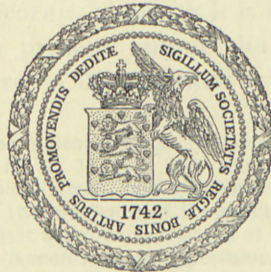


DET KGL. DANSKE VIDENSKABERNES SELSKAB
BIOLOGISKE MEDDELELSER, BIND XXI, NR. 6

A REVISION OF THE GENUS
ICELUS (COTTIDