deutscher Naturf. u. Aerzte in Kiel, 1847, p. 222.

from there. From recent year's collections, however, *C. decussata* proves to be common all round Iceland at depths of 6—50 fm. The following are the various localities where it has been found.

East Iceland:

Lónsvik	40 fm., ooze and clay.	1 spec. & 3 valves.
Oster Horn	40 -	4 valves.
Berufjördr, Djupivogr	6 -	100 spec. & 16 valves.
— —	6—9 - , mud with black sand.	1
Breiddalsvik	14 -	6
64°58′ N. L., 13°25′ W. L.	40 -	4 — & 25 valves.
Vidfjördr	8—12 -	70 — & 70
—	15 -	5
Nordfjördr	40 -	2 valves
Seydisfjördr at Skulavig	6 -	7 spec.
Bakkafjördr	12—15 - , black sand.	10 — & 3 valves.
—	32—25 - , clay and sand with shells.	5 — & 5
—	52—43 -	1 — & 2
Finnafjördr	18 -	1 valve.

The maximum size is 4.75 mm.

North Iceland:

Thórshöfn	6 fm., mud.	1 valve.
Vidarvik	11 -	2 spec. & 3 valves.
—	$13^{1}/_{2}$ - , black sand.	1 valve.
Axafjördr	30 - , sand and stones.	9 valves.
Siglufjördr	15 -	3 spec. & 3 valves.
Skagastrand		1 spec.

The largest of these specimens is 3.75 mm.

West Iceland:

Isafjardardjup	60—63 fm.	1 spec.
Dyrafjördr, inside Thingnæs	$10—12^{1}/_{2}$ - , mud, small stones.	4 valves.
Hvalfjördr	24 -	60 spec. & 140 valves.
Krossvik	8 - , shell-gravel, blue clay, stones.	11 & 4
Faxafjördr	17 - , coarse shell-sand.	1 — & 12 —
— off Kollafjördr	$8—11^{1}/_{2}$ - , ooze and stones.	1 — & 28 —
— - —	10 -	Several hundred spec. & valves.
— mouth of Kollafjördr	$9^{1}/_{2}$ -	24 spec. & ca. 200 valv.

Faxafjördr, mouth of Kollafjördr	$9^1/_2$—11 fm.,	fine black sand and ooze.	3 spec. & 4 valves.
— Keflavik	15—16 - ,	fine black sand.	4 — & ca. 150 valv.
— ca. 2 miles N.E. of Keflavik	$19^1/_2$—$20^1/_2$ - ,	ooze.	2 — & - 100 —
— 19 miles W. of Helgasker Vager	13—16 - ,	shell-gravel, stones & Lamin.	5 — & 8 valves.
— 4.3 miles W. $^3/_4$ S. of Helgasker Vager	25 -		ca. 200 valves.
— E. of Videy	9—10 - ,	fine sand and ooze.	2 spec. & 20 valves.
— 7 miles N. N. E. of Skagens Light	17—$20^1/_2$ - ,	sand and shells.	1 — & 1 valve.
Hafnarfjördr	25 - ,	fine black sand and ooze.	2 valves.

The maximum size of all these specimens is 4^{mm}.

South Iceland:

Vestmannaeyjar	49 fm.,	clay with a little mud.	5 spec. & 60 valves.

The maximum size is 3^{mm}.

The Færoes.

At the time when Mörch prepared his Faunula Moll. Ins. Færoënsium, *Crenella decussata* was still unknown. During the investigations of recent years it has frequently been found at the Færoes, at a depth of ca. 5—50 fm.; the following are the different localities:

Klaksvig	11 fm.		2 spec. & 1 valve.
—	10—15 -		10 — & 160 valves.
Bordövig	7—10 -	black sand, small stones, Laminaria.	ca. 300 spec. & numerous valves.
—	10 - ,	sand with Laminaria.	60 spec.
Ejde	5—6 - ,	coarse, black sand.	35 — & ca. 100 valv.
Fundingsfjord	12—ca. 20 - ,	coarse sand & clay.	80 — & - 200 —
Kongshavn	12—16 -		10 — & 60 valves.
—	25—35 -		1 —
—	ca. 50 -		9 — & 160 —
Vestmanhavn	$3^1/_2$—5 - ,	fine black sand.	Over 1000 spec.
—	5—6 - ,	fine black sand.	ca. 200 spec. & a number of valves.
—	10—30 -		1 spec.
Sorvaag	14—$16^1/_2$ - ,	ooze.	1 valve.
Kalbakfjord	40—10 -		3 valves.
Trangisvaag			5 spec.
61°40' N. L., 7°40' W. L.	135 -		1 valve.
9 miles E. S. E. of Bispen	ca. 70 -		1 —

16 miles E. by S. of south point of Nolsø	80 fm.	1 spec. & 2 valves.
13 — W. by S. of Munken........	ca. 150 -	12 valves.

The maximum size of all these shells in only 3.5 mm.

Distribution. *Crenella decussata* is an arctic and boreal species, ranging in the north to Melville Bay ("Fox"), West and East Greenland, Spitzbergen (Torell and others), Nova Zembla (Leche), Kara Sea (Pfeffer) and Bering Sea (Krause); in the south it reaches to Cape Hatteras (fide Dall, 1889), the British Isles[1], Korea and California. In Danish waters it reaches to the southern Kattegat. The vertical distribution extends from 2—300 fm.; Jeffreys' statement, that it goes down to 1750 fm. probably rests on some mistake.

According to my measurements the species becomes 5.5 mm. at Greenland, 4.75 mm. at East Iceland, 4 mm. at West Iceland and only 3.5 mm. at the Færoes. The size thus decrease in the same proportion as the marine climate becomes milder.

Cardiidæ.

Cardium echinatum Linné.

Pl. III, fig. 11 (young).

Cardium echinatum Linné, Syst. Nat. ed. 12, 1, 2, 1767, p. 1122; Jeffreys, Brit. Conchol. II, 1863, p. 270, Pl. 34, fig. 2.

Cardium (Acanthocardia) echinatum Mörch, Vidensk. Medd. Naturh. Foren. Kbhvn. 1867, p. 93.

[Greenland].

Fabricius mentions[2]), that he had seen a weathered valve washed up on the beach. Since then no one has found the species at Greenland and there is in fact not the least probability that it lives there.[3])

Iceland.

The species, which was not known earlier from this island, has in recent years been found at several places on the south-western, southern and south-eastern coasts.

South-West Iceland:

Faxafjördr, off Kollafjördr...........	$8-11^1/_2$ fm., ooze and stones.	1 spec. &	6 valves.
— - —	10 -	3 — &	50 —
— mouth of Kollafjördr......	$9^1/_2-11$ - , fine black sand and ooze.	3 — &	25 —
— Keflavik.................	15—16 - , fine black sand.	4 — &	40 —

[1]) According to Jeffreys the "Porcupine" has taken *Crenella decussata* on Adventure Bank in the Mediterranean; this statement seems all the more remarkable as the species is not mentioned either by French or Italian malacologists.

[2]) Fauna groenlandica, 1780, p. 409.

[3]) Cf. also W. H. Dall in Proc. U. S. Nat. Mus. XXIII, 1900, p. 388: "*Cardium echinatum*, O. Fabricius 1780, from Greenland was doubtless derived from European ballast."

Faxafjördr, ca. 2 miles N. E. of Keflavik	$19^{1}/_{2}$—$20^{1}/_{2}$ fm., ooze.		4 spec. & 24 valves.
— , 4.3 miles W. $^{3}/_{4}$ S. of Helgasker Vager	25 -		13 valves.
— , E. of Videy	9—10 - , fine sand and ooze.		4 —
— , 7 miles N. N. E. of Skagens Light	17—$20^{1}/_{2}$ - , sand and shells.		1 valve.
Hafnarfjördr	25 - , fine black sand and ooze.		1 spec. & 10 valves.

These are on the whole small shells; the largest is only 40 mm. long, and of the specimens containing the soft parts the largest is only 22 mm. long.

South Iceland:

Vestmannaeyjar		1 spec.
—	49 fm., clay with a little mud.	1 fragment & 2 valves.
S. W. of Eyjafjällajökul	17 -	2 spec.
— - —	23 -	15 — & 4 valves.
63°$17^{1}/_{2}$' N. L., 17°39' W. L.	87 - , sand mixed with ooze.	1 valve.
Medalland Bugt	47—37 -	6 valves.

The maximum length of these specimens is likewise small, namely 38 mm.

South-East Iceland:

Myre Bugt	58 fm., sand mixed with ooze.	3 valves.
64°17.3' N. L., 14°44' W. L.	45 - , black clay.	1 spec. & 4 valves.
Lónsvik	40 - , ooze and clay.	7 — - 2 —

The maximum length of these is also only 40 mm.

The Færoes.

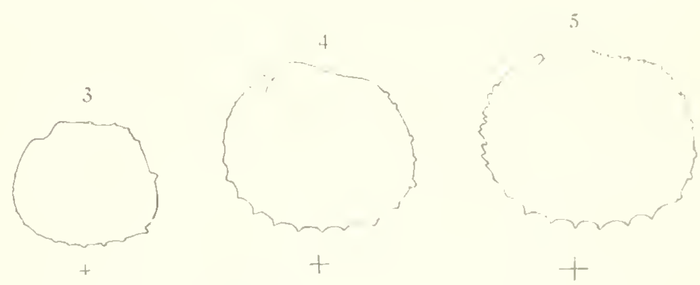
Here the species is common, at depths from ca. 5—80 fm., and reaches a considerable length, namely 57 mm. The various places where it has been found are the following:

Viderejde	ca. 25 fm.	4 valves.
Klaksvig	6—10 -	3 —
Bordövig	7—10 - , black sand and small stones.	2 spec. and 6 valves.
—	10 - , sand.	2 —
Ejde	5—6 - , coarse black sand.	2 valves.
Fundingsfjord	12—ca. 20 - , coarse sand and clay.	2 spec. & 20 valves.
Skaalefjord	4—10 -	4 valves.
Kongshavn	ca. 50 -	3 —
Vestmanhavn	3—14 -	4 —
	5—6 - , black sand.	7 spec.

Off Sandevaag.		1 spec.
Sörvaag, beach.		7 —
—	14–16½ fm., ooze.	1 —
Kalbakfjord	40–10 -	12 valves.
Thorshavn.		2 spec.
Trangisvaag.		4 —
—	15 -	7 valves.
13 miles S. of Myggenæsholm	ca. 70 -	1 valve.
16 — E. by S. of south point of Nolsö	- 80 -	2 spec.

Distribution. *Cardium echinatum* is distributed along Europe from West Finmarken to Madeira and the Canary Isles, it reaches down to the south-western Kattegat and the Sound (Hveen). Towards the west it extends over the Færoes to the south-eastern, southern and south-western coasts of Iceland. In the Mediterranean, including the Adriatic and Sea of Marmora, a variety (var. *mucronata*) occurs. Its vertical distribution is ca. 5—80 fm.[1])

Remarks. The very small specimens of this species are not easy to recognize at first glance; as fig. 3 shows, the antero-dorsal corner forms a sharp angle. During the growth of the shell, however, the distance between the "angle" and the beak becomes reduced (see figs. 4 & 5), so that the earlier, prominent corner now only appears as a tooth close in front of the umbo.



Figs. 3–5. *Cardium echinatum*, very young specimens. The appended cross indicates the natural size.

Cardium edule Linné.

[Iceland.]

Dr. A. C. Johansen has brought home a left valve of *C. edule* taken on the beach at Heimaey, which is the largest of the Vestmanna Islands at South-Iceland; the valve is thick-shelled and 33.5 mm. long. As the species has not been found elsewhere at Iceland, we must be careful in drawing conclusions from this isolated find; this valve may have been brought to the islands with ballast or in other ways.[2])

[The Færoes.]

According to Mörch (Vidensk. Medd. Naturhist. Foren. Kbhvn. 1867, p. 93) *C. edule* lives at the Færoes, but from an examination of the specimens from the Færoes labelled "*Cardium edule*"

[1]) According to Jeffreys the Porcupine Expedition of 1869 has taken it W. of Ireland down to 183 fm., but it is not stated whether the specimens were living or not.

[2]) Mohr's *C. edule* (Forsog til en Islands Historie, 1786, p. 128) is identical with *Cardium ciliatum* Fabricius.

by Mörch and preserved in the Museum I have found, that this statement rests on a confusion with *C. fasciatum* Mtg.[1]) (cf. p. 79 and figs. 9f, g and h in Pl. III).

The species is thus not known from the Færoes and must be omitted from the fauna list.

Cardium minimum Philippi.

Cardium minimum Philippi, Enum. Moll. Sicil. I, 1836, p. 51; II, 1844, p. 38, Pl. 14, fig. 18. — *Cardium suecicum* Lovén, Index Moll. Scand., 1846, p. 36. — *Cardium minimum* Jeffreys, Brit. Conchol. II, 1863, p. 292, Pl. 35, fig. 6.

The "Ingolf" has taken this small species at the following places:

St. 98.	W. of Iceland	138 fm.	5.9° C.	3 spec. & ca. 200 valves.
- 86.	- - — (Brede Bugt)......	76 -		1 — & 4 valves.
- 87.	- - — — —	110 -		1 valve.
- 10.	- - —	788 -	3.5° -	2 corresponding valves.
- 8.	S. W. of Iceland	136 -	6° -	3 spec. & 4 valves.
- 85.	- - - —	170 -		50 — & ca. 100 valves.
- 6.	S. of Iceland	90 -	7° -	10 — & - 75 —

[West Greenland.]

According to Posselt[2]), there are 5 specimens of *C. minimum* in the Riksmuseum of Stockholm, labelled as taken by the Swedish Expedition of 1871 at Kekertarsuak, which lies at Disko Fjord at 69½ N. L. I have had the opportunity of seeing one of these specimens and can confirm the correctness of the determination; but on taking the general geographical distribution of the species into account, I feel convinced that some change in the label has taken place, and that the specimens in question do not come from Greenland.

Iceland.

The species was not known earlier from Iceland, but in recent years it has been taken (besides at the "Ingolf" stations noted above) at the following places:

63°15′ N. L., 22°23′ W. L.	170—114 fm.		ca. 1000 spec.
63°18′ — 21°30′ —	94 -		10 — & 18 valves.
63°05′ — 20°7′ —	293 -		- 150 — & a number of valves.
Vestmannaeyjar	68 -		5 —
63°17½′ N. L., 17°39′ W. L.	87 -	, black sand with shells and stones.	1 spec. & 4 valves.
63°42′ N. L., 17°34′ W. L.	18—40 -		5 valves.

[1] Has Mörch himself been in doubt as to the correctness of the determination, since he has not included *C. edule* in his summary at the end of his paper, or has he simply forgotten?

[2]) Medd. om Grønland, XXIII, 1898, p. 60.

Myre Bugt....	58 fm., sand mixed with ooze.	1 valve
Lónsvik	40 - , ooze and clay.	4 spec. & 9 valves.

C. minimum is thus fairly common and even occurs in considerable numbers off the western and southern coasts of Iceland, at depths of 40—293 fm.[1]). The maximum length is 10 mm.

The Færoes.

Nor was the species known from here formerly, but in recent years it has been taken at the following places:

Fundingsfjord	12—ca. 20 fm., coarse sand and clay.	1 spec.
Vestmanhavn	5—6 - , fine, black sand.	1 -
61°40′ N. L., 7°40′ W. L.	135 -	1 - & 75 valves.
61°15′ — 9°35′ —	ca. 475 -	ca. 600 spec.
61°7′ — 9°30′ —	440 -	- 400 -
16 miles E. by S. of south point of Nolsö	80 -	1 spec.
Akralejte in N. 57 W., 12 miles	150 -	40 — & a number of valves.

The specimen from shallow water (Vestmanhavn, 5—6 fm.) is very small (2 mm.); at the other localities the species reaches a length of 7—9 mm. Large numbers still occur at a depth of 475 fm.

Distribution. *Cardium minimum* is distributed along Europe from the North Cape to Gibraltar, also in the Mediterranean; through the Kattegat it reaches down to the north coast of Funen and the Sound; over the Færoes it extends to the south and west coast of Iceland. It has been taken at depths of 10—ca. 800 fm.

Cardium fasciatum Montagu.

Pl. III, figs. 9a—k.

Cardium fasciatum Montagu, Test. Brit. Suppl., 1808, p. 30, Pl. 27, fig. 6; Jeffreys, Brit. Conchol. II, 1863, p. 281, Pl. 35, fig. 3.

Cardium fasciatum Mörch, Vidensk. Medd. Naturh. Foren. Kbhvn. 1867, p. 93; ibid. 1868, p. 220. — *Cardium edule* Mörch (non Linné), ibid. 1867, p. 93.

The "Ingolf" has taken this species at:

St. 98. W. of Iceland	138 fm.	5.9° C.	2 valves.
- 86. - - — (Brede Bugt)...	76 -		4 spec. & 80 valves.
- 87. - - — — — ...	110 -		ca. 70 valves.

These valves are up to 11 mm.

[West Greenland.]

According to Posselt[2]) there are 2 specimens of this species in the Riksmuseum of Stockholm, which are stated to have been taken at Julianehaab in southern West Greenland. I feel con-

[1]) A single specimen indeed has been taken at a depth of 788 fm. ("Ingolf" St. 10), but it was dead.

[2]) Medd. om Grønland, XXIII, 1898, p. 60.

vinced, however, for the same reason as that given under the preceding species, that some mistake or other has occurred, and that *C. fasciatum* does not live at all at Greenland.

Iceland.

From the west coast it is present from many localities, and in some cases in fairly large numbers, so that we may say that it is common there; it seems also to be fairly common on the south coast; it occurs in smaller numbers and at comparatively few localities on the north and east coasts, which is also quite natural, as these coasts have a relatively cold marine climate[1]). The depths at which the species has been taken lie between ca. 10—120 fm. The maximum length is 15 mm.

The various localities are as follows.

East Iceland:

Myre Bugt	26 fm.	2 valves.
Seydisfjördr off Brimnes	40 -	1 valve.
Bakkafjördr	32—25 -	1 spec.

The largest specimen is 9.5 mm. long.

North Iceland:

Thistil Fjördr	50 fm., clay with many stones.	1 valve.
Axafjördr	22 - , mud.	1 —
Skjálfandi Bugt	31 - , very fine black sand.	2 spec.
Husavik in E. 4 miles	42 -	1 —
Ofjord at Svalbardseyri	10—20 -	1 —
Skagastrand Bugt	119 - , mud.	1 —
Kollafjördr	10 -	1 —
Veidileysa	21—25 -	1 —

The largest of these specimens is 12 mm. long.

West Iceland:

Önundarfjördr	10 fm.	7 spec. & 7 valves.
—	ca. 12 -	ca. 100 spec.
Dyrafjördr.		7 spec. & 5 valves.
— inside Thingnæs	$10^1/_2$—$12^1/_2$ - , mud and small stones.	50 — & ca. 300 valv.
Fossfjördr.		1 spec.
Tálknafjördr.		6 —
N. W. of Talkni.		1 spec. & 3 valves.
Brede Bugt, off Hellissandur	20 -	1 valve.
Krossvik	8 - , shell-gravel, blue clay, stones.	1 —

[1]) It has to be remembered, however, that not so many collections have been made at the other coasts as on the west coast

Faxafjördr.			12 spec. & 20 valves.
— , ...	17 fm.,	coarse shell-sand.	4 valves.
— , ...	14—29 -		2 —
— , off Kollafjördr	8—11½ -	, ooze and stones.	5
— , - —	10 -		1 spec. & 34 valves.
— , mouth of Kollafjördr...	9½—11 -	, fine black sand and ooze.	5 & 9
— , Keflavik...............	15—16 -	, fine black sand.	4 & 80 —
— , 2 miles N. E. of Keflavik	19½—20½ -	, ooze.	1 & 44 —
— , 1 mile W. of Helgasker Vager	13—16 -	, shell-gravel, stones.	1 valve.
— , 4.3 miles W. ¾ S. of Helgasker Vager	25 -		5 spec. & 80 valves.
— , E. of Videy.............	9—10 -	, fine sand and ooze.	2 — & 7 —
— , 7 miles N. N. E. of Skagens Light	17—20½ -	, sand and shells.	4 valves.
Reykjavik.			3 spec. & 9 valves.
Reykjavik Roads.			1 spec.
Hafnarfjördr ..	11½ -		1 —
—	25 -	, fine black sand and ooze.	1 — & 9 valves.
Skagi	21 -		1 —

One of these specimens is 15 mm. long, a second 14.5 mm. and several are 10—13 mm. long.

South Iceland:

Heimaey, beach.			2 valves.
Vestmannaeyjar	30 fm.,	shell-gravel.	1 spec. & 7 valves.
—	49 -	, clay with a little mud.	16 — & 160 —
S. W. of Eyjafjällajökul..............	15—18 -		1 valve.
63°17½′ N. L., 17°39′ W. L.	87 -		1 spec.
63°24′ N. L., 17°5′ W. L.	70 -		1 —

The largest specimen is 11.5 mm.

Færoes.

From these islands we have numerous specimens and valves from many localities, so that it must be considered common both near the coast and out to sea; living specimens have been taken in depths of ca. 5—135 fm. It may attain a considerable size, namely up to 19 mm. and is not rarely 14—16 mm.; in deep water, however, just as at Iceland, it seems to have a smaller size.

The localities are as follows:

Viderejde............................	10 fm.		1 valve.
Bordövig..............................	7—10 -	, black sand, small stones.	2 valves.
Ejde	5—6 -	, coarse black sand.	36
Fundingsfjord......................	12—ca. 20 -	, coarse sand and clay.	8 spec. & 42 valves.

Skaalefjord	4—5 fm.		2 valves.
Kongshavn	12—16 -	, sand and ooze.	14 spec. & 17 valves.
—	25—35 -		1 valve.
—	ca. 50 -		10 spec. & 45 valves.
Vestmanhavn	$3^1/_2$—5 -	, fine black sand.	2 — & 3 —
—	5—6 -	, — — —	1 — & 2 —
Sörvaag	14—$16^1/_2$ -	, ooze.	2 — & 9 —
Kollefjord.			1 —
Thorshavn.			2 —
— , outer roads	12—16 -		2 valves.
Nolsö, deep hole at north end	ca. 100 -		2 spec. & 8 valves.
Trangisvaag.			Numerous spec. & —
5 miles N. by E. of Myggenæs east point	50 -		1 valve.
13 - S. of Myggenæsholm	- 70 -		50 valves.
61°40' N. L., 7°40' W. L.	135 -		2 spec. & 11 valves.
6 miles N. by W. of Kalsö	60 -		1 valve.
$1^1/_2$—2 miles off the mouth of Bordövig	20—30 -		1 spec.
16 miles S. of south point of Nolsö	ca. 80 -		5 —
16 — E. by S. of south point of Nolsö	- 80 -		1 — & 4 valves.
Akralejte in N. 57 W., 12 miles	- 150 -		2 valves.
13 miles W. by S. of Munken	- 150 -		40 —

Distribution. *C. fasciatum* is distributed along the whole of Europe, from the western part of the Murman Coast to the Canary Isles and the Eastern Mediterranean; through the Belts it reaches down into the Western Baltic. Towards the west it extends to the Færoes and Iceland. G. O. Sars estimates the vertical distribution to be from 10—180 fm.[1]), but at the Færoes it reaches up to 5 fm. (cf. above), according to Sparre Schneider it comes into 3 fm. (at Tromsö) and according to C. G. Joh. Petersen into 2 fm. in the southern Kattegat.

Remarks. *Cardium fasciatum* appears to be a very variable species at Iceland and the Færoes. It occurs in two forms:

a. The shell short, strongly ventricose, with the posterior area sloping quickly downwards and as if abruptly separated from the middle area by a keel (Pl. III, figs. 9a—b).

b. The shell somewhat elongated (especially posteriorly), not much tumid, with the middle area grading without sharp boundary into the posterior area (Pl. III, figs. 9c—d).

Between these extreme forms, however, there are transitions. So far as my experience goes, the tumid variety is usually an oceanic form, whilst the elongated and flat variety is found in fjords; but both may be found together in the latter[2]).

[1]) Jeffreys states, that the "Porcupine" has taken it W. of Ireland at a depth of 808 fm., but as usual without stating whether living specimens or dead shells were found. But the statement itself is perhaps erroneous.

[2]) Whilst the tumid form is predominant at Iceland and the Færoes, I find the flat form by far the commonest in

The contour changes from the obliquely cordiform or quite triangular (see Pl. III, fig. 9i; just as in *C. exiguum*) to become broadly oval or almost circular.

There is also great variation in regard to the sculpture. Sometimes for example, the ribs may be rough with scales and pointed tubercles not only on the anterior and posterior area, but the middle area may also be partially or wholly beset with scales or tubercles; in this way we obtain a form such as that figured in Pl. III, fig. 9e, the sculpture of which resembles that in *C. nodosum*, but transitions show, that it can be traced back to the common form *C. fasciatum* with smooth, central ribs. In the young, with contour like that of *C. exiguum*, the posterior ribs are beset with very pointed and comparatively long spines.

The ribs are usually quite flat and only separated by a fine line, but very often the interspace between them is somewhat broader, yet never so broad as the ribs themselves. Sometimes, however, the ribs are more or less convex, especially when they are separated by a distinct interspace. Not rarely an intercostal sculpture is seen under the lens in the form of a fine pricking (Pl. III, fig. 9k).

I have further represented (Pl. III, fig. 9f, g and h) that form of *C. fasciatum*, which was confused by Mörch with *C. edule*; the resemblance is striking, indeed, but the pointed tubercles on the posterior ribs (Pl. III, fig. 9h) reveal its true nature — in *C. edule* the rugosities are lamelliform here.

Cardium nodosum Turton.

[Færoes].

To this species Mörch (Vidensk. Medd. Naturh. Foren. Kbhvn. 1867, p. 94) refers 7 specimens from Thorshavn in the Færoes. I have not been able to find these specimens here in the Museum, and as the species is not present in the considerable collections, which have been made at the Færoes in recent years, I think it very doubtful, if the species occurs there. Possibly, an unusually well sculptured form of *C. fasciatum* (cf. above and Pl. III, fig. 9e) has given rise to the confusion.

Cardium ciliatum Fabricius.

Pl. III, fig. 10 (young).

Cardium ciliatum Fabricius, Fauna groenl., 1780, p. 410. — *Cardium islandicum* Chemnitz, Conch. Cab. VI, 1782, p. 200, Pl. 19, fig. 195—96.[1] — *Cardium pubescens* Couthouy, Boston Journ. Nat. Hist. II, 1838, p. 60, Pl. 3, fig. 6 — *Cardium arcticum* Sowerby, Proc. Zool. Soc. 1840, p. 106; Conch. Illustr., 1841, fig. 26. — *Cardium Hayesii* Stimpson, Proc. Acad. Nat. Sc. Philadelphia, 1863, p. 58; Packard, Mem. Boston Soc. Nat. Hist. I, 1867, p. 278, Pl. 7, fig. 14. — *Cardium islandicum* Gould & Binney, Rep. Invert. Mass., 1870, p. 139, fig. 450. — *Cardium ciliatum* Sars, Moll. Reg. Arct. Norv., 1878, p. 46, Pl. 5, fig. 4.

Cardium edule Mohr (non Linné), Forsog til en Islandsk Naturhistorie, 1786, p. 128. — *Cardium islandicum* Moller, Index Moll. Groenl., 1842, p. 20. — *Cardium ciliatum* Mörch, Rink's

the material collected from Denmark; it is only among the specimens from the Kattegat that there are some which resemble the ventricose, keeled form from Iceland and the Færoes.

[1]) Chemnitz is the author of the name *Cardium islandicum*, not Linné, as the species first occurs in the 13th Ed of Syst. Nat, pars 6, 1792 (p. 3252) and with a reference to Chemnitz' work of 1782. By erroneously referring the name *C. islandicum* to the 12th Ed (1767) of Linnei Syst. Nat. (though no *Cardium* of that name occurs there), several older authors have got the present species renamed "*Cardium islandicum* Linné"; this error appears again in Kobelt's Prodr. Faun. Moll. Test. Mar. Eur. (1880).

Grønland, 1857, p. 92; Vidensk. Medd. Naturh. Foren., 1868, p. 220; Arctic Manual, 1875, p. 132; Rink's Dan. Greenland, 1877, p. 441; Posselt, Medd. om Grønland, XIX, 1895, p. 70; ibid. XXIII, 1898, p. 57; Hägg, Ark. f. Zoologi, Bd. 2, 1904, No. 2, p. 51; Jensen, Medd. om Grønland, XXIX, 1909, p. 352.

The "Ingolf" has taken this species at:

St. 113.	Norwegian Sea	1309 fm.		1 valve, of a very small spec.
- 104.	– –	957 -		1 small spec., dead but with connected valves.
- 98.	W. of Iceland	138 -	5.9° C.	1 spec. (young).

West Greenland.

Here the species is very common from the southernmost part of the coast at least up to Upernivik; further north, it has been taken in Melville Bay ("Fox"), and on the American side it has been found as far north as at Grinnell Land in Dobbin Bay (79°40′ N. L.). It occurs most frequently on clay bottom and in moderate depths (10—80 fm.), but is also found both on hard and quite soft bottom, as also in greater depths (100—280 fm.). The largest specimen is 65 mm. long.

East Greenland.

It has been taken here at 5 localities, from Angmagssalik to Mackenzie Bay (65°35′—ca. 73½° N. L.) and in depths of ca. 10—40 fm. The largest specimen is 62 mm. long.

Iceland.

On the north coast *Cardium ciliatum* is very common, as also on the east coast (at least down to Berufjördr[1]) and on the north-west coast; on the south-west coast it lives in Hvalfjördr[2]); on the south coast it has not been found. It keeps especially to clay and sand mixed with clay, but is also found where there is ooze. The depths vary from 6—85 fm., but are most frequently 25—50 fm., the young however being comparatively frequent in more shallow water; on the other hand, the "Ingolf" took a very young specimen (living) at 138 fm. (cf. above). The maximum length is 74 mm.

The various places where the species was found are as follows.

East Iceland:

Myre Bugt	58 fm., sand mixed with ooze.	1 spec.	
Lónsvik	40 - , ooze and clay.	4 —	& 10 valves.
Berufjördr	6 - , mud with black sand.	2 —	
mouth	54—41 - , ooze.	27 —	
Breiddalsvik	14 - , sand.	3 —	
Faskrudsfjördr	50—20 - , blue clay.	24 —	

[1]) On the boundary to the south coast it has been taken in Lónsvik and Myre Bugt, but only as small and dead specimens.

[2]) It has also been taken at various places out in Faxafjördr (cf. the following list), but only as dead specimens and valves.

Reydarfjördr	48 fm.		1 spec. & 1 valve.
—	50 -		5 —
—	68 -		8 — & 12 valves.
—	74 -		1 — & 1
—	86 -		1 —
Outer Reydarfjördr	68—80 -		2 —
Vidfjördr	15 -		1 —
Nordfjördr	40 -		3 valves.
Mjófifjördr, head of fjord.			1 spec.
Seydisfjördr	9—5 -		1 —
—	26—50 -		14 —
—	40 -	, ooze and clay.	3
Mouth of Seydisfjördr	38—14 -	, mud.	23 —
— - —	ca. 40 -	, stomach of haddock.	9 —
Seydisfjördr	60—30 -		1
— Hánefsstadeyrar	10— 2 -		1 —
Lodmundarfjördr	30—23 -	, ooze.	1 —
Bank off Lodmundarfjördr	38—47 -		1 —
65°42′ N. L., 13°57′ W. L.	60 -		1 —
Vopnafjördr	6—12 -		2 —
Bakkafjördr	7 -		1 —
—	12—15 -	, black sand.	12 —
—	20—28 -	, clay mixed with sand.	4 —
—	32—25 -	, — — — —	7 —
—	20—52 -	, — — — —	30 — & 35 valves.
—	52—43 -	, — — — —	12 —
Off Midfjördr	35—50 -		1 —
Finnafjördr	18 -		1 valve.

As already mentioned, the specimens from the two southernmost localities are small; from Myre Bugt there is only a very small specimen (1.5 mm.), which besides was dead; and from Lónsvik the specimens are likewise dead, though of a fresh appearance and of at most 22.5 mm. in length. But from Berufjördr already the species becomes common, the specimens being up to 50 mm. in length. The largest specimen taken on the east coast is 73 mm.

North Iceland:

Thistil Fjördr	10—24 fm.	, sand and "coral".	1 valve.
— —	27—28 -	, sand with mud.	4 spec. & 3 valves
— —	50 -	, clay with many stones.	1 valve.
Thorshöfn	6 -		1 —

Vidarvik	$13^1/_2$ fm.,	black sand.	1 spec. & 3 valves.
Axafjördr	22 - ,	stones and shells.	1 —
—	22 - ,	mud.	11 —
—	25 - ,	ooze.	3 spec. & 2 valves.
—	30 - ,	sand and stones.	5 valves.
Skjálfandi Bugt	21 - ,	black sand.	4 —
— —	31 - ,	very fine, black sand.	1 spec.
Husavik in E. 4 miles	42 -		2 —
— in E. by S.	47—58 -		3 —
Öfjord.			3 —
— , west side of Oddeyri	5—9 -	From stomach of *Hippoglossoides platessoides.*	8 —
— , Höfdi	6—12 -		1 —
— , at Svalbardseyri	10—20 -		1 —
— , Akureyri	17 -		1 —
— , just S. of Hrisey	18 - ,	clay.	2 —
— , S. of Hrisey	17—20 - ,	stones and mud.	1 valve.
Kollafjördr	5 -		1 spec.
Skagastrand.			2 —

The largest specimen is 74 mm. long.

West Iceland:

Skutulsfjördr	5—13 fm.		1 spec.
Önundarfjördr	10 -		2 —
—	ca. 11 -		6 —
—	- 12 -		6 —
Dyrafjördr.			11 —
— , inside Thingnæs	$10^1/_2$—$12^1/_2$ - ,	mud and small stones.	12 valves.
65°52' N. L., 23°58' W. L.	33 -		1 valve.
Fossfjördr	44 -		6 spec.
Tálknafjördr.			4 —
—	ca. 25 -		1 —
N. W. of Tálkni.			1 —
Grundarfjördr.			1 —
Hvalfjördr	24 -		20 spec. & 75 valves.
Krossvik	8 - ,	shell-gravel, blue clay, stones.	1 fragment.
Faxafjördr, off Kollafjördr	8—$11^1/_2$ - ,	ooze and stones.	14 valves.
— , - —	10 -		5 spec. & 34 valves.
— , mouth of Kollafjördr	$9^1/_2$—11 - ,	fine black sand and ooze.	2 — & 40 —
— , Keflavik	15—16 - ,	fine black sand.	30 valves.

Faxafjördr, ca. 2 miles N.E. of Keflavik	$19^1/_2$—$20^1/_2$ fm., ooze.		18 valves.
—, 1 mile E. N. E. of Helgasker Vager	$11^1/_2$ -		1 spec.
—, 4.3 miles W. $^3/_4$ S. of Helgasker Vager	25 -		5 valves.
—, E. of Videy	9—10 -	, fine sand and ooze.	1 spec. & 1 valve.
—, ca. $1^1/_2$ miles N. W. $^1/_4$ N. of Engey Baake	19 -	, shells and stones.	1 -
Reykjavik.			3 valves.
—, Engey	7—$8^1/_2$ -	, ooze.	1 spec. & 2 valves.
Hafnarfjördr	25 -	, fine black sand and ooze.	1 — & 20 —

From the south-west coast (region of Faxafjördr) only separated valves or dead (empty) specimens are represented, though they often appear quite "fresh", with well-preserved ligament and periostracum; the maximum length is only 53 mm. Hvalfjördr is however an exception from what has just been said, as living specimens have been taken there, the largest of which is 14 mm. long; a much larger, but dead specimen appears quite "fresh" and the largest of the separated valves is 61 mm. long. On the north-west coast the species thrives well and reaches a length of 73 mm.

[Færoes.]

A valve has been taken south-west of Syderö (61° 9' N. L., 7° 54' W. L.) at a depth of 180 fm., but it is quite small (3.75 mm.) and looks ancient (fossil). The species does not live at the islands.

Distribution. *Cardium ciliatum* is a high-arctic and circumpolar species, as it occurs, apart from West and East Greenland and northern Iceland, at Spitzbergen, in the Barents Sea, at Nova Zembla and in the Kara Sea, in the Polar Sea of Siberia, Bering Sea, at Sitka and in the Wellington Channel; the southern boundary for its distribution lies at Cape Cod (Dall), East Finmarken (Sars and Friele), northern Japan and Puget Sound (Dall).

Remarks. The shape of this species varies a good deal, as will be seen from the accompanying measurements of 4 specimens from Iceland:

Length	Height	$\frac{\text{Height}}{\text{Length}}$	Breadth	$\frac{\text{Breadth}}{\text{Length}}$
73 mm.	67 mm.	91.8 %	48 mm.	65.8 %
72 -	71 -	98.6 -	40 -	55.6 -
71 -	64 -	90.1 -	42.5 -	59.9 -
65 -	58 -	89.2 -	33 -	50.8 -

The very small specimens (see Pl. III, fig. 10) can only be recognized as belonging to this species on comparing them with somewhat larger specimens because the dorsal margin forms an angle with the anterior margin. The young thus obtain some resemblance to those of *C. echinatum* (cf. p. 73 and Pl. III, fig. 11), but are easily distinguished by the fact, that the radiating ribs are more numerous, ca. 27 (against ca. 19 in *C. echinatum*) and have a much finer spination; further, the posterior margin rises almost vertically (in *C. echinatum* on the other hand the posterior margin bends forwards).

Cardium elegantulum (Beck) Møller.

Cardium elegantulum (Beck) Møller, Index Moll. Groenl., 1842, p. 20; Gould & Binney, Rep. Invert. Mass., 1870, p. 141, fig. 451; Sars, Moll. Reg. Arct. Norv., 1878, p. 47, Pl. 5, fig. 5.

Cardium elegantulum Mörch, Rink's Grønland, 1857, p. 92; Vidensk. Medd. Naturh. Foren. 1868, p. 220; Arctic Manual, 1875, p. 132; Rink's Dan. Greenland, 1877, p. 441; Posselt, Medd. om Grønland, XXIII, 1898, p. 56; Jensen, ibid. XXIX, 1909, p. 352; Odhner, Ark. f. Zoologi, Bd. 7, No. 4, 1910, p. 19.

West Greenland.

The species has been taken here at several localities, from Julianehaab (60°43′ N. L.) to Upernivik (72°47′ N. L.); it keeps mainly to clay bottom and depths of 20–100 fm. It reaches a length of 15 mm.

East Greenland.

The Danish Expedition of 1898—99 took a specimen of 12 mm. in length at 65°39′ N. L., namely at Tasiusak, 20—30 fm., stony ground with sparse algal vegetation.

Iceland.

It has only been taken here at some few places and only on the north-eastern part of the island (between Berufjördr on the east coast and Thistil Fjördr on the north coast). The various places are as follows:

East Iceland:

Mouth of Berufjördr	54—41 fm., ooze.	3 spec. & 6 valves.
Off Borgarfjördr......	80 -	2 valves.

The largest specimen is 12 mm. long. Odhner (l. c.) also records some few specimens from Berufjördr.

North Iceland:

N. of Langanes	70 fm.	1 spec.
Thistil Fjördr	50 -	1 valve.

The largest specimen is 9.5 mm. long. Odhner (l. c.) records further a young specimen from Thistil Fjördr, 10—16 fm.

Distribution. *C. elegantulum* is an arctic species, which is found, apart from West and East Greenland and North-East Iceland, only at north-western Norway (to Tromsö) at depths of (10) 15–127 fm. (Sars, Sp.-Schneider, Friele & Grieg)[1]. — It has been found as fossil by M. Sars at

[1] Both G. O. Sars and H. J. Posselt give the east coast of N. America as habitat for this species, but this is undoubtedly a mistake; both of these authors have probably assumed that *Cardium elegantulum* is American, because it was included by Gould in his work on the Invertebrates of Massachusetts (l. c.), but Gould does not give any American locality, only Greenland. Nor have I been able to find the species as American in other lists of Packard, Dall, Bush, Whiteaves etc.; thus, it is only mentioned as from Greenland by W. H. Dall in his "Synopsis of the Fam. Cardiidæ and of the North American Species" (Proc. U. St. Nat. Mus. XXIII, 1900, p. 386).

Christiansund in western Norway, by W. C. Brögger at Christiania (in the "younger Arca-clay") and by Knipowitsch at Dwina.

Remarks. Measurements of some specimens show, that the shape is more or less variable:

Length of shell	Height of shell	Breadth of shell
12.5 mm.	11.25 mm.	8 mm.
12.5 -	10 -	8 -
12 -	11.5 -	9.5 -
12 -	9.5 -	7.5 -

[Cardium norvegicum Spengler.]

Mörch has shown already (Vidensk. Meddel. Naturh. Foren. Kbhvn. 1867, p. 94), that Jeffreys' reference to this species as Færoese (Brit. Conchol. II, 1863, p. 296) is due to a misunderstanding.

Cardium (Serripes) groenlandicum Chemnitz.

Pl. III, figs. 12 a—b (young).

Cardium groenlandicum Chemnitz, Conch. Cab. VI, 1782, p. 202, Pl. 19, fig. 198. — *Cardium boreale* Reeve, Conch. Icon. II, 1844—45, Sp. 131, Pl. 22, fig. 131. — *Cardium fabricii* Deshayes, Proc. Zool. Soc., 1854, p. 333. — *Aphrodite groenlandica* Gould & Binney, Rep. Invert. Mass., 1870, p. 144, fig. 454; Sars, Moll. Reg. Arct. Norv., 1878, p. 49, Pl. 5, fig. 3.

Venus islandica Fabricius (non Linné), Fauna groenl., 1780, p. 411. — *Cardium groenlandicum* Møller, Index Moll. Groenl., 1842, p. 20; Beck, in Gaimard, Voyage de la Recherche, Pl. 15, fig. 1—15; Mörch, Rink's Grønland, 1857, p. 92; Vidensk. Medd. Naturh. Foren., 1868, p. 221 (var. *solida*); Arctic Manual, 1875, p. 132; Rink's Dan. Greenland, 1877, p. 441; Friele, Nyt Mag. f. Naturvidensk., 24 Bd., 1879, p. 222; Becher, Österr. Polarst. Jan Mayen, 1886, III, p. 70; Posselt, Medd. om Grønland, XIX, 1895, p. 70; ibid. XXIII, 1898, p. 55; Jensen, ibid. XXIX, 1909, p. 353; Hägg, Ark. f. Zool., Bd. 2, 1904, No. 2, p. 50.

The "Ingolf" has taken this species at:

St. 113.	Norwegian Sea	1309 fm.	A fragment of a left valve.
- 119.	— -	1010 -	A fragment of a right valve.

West Greenland.

The species is one of the commonest Molluscs here, from the southernmost part of the coast at least up to Upernivik; further north it has been taken by the "Fox" in Melville Bay and by the "Fram" on the American side in Rice Strait (78°45' N. L.). It keeps mainly to soft (clay) bottom and to depths of 10—50 fm. It may attain a length of 110 mm.

East Greenland.

It has been taken here at 9 localities, distributed from Angmagssalik to Sabine Island, with depths of ca. 7—25 (40) fm. The largest specimen was 70 mm. long.

Jan Mayen.

The Norwegian North-Atlantic Expedition of 1877 took numerous, small specimens at 10—20 fm., the Austrian Polar Exped. of 1883 17 specimens up to 62 mm. long at a depth of 10 fm. The Danish Expedition of 1900 also took several specimens up to 62 mm. long, but all empty, at depths of 55 and 50—60 fm.

Iceland.

The species is very common on the north-west, north and east coasts (down to Berufjördr); on the south-west coast it lives at any rate in Hvalfjördr; it has not been found on the south coast. It keeps to soft bottom and depths of ca. (4) 6—60 fm. The largest specimen is 92 mm. long.

The various localities are as follows.

East Iceland:

Hornafjördr, beach.			1 spec.
Berufjördr	35—22 fm.		1 —
Djupivogr	6 -	, mud with black sand.	9 —
—	10 -	, stones.	2 —
Breiddalsvik	14 -	, sand.	2 spec. & 3 valves.
Faskrudsfjördr	50—20 -	, blue clay.	1 spec.
Eskifjördr	20 -		1 —
Vidfjördr	15 -		1 —
Seydisfjördr.			18 —
—, between the bridges on north side of fjord.			1 —
—, Brimnes	4 -		1 —
—, at Skulavik	6 -	, black sand.	1 —
—	31—15 -		4 —
—	38—14 -	, mud.	1 —
—	20—50 -		1 —
—, mouth	ca. 40 -	, stomach of haddock.	1 —
Bank off Lodmundarfjördr	38—47 -		1 —
Vopnafjördr	6 -		2 —
—	6—12 -		1 —
Bakkafjördr	12—15 -	, black sand.	7 —
—	32—25 -	, clay mixed with sand.	1 valve.
Finnafjördr	18 -		5 spec.

The specimen from the southernmost locality, Hornafjördr, is empty and only 8.5 mm. long; but from Berufjördr northwards the species becomes common and reaches a considerable size (maximum length 92 mm.). The specimen from the shallowest depth, 4 fm. namely, is young (only 15.5 mm. long), but already at a depth of 6 fm. the species reaches a length of 89 mm.

North Iceland:

Thistil Fjördr	25 fm.	, sand.	3 spec.
Thorshöfn, $1^1/_2$ miles from mouth of river	6 -	, sand.	1 -
Haganesvik	$3^1/_2$—4 -		2 —
Husavik in E. 4 miles	42 -		4 valves.
— in E. by S.	47—58 -		3 spec.
Ofjord at Svalbardseyri	10—20 -		1 —
— Höfdi	16—12 -		3 —
Siglufjördr	15 -		1 —
Skagafjördr, Miklavatn in Fljótum	5—6 -		1 —

It is due naturally to incomplete collections, that so little of this species is present from the north coast. The specimen from the shallowest depth (4—$3^1/_2$ fm.) is only 28 mm. long, but that from a depth of 6 fm. is 86.5 mm.

West Iceland:

Lónafjördr	$27^1/_2$—30 fm.		1 spec.
Isafjardardjup	60—63 -		1 —
Arnarnes	5—7 -		2 —
Onundarfjördr.			2 —
—	ca. 9 -		1 —
—	10 -		6 —
—	- 10 -		35 —
—	- 12 -		3 —
—	12—14 -		7 —
Dyrafjördr.			4 —
—, inside Thingnæs	10—$12^1/_2$ -	, mud and small stones.	33 valves.
Fossfjördr	44 -		1 valve.
Talknafjördr.			3 spec.
Patriksfjördr.			1 —
Grundarfjördr.			8 valves.
Olafsvik.			3 —
Hvalfjördr	10—12 -		1 spec. & 3 valves.
—	24 -		10 —
—, Hvammsvik	10—12 -	, black ooze.	2 —
— —	$11^1/_2$—12 -		3 —
Faxafjördr, Kollafjördr	8 -	, fine sand and mud.	1 —
—, mouth of Kollafjördr	$9^1/_2$ -		7 — & 40 valves.
—, — - —	$9^1/_2$—11 -	, fine black sand and ooze.	1 & 22
—, off Kollafjördr	8—$11^1/_2$ -	, ooze and stones.	1 & 30 —

Faxafjördr, off Kollafjördr	10 fm.		ca. 25 spec. & 100 valves.
— , Keflavik	15—16 -		1 — & 2 —
— , ca. 2 mil. N.E. of Keflavik	$19^1/_2$—$20^1/_2$ -	, ooze.	1 —
— , E. of Videy	9—10 -	, fine sand and ooze.	3 —
Reykjavik, Engey	7—$8^1/_2$ -	, ooze.	1 fragment of a valve
Hafnarfjördr.			1 valve.
—	25 -	, fine black sand and ooze.	1 —

On the northern part of the west coast *C. groenlandicum* is common and reaches the considerable length of 80 mm. As the above list shows, a considerable material has also been collected on the southern part of the west coast (region of Faxafjördr); we might think, therefore, that the species is also common on this part of the coast. It must be emphasized, however, that the living specimens hitherto taken from the bottom of the sea are usually small (2—12 mm. long), and that the separated valves accompanying them most often have an "ancient" appearance and do not reach any great length either (at most 43 mm. long). From this, however, Hvalfjördr, with the Hvammsvik lying on its south side, again forms an exception, as very large specimens have been taken here (up to 79 mm. in length) and containing the animals. The specimen from Keflavik is also of a fairly good size and, though empty, appears rather "fresh".

Distribution. *Cardium groenlandicum* is a high-arctic and circumpolar species; its southern boundary lies in the Atlantic at Cape Cod (Dall) and Varanger Fjord (G. O. Sars)[1] and Porsanger Fjord (Friele), in the Pacific at Hakodade and Puget Sound (Dall).

Remarks. However well-characterized this species may be against all the other northern *Cardiidæ*, it nevertheless shows a series of variations.

This is especially evident in quite young specimens. In regard to sculpture some are radially furrowed only on the posterior area, the majority likewise on the anterior area, some even over the whole shell. Some are quite flat, others greatly ventricose and transitions occur. Some are uniformly coloured, whitish, straw-yellow, gray or brownish, others again have dashes of yellowish-red.

Adult specimens vary especially in regard to form. Some are high, short and greatly ventricose, others comparatively elongated and flat, as will appear from the accompanying measurements:

Locality	Length	Height	Height / Length	Breadth	Breadth / Length
Berufjördr (Iceland)	90 mm.	77 mm.	85.6 %	50 mm.	55.6 %
Jakobshavn (Greenland) ..	85 -	71 -	83.5 -	50 -	58.8 -
Djupivogr (Iceland)	75 -	59.5 -	79.3 -	35 -	46.7 -
Tunugdliarfik (Greenland)	73.5 -	57 -	77.6 -	34 -	46.3 -
Onundarfjördr (Iceland) ..	71 -	59.5 -	83.6 -	37 -	52.1 -
Godhavn (Greenland)	70 -	62 -	88.6 -	42 -	60 -

[1]) At this place, however, only small specimens have been taken, according to Sars l. c.

Both Mörch and Posselt have noticed that the species is variable. The former remarks: "The Icelandic specimens are much more thick shelled and elongated than those from Greenland". Posselt modifies the last part of the sentence in the following statement: "The variety *oblonga*, which is the commonest form at Iceland, is met with here and there at South Greenland". So far as I can judge, there is no such connection between the geographical distribution and the outer form of the animal; the variation seems rather individual. In any case, Mörch's statement is erroneous in regard to the first point and greatly exaggerated as to the second.

In Pl. III, fig. 12 a I have represented a small specimen of the strongly sculptured, youthful form, which might possibly give rise to difficulty in the determination, if it occurred isolated. Further, for the sake of comparison I give a comparatively smooth specimen (Pl. III, fig. 12 b), on which, however, as usual the prodissoconch is strongly sculptured.

Isocardiidæ.

[Isocardia cor Linné.]

Posselt has introduced this characteristic Bivalve into the fauna of Greenland. In the Stockholm Museum he found, namely, a fragmentary valve, 70 mm. long, taken according to the label by the Swedish Exped. of 1871 at 63°35′ N. L., 52°57′ W. L. and a depth of 43 fm. "To judge from the discovery of the dead valve, it may be taken as probable, that *Isocardia cor* lives in the Davis Strait", writes Posselt[1]).

W. C. Brögger[2]), on the other hand, has pointed out, that *Isocardia cor*, which is a southern (Lusitanian) form, at the present time to be considered a great rarity on the Norwegian coasts, is certainly extinct at Greenland, and that the fragment mentioned by Posselt must in all probability have belonged to a fossil specimen.

As *I. cor* does not occur at the Færoes, nor at Iceland, which have a much milder marine climate than West Greenland, and as it does not occur at North America either, I also think it quite improbable that it lives on the banks in the Davis Strait.

During a visit to the Stockholm Museum I came to the conviction, that an exchange of label had probably taken place, and that the valve referred to had not been taken at Greenland at all. In any case *Isocardia cor* should be struck out of the Greenland fauna.

Cyprinidæ.

Cyprina islandica Linné.

Venus islandica Linné, Syst. Nat. ed. 12, 1, 2, 1767, p. 1131. – *Cyprina islandica* Jeffreys, Brit. Conchol. II, 1863, p. 304, Pl. 36, fig. 2; Gould & Binney, Rep. Inv. Mass., 1870, p. 129, fig. 443.

Cyprina islandica Mörch, Rink's Grønland, 1857, p. 92; Vidensk. Medd. Naturh. Foren., 1867, p. 94; ibid. 1868, p. 221; Arctic Manual, 1875, p. 132; Rink's Dan. Greenland, 1877, p. 441; Posselt, Medd. om Grønland, XXIII, 1898, p. 61.

[1]) Medd. om Grønland, XXIII, 1898, p. 54.

[2]) Brögger: Om de senglaciale og postglaciale nivaforandringer i Kristianiafeltet, 1900–01, p. 591.

The "Ingolf" has taken this species at:

St. 86.	West Iceland (Brede Bugt)	76 fm.	A spec. 13 mm. long and 3 valves of small specimens and fragments of a larger specimen.
- 6.	S. E. of Iceland	90 -	A fragment (with sharp edges) of a large specimen.

[West Greenland].

The Copenhagen Zoological Museum contains:

a. 2 corresponding valves, 43 mm. in length, taken according to the label at Jakobshavn by Dr. Rudolph; on this basis *C. islandica* was for the first time recorded as belonging to Greenland in Mörch's list of 1857. The periostracum is preserved; there is no trace of soft parts and the valves bear distinct marks of having lain in a mass of sand mixed with clay.

b. 1 right valve[1]), 37 mm. long[2]), taken according to the label by the malacologist H. P. C. Moller (thus about the middle of last century) in "Davis Strait, 7—8 miles from land".

Thus, living specimens are not known from Greenland, and it seems to me inconceivable, that a Bivalve such as *C. islandica* could possibly have escaped attention, if it now lives anywhere at Greenland In the first place, its size is considerable, so that it is not likely to have been overlooked, as the Danish part of the West Greenland may be said to have been well-investigated, so far as the coastal belt is concerned. Further, we must remember, that *C. islandica* is frequently washed up on the beach, near which it lives; but *C. islandica* is not found either among the large number of washed-up shells, which have been brought home from Greenland.

These facts seem to me to indicate quite definitely, that *C. islandica* does not now live at Greenland; the "dead" shells mentioned above may be taken to have been "subfossil", unless some change of label has taken place in the course of time.

In any case *Cyprina islandica* should be omitted from the Greenland fauna.

Iceland.

The species is to hand in large numbers from the east, north, west and south coasts, so that it is probably common all round the island[3]). Adult specimens have been taken at depths of 4—30 fm.[4]), the young down to 76 fm. It lives chiefly on sandy bottom or sand mixed with clay, but may also be met with on clay bottom. The maximum length is 105 mm.

Færoes.

Here the species is quite common, on sandy bottom or sand mixed with clay, and reaches a length of 110 mm. Adult specimens have been taken at depths of 5--50 fm., the young down to 70 fm.

[1]) This single valve is erroneously given in Posselt as "2 spec.".

[2]) It is consequently misleading, when the length is given as 120 mm. in Consp. Faunæ groenlandicæ.

[3]) I omit stating the various places where it has been found, as the material at hand consists for the most part of young and small specimens, whilst adults are rarely brought home, owing to the large space they take up.

[4]) On the south and south-east coasts, however, large empty shells have been taken at several places at greater depths, down to 90 fm.

Distribution. On the North American side *Cyprina islandica* occurs from Cape Hatteras to the Newfoundland Bank and the southern part of the Gulf of St. Lawrence[1]. On the European side it is distributed from the south-west of France (Arcachon) to the Murman Coast and White Sea[2]; towards the west it reaches over the Færoes to Iceland; from the Kattegat it reaches into the Sound and through the Belts down into the south-western Baltic[3]. *Cyprina islandica* is consequently, as I have already more fully shown on an earlier occasion[4], a distinctly boreal form, a result that Prof. Brögger has also come to from a consideration of its late immigration into southern Norway[5]. The vertical distribution is ca 4—50 fm., but the young may be met with in greater depths[6].

In geologically very late (postglacial) deposits it has been found as far north as at Spitzbergen, which indicates that the climate of that time was somewhat milder than it is now[7].

Remarks. Gould & Binney write regarding *Cyprina islandica* (op. cit. p. 131): "It is subject to very little variety". This does not agree with the experience I have gained on going through a number of specimens from Iceland and the Færoes. I find, that the three dimensions of the shell may vary considerably, as will be seen from the measurements given below.

Locality	Length	Height	Height / Length	Breadth	Breadth / Length
Reykjavik	105 mm.	93 mm.	88.6 %	61.5 mm.	58.6 %
Vestmanhavn	104.5 -	89 -	85.2 -	51 -	48.8 -
Keflavik	102.5 -	83.5 -	81.5 -	58 -	56.6 -
Seydisfjördr	102 -	78 -	76.5 -	51 -	50 -
Reykjavik	99 -	82 -	82.8 -	57 -	55.8 -
Onundarfjördr	98.5 -	82 -	83.2 -	50 -	50.8 -
Vidarvik	93 -	88 -	94.6 -	52 -	55.9 -

1) Posselt (l. c.) gives it from Labrador and Packard as his authority, but it is not mentioned in the latter's "View of the recent Invertebrate Fauna of Labrador" (Mem. Boston Soc. Nat. Hist. vol. I, Part II, 1867, p. 262), nor in the later lists of the Molluscan fauna of Labrador by W. H. Dall and Katharine Bush. The northern boundary for its occurrence at N. America is fixed, I find by the following statement of Whiteaves: "Although recorded by Fabricius as a Greenland shell, this species has not yet been found in the Gulf of St. Lawrence, north of the Baie des Chaleurs" (Catal. of the Marine Invertebrata of Eastern Canada, p. 130; Geol. Survey of Canada, 1901). W. is not right however in his reference to Fabricius' *Venus islandica* (Fauna groenlandica, 1780, p. 411), as this is obviously not identical with Linné's *Venus (Cyprina) islandica*, but with *Cardium (Serripes) groenlandicum* Chemnitz.

2) Cattie states, that it has also been taken in the eastern (the "cold") part of the Murman Sea (Les Lamellibranches .... du "Willem Barents". Bijdragen tot de Dierkunde, 1886), but Knipowitsch has never found it there (Zur Kenntniss der geol. Gesch. der Fauna des Weissen und des Murman-Meeres, p. 24. Verhandl. Kais. Russ. Mineral. Gesellsch. St. Petersburg. 2. Ser., Bd. XXXVIII, No. 1), so that it must be in any case extremely rare.

3) In his lists showing the distribution of the Mollusca taken by the Swedish Expeditions of 1875 and 1876, Leche has given *C. islandica* as occurring in the Bering Sea (K. Sv. Vet.-Akad. Handl. Bd. 16, No 2, 1878, p. 81), and this statement appears again in Posselt (l. c.); some mistake in writing or printing must have crept in here, as the species is not mentioned in any of the lists published by Dall, Crosse, Edg. Smith or Krause on the Mollusca of the Bering Sea.

4) Ad. S. Jensen: Studier over nordiske Mollusker. II. *Cyprina islandica*. Vidensk. Medd. naturh. Foren. Kbhvn., 1902, p. 33.

5) Brögger: Om de senglaciale og postglaciale nivåforandringer i Kristianiafeltet, 1900—01, p. 573.

6) A. C. Johansen has shown, that small (young) specimens can be met with even in the abyssal region, as Jeffreys' statement of the occurrence of *C. islandica* W. of Ireland down to 1215 fm. refers to quite small individuals (Vid. Medd. Naturh. Foren. Kbhvn., 1901, p. 44).

7) Cf. my paper on *Cyprina islandica* l. c. and Jensen & Harder in: "Postglaziale Klimaveränderungen, Stockholm 1910, p. 400.

Astartidæ.

Astarte borealis Chemnitz.

Pl. IV, figs. 1 a—f.

Venus borealis Chemnitz (partim), Conch. Cab. VII, 1784, p. 26, Pl. 39, fig. 412 (non figs. 413—414[1]). — *Tridonta borealis* Sars, Moll. Reg. Arct. Norv., 1878, p. 50, Pl. 5, fig. 8[2]).

Astarte arctica Møller, Index Moll. Groenl., 1842, p. 19. — *Astarte semisulcata* Mörch, Rink's Grønland, 1857, p. 92; Vidensk. Medd. Naturh. Foren., 1867, p. 95; ibid. 1868, p. 222; Arctic Manual, 1875, p. 132; Rink's Dan. Greenland, 1877, p. 441. — *Astarte borealis* Posselt, Medd. om Grønland, XIX, 1895, p. 71, Pl. I, figs. 8—12 (var. *sericea* Poss.); ibid. XXIII, 1898, p. 61; Jensen, ibid. XXIX, 1909, p. 335.

The "Ingolf" has taken this species at:

St. 33.	Davis Strait	35 fm.	1 living, 1 dead spec. and 1 valve.
- 35.	— —	362 -	1 valve of a young spec.
- 86.	W. of Iceland	76 -	8 valves of young spec.
- 124.	N. - —	495 -	1 valve.
- 125.	- - —	729 -	1 —
- 110.	N. E. of —	781 -	4 valves (corresponding).
- 120.	— - —	885 -	4 — —
- 116.	S. of Jan Mayen	371 -	4 — —
- 117.	- - - —	1003 -	1 valve.
- 113.	- - - —	1309 -	1 —

West Greenland.

A. borealis is common along the Danish part of the coast; further north, it is found at Port Foulke on Smith Sound (Hayes), on the American side even at Dumbbell Harbour at 82°30' N. L. ("Alert & Discovery"); the bottom-soil is mud, sand and clay. The depths recorded lie between 5—50 fm.[3]). The maximum length is 44 mm.

East Greenland.

Here the species has been taken by Danish, Swedish and German Expeditions at quite a dozen places on the stretch from Angmagssalik to Shannon Island (ca. 65°30'—75°30' N. L.), in depths of 3—40 fm. The maximum length is 44 mm.

[1]) Fig. 413 obviously represents *Astarte crenata* Gray, fig. 414 *A. sulcata* d. C.

[2]) A fairly detailed synonymy-list for this species of many names is given by Kobelt: Prodr. Moll. Test. Mar. Europ., 1888, p. 394.

[3]) As will be seen, the species is certainly taken in the Davis Strait at the considerable depth of 362 fm., but as the shell in question is of a young specimen, the occurrence cannot be considered as normal

Jan Mayen.

A. borealis has been taken here by the Norwegian North-Atlantic Expedition at 10—15 fm. (Friele), the Austrian Expedition at 65—90 fm. (Becher, sub. nom. *A. borealis* Ch. and *A. producta* Sow.) and the Danish Expedition of 1900 at 15 and 50 fm.

Iceland.

On the west coast a large number of specimens have been taken at many localities, so that the species must be common here. From the north coast and especially from the east coast, on the other hand, we have *A. borealis* only from a few places and it would thus seem to be comparatively rare in these parts of Iceland. — It occurs on sand, clay and mixed bottom-soil; the depths recorded for living specimens lie between 3 and 31 fm. The maximum length is 47 mm.[1])

The various localities are as follows.

East Iceland:

Berufjördr, Djupivogr	10 fm.	2 valves.
Seydisfjördr, at Skulavig	6 - , black sand.	1 spec.
Lodmundarfjördr	ca. 20 - , from stomach of haddock.	1 —
Gunnólfsvik.		7 valves.

These few occurrences might indicate, as mentioned, that *A. borealis* is comparatively rare on the east coast; and we can hardly consider it due to chance, that this species especially has not been taken by the collectors, when a species of similar size and occurrence such as *A. elliptica* is to hand from the east coast in large numbers and from rather many localities (cf. p. 109).

On referring to Dr. A. C. Johansen, who has explored the coasts of Iceland, this zoologist has kindly given me the following information, which agrees well with what has been said above: "In my notes from Iceland I find *Astarte borealis* recorded from the beach at Seydisfjördr, but not from Bakkafjördr, Berufjördr or Hamarsfjördr. As I have noted it from the beach on the south-west and west coasts, from Vestmannaeyjar, Reykjavik, Stykkisholmr and Arnarfjördr, this would indicate, that it is commoner on the shores of the south-west and west coasts than those of the east coast".

It may however be added, at the same time, that Nils Odhner, who has only had a relatively small material at his disposal for his paper: "Marine Mollusca of Iceland"[2]) is able, nevertheless, to record *A. borealis* from a locality on the east coast, namely:

Berufjördr	9—30 fm.	Many spec.

The largest of our specimens is 44 mm. long, of Dr. Odhner's 46 mm.

North Iceland:

Thistil Fjördr	10—24 fm., sand and "coral".	5 spec.
Vidarvik	13½ - , black sand.	6 spec. & 5 valves.

[1]) Some separate valves, which are only labelled "Iceland", reach however a much larger size, namely 52—56 mm.
[2]) Arkiv för Zoologi, Bd. 7, 1910, No. 4.

Axafjördr	30 fm.,	sand and stones.	1 spec.
Skjálfandi Bugt	31 - ,	fine black sand.	1 —
Husavik	$7^1/_2$—10 -		1 valve.
Ofjord			1 —
Skagastrand			1 —

Odhner l. c. records it as taken at:

Raufarhöfn	30 fm.	Many spec.

The largest of the specimens to hand is 40 mm. long.

The same almost may be said regarding this part of the coast as about East Iceland; we might have expected to find *A. borealis* very common on the north coast, and it is thus remarkable that there is so little material from there.

West Iceland:

Höfnvik	10 fm.		3 spec.
Adalvik	$5^1/_2$—9 -		2 —
Hesteyrarfjördr	15—$17^1/_2$ -		5 valves.
Isafjördr			3 spec. & 1 valve.
— , beach.			1 — & 1 —
Skutilsfjördr			1 spec.
—	5—13 -		1 —
Onundarfjördr	ca. 9 -		2 —
Dyrafjördr			3 —
— , inside Thingnæs	10—$12^1/_2$ - ,	mud and small stones.	4 valves.
65°56′ N. L., 24°30′ W. L.	37 -		2 —
Arnarfjördr, beach.			2 —
Talknafjördr			2 spec.
65°32′ N. L., 24°38′ W. L.	22 - ,	stones.	3 —
Stykkisholmr, beach.			1 valve.
Grundarfjördr			1 spec. & 1 valve.
Olafsvik			1 —
Hvalfjördr	5—13 -		1 valve.
—	24 -		1 —
Krossvik	8 - ,	shell-gravel, blue clay, stones.	5 spec. & 20 valves.
Faxafjördr	15—16 - ,	fine black sand.	1 — & 2 —
—	17 - ,	coarse sand.	2 — & 14 —
—	14—29 -		3 valves.
—	25 -		1 valve.
— , mouth of Kollafjördr	$9^1/_2$—11 - ,	fine black sand and ooze.	4 spec. & 17 valves.
— , off Kollafjördr	8—$11^1/_2$ - ,	ooze and stones.	6 — & 9 —

Faxafjördr, 1 mile E. N. E. of Helgasker	$11^{1}/_{2}$ fm.		1 spec.
— , 1 — W. of Helgasker	13—16 -	, shell-gravel and stones.	10 valves.
— , 7 miles N. N. E. of Skagens Light	17—$20^{1}/_{2}$ -	, sand and shells.	1 spec. & 10 valves.
Reykjavik			1 —
— , beach.			1 —
—	8 -		1 — & 3 —
— (Engey)	7—$8^{1}/_{2}$ -	, ooze.	1 —
Hafnarfjördr			3 —
—	3—4 -	, ooze.	1 —

The largest specimen is 47 mm. long.

South Iceland:

Vestmannaeyjar, beach.			5 spec.
— , harbour	$^{1}/_{2}$—0 fm.		7 —
—	30 -	, gravel.	3 — & 3 valves.
—	49 -	, clay with a little mud.	1 valve.
— , Heimaey, beach.			3 spec. & 23 —
63°21' N. L., 17°31' W. L.	69 -	, black sand.	1 valve.
63°21' — 17°15' —	58 -	, sand, stones, shell-gravel.	1 —
63°42' — 16°32' —	29 -		3 spec.

The largest specimen is 39 mm. long.

[The Færoes.]

Landt records "*Venus borealis*" as "taken at the bottom of Vestmanhavn Fjord"[1], and Mörch states, that a very large specimen of *Astarte semisulcata* Leach was received from the pastor P. Holm, who had collected at the Færoes[2]. As *A. borealis* has not been found however during the extensive investigations of recent years, these records probably are mistakes, and I believe myself entitled to remove *A. borealis* from the fauna of the Færoes, unless certain records are forthcoming.

Remarks. At Iceland and Greenland *Astarte borealis* is very variable, both in regard to form and sculpture of the shell and the structure of the periostracum.

Periostracum. On the Icelandic specimens the periostracum may form a thin layer, smooth or finely fibrous towards the margin, or it may be somewhat thicker and as if frayed; the smooth periostracum is most frequently fairly light-coloured, yellowish-brown and somewhat glistening, the fibrous kind is darker, brown or almost quite black.

In the West Greenland specimens the periostracum varies in the same way.

In all my specimens from East Greenland the periostracum is brown to swarthy, thick and bast-like.

1) Landt: Forsøg til en Beskrivelse over Færöerne, 1800, p. 289.
2) Mörch l. c. 1868, p. 95.

It seems as if the periostracum were thickest and most frayed in arctic specimens, as this characteristic is seen not only in the specimens from East Greenland (and in part those from West Greenland [and Iceland]), but also in (my) specimens from Spitzbergen and the Kara Sea[1]).

Sculpture. The shell may be, apart from the fine lines of growth, quite smooth or more or less distinctly folded, at the umbones only or more or less far down on the shell. The folds sometimes appear as fine and dense, sometimes coarser ribs with wider intervals, and these ribs may sometimes in the adult specimens reach at least halfway down on the shell.

Form. At Iceland the form is relatively high and more or less convex, as will be seen from the following measurements:

Locality	Length	Height	Height/Length	Breadth	Breadth/Length
Vestmannaeyjar	44 mm.	38 mm.	86.4 %	17 mm.	38.6 %
Reykjavik	43 -	36.2 -	84.2 -	17.75 -	41.3 -
—	42 -	34 -	81 -	15.5 -	36.9 -
—	38 -	33.5 -	88.2 -	17 -	44.7 -
Faxafjördr	37 -	32.25 -	87.2 -	14.25 -	38.5 -
—	36.5 -	32.5 -	89 -	16 -	43.8 -
—	34.75 -	29 -	83.5 -	16.5 -	47.6 -
Seydisfjördr	44.25 -	34.25 -	77.4 -	20.25 -	45.8 -

At West Greenland similar forms occur, but here also — though apparently not very frequently along the more southern (Danish) part of the coast — we find a greatly compressed form (var. *placenta* Mörch[2]) = *Astarte Richardsoni* Reeve[3]), of which I may give the following measurements as example:

Locality	Length	Height	Height/Length	Breadth	Breadth/Length
West Greenland	39 mm.	31 mm.	79.5 %	12.25 mm.	31.4 %

At East Greenland we find more or less compressed, often strikingly elongated forms[4]) as will be seen from the following measurements:

Locality	Length	Height	Height/Length	Breadth	Breadth/Length
Turner Sound	44 mm.	35 mm.	79.5 %	18 mm.	40.9 %
— —	40 -	30 -	75 -	14.25 -	35.6 -
Tasiusak	32.5 -	27.2 -	83.7 -	13 -	40 -
—	29 -	24.5 -	84.5 -	10.5 -	36.2 -
Hekla Havn	29 -	21.5 -	74.1 -	9.5 -	32.8 -
Forsblads-Fjord	27 -	20 -	74.1 -	8.25 -	30.6 -

[1]) C. G. Joh. Petersen's statement regarding *A. borealis* in Danish waters seems to me of interest in this connection: "the epidermis is here (i. e. in specimens from the Belts and Baltic) much more frayed than in the Kattegat specimens" (Det vidensk. Udbytte af Kanonbaaden Hauch's Togter, 1893, p. 75). Compare also in this connection A. Krogh: "The tension of carbonic acid affecting the structure and preservation of molluscan shells"; Medd. om Grønland, XXVI, 1904, p. 387.

[2]) Mörch: Catal. des Moll. du Spitzberg. Mém. Soc. Malacol. Belgique, T. IV, 1869, p. 22.

[3]) Reeve in Belcher: The last of the Arctic Voyages, II, 1855, p. 397, Pl. 33, fig. 7.

[4]) For such specimens Posselt (l. c.) has set up a special variety, *sericea*, on account of the elongated form of the shell, the thick epidermis and its silk-like sheen; in my opinion it cannot be kept separate from the variety *placenta* Mörch.

The following figures on Pl. IV may serve as illustrations of the above-mentioned, varying form and structure in *Astarte borealis*:

Fig. 1a represents a specimen without folds and with an almost smooth (fibrous only at the margin), fairly light-coloured periostracum. The shell is rather convex, as is seen from fig. 1b. Western Iceland.

Fig. 1c represents a very high form, with quite narrow folds on the uppermost part of the shell and with fairly thick, fibrous periostracum on the lowest part. Western Iceland.

Figs. 1d and 1e represent a strongly compressed form (var. *placenta* Mörch) with distinct folds on the uppermost part of the shell. Western Greenland.

Fig. 1f represents a very elongated form (var. *sericea* Posselt). East Greenland.

Distribution. *Astarte borealis* is an arctic and circumpolar species. In Norway it is said not to live south of Bergen[1], nor has it been taken living in the Skager Rak or Northern Kattegat; but after this break in its distribution it appears again in the south-western Kattegat and reaches through the Sound and Belts, increasing in numbers but decreasing in size, down into Kiel Bay and thence south of Lolland to a little east of Bornholm (C. G. Joh. Petersen). It is said to occur in the middle of the North Sea[2]), but empty shells only have been found at Scotland, the Hebrides and Shetland. On the American side the southern boundary lies at New England, in the Pacific at Alaska, the Aleutians and Kamschatka. — Its bathymetric distribution is 3—260 fm.[3]).

Astarte Montagui Dillwyn.

Pl. IV, figs. 2a—c.

Venus compressa (non Linné) Montagu, Test. Brit. Suppl., 1808, p. 43, Pl. 26, fig. 1; (*Astarte*) Forbes & Hanley, Hist. Brit. Moll., I, 1853, p. 464, Pl. 30, fig. 1; Jeffreys, Brit. Conchol., II, 1863, Pl. 37, fig. 3. — *Venus Montagui* Dillwyn, Descript. Catal. Recent Shells, I, 1817, p. 167. — *Nicania Banksii* Leach, Ross' Voyage of Discovery, 1819, Append. p. 62; Sars, Moll. Reg. Arct. Norv., 1878, p. 51, Pl. 6, fig. 1. — *Nicania striata* Leach, l. c. p. 62. — *Astarte globosa* Møller, Index Moll. Groenl., 1842, p. 19; Reeve, Belcher's Last of the Arctic Voyages, 1855, p. 398, Pl. 33, fig. 6. — *Astarte Warhami* Hancock, Ann. Mag. Nat. Hist., vol. 18, 1846, p. 336, Pl. 5, fig. 15—16. — *Astarte pulchella* Jonas, Philippi, Abbild. u. Beschreib. neuer Conchyl., II, 1847, p. 60, Pl. 1, fig. 12. — *Astarte fabula* Reeve, l. c. p. 398, Pl. 33, fig. 5[4]).

Astarte Banksii Møller, Index Moll. Groenl., 1842, p. 19; Mörch, Rink's Grønland, 1857, p. 20; Vidensk. Medd. Naturh. Foren. 1868, p. 223; Arctic Manual, 1875, p. 132; Rink's Dan. Greenland, 1877, p. 441; Posselt, Medd. om Grønland, XIX, 1895, p. 73, Pl. 1, figs. 1—4; ibid. XXIII, 1898, p. 68;

1) C. G. Joh. Petersen's reference to it as living in Christiania Fjord (Om de skalbærende Molluskers Udbredningsforhold, 1888, p. 46) is based on a mistake, caused by Asbjörnsen; Brögger has explained (Om de senglaciale og postglaciale nivåforandringer i Kristianiafeltet, 1900–01, p. 581), that Asbjörnsen's "*A. semisulcata*" was not *A. borealis* but a form of *A. elliptica*.

2) Schrader: Lamellibranchiaten der Nordsee (Inaug.-Dissert.), 1910, p. 43.

3) As a rule the boundary is placed at a depth of ca. 60 fm., but greater depths — down to 260 fm. — are recorded by Friele & Grieg (Norw. North-Atlantic Exped., Mollusca III, 1901, p. 24) from Spitzbergen.

4) For further references to the extensive synonymy see Kobelt: Prodr. Moll. Test. Mar. Europ., 1888, p. 305, under *Astarte Banksii* Leach.

Jensen, ibid., XXIX, 1909, p. 333. — *Astarte striata* Møller l. c., p. 20; Mörch l. c. 1857, p. 20; 1875, p. 132; 1877, p. 441. — *Astarte pulchella* Mörch, l. c. 1857, p. 20; 1875, p. 132; 1877, p. 441. — *Astarte Montagui* Mörch, Vidensk. Medd. Naturh. Foren. 1867, p. 95; ibid. 1868, p. 223.

The "Ingolf" has taken *A. Montagui* at the following places:

St. 35.	Davis Strait	362 fm.	1 valve.
- 33.	— —	35 -	2 valves.
- 86.	W. of Iceland (Brede Bugt)	76 -	30 —
- 87.	- - — — —	110 -	2 —
- 104.	N. E. of Iceland	957 -	4 —
- 113.	S. E. of Jan Mayen	1309 -	5 —

Remarks. In the figures 2a—c on Pl. IV I have compared 3 specimens, which seem to me to illustrate the main types of this very variable species within the faunistic region dealt with here.

Fig. 2a represents *A. Montagui* Dillw. *typica*, a short and high, somewhat triangular form; the anterior end is a little elongated-rounded, the posterior end shorter, strongly sloping downwards, truncate; the umbones lie a little behind the middle of the shell.

Fig. 2b represents *A. Montagui* Dillw. var. *striata* (Leach) Sars, a more elongated form, which stands midway between the foregoing and the following.

Fig. 2c represents *A. Montagui* Dillw. var. *Warhami* Hancock, the shell of which is elongated, elliptical, in general rounded both in front and behind; the umbones lie almost in the middle of the shell.

The measurements of the three specimens, which I have chosen as types, are as follows:

	Length	Height	Height / Length	Breadth	Breadth / Length
A. Montagui typica	14 mm.	13 mm.	92.9 %	7.5 mm.	53.6 %
- — var. *striata*	15 -	13 -	86.7 -	8 -	53.3 -
- — - *Warhami*	22 -	16.75 -	76.1 -	9.5 -	43.2 -

These three forms are not at all sharply separated, however; all transitions may occur. In discussing the separate geographical regions further opportunity will be taken to mention the variability of this species.

West Greenland.

Here the species is common, from the southernmost parts up to Cape York; on the American side it has been taken as far north as 80° N. L. It occurs most frequently at depths of 5—50 fm., but is also met with at greater depths.

At West Greenland the variety *striata* is by far the most predominant, and along with it occurs rather frequently the variety *globosa* Møller, which is characterized by an extremely tumid form; the typical form and the variety *Warhami* are comparatively rare. At the same time it must be remembered, however, that all possible transitional stages exist between the forms mentioned.

The maximum length is 23 mm.

The measurements of some specimens will illustrate the form-relation among the varieties mentioned.

A. Montagui typica:

Length	Height	Height / Length	Breadth	Breadth / Length
20 mm.	18.5 mm.	92.5 %	11.5 mm.	57.5 %
16 -	15 -	93.7 -	9.25 -	57.8 -
15 -	14 -	93.3 -	9 -	60 -
14 -	13 -	92.9 -	8.25 -	58.9 -
12.8 -	12 -	93.8 -	7.25 -	56.6 -

A. Montagui var. *globosa:*

17 -	15 -	88.2 -	11 -	64.7 -
14.5 -	12.75 -	85.2 -	9.5 -	65.5 -
11.8 -	11.5 -	97.5 -	8.2 -	69.5 -
11.5 -	10.5 -	91.3 -	7.2 -	62.6 -
11.5 -	11.25 -	97.8 -	8 -	69.6 -
10.5 -	10.25 -	97.6 -	7.25 -	69 -

A. Montagui var. *striata:*

23 -	19.75 -	85.9 -	12 -	52.2 -
19.8 -	16.75 -	84.6 -		
19 -	16.5 -	86.8 -	9.5 -	50 -
18.5 -	16 -	86.5 -	9.25 -	50 -
17 -	14.75 -	86.8 -	8.5 -	50 -
15 -	13 -	86.7 -	8 -	53.3 -

A. Montagui var. *Warhami:*

19 -	15 -	78.9 -	9.25 -	48.4 -
17.75 -	14 -	78.9 -	9 -	50.7 -
14.5 -	11.25 -	77.6 -	7 -	48.3 -
12.75 -	9.75 -	76.5 -	6.5 -	51 -

East Greenland.

Here *A. Montagui* has been taken at 15 localities between Angmagssalik and Sabine Island (65°40′–74°32′ N. L.), at depths of 3—50 fm. The largest specimen is 24.2 mm. long.

The majority of the specimens at hand belong to the variety *Warhami*, in a form which is generally rather compressed but is sometimes rather tumid; the variation in this regard will be seen from the accompanying measurements.

A. Montagui var. *Warhami*:

Length	Height	Height / Length	Breadth	Breadth / Length
24.2 mm.	18.5 mm.	76.4 %	8.25 mm.	34.1 %
23.5 -	16.5 -	70.4 -	8.5 -	36.2 -
23 -	18 -	77.8 -	9.75 -	42.2 -
22.5 -	18 -	80 -	12 -	53.3 -
22 -	17.25 -	78.4 -	8.75 -	39.8 -
22 -	16.75 -	76.1 -	9.5 -	43.2 -
20.5 -	15.75 -	76.8 -	8.5 -	41.5 -
20.5 -	15.5 -	75.6 -	8 -	39 -
20.5 -	16.5 -	80.5 -	9 -	43.9 -
20 -	16 -	80 -	10 -	50 -

The concentric ribs frequently reach right down to the ventral margin, but other specimens are only ribbed on the umbonal region or to the middle of the shell, showing on the rest of the shell only fine lines of growth (= *Astarte fabula* Reeve).

Some few specimens belong to the variety *striata*, which in my opinion — as already mentioned — is only a shorter form than *Warhami*[1]); to try and keep them distinct owing to the different colour of the periostracum is not correct, as the variety *Warhami*, for example, may begin as straw-yellow and end as dark-brown. — For the sake of comparison I may give here the measurements of the few specimens from East Greenland:

A. Montagui var. *striata*:

Length	Height	Height / Length	Breadth	Breadth / Length
21.5 mm.	17.5 mm.	82.6 %	9.75 mm.	45.3 %
19 -	16 -	84.2 -	10.25 -	53.9 -
17.5 -	14.5 -	82.9 -	9 -	51.4 -

Only one specimen (from Hekla Havn) is so short in form, that it can be referred to the typical *Astarte Montagui*; it has the following measurements:

Length	Height	Height / Length	Breadth	Breadth / Length
14 mm.	12.75 mm.	91.1 %	7.75 mm.	55.3 %

This specimen also differs in its sculpture, the shell only showing fine lines of growth and not the usual concentric ribs.[2]).

Jan Mayen.

None of the Danish Expeditions have found it here, but it is stated to have been taken by the Norwegian North-Atlantic Expedition as the variety *globosa* at a depth of 195 fm. (Friele) as also by the Austrian Expedition at a depth of 105 fm. (Becher).

[1]) The "*Astarte Banksii* Leach var. *Warhami*" of Posselt in his East Greenland Molluscs (l. c. 1895; Pl. I, figs. 3—4) has to be referred in my opinion to the variety *striata* owing to the relative shortness of the shell.

[2]) It is this specimen which is figured by Posselt, l. c., figs. 1—2, under the name of *Astarte Banksii* Leach.

Iceland.

A. Montagui has been taken in large quantity on the west coast, in part also on the east coast; from the south coast there are but few specimens and from the north coast only one, but whether this is due to imperfect collections or to the actual scarcity of the species on the north coast, I am unable to say[1]). The depths noted lie between ca. 8—50 fm. On the west coast it reaches to 19 mm., and on the east coast to a very considerable size, namely 26.2 mm.

The various localities are as follows.

East Iceland:

Myre Bugt	26 fm.	1 valve.	
Berufjördr, Djupivogr	6—9 - , mud with black sand.	50 spec.	
Mouth of Berufjördr	54—41 - , ooze.	1 —	
64°58′ N. L., 13°25′ W. L.	40 -	4 —	& 27 valves.
Breiddalsvik	14 -	2	& 1 valve.
Vattarnes	20—16 -	1 —	
Vidfjördr	8—12 -	1 —	
—	15 -	2 —	
Nordfjördr	40 -	9 —	
Seydisfjördr	15—20 -	1 —	
— , the mouth	38—14 - , mud.	12 —	
— , off Brimnes	40 - , ooze and clay.	1 —	

The specimens from East Iceland belong in part to the variety *striata*, in part to the typical form or to transitional stages between the two, as will be seen from the following measurements:

Locality	Length	Height	Height / Length	Breadth	Breadth / Length
Djupivogr	26.2 mm.	23 mm.	87.8 %	12.5 mm.	47.7
—	24.7 -	22.25 -	90.1 -	11.2 -	45.3 -
—	22.5 -	18.75 -	83.3 -	12 -	53.3 -
Berufjördr	16 -	14.5 -	90.6 -	8 -	50 -
Vattarnes	17 -	14.5 -	85.3 -	9.2 -	54.1 -
Seydisfjördr	22 -	19.25 -	87.5 -	10 -	45 -
—	21.2 -	19 -	89.6 -	10.2 -	48.2 -
—	20.5 -	18.5 -	90.2 -	10 -	48.8 -
—	20.2 -	17.8 -	88.1 -	10 -	49.5 -
—	20 -	18 -	90 -	10 -	50 -
—	20 -	17.2 -	86 -	10 -	50 -
—	19.5 -	17 -	87.2 -	9.25 -	47.4 -
—	19 -	17 -	89.5 -	9 -	47.4 -
Nordfjördr	21.8 -	18.75 -	86 -	10.8 -	49.5 -
—	21.5 -	19 -	88.4 -	11.75 -	54.7 -
—	20.2 -	18.25 -	90.3 -	9.5 -	47 -

[1]) As Odhner in his list over the comparatively small collection of marine Mollusca from Iceland in the Stockholm Museum records the species from 2 localities from the north coast (Arkiv för Zoologi, Bd. 7, No. 4, 1910, p. 20), the first view seems to be the most probable one.

North Iceland:

From here we have only a small specimen (12.5 mm. long) from

Axafjördr	30 fm., sand and stones.	1 spec.

But, in addition, Odhner (l. c.) records it from the following localities on the north coast, up to 18 mm. in length:

Raufarhöfn	35 fm.	13 spec.
Siglufjördr	12 -	Many spec.

West Iceland:

Skutilsfjördr.		9 spec.
Dyrafjördr.		1 —
Talknafjördr.		7 —
N. W. of Talkni.		1 valve.
Patreksfjördr	10—20 fm.	1 spec.
—	14 -	3 — & 5 valves.
Grundarfjördr.		1 —
—	12 -	2 —
Hvalfjördr	24 -	75 spec. & ca. 100 valv.
Faxafjördr	25 -	2 valves.
—, mouth of Kollafjördr	9½ -	1 spec. & 40 valves.
— — - —	9½—11 - , fine black sand and ooze.	10 — & ca. 100 valv.
—, off Kollafjördr	8—11½ - , ooze and stones.	3 — & - 225 —
— - —	10 -	ca. 100 valves.
—, Keflavik	15—16 - , fine black sand.	6 spec. & 135 valves.
—, 2 miles N. E. of Keflavik	19½—20½ - , ooze.	110 valves.
—, 1 mile E. N. E. of Helgasker Vager	11½ -	1 spec.
—, 4.3 miles W. ¾ S. of Helgasker Vager	25 -	2 spec. & 55 valves.
E. of Videy	9—10 - , fine sand and ooze.	4 valves.
Reykjavik.		6 spec. & 11 valves.
—, beach.		20 valves.
— (Engey)	7—8½ - , ooze.	2 spec.
Hafnarfjördr	25 - , fine black sand and ooze.	11 valves.
Skagi	21 -	1 valve.

The maximum length is 19 mm.

By far the great majority of the West Icelandic specimens belong to the typical *A. Montagui*[1].

Thus, all the specimens from the southern part of the west coast belong to the typical form, as will be seen from the following examples:

Locality	Length	Height	Height / Length	Breadth	Breadth / Length
Grundarfjördr	18.3 mm.	17 mm.	92.9 %	10 mm.	54.6
—	17 -	15.7 -	92.4 -	9 -	52.9 -
Engey	17.2 -	15.8 -	91.9 -	8 -	46.5 -
Hafnarfjördr	17.2 -	16 -	93 -	10 -	58.1 -
—	16.5 -	15.8 -	95.8 -	10 -	60.6 -
E. N. E. of Helganes	13.5 -	13 -	96.3 -	7.5 -	55.6 -
Keflavik	14 -	13 -	92.9 -	7.5 -	53.6 -

The typical *A. Montagui* also occurs on the northern part of the west coast, but by side of it we find moreover somewhat more elongated specimens, which approach to or may be entirely referred to the variety *striata*: this is seen from the following measurements:

Locality	Length	Height	Height / Length	Breadth	Breadth / Length
Talknafjördr	18.2 mm.	16 mm.	87.9 %	9 mm.	49.4 %
—	16.8 -	15.2 -	90.5 -	8.5 -	50.6 -
—	15 -	14 -	93.3 -	8 -	53.3 -
Patreksfjördr	19 -	16.5 -	86.8 -		
—	17 -	15.2 -	89.4 -	8.75 -	51.5 -
—	15.7 -	14 -	89.2 -	8 -	51 -
—	14 -	13 -	92.8 -	7.5 -	53.6 -

South Iceland:

Vestmannaeyjar	30 fm., gravel.	5 valves.
—	49 - , clay with a little mud.	1 spec. & 40 valves.
63° 24' N. L., 17° 5' W. L.	70 -	2 valves.

The maximum length of these specimens, which belong to the typical *A. Montagui*, is 14 mm.

Færoes.

Here the species is common at depths of ca. 5—50 fm. The maximum length is 19.8 mm.

The various localities are as follows:

Viderejde	10 fm.	1 spec. & 6 valves.
Klaksvig	10—15 -	1 - & 7 -

[1]) A specimen from Grundarfjördr is even so high and short, with the posterior margin sloping so steeply, that it resembles the form figured by Brown under the name of *Crassina obliqua* (Illustr. Conchol. Great Britain and Ireland, 1827, Pl. 18, fig. 6), but in the second edition of his work given as a variety of *Crassina striata* (Illustr. Rec. Conchol. Gr. Britain and Ireland, 1844, p. 96, Pl. 38, fig. 6). Its measurements are as follows: height 17.5 mm., length 17.5 mm., breadth 10.5 mm. This characteristic form also occurs at the Færoes.

Klaksvig	11 fm.,	from rhizoids of Laminaria.	1 spec.
Bordövig....	7—10 - ,	black sand and small stones.	30 — & 14 valves.
—	10 - ,	sand.	5 — & 4 —
Fundingsfjord	12—ca. 20 - ,	coarse sand and clay.	2 — & 2 —
Andefjord	16—23 -		2 — 1 valve.
Skaalefjord	4—5 -		1 valve.
Kongshavn			2 spec.
—	12—16 - ,	small stones, sand & ooze.	3 — & 14 valves.
—	ca. 50 -		33 — & 90 —
Vestmansund.........................	- 70 -		12 valves.
Vestmanhavn	$3^{1}/_{2}$—5 - ,	fine black sand.	ca. 125 spec. (small).
—	5—6 - ,	fine black sand.	10 spec. & 70 valves.
Sörvaag..............................	14—$16^{1}/_{2}$ - ,	ooze.	1 valve.
Midvaag, beach			1 —
Thorshavn			3 —
Nolsö, deep hole at north end	ca. 100 fm.		1 spec. & 1 valve.
Vaagfjord	10 -		1 —
5 miles S. S. E. of Bispen.............	50 -		8 valves.
13 — W. by S. of Munken	- 150 -		1 valve.

The Færoese specimens belong to the typical *A. Montagui*, though sometimes with a tendency in the direction of var. *striata*, as will be seen from the measurements below:

Locality	Length	Height	Height / Length	Breadth	Breadth / Length
Klaksvig	20.6 mm.	19.5 mm.	94.7 %	9.8 mm.	49 %
Andefjord	19.8 -	17.5 -	88.4 -	10 -	50.5 -
—	16.8 -	15.5 -	92.3 -	8.75 -	52.1 -
Nolsö	17.2 -	15.2 -	88.4 -	7.8 -	45.3 -
Kongshavn.................	17 -	15.3 -	90 -	8.2 -	48.2 -
—	16 -	14.2 -	88.8 -	8.2 -	51.3 -
—	15.8 -	15 -	94.9 -	8.5 -	53.8 -
—	15.5 -	13.8 -	89 -	8 -	51.6 -
—	14.7 -	13 -	92.9 -	7.5 -	51 -
—	14 -	13.5 -	96.4 -	8 -	57.1 -
—	14 -	13 -	92.2 -	7.5 -	53.6 -
Vaagfjord	14 -	12.7 -	90.7 -	7 -	50 -
Fundingsfjord	12.8 -	11.8 -	92.2 -	7.2 -	56.3 -
Viderejde	13 -	11.7 -	90 -	7 -	53.8 -

Concluding remarks. It may be seen from the foregoing, that there is a certain regularity in the variation of the species, since the form becomes elongated on the whole in the same degree as the marine climate becomes more severe. At the Færoes and the southern West Iceland we have only the short *A. Montagui typica*, though sometimes with a tendency in the direction of the slightly more elongated variety *striata*; at northern West Iceland the variety *striata* begins to appear and at East Iceland it occurs commonly together with the typical *Montagui*. At West Greenland the variety *striata* is by far the most predominant, and at the same time the still more elongated variety *Warhami* is appearing; lastly, at East Greenland the variety *Warhami* is almost the only form. Accompanying the elongation of the form we also find an increase in the maximum length, namely from ca. 19–20 mm. at the Færoes and West Iceland to 23–26 mm. at East Iceland and Greenland.

Distribution. *Astarte Montagui* is circumpolar in arctic seas. Towards the south it reaches to the Aleutians and Vancouver Island in the Pacific, and in the Atlantic to Massachusetts and the Channel.

Astarte sulcata da Costa.

Pl. IV, figs. 3 a–c.

Pectunculus sulcatus da Costa, Brit. Conchol., 1778, p. 192. — *Astarte sulcata* Forbes and Hanley, Hist. Brit. Moll., I, 1853, p. 452, Pl. 30, figs. 5–6[1] & Pl. 133, fig. 4; G. O. Sars, Moll. Reg. Arct. Norv., 1878, p. 52.

Astarte sulcata Posselt (partim), Medd. om Grønland, XIX, 1895, p. 72; ibid. XXIII, 1898, p. 65.

The "Ingolf" has taken this species at:

St. 94.	Off South-East Greenland	204 fm.	4.1° C.	1 spec.
- 16.	W. of Iceland	250 -	6.1° -	1 valve.
- 98.	- - —	138 -	5.9° -	2 spec. and several hundred separate valves, mostly of very small specimens.
- 86.	- - — (Brede Bugt).	76 -		1 large valve and many quite small.
- 87.	- - — — —	110 -		ca. 20 valves.
- 89.	- - —	310 -	8.4° -	1 spec. & 1 valve.
- 9.	- - —	295 -	5.8° -	4 spec. & ca. 20 valves.
- 8.	S. W. of Iceland	136 -	6.0° -	10 separated valves of young specimens.
- 85.	- - - —	170 -		ca. 20 spec. & many valves.
- 84.	- - - —	633 -	4.8° -	1 valve.
- 81.	- - - —	485 -	6.1° -	6 ancient valves.
- 73.	- - - —	486 -	5.5° -	1 valve.
- 6.	S. E. of Iceland	90 -	7.0° -	Some fragments of larger valves and a number of valves, separate or connected, of quite small specimens.

West Greenland.

Posselt records *A. sulcata* from Igaliko Fjord, Sukkertoppen and the fjord off Upernivik; of these I have seen one specimen labelled as coming from the first-named locality, but in appearance it is so "European", that I think it not unlikely that some exchange of labels has taken place.

[1]) In the explanation of the figures under the Plate, fig. 6 is given under the synonym *A. Danmoniensis*, fig. 5 by a type-error as *A. triangularis*.

East Greenland.

Here there occurs a comparatively closely ribbed form of *A. sulcata*, which has been taken off the south-eastern ("warm") part by Nordenskjöld's Expedition (1883) at 130 fm. depth and by the Ingolf-Expedition at St. 94 in 204 fm., as also by the Amdrup Expedition off Angmagssalik at a depth of 140 fm. The maximum length is 23 mm. — Further, Möbius[1]) records it from north-eastern Greenland, but I feel certain that this record is due to some mistake.

[Jan Mayen].

Becher records the species from here[2]), but I am convinced that his record refers to a form of *A. crenata* Gray (cf. *A. crenata* var. *inflata*, p. 117); *A. sulcata* is perfectly clearly, from the results of the Ingolf-Expedition, a distinctly warm-water form.

Iceland.

In addition to the stations mentioned of the Ingolf-Expedition, *A. sulcata* has later been taken at the following places:

63°15′ N. L., 22°23′ W. L.	170—114 fm.		6 spec. & 24 valves.
63°18′ - - 21°30′ - -	94 -		1 — - 1 —
63°05′ - - 20° 7′ - -	293 -		15 valves.
62°57′ - - 19°58′ - -	500 -		1 valve.
63°21′ - - 17°31′ - -	69 -	, black sand.	1 —
63°21′ - - 17°15′ - -	58 -	, sand, stones, shell-gravel.	3 spec. and 12 valves.
63°24′ - - 17° 5′ - -	70 -	, black sand with stones and shells.	1 spec. and 3 valves.

Thus, taken on the whole, *A. sulcata* may be said to be fairly common off western and southern Iceland; living specimens have been taken at depths of 58—310 fm., but dead shells even at a depth of 633 fm. The maximum length is 26 mm.

The Færoes.

From the investigations of recent years the Zoological Museum has obtained *A. sulcata* from the following places.

Fundingsfjord	12—20 fm.,	coarse sand and clay.	9 spec. & 34 valves.
Nolsö, deep hole at north end	ca. 100 -		4 — & 6 —
62°29′ N. L., 5°17′ W. L.	160 -	, stones and sand.	1 — & 5 —
62°29′ - - 4°52′ - -	112 -	, sand.	2 spec.
62°17½′ - - 4°57′ - -	144 -	, clay and stones.	2 —
13 miles S. of Myggenæsholm	70 -		1 spec. & 9 valves.
S. W. of Myggenæs	135 -		18 — & 165 —

[1]) Die zweite Deutsche Nordpolarfahrt in d. Jahren 1869 u. 1870. Wiss. Ergebn., II, 1874, Zoologie, p. 251.
[2]) Die Österr. Polarstation Jan Mayen, Beob.-Ergebn., III, 1886, p. 71.

61° 15' N. L., 9°35' W. L.	ca. 475 fm.		9? valves.
61° 7' - - 9°30' - -	440 -		12 spec. & 185 valves.
61° 9' - - 7°54' - -	181 -	, sand and shells.	4 & 2 —
61°10' - - 5°46' - -	160 -	, sand with stones and shells.	2 & 1 —
5 miles S. S. E. of Bispen	50 -		1
16 miles E. by S. of south point of Nolsö	ca. 80 -		2 & 9
12 miles S. S. E. of Akralejte	150 -		70 & 42 —
13 miles W. by S. of Munken	ca. 150 -		25 —

A. sulcata has thus been taken at various places round about and in part also at the Færoes at depths of (12) 20—440 fm. It reaches a length up to 29 mm.

Remarks. Compared with other *Astarte* species, *A. sulcata* is subject to comparatively little variation, so far as the present geographical region is concerned. The most important variation — so far as I can see — consists in a tendency of the number of ribs to increase somewhat in the western part of the geographical region of the species; in specimens from off the south-eastern Greenland the ribs are so dense, that their number — in specimens of 19—23 mm. in length — amounts to ca. 35—42, whilst the number in typical specimens, 21—23 mm. in length, from the Færoes is ca. 30—33.

The form may vary somewhat, as will be seen from the following measurements of some specimens, most different from one another in regard to the three dimensions:

Locality	Length	Height	Height / Length	Breadth	Breadth / Length
East Greenland	23 mm.	18.25 mm.	79.3 %	11.2 mm.	48.7 %
— —	20.25 -	15.5 -	76.5 -	9.5 -	46.9 -
— —	20.25 -	15.75 -	77.8 -	8.5 -	42 -
Iceland	24 -	19.75 -	82.3 -	12.75 -	53.1 -
—	23.5 -	21 -	89.4 -	12 -	51.1 -
Færoes	26 -	21.5 -	82.7 -	13.5 -	51.9 -
—	23.5 -	17.75 -	75.5 -	12.5 -	53.2 -
—	22 -	18.2 -	82.7 -	12 -	54.5 -

As a further illustration of the change of form in this species as a whole, I may give here the measurements of 3 specimens, which I have dredged along with many others N. E. of Shetland, at a depth of 150—220 fm.

Length	Height	Height / Length	Breadth	Breadth / Length
26 mm.	21.5 mm.	82.7 %	12 mm.	46.2 %
25 -	19.5 -	78 -	11.75 -	47 -
25 -	21.75 -	87 -	13 -	52 -

In illustration of the variability with regard to the number of concentric ribs, the following examples are represented on Pl. IV:

Fig. 3 a. A typical specimen from the Færoes,

Fig. 3 c. A specimen with comparatively closely-placed ribs, from East Greenland.

Distribution. On the European side *Astarte sulcata* is distributed from the western part of the Murman Coast (Knipowitsch) to the Mediterranean and west coast of North Africa; it goes down into the Kattegat. Over the Færoes it reaches to the southern and western coasts of Iceland and to Denmark Strait off the south-eastern Greenland. The bathymetric distribution is 5—ca. 1000 fm.

Astarte elliptica Brown.

Pl. IV, figs. 4 a—g.

?*Venus compressa* Linné, Mantissa Plantarum Altera, 1771, Regni Animalis App., p. 546. — *Crassina elliptica* Brown, Ill. Conchol. Great Britain and Ireland, 1827, Pl. 18, fig. 3; Ill. Rec. Conchol. Great Brit. and Ireland, 1844, p. 96, Pl. 38, fig. 3. — *Astarte compressa* Sars, Moll. Reg. Arct. Norv., 1878, p. 53[1]).

Astarte semisulcata Møller, Index Moll. Groenl., 1842, p. 19. — *Astarte compressa* Mörch, Rink's Grønland, 1857, p. 91; Vidensk. Medd. Naturh. Foren. 1867, p. 95; ibid. 1868, p. 222; Arctic Manual, 1875, p. 131; Rink's Dan. Greenland, 1877, p. 441; Posselt, Medd. om Grønland, XIX, 1895, p. 72, Pl. I, figs. 5—7 (var. *depressa* Poss.); ibid. XXIII, 1898, p. 66; Jensen, ibid., XXIX, 1909, p. 339.

The "Ingolf" has taken this species at:

St. 86.	W. of Iceland	76 fm.	12 valves of young (mostly quite young) specimens.
- 87.	- - —	110 -	5 valves of young specimens.
- 113.	S. of Jan Mayen	1309 -	2 valves.
- 104.	N. W. of Iceland..............	957 -	1 valve of a young specimen.

West Greenland.

Here the species occurs commonly from the southernmost parts up to Melville Bay, on mud, clay, shell and stone ground. The depths noted for living specimens lie between 10 and 235 fm.[2]). The maximum length amounts to 36 mm.

East Greenland.

A. elliptica has been taken by Danish Expeditions at Angmagssalik, Cape Dalton, in Scoresby Sound and Forsblads Fjord, (3) 10—30 (50) fm., on mud, clay and stony ground, as also by the Germania Expedition at northern East Greenland (Möbius, as *A. sulcata*). The maximum length amounts to 30 mm.

[Jan Mayen.]

Here, curiously enough, the species has not been met with. Posselt (l. c. 1898, p. 67) records it from Jan Mayen and Copenhagen Museum as the authority or source, but this is due to some mistake, as our Museum possesses no specimen of *A. elliptica* from this island.

[1]) For the remaining synonyms cf. Kobelt: Prodr. Moll. Test. Mar. Europ. 1888, p. 392.

[2]) A living, adult specimen from this considerable depth has been taken at 66°49′ N. L., 56°28′ W. L.

Iceland.

Here *Astarte elliptica* is common round the island; it occurs both on sand, ooze, mud and mixed bottom-soil; living it is taken at depths of 5—60 fm., once of 100 fm. The maximum length is 38.5 mm.

The various localities are as follows:

East Iceland:

Berufjördr, Djupivogr	6—9 fm., mud with black sand.	25 spec.	
— mouth	54—41 - , ooze.	13	
Faskrudsfjördr	50—20 - , blue clay.	1 —	& 1 valve.
64°58′ N. L., 13°25′ W. L.	40 -	1 —	& 44 valves.
Eskifjördr	0—12 -	2 —	
Vidfjördr	15 -	17 —	
Nordfjördr	22 -	4 —	
—	40 -	8 —	& 6 valves.
Seydisfjördr	9—5 -	1 —	
— , mouth	38—14 - , mud.	24 —	
— , mouth	ca. 40 - , stomachs of haddock.	1 valve.	
—	50—20 - , blue clay.	2 spec.	
65°42′ N. L., 13°57′ W. L.	60 -	1 —	
Bakkafjördr	28—20 - , sand mixed with clay.	4 —	and 2 valves.
—	32—25 - , sand mixed with clay.	22 —	and 30 valves.
—	52—43 - , sand mixed with clay.	7 —	and 5 valves.

The largest specimen is 38 mm. long.

North Iceland:

Thistilfjördr	10—24 fm., sand and "coral".	2 spec.
—	50 - , clay with many stones.	30 valves.
Axafjördr	22 - , mud.	14 spec.
Skjálfandi Bugt	21 - , black sand.	5 —
— —	31 - , fine sand.	19
4 miles E. of Brik Skær	100 -	1
Husavik in E. 4 miles	42 -	4 —
66°17′ N. L., 18°13′ W. L.	52 -	1 valve.
Ofjord		40 spec.
— just S. of Hrisey	18 - , clay.	5 —
Veidileysa	21—25 -	7

The largest of these specimens are 35 mm. long.

West Iceland:

Hesteyrarfjördr, at the head	15—17½ fm.		1 spec. & 30 valves.
Önundarfjördr	9 -		21 —
Dyrafjördr, inside Thingnæs	10—12½ -	, mud and small stones.	2 — & 40 valves.
—	13 -		2 —
Fossfjördr	44 -		1 —
Talknafjördr			42 —
N. W. of Talkni			2 — & 2 valves.
Patreksfjördr	5 -		5 —
—	14 -		1 —
Grundarfjördr			1 —
Hvalfjördr	24 -		50 — & 70 valves.
Faxafjördr	15 -		5 —
—	25 -		1 valve.
— , mouth of Kollafjördr	9½—11 -	, fine black sand and ooze.	1 spec. and 30 valves.
— , off Kollafjördr	8—11½ -	, ooze and stones.	11 valves.
— — —	10 -		1 spec. & 10 valves.
— , Keflavik	15—16 -	, fine black sand.	3 — and 80 valves.
— , ca. 2 miles N. E. of Keflavik	19½—20½ -	, ooze.	21 valves.
— , 1 mile E. N. E. of Helgasker Vager	11½ -		7 spec.
— , 4.3 miles W. ¾ S. of Helgasker Vager	25 -		40 valves.
Reykjavik (Engey)	7—8½ -		5 —
— , roads	8 -		1 spec.
Hafnarfjördr	25 -	, fine black sand and ooze.	1 — and 14 valves.

The largest of these numerous specimens is 38.5 mm.

South Iceland:

Vestmannaeyjar	30 fm.	, shell-gravel.	2 valves.
—	49 -	, gray, fatty clay.	4 spec. & 4 valves.

The largest specimen is 27 mm. long.

Færoes.

Here *A. elliptica* seems to be common at depths of 3—50 fm. The maximum length is 37 mm.

The separate localities at which the species has been taken are as follows:

Viderejde	10 fm.	4 valves.
Kvannesund, between Viderö and Bordö	4—6 -	1 spec.

Klaksvig	6—10 fm.		1 spec.
—	10—15 -		40 — & many valves.
—	11 -	, from Laminaria rhizoids.	18 —
Arnefjord	0—15 -	, hard ground.	1
Bordövig	7—10 -	, black sand and small stones.	1 valve.
—	10 -	, sand with Laminaria.	4 spec.
Andefjord	16—23 -		4 —
Kongshavn	12—16 -	, small stones, sand and ooze.	2 —
—	ca. 50 -		ca. 25 spec. & 90 valves.
Vestmanhavn	$3^1/_2$—5 -	, fine black sand.	80 spec.
—	5—6 -	, fine black sand.	6 — & 40 valves.
—	10 -		1 —
—	10—30 -		3 valves.
Sörvaag	14—$16^1/_2$ -	, ooze.	1 spec. & 2 valves.
Nolsö, beach			1 valve.
Trangisvaag	$1^1/_4$—3 -		1 spec. & 2 valves.
—	6—8 -		1 valve.
Vaagfjord	barely 1 -		1 spec.
—	10 -		1 —
S. W. of Myggenæs	135 -		1 valve[1].
$1^1/_2$—2 miles off the mouth of Bordövig	20—30 -		1 spec. & 1 valve.

Remarks. The material to hand from the Færoes, Iceland and Greenland shows, that both the form and sculpture vary to a great degree in *Astarte elliptica*.

At the Færoes, however, the character is fairly uniform, it seems. The species appears here with strongly marked folds right from the umbones down to the ventral margin and they only disappear at the very back. It is only in a single specimen that the folds become indistinct a little below the middle of the shell. The form is not specially variable, on the whole rather elongated, more or less compressed, sometimes however somewhat vaulted. Measurements of some of the specimens which differ in dimensions give the following result:

Length	Height	$\frac{\text{Height}}{\text{Length}}$	Breadth	$\frac{\text{Breadth}}{\text{Height}}$
30 mm.	23 mm.	76.8 %	11 mm.	36.7 %.
31 -	23.5 -	75.8 -	12.5 -	40.3 -
31.25 -	22.5 -	72 -	14 -	44.8 -

At Iceland, on the other hand, we very frequently find forms which lack the folds over a greater or smaller part of the shell; sometimes the folds disappear below the middle of the shell, in other specimens they only reach to the middle of the shell, and some specimens even have folds only

[1]) The shell from this considerable depth has a very ancient ("fossil") appearance.

on the umbonal area. Such specimens may have great resemblance and are certainly often confused with the more or less folded varieties of *Astarte borealis* Chemn. ("*A. semisulcata* Leach" etc.)[1]; the large ligament projecting over the shell of the last-named as also the more or less fibrous or frayed structure of the periostracum makes the separation in general quite easy. — The form also appears to be very variable, both in relative height and breadth, as will be seen from the following measurements.

Locality	Length	Height	Height / Length	Breadth	Breadth / Length
Seydisfjördr	32.25 mm.	23.25 mm.	72.1 %	9.5 mm.	29.5 %
—	31.25 -	21.75 -	69.6 -	12 -	38.3 -
Nordfjördr	32.5 -	23.25 -	71.5 -	11.75 -	36.2 -
Dyrafjördr	31 -	23 -	74.2 -	14 -	45.2 -
Talknafjördr	32 -	25.5 -	79.7 -	14 -	43.8 -

At West Greenland *A. elliptica* is subject to similar variations as at Iceland. In regard to form there are specimens which are even higher and more vaulted than those which go to an extreme in this direction at Iceland, so that we find such dimensions as the following:

Length	Height	Height / Length	Breadth	Breadth / Length
31.25 mm.	26.25 mm.	84 %	15.2 mm.	48.6 %
27.25 -	23.25 -	85 -	14.2 -	52.1 -

It has obviously been such specimens as these, which have led Leche to set up the variety *crassa*[2].

At East Greenland *A. elliptica* usually appears with folds right down to the ventral margin; not rarely, however, they cease about the middle of the shell. — With regard to the form, this is remarkable on the whole for its elongation, as will be seen from the measurements below; Posselt for this reason set up a special variety *depressa* (for specimens from Hekla Havn[3]).

Locality	Length	Height	Height / Length	Breadth	Breadth / Length
Cape Dalton	29.5 mm.	21.5 mm.	72.9 %	12.5 mm.	42.4 %
— —	29.5 -	21.5 -	72.9 -	11.5 -	39 -
Hurry Inlet	27 -	20 -	74.1 -	9.5 -	35.2 -
Hekla Havn	23.5 -	16 -	68.1 -	8 -	34 -
— —	22.5 -	16.5 -	73.3 -	7.75 -	34.4 -

The following figures on Pl. IV may serve as illustration of the varying form and sculpture in *Astarte elliptica*, mentioned in the foregoing:

Fig. 4 a and b represent a typical *A. elliptica* (from the Færoes), seen from the side and from above.

[1]) For example, both Mörch and Posselt have made mistakes in this direction.

[2]) Leche: Öfversigt öfver de af svenska expeditionerna till Nowaja Semlja och Jenissej 1875 och 1876 insamlade hafs-mollusker, p. 19, Pl. I, figs. 3 a—b. Kongl. Sv. Vet. Akad. Handl., Bd. 16, No. 2, 1878.

[3]) L. c. 1895, p. 72, Pl. I, figs. 5—7.

Figs. 4 c and d represent a very elongated form (var. *depressa* Posselt), from East Greenland.

Figs. 4 e and f show a very high (and ventricose) form (var. *crassa* Leche), from West Greenland.

Fig. 4 g shows a specimen in which the folds disappear almost about the middle of the shell. From West Greenland.

Distribution. *Astarte elliptica* is an arctic-boreal species, known from the east coast of North America down to New England, from Greenland, Iceland, the Færoes, British Isles, Danish waters down to Bornholm, Norway, north coast of Russia, Kara Sea and Spitzbergen. The bathymetric distribution is 3—235 fm.

Astarte crenata Gray.

Pl. IV, figs. 5 a—m.

Nicania crenata Gray, Parry's first voyage, Suppl. to Append., 1824, p. 242.

Astarte crebricostata Mörch, Rink's Grønland, 1857, p. 91; Vidensk. Medd. Naturh. Foren. 1868, p. 222; Arctic Manual, 1875, p. 131; Rink's Dan. Greenland, 1877, p. 441. — *Astarte crenata* Posselt, Medd. om Grønland, XIX, 1895, p. 71; ibid., XXIII, 1898, p. 64; Jensen, ibid., XXIX, 1909, p. 337.

The "Ingolf" has taken this species at various stations and in three varieties, namely:

forma *typica*

St. 29.	Davis Strait	68 fm.	0.2° C.	1 spec.

var. *subæquilatera* Sowb.

St. 32.	Davis Strait	318 fm.	3.9° C.	Numerous spec.
- 31.	— —	88 -	1.6° -	3 spec.
- 35.	— —	362 -	3.6° -	Numerous spec.
- 28.	— —	420 -	3.5° -	— —
- 27.	— —	393 -	3.8° -	— —
- 115.	Jan Mayen	86 -	0.1° -	6 spec. and a number of connected or separated valves.

var. *acuticostata* Jeffr.

St. 116.	S. of Jan Mayen	371 fm.	÷ 0.4° C.	Numerous spec.
- 15.	N. W. of Iceland	330 -	÷ 0.75° -	1 spec.
- 124.	N. of Iceland	495 -	0.6° -	Numerous spec.
- 126.	- - —	293 -	0.5° -	1 valve.
- 128.	- - —	194 -	0.6° -	4 spec.
- 106.	E. of Iceland	447 -	÷ 0.6° -	5
- 3.	Between Færoes and Iceland	272 -	0.5° -	3 spec. & 4 valves.

and also at the following station, where the variety cannot be determined:

St. 127.	N. of Iceland	44 fm.	5.6° C.	1 spec. & 1 valve (both small).

Astarte crenata is an extremely variable species and has given rise to not a few "species"; these I can only recognize as nominal, as my material contains transitions between them. The specimens living in the waters of Iceland, Jan Mayen and Greenland must, therefore, in my opinion, be arranged under the following varieties: forma *typica*, var. *subæquilatera* Sowb., var. *crebricostata* Mc. Andr. & Forb., var. *inflata* Hägg and var. *acuticostata* Jeffr.

Forma *typica*.

Pl. IV, figs. 5 a, b and c.

Astarte crenata Reeve, Conchol. Icon. XIX, 1874, *Astarte*, sp. 9, Pl. 2, fig. 9. — *Astarte oblonga* Sowerby, Thes. Conchyl. II, 1855, p. 781, Pl. 167, fig. 19. — *Astarte crenata* Gray f. *typica* Jensen, Medd. om Grønland, XXIX, 1909, p. 337.

The shell oval, more or less convex, with numerous (ca. 50), relatively low, concentric ribs, which disappear on the posterior part of the shell; periostracum light-coloured, yellowish.

In its typical shape (Pl. IV, figs. 5 a and b) it is quite characteristic, but this again is subject to great changes[1]). The ribs may be fewer and more prominent (Pl. IV, fig. 5 c), so that the boundary towards var. *subæquilatera* vanishes. All three dimensions are subject to considerable variations, as will be seen from the accompanying measurements:

Locality	Length	Height	Height / Length	Breadth	Breadth / Length
Hurry Inlet	23 mm.	17.5 mm.	76.1 %	10.5 mm.	45.7 %
Cape Hope	23.5 -	17.5 -	74.5 -	11.25 -	47.9 -
S. E. of Sabine Island	23.5 -	18.2 -	77.4 -	12.5 -	53.2 -
- —	26.5 -	21.5 -	81.1 -	12 -	45.3 -

This form occurs at East Greenland, where the Danish Expeditions[2]) have taken it at the following places:

Hurry Inlet..........................	50 fm., clay with stones.	Numerous spec.
Cape Hope	121 - — — —	3 spec.
Cape Tobin	120 -	1 spec.
72°24′ N. L., 19°42′ W. L..............	130 -	1 living & 2 empty spec.
72°51′ - - 20°23½′ W. L................	124 - , clay.	1 spec. (empty).
72°53′ - - 20°36′ W. L..................	96 -	6 —
73°24′ - - 20° - -	106 -	2 —
S. E. of Sabine Island	110 - , fine clay with stones and gravel.	10 spec. & some valves.

and the Swedish Expedition of 1900 at the following places:

72°25′ N. L., 17°56′ W. L.	ca. 160 fm., stones and sand.	5 spec.

[1] For some very short and convex specimens Hägg has set up the variety *incostata* (Ark. f. Zoologi, Bd. 2, Nr. 2, 1904, p. 37, Pl. 1, figs. 11–12); a similar form, likewise with weakly developed and very densely placed ribs, is in our Museum from Umanak in West Greenland (cf. the following).

[2]) *A. crenata* has for the rest been taken at East Greenland (Shannon Isl., 30 fm.) already in 1869–70 by "Die zweite Deutsche Nordpolarfahrt" (cf. Wissenschaftl. Ergebnisse, II, 1874, p. 252 under the name of *Astarte crebricostata*).

74°35′ N. L., 18°15′ W. L.	79 fm., mud and stones.	2 spec.
Off Mackenzie Bay	58 - , mud.	10 —

and the Belgica Expedition at the following places [1]):

75°58.5′ N. L., 14°08′ W. L.	158 fm., bottom-temp. 0.4 C.	4 spec.
77°35.5′ - - 18°12′ - -	28 - , — — ÷ 1.79 -	16 —

Thus, at East Greenland the typical *A. crenata* has been taken at 13 localities from 70°36′ N. L. — 77°35′.5 N. L., and at depths of 50—160 fm. The largest specimens are 28 mm.

From West Greenland I have only seen it from the above-mentioned St. 29 of the "Ingolf" and from Umanak, 250 fm., but I imagine that quite a number of the specimens, which Posselt records in Consp. Faun. Groenl. simply as "*Astarte crenata*", belong to the typical form. The specimens to hand from Umanak are remarkably short and on the whole much convex, as will be seen from the measurements below:

Length	Height	Height / Length	Breadth	Breadth / Length
21.5 mm.	16.3 mm.	75.8 °/o	11.6 mm.	54 °/o
18.75 -	15.5 -	82.7 -	10.2 -	54.4 -
18 -	14.2 -	78.9 -	10.2 -	56.9 -
17.5 -	14 -	80 -	9 -	51.4 -
17 -	14 -	82.4 -	10.2 -	60 -

Var. *subæquilatera* Sowerby.

Pl. IV, figs. 5 d and e.

Astarte subæquilatera Sowerby, Thes. Conchyl. II, 1855, p. 780, Pl. 167, fig. 13; Reeve, Conchol. Icon. XIX, 1874, sp. 5, Pl. I, fig. 5.

This resembles the typical *crenata* in the oval form of the shell, but the concentric ribs are fewer in number and coarser; the periostracum on the whole darker, yellowish-brown, olive-coloured or brown.

The form is besides subject to great variation, as will appear clearly from the measurements below; it varies from the elongated-oval or elliptical to the orbicular, somewhat triangular:

Locality	Length	Height	Height / Length	Breadth	Breadth / Length
Ingolf St. 27	27 mm.	21.5 mm.	79.6 °/o	13.5 mm.	50 °/o
— - -	26.5 -	19.5 -	73.6 -	11.5 -	43.4 -
— - 32	24.5 -	18.25 -	74.5 -	10.75 -	43.9 -
Julianehaab	24.5 -	21.5 -	87.8 -	14.3 -	58.4 -
Jan Mayen	30 -	22 -	73.3 -	14 -	46.7 -
— —	27.75 -	21.75 -	78.4 -	14.5 -	52.3 -

[1]) Grieg, in Duc d'Orléans Croisière océanographique, 1909, p. 534.

The ribbing may also be subject to some variation, in regard to denseness and strength.

This variety is common at West Greenland; apart from the "Ingolf" stations mentioned before I have seen specimens from the following localities:

Julianehaab.		
Mouth of Ameralik Fjord (as a short, convex, rather densely ribbed form).		
66°49' N. L., 56°28' W. L.	235 fm., sand and ooze.	4.4° C.
Disko Bay	65 -	

Quite a number of the localities which Posselt notes from West Greenland under *Astarte crenata* Gray (Medd. om Grønland, XXIII, 1898, p. 64), also refer probably to the variety *subæquilatera*. — The largest specimens are 30 mm. long.

At Jan Mayen, in addition to at the "Ingolf" St. 115, it has been taken by the Danish Expedition of 1900 at a depth of 55 fm., on ooze mixed with coarser material. The Austrian Polar Station took it on the north side of the island, at a depth of 75—95 fm. (Becher l. c. p. 70). The maximum length is 30 mm.

From Denmark Strait there is a single valve from 64°42' N. L., 27°40' W. L., 426 fm. (W. of Iceland).

Var. *crebricostata* Mc. Andr. & Forbes.

Pl. IV, figs. 5 f and g.

Astarte crebricostata Mc. Andr. & Forbes, Ann. Mag. Nat. Hist. XIX, 1847, p. 98, Pl. 9, fig. 4; Forbes & Hanley, Brit. Moll. I, 1853, p. 456, Pl. 30, fig. 9; Sowerby, Thes. Conchyl. II, 1855, p. 780, Pl. 167, fig. 10; Reeve, Conchol. Icon. XIX, 1874, *Astarte*, sp. 10, Pl. 2, fig. 10; Sars, Moll. Reg. Arct. Norv., 1878, p. 54, Pl. 5, fig. 7.

In this variety the ribbing is very like that in the foregoing, but the shell is in general more triangular or oval-cordiform and has the umbones moved more in front. It is however very close to the var. *subæquilatera* and cannot always be kept separate from this.

It occurs at North and East Iceland, whence we have it from the following localities:

Skagestrands Bugt	119 fm.		5 spec.
66°17' N. L., 18°13' W. L.	52 -		1 —
Husavik in E. by S.	47—58 -		1 —
Thistil Fjördr	50 -	, clay with many stones.	4 — & 85 valves.
66°32' N. L., 15°15 W. L.	75 -		3 valves.
Bakkafjördr	52—43 -	, clay mixed with sand.	1 spec.
Seydisfjördr	50—20 -		1 —
—	38—14 -	, mud.	

The largest specimen is 31 mm. long.

Var. *inflata* Hägg.

Pl. IV, figs. 5 h and i.

Astarte crenata Gray var. *inflata* Hägg, Arkiv för Zoologi, Bd. 2, Nr. 2, 1904, p. 37, Pl. I, figs. 4—6; Jensen, Medd. om Grønland, XXIX, 1909, p. 338.

The shell is ventricose, approximating to the obliquely square, with the upper and lower margins almost parallel, the anterior end short, rounded, the posterior end truncate; the concentric ribs in general rather numerous and strong, sometimes however less prominent or even vanishing on a larger or smaller part of the shell (very rarely even quite wanting, so that the shell only shows a fine striation). Periostracum yellow or brownish-yellow.

It is a small form; I have not seen any specimen larger than 19 mm.

Some measurements will show its limits of variation, from the oblong-trapeziform to almost quadratic, as also the more or less ventricose.

Length	Height	Height/Length	Breadth	Breadth/Length
19 mm.	14.5 mm.	76.3 %	10 mm.	52.6 %
16.5 -	11.75 -	71.2 -	9.2 -	55.8 -
15.25 -	12 -	78.7 -	8.5 -	55.7 -
15 -	11 -	73.3 -	7.3 -	48.7 -

The number of ribs may rise to ca. 40 and fall to ca. 24 or even fewer, as the umbonal region is frequently without folds; quite smooth specimens, as mentioned, may also occur. In small specimens the ribs are frequently sharp, almost as in the following variety.

This variety has been taken at the following places at East Greenland by Danish Expeditions:

Forsblads Fjord	ca. 50 fm., clay with stones.	5 spec.
— —	90—50 - , clay with stones.	Numerous spec.
74°17′ N. L., 15°20′ W. L.................	127 - , clay with stones.	2 spec.

and by the Swedish Expedition of 1900 at:

72°25′ N. L., 17°56 W. L.	ca. 160 fm., stones and sand.	7 spec.
Mouth of Franz Josefs Fjord	106—158½ - , mud.	1

and S. of Jan Mayen by the Danish Expedition of 1891 at:

70°21 N. L., 8°25′ W. L.	160 fm., clay.	2 spec. (empty).

I presume that it was this variety, of which the Austrian Station took 3 specimens on the north side of Jan Mayen, at a depth of 75—95 fm.; E. Becher determined them as *Astarte sulcata* d. C. (Österr. Polarst. Jan Mayen, III, 1886, p. 71), but the latter is a warm-water form and the present variety has some resemblance to it.

Var. *acuticostata* Jeffreys.

Pl. IV, figs. 5 k, l and m.

Astarte acuticostata Jeffreys M.S., Friele, Nyt Mag. f. Naturvidensk. 23 Bd., 1877, 3 Hft., p. 1; ibid. 24 Bd., 1879, p. 223; Jahrb. Deutsch. Malacozool. Gesellsch. 6 Bd., 1879, p. 267, Pl. 4, fig. 8;

Jeffreys, Proc. Zool. Soc. 1881, p. 711, Pl. 61, fig. 9; Posselt, Medd. om Gronland, XIX, 1895, p. 70; Friele & Grieg, Norw. North-Atl. Exped., Zoology, Moll. III, 1901, p. 25; Friele, Bergens Museums Aarbog, 1902, No. 3, p. 4. — *Astarte crenata* Gray var. *acuticostata* Jensen, Medd. om Gronland, XXIX, 1909, p. 338; Grieg, in Duc d'Orléans, Croisière océanographique, 1909, p. 534.

The form almost as in the foregoing variety, forming a shorter or longer, oblique quadrangle (sometimes a rhomb), more or less convex; the concentric ribs numerous (ca. 25—40), strong and more or less sharp, in part lamellar and imbricate. Periostracum yellow. Maximum length 13 mm.

In its typical development, with lamella-like, somewhat imbricate folds it is a very characteristic form, which might well be taken as a "good" species, but there are transitions, which with their more rounded ribs connect it with the preceding variety and through this with the more divergent forms of the species *crenata* Gray. I can thus agree with the view put forward by Friele in the year 1879 (l. c.), that *Astarte acuticostata* Jeffreys is only a pygmy form of *A. crenata* Gray[1]; it comes very near especially to the var. *inflata* and may be regarded as a form derived from this and connected with deeper water. I have therefore taken the advanced step of including the present form as a variety under *A. crenata*, whereas Friele, the last time he has mentioned it (l. c. 1902), still retains the distinct specific name *A. acuticostata*.

For the rest, it is also rather variable however in regard to form. The anterior end, for example, may sometimes be very short, sloping abruptly downwards, sometimes more projecting; the posterior end is frequently high as if slightly expanded, but at other times the greatest height lies further forward. Some measurements will illustrate the variation in the proportions:

	Length	Height	Height / Length	Breadth	Breadth / Length
Ingolf St. 116	13 mm.	11 mm.	84.6 %	7.5 mm.	57.7 %
- —	12.3 -	10 -	81.3 -	7 -	56.9 -
— - 106	12 -	10 -	83.3 -	6.3 -	52.5 -

In addition to from the "Ingolf" stations mentioned above, it is also present from East Greenland, from:

N. of Stewart Island	158 fm., clay with stones.	2 spec.
Fleming Inlet	118 - , clay.	1 —

At East Greenland it has also been taken by the "Belgica" at:

75°58.5′ N. L., 14°08′ W. L.	158 fm., bottom-temp. 0.40° C.	1 spec.

Further, we have it from:

70°32′ N. L., 8°10′ W. L. (S. of Jan Mayen)	470 fm.	1 spec.
63°03′ N. L., 9°28′ W. L. (N. W. of Færoes).	275 - , botm.-temp. 0.97 C.	1 spec. & 1 valve.

[1] Against this we have seemingly Friele and Jeffreys' statement, that the inner margin in *A. acuticostata* is smooth, but in my material I have found specimens with crenulated margin.

62°35′ N. L., 4° 4′ W. L. (E. of the Færoes)
335–345 fm., clay, botm.-temp. 0.90 C. 2 spec. & 1 valve
62°40′ - - 1°56′ E. L. (between the Færoes and Norway) .... 360 - , botm.-temp. — 0.3 C. 3 spec.

The Norwegian North Atlantic Expedition took it off Spitzbergen, Jan Mayen, East Iceland and northern and western Norway, at depths of 223–649 fm. and temperatures of as a rule below 0° C. (down to —1.3° C.), more rarely a little above 0° C. (to 1.5° C.). The Expeditions "Lightning" and "Porcupine" took it in the Færoe Channel, at depths of 345–550 fm. and temperatures of ca. 0° C.

We may say regarding the variety *acuticostata* Jeffr., consequently, that it is mainly bound to the "cold area", but that it may also occur on the boundary region to the cold area [1].

Distribution. *Astarte crenata* Gray is an arctic species, which is known from the north and east coast of America down to Maine, Greenland, Jan Mayen, North and East Iceland, Norway down to the Lofotens, Murman Sea, Barents Sea, Spitzbergen, Kara Sea and Polar Sea of Sibiria. The bathymetric distribution is 5–650 fm.

[1] Jeffreys (l. c.) records *Astarte acuticostata* from the Osterfjord at Bergen, but I think this statement incorrect; Friele and Grieg also say (l. c.), that they have not observed it there, although they have dredged a good deal at the place. — Jeffreys gives Leche as his authority for its occurrence at Nova Zembla, but I have not been able to find, where Leche mentions it.

Corrigenda.

P. 32, l. 17 from bottom, for "410–05 fm." r. "410–705 fm."

Plate I.

Plate I.

Fig. 1 *Anomia patelliformis* L.

a. The upper valve, showing the position of umbo. $\times 1^1/_2$. The Færoes.

b. The lower valve, showing the size and form of the notch. $\times 1$. South Iceland, ca. 20 fm.

c. The upper valve from the inside, showing the two muscular impressions (one of the adductor, one of the byssus muscle). $\times 1$. The Færoes.

— 2. *Anomia squamula* L.

a. The upper valve, showing the position of the umbo. $\times 1^1/_2$. West Iceland (Dyrafjördr).

b. The lower valve of the same specimen, showing the size and form of the notch. $\times 1^1/_2$.

c. The upper valve from the inside, showing the two muscular impressions (one of the adductor, one of the byssus muscle). $\times 1^1/_2$. South Iceland, 58 fm.

d. Var. *aculeata* Müller. The upper valve showing the spinous surface. $\times 1^1/_2$. West Iceland, $19^1/_2$ fm.

— 3. *Anomia ephippium* L.

The upper valve from the inside, showing the three muscular impressions (one of the adductor, two of the byssus musculature). $\times 1$. The Mediterranean.

— 4. *Pecten islandicus* Müller.

a. A part of the shell, to show the rasp-like structure, characteristic of the species. $\times 7$. Of a specimen from East Iceland, 35—55 fm.

b. The rasp-like structure disappears on the lower part of the shell, where the radiating ribs lie very close and are covered with scales. $\times 10$. Of a specimen from West Iceland, 4—7 fm.

c & d. A very small specimen to show that its sculpture is quite different from that of the older. $\times 11$. East Iceland, 52—43 fm.

— 5. *Pecten aratus* Gmelin.

a & b. A specimen with well marked, primary ribs. $\times 1$. S. W. of Iceland, 295 fm. (Ingolf St. 9).

c & d. A specimen with the radiating ribs more equally developed. $\times 1$. S. of Iceland, 268 fm.

e. A part of the shell figured in 5 d; the radiating ribs are rough from small, down-turned scales (almost as in *P. islandicus*, comp. fig. 4 b, but it lacks the intercostal rasp-like structure of the latter). $\times 12$.

— 6. *Pecten septemradiatus* Müller.

a & b. A specimen with relatively many folds and provided with small spines, especially on the left valve (var. n. *scaber*). $\times 1$. S. W. of Iceland, 295 fm. (Ingolf St. 9).

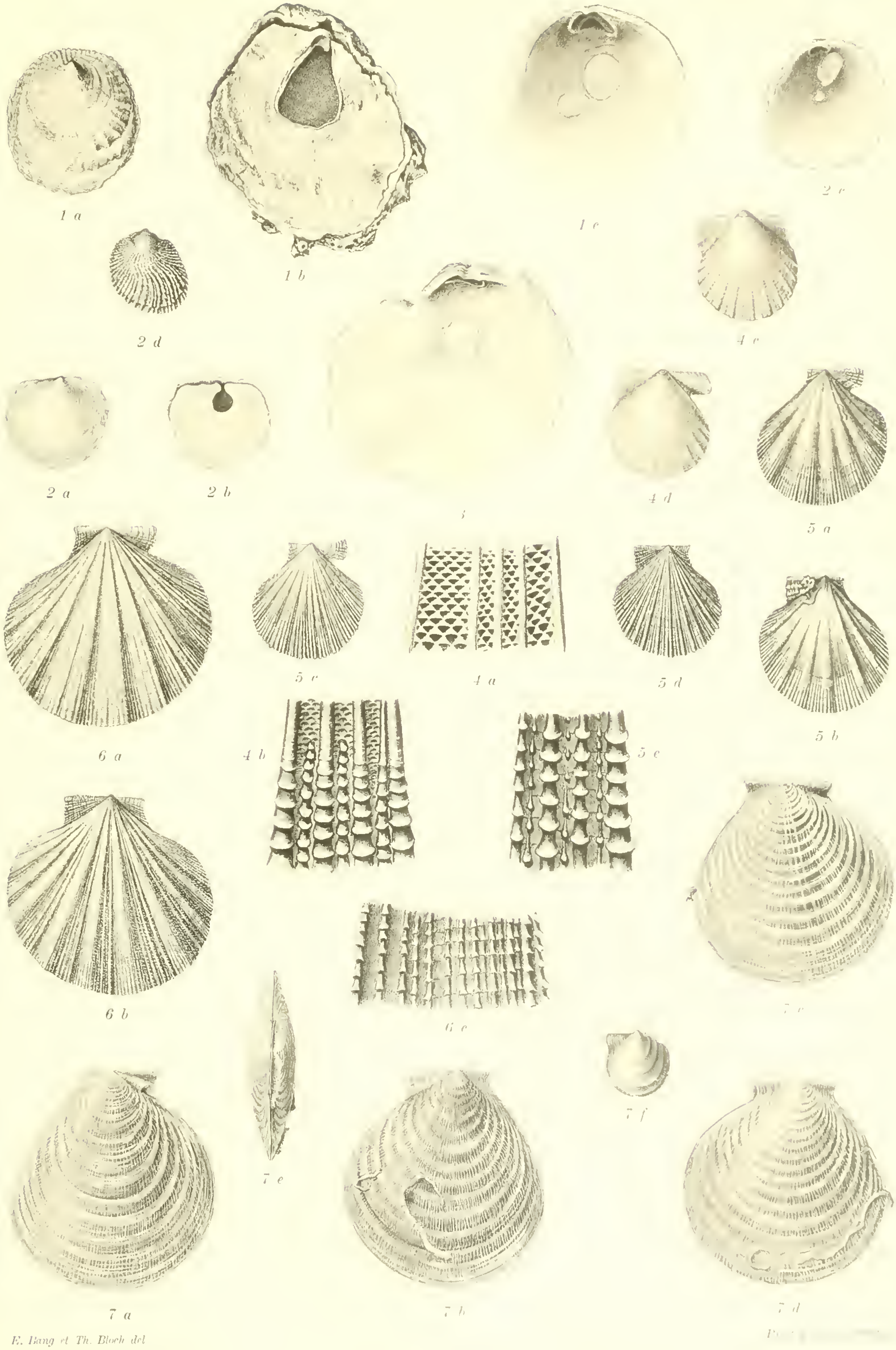
c. A part of the left valve to show that the radiating striæ are densely beset with sharp scales. $\times 9$.

— 7. *Pecten frigidus* Jensen.

a, b & e. A specimen from the Norwegian Sea, 1010 fm. (Ingolf St. 119). $\times 1^1/_2$.

c & d. A specimen from the Norwegian Sea, 1060 fm. (Ingolf St. 118). $\times 1^1/_2$.

f. A very young specimen from the Ingolf St. 119. $\times 7$.



E. Bang et Th. Bloch del

Plate II.

Plate II.

Fig. 1. *Pecten imbrifer* Lovén var. *major* Leche, the left valve.
a. A specimen with few, distant rows of very small outgrowths. $\times 1^1/_2$. East Greenland (Forsblads Fjord), 50—90 fm.
b. A specimen with many rows of outgrowths. $\times 1^1/_2$. East Greenland (Forsblads Fjord), 50—90 fm.
c. A specimen with larger and fewer, rather vaulted outgrowths. $\times 1^1/_2$. East Greenland (Forsblads Fjord), 50—90 fm.
d. Almost all the vesicular outgrowths are broken off. $\times 1^1/_2$. S. of Jan Mayen, 86 fm.
e. The vesicles are so broad and flat, that they almost meet one another. $\times 1^1/_2$. East Greenland (Forsblads Fjord), 50—90 fm.
f. The vesicles are fused together to concentric wrinkles, which are in general broken, so that only remnants of them remain as sharp combs (var. *lamellosa* Posselt). $\times 2$. West Greenland (72°4′ N. L. 59°50′ W. L.), 227 fm. After Posselt.
g. A part of the shell showing the pored outgrowths or vesicles. $\times 12$.
h. A single pored vesicle, more magnified.
i. A part of a shell, near the umbo, where the vesicles are rubbed off, so that the lines of growth appear like cogs on a cog-wheel. $\times 5$.

— 2. *Pecten imbrifer* Lovén var. n. *minor*, the left valve.
a. A shell in which the very small outgrowths mainly appear only towards the margin. $\times 2$. S. W. of Iceland, 485 fm. (Ingolf St. 81).
b. A specimen almost quite smooth. $\times 2^1/_2$. S. of Iceland, 500 fm.

— 3. *Amussium lucidum* Jeffreys.
a. A right valve from the outer side. $\times 2$. Denmark Strait, 788 fm. (Ingolf St. 10).
b. A left valve from the outer side. $\times 2$. The same locality.
c. The same valve as in fig. a, but seen from the inner side. $\times 2$.

— 4. *Lima gwyni* Sykes.
a & b. A specimen from Norway (Bergen). $\times 1^1/_2$.
c. A part of the shell showing the serrate radiating ribs. $\times 30$.

— 5. *Lima hyperborea* Jensen.
a & b. A specimen from East Greenland (Forsblads Fjord). 90—50 fm. $\times 1^1/_2$.
c & d. The same specimen seen from in front and from above. $\times 1^1/_2$.
e. A part of the shell showing the sharp radiating ribs. $\times 18$.

— 6. *Lima subauriculata* Montagu.
a & b. A specimen from West Greenland (Ritenbenk). $\times 3$.
c. A part of the shell showing the radiating ribs. $\times 20$.

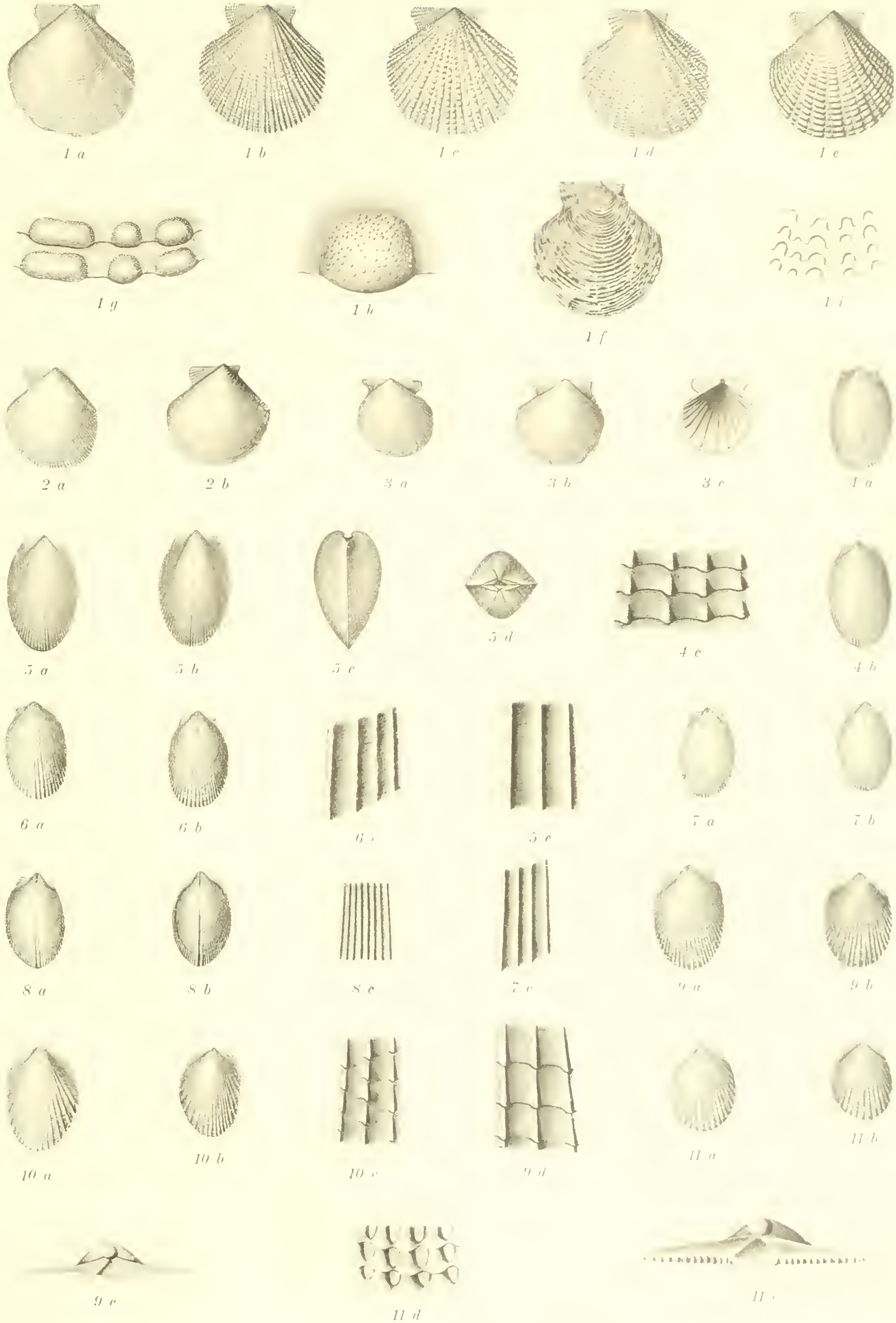
— 7. *Lima similis* n. sp.
a & b. A specimen from the Bay of Biscay, 250—790 fm. ("Thor", 1906), $\times 3$.
c. A part of the shell showing the radiating ribs. $\times 20$.

— 8. *Lima subovata* Jeffreys.
a & b. A specimen from Davis Strait, 1435 fm. (Ingolf St. 36). $\times 4$.
c. A part of the shell showing the numerous radiating ribs. $\times 20$.

— 9. *Lima ingolfiana* n. sp.
a. A right valve from W. of Iceland, 568 fm. (Ingolf St. 90). $\times 4$.
b. A left valve from S. W. of Iceland, 799 fm. (Ingolf St. 78). $\times 4$.
c. The dorsal margin of the shell seen from the inner side. $\times$ ca. 18.
d. A part of the shell showing its finely scaled or spined radiating ribs. $\times 30$.

— 10. *Lima jeffreysi* Fischer.
a. A left valve from S. of Iceland, 500 fm. ("Thor", 1903). $\times 2$.
b. A right valve from S. of Iceland, 293 fm. ("Thor", 1903). $\times 2$.
c. A part of the shell showing its squamular, radiating ribs. $\times 12$.

— 11. *Lima sarsii* Lovén.
a & b. A right and a left valve, from Norway (Bergen). $\times 5$ & 4.
c. The upper part of the shell seen from the inner side, to show the crenulated cardinal margin. $\times 30$.
d. A part of the shell showing its densely and coarsely scaled surface. $\times 30$.


1 a
1 b
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3 a
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3 c
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5 c
5 d
4 c
4 b
6 a
6 b
6 c
5 e
7 a
7 b
8 a
8 b
8 c
7 c
9 a
9 b
10 a
10 b
10 c
9 d
11 a
11 b
9 e
11 d
11 c

E. Bang del.

Plate III.

Plate III.

Fig. 1. *Modiola modiolus* L., young.
a. A left valve from the inner side. × $^3/_1$. Iceland.
b. The anterior end of the same valve. × 7.

— 2. *Modiola phaseolina* Philippi.
a. A left valve from the inner side. × 1. Iceland.
b. The anterior end of the same valve. × 8.

— 3. *Idas argenteus* Jeffreys.
a. A left valve from the outer side. × $6^1/_2$. S. of Iceland, 975 fm. (Ingolf St. 67).
b. A left valve from the outer side, without the hairy periostracum. × 12.
c. A specimen from the upper side. × 12.
d. Hinge of right valve. × 10.
e. Hinge of the same. × 20.

— 4. *Modiolaria discors* L. var. *lævigata* Gray.
a. A specimen from Spitzbergen. × 1.
b. Dorsal view of the same. × 1.

— 5. *Modiolaria discors* L. var. *substriata* Gray.
a. A specimen from West Greenland. × 1.
b. Dorsal view of the same. × 1.
c. A part of the middle area to show its "smooth" (simply striated) surface. × 5.

— 6. *Modiolaria discors* L.
a. A specimen from Denmark. × 2.
b. Dorsal view of the same. × 2.

— 7. *Modiolaria corrugata* Stimpson.
a. A specimen from Spitzbergen. × $1^1/_2$.
b. A specimen from West Greenland (Fiskenæsset). × $1^1/_2$.
c. Dorsal view of the same. × $1^1/_2$.
d. A part of the middle area to show its shagreen-like wrinkled surface. × 5.

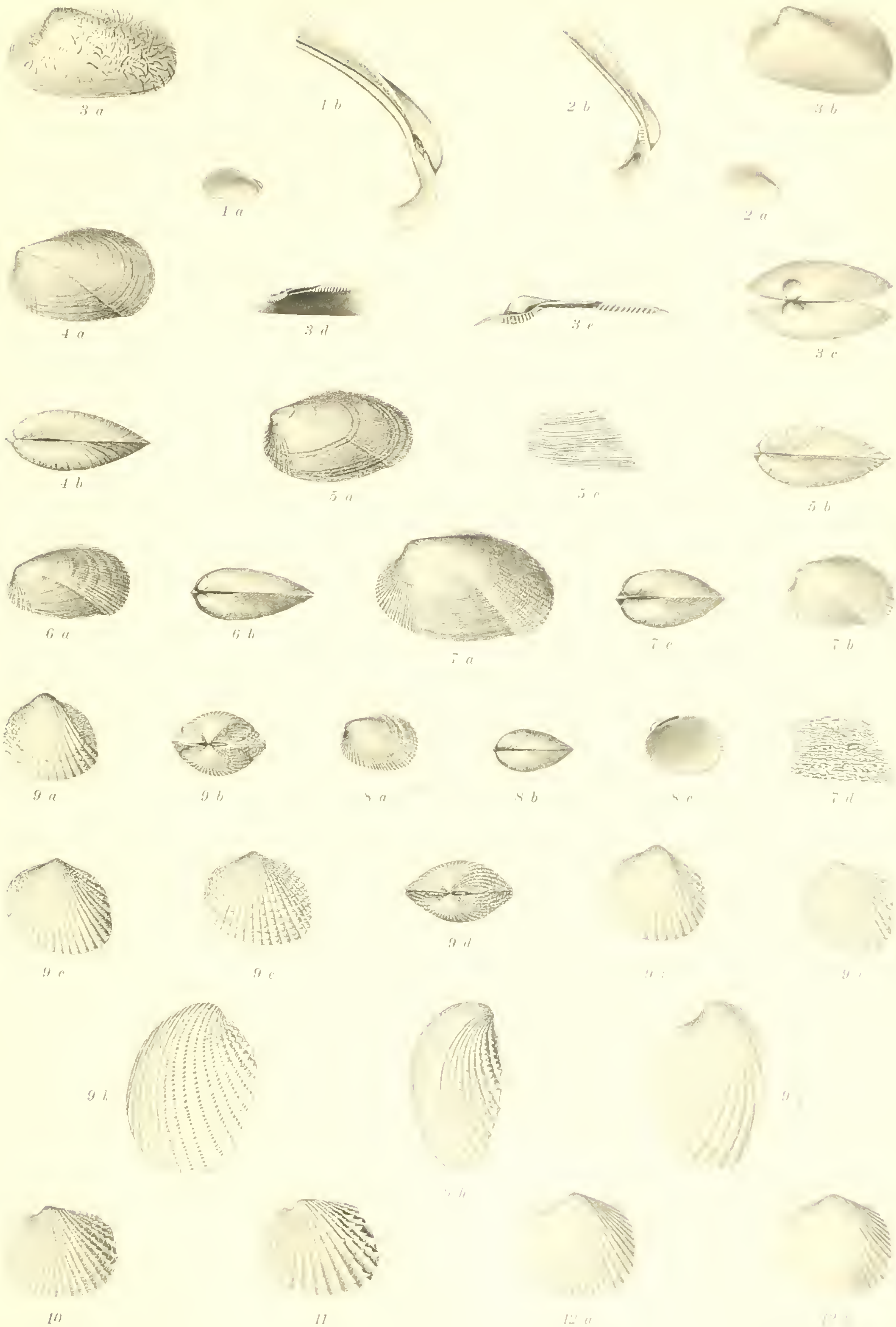
— 8. *Modiolaria faba* (Müller) Fabricius.
a. A specimen from West Greenland (Ritenbenk). × 1.
b. Dorsal view of the same. × 1.
c. Interior of the right valve. × 1.

— 9. *Cardium fasciatum* Montagu.
a & b. A specimen of the short, strongly ventricose form. × $1^2/_3$. Færoes, 20—30 fm.
c & d. A specimen of the somewhat elongated, not much tumid form. × 3. West Iceland (Önundarfjördr), ca. 12 fm.
e. A specimen with tubercles not only on the anterior and posterior area, but also on the middle area. × 6. West Iceland (Önundarfjördr), ca. 12 fm.
f. That form which was confused by Mörch with *C. edule* L. × $1^2/_3$. Færoes.
g. The same half from in front. × 3.
h. The same half from behind. × 3.
i. A specimen with an obliquely cordiform contour. × $8^1/_2$. Færoes, 135 fm.
k. A specimen half from behind showing an intercostal sculpture in the form of a fine pricking. × 5. West Iceland (Önundarfjördr), ca. 12 fm.

— 10. *Cardium ciliatum* Fabricius.
A very young specimen. × $10^1/_2$. East Iceland (Bakkafjördr), 52—43 fm.

— 11. *Cardium echinatum* L.
A very young specimen. × $10^1/_2$. South Iceland, 17—23 fm.

— 12. *Cardium (Serripes) groenlandicum* Chemnitz.
a. A very young, strongly sculptured specimen. × 6. West Greenland (Godthaabs Fjord).
b. A very young, comparatively smooth specimen. × 5. West Iceland (Önundarfjördr), 10 fm.


3 a
1 b
2 b
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3 d
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4 b
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7 a
7 c
7 b
9 a
9 b
8 a
8 b
8 c
7 d
9 c
9 e
9 d
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12 a

E. Bang del.

Plate IV.

Plate IV.

Fig. 1. *Astarte borealis* Chemnitz.

a. A specimen without folds and with an almost smooth periostracum. × 1. West Iceland, 22 fm.

b. The same from above.

c. A very high form, with quite narrow folds on the uppermost part of the shell and with fairly thick, fibrous periostracum on the lowest part. × 1. West Iceland (Faxafjördr), 8—11½ fm.

d & e. A strongly compressed form with distinct folds on the uppermost part of the shell. × 1. West Greenland.

f. A very elongated form from East Greenland (Hekla Havn). × 1½.

— 2. *Astarte Montagui* Dillwyn.

a. Forma *typica*, a short and high, somewhat triangular form. × 1½. West Iceland (Faxafjördr), 15—16 fm.

b. Var. *striata* (Leach) Sars, a more elongated form. × 1½. West Greenland (Jakobshavn).

c. Var. *Warhami* Hancock, an elongated, elliptical form. × 1. East Greenland (Hurry Inlet), 10 fm.

— 3. *Astarte sulcata* da Costa.

a & b. A typical specimen from the Færoes, 150 fm. × 1.

c. A specimen with comparatively close-placed ribs, from Denmark Strait off south-eastern Greenland (Ingolf St. 94), 204 fm. × 1.

— 4. *Astarte elliptica* Brown.

a & b. A typical specimen from the Færoes (Klaksvig), 10—15 fm. × 1.

c & d. A very elongated form, from East Greenland (Hekla Havn). × 1.

e & f. A very high and convex form, from West Greenland. × 1.

g. A specimen in which the folds disappear almost about the middle of the shell. × 1. West Greenland (Vaigat).

— 5. *Astarte crenata* Gray.

a & b. A typical specimen from East Greenland (Hurry Inlet), 50 fm. × 1.

c. A specimen with fewer and more prominent ribs. × 1. East Greenland (Cape Hope), 121 fm.

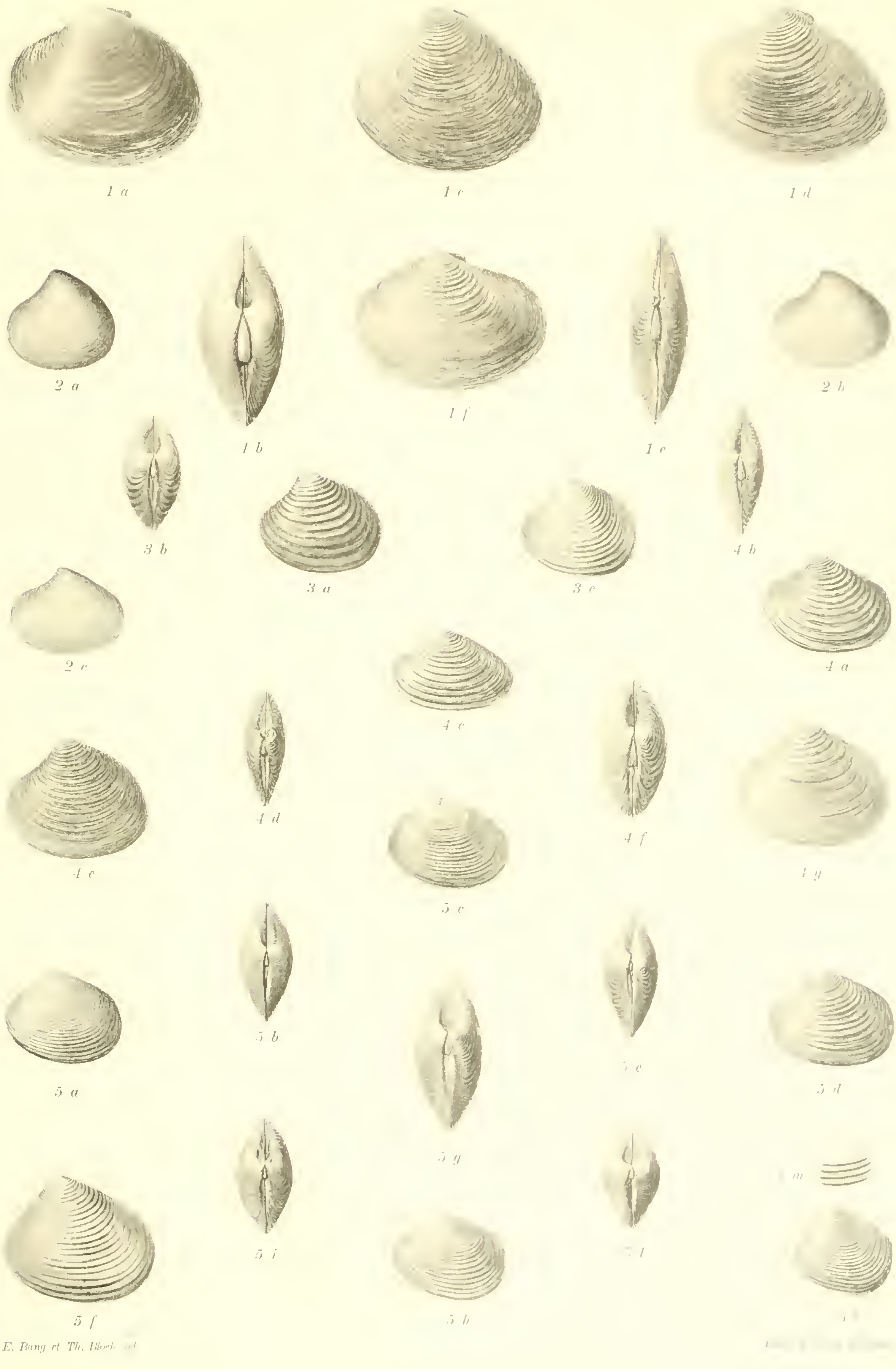
d & e. A specimen of var. *subæquilatera* Sowerby. × 1. Davis Strait (Ingolf St. 32), 318 fm.

f & g. A specimen of var. *crebricostata* Mc. Andr. & Forbes. × 1. North Iceland (Skagestrands Bugt), 119 fm.

h & i. A specimen of var. *inflata* Hägg. × 1½. East Greenland (Forsblads Fjord), 90—50 fm.

k & l. A specimen of var. *acuticostata* Jeffreys. × 1½. S. of Jan Mayen (Ingolf St. 116), 371 fm.

m. A part of the shell, more magnified.



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THE INGOLF-EXPEDITION

1895–1896.

THE LOCALITIES, DEPTHS, AND BOTTOMTEMPERATURES OF THE STATIONS.

Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom temp.
1	62° 30′	8° 21′	132	7°2	24	63° 06′	56° 00′	1199	2°4	45	61° 32′	9° 43′	643	4°17
2	63° 04′	9° 22′	262	5°3	25	63° 30′	54° 25′	582	3°3	46	61° 32′	11° 36′	720	2°40
3	63° 35′	10° 24′	272	0°5		63° 51′	53° 03′	136		47	61° 32′	13° 40′	950	3°23
4	64° 07′	11° 12′	237	2°5	26	63° 57′	52° 41′	34	0°6	48	61° 32′	15° 11′	1150	3°17
5	64° 40′	12° 09′	155			64° 37′	54° 24′	109		49	62° 07′	15° 07′	1120	2°91
6	63° 43′	14° 34′	90	7°0	27	64° 54′	55° 10′	393	3°8	50	62° 43′	15° 07′	1020	3°13
7	63° 13′	15° 41′	600	4°5	28	65° 14′	55° 42′	420	3°5	51	64° 15′	14° 22′	68	7°32
8	63° 56′	24° 40′	136	6°0	29	65° 34′	54° 31′	68	0°2	52	63° 57′	13° 32′	420	7°87
9	64° 18′	27° 00′	295	5°8	30	66° 50′	54° 28′	22	1°05	53	63° 15′	15° 07′	795	3°08
10	64° 24′	28° 50′	788	3°5	31	66° 35′	55° 54′	88	1°6	54	63° 08′	15° 40′	691	3°9
11	64° 34′	31° 12′	1300	1°6	32	66° 35′	56° 38′	318	3°9	55	63° 33′	15° 02′	316	5°9
12	64° 38′	32° 37′	1040	0°3	33	67° 57′	55° 30′	35	0°8	56	64° 00′	15° 09′	68	7°57
13	64° 47′	34° 33′	622	3°0	34	65° 17′	54° 17′	55		57	63° 37′	13° 02′	350	3°4
14	64° 45′	35° 05′	176	4°4	35	65° 16′	55° 05′	362	3°6	58	64° 25′	12° 09′	211	0°8
15	66° 18′	25° 59′	330	−0°75	36	61° 50′	56° 21′	1435	1°5	59	65° 00′	11° 16′	310	0°1
16	65° 43′	26° 58′	250	6°1	37	60° 17′	54° 05′	1715	1°4	60	65° 09′	12° 27′	124	0°0
17	62° 49′	26° 55′	745	3°4	38	59° 12′	51° 05′	1870	1°3	61	65° 03′	13° 06′	55	0°4
18	61° 44′	30° 29′	1135	3°0	39	62° 00′	22° 38′	865	2°9	62	63° 18′	19° 12′	72	7°92
19	60° 29′	34° 14′	1566	2°4	40	62° 00′	21° 36′	845	3°3	63	62° 40′	19° 05′	800	4°0
20	58° 20′	40° 48′	1695	1°5	41	61° 39′	17° 10	1245	2°0	64	62° 06′	19° 00′	1041	3°1
21	58° 01′	44° 45′	1330	2°4	42	61° 41′	10° 17′	625	0°4	65	61° 33′	19° 00′	1089	3°0
22	58° 10′	48° 25′	1845	1°4	43	61° 42′	10° 11′	645	0°05	66	61° 33′	20° 43′	1128	3°3
23	60° 43′	56° 00′	Only the Plankton Net used		44	61° 42′	9° 36′	515	4°8	67	61° 30′	22° 30′	975	3°0

Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.
68	62° 06′	22° 30′	843	3°4	92	64° 44′	32° 52′	976	1°4	118	68° 27′	8° 20′	1060	−1°0
69	62° 40′	22° 17′	589	3°9	93	64° 24′	35° 14′	767	1°46	119	67° 53′	10° 19′	1010	−1°0
70	63° 09′	22° 05′	134	7°0	94	64° 56′	36° 19′	204	4°1	120	67° 29′	11° 32′	885	1°0
71	63° 46′	22° 03′	46			65° 31′	30° 45′	213		121	66° 59′	13° 11′	529	−0°7
72	63° 12′	23° 04′	197	6°7	95	65° 14′	30° 39′	752	2°1	122	66° 42′	14° 44′	115	1°8
73	62° 58′	23° 28′	486	5°5	96	65° 24′	29° 00′	735	1°2	123	66° 52′	15° 40′	145	2°0
74	62° 17′	24° 36′	695	4°2	97	65° 28′	27° 39′	450	5°5	124	67° 40′	15° 40′	495	−0°6
	61° 57′	25° 35′	761		98	65° 38′	26° 27′	138	5°9	125	68° 08′	16° 02′	729	−0°8
	61° 28′	25° 06′	829		99	66° 13′	25° 53′	187	6°1	126	67° 19′	15° 52′	293	−0°5
75	61° 28′	26° 25′	780	4°3	100	66° 23′	14° 02′	59	0°4	127	66° 33′	20° 05′	44	5°6
76	60° 50′	26° 50′	806	4°1	101	66° 23′	12° 05′	537	0°7	128	66° 50′	20° 02′	194	0°6
77	60° 10′	26° 59′	951	3°6	102	66° 23′	10° 26′	750	−0°9	129	66° 35′	23° 47′	117	6°5
78	60° 37′	27° 52′	799	4°5	103	66° 23′	8° 52′	579	0°6	130	63° 00′	20° 40′	338	6°55
79	60° 52′	28° 58′	653	4°4	104	66° 23′	7° 25′	957	1°1	131	63° 00′	19° 09′	698	4°7
80	61° 02′	29° 32′	935	4°0	105	65° 34′	7° 31′	762	−0°8	132	63° 00′	17° 04′	747	4°6
81	61° 44′	27° 00′	485	6°1	106	65° 34′	8° 54′	447	−0°6	133	63° 14′	11° 24′	230	2°2
82	61° 55′	27° 28′	824	4°1		65° 29′	8° 40′	466		134	62° 34′	10° 26′	299	4°1
83	62° 25′	28° 30′	912	3°5	107	65° 33′	10° 28′	492	0°3	135	62° 48′	9° 48′	270	0°4
	62° 36′	26° 01′	472		108	65° 30′	12° 00′	97	1°1	136	63° 01′	9° 11′	256	4°8
	62° 36′	25° 30′	401		109	65° 29′	13° 25′	38	1°5	137	63° 14′	8° 31′	297	−0°6
84	62° 58′	25° 24′	633	4°8	110	66° 44′	11° 33′	781	0°8	138	63° 26′	7° 56′	471	−0°6
85	63° 21′	25° 21′	170		111	67° 14′	8° 48′	860	0°9	139	63° 36′	7° 30′	702	−0°6
86	65° 03′6	23° 47′6	76		112	67° 57′	6° 44′	1267	−1°1	140	63° 29′	6° 57′	780	−0°9
87	65° 02′3	23° 56′2	110		113	69° 31′	7° 06′	1309	−1°0	141	63° 22′	6° 58′	679	−0°6
88	64° 58′	24° 25′	76	6°9	114	70° 36′	7° 29′	773	1°0	142	63° 07′	7° 05′	587	−0°6
89	64° 15′	27° 20′	310	8°4	115	70° 50′	8° 29′	86	0°1	143	62° 58′	7° 09′	388	−0°4
90	64° 45′	29° 06′	568	4°4	116	70° 05′	8° 26′	371	−0°4	144	62° 49′	7° 12′	276	1°6
91	64° 44′	31° 00′	1236	3°1	117	69° 13′	8° 23′	1003	1°0					


Jan Mayen
Davis Strade
GRÖNLAND
Godthavn
Egedesminde
Holstensborg
Sukkertoppen
Godthaab
Frederikshaab
Julianehaab
C. Farvel
Angmagsalik
Danmarks Stræde
ISLAND
Reykjavik
Färöerne
under (below) 0°
over (above) 0°
30° V. f. Greenwich
Grænselinie mellem koldt og varmt Bundvand
Limit between cold and warm water at the bottom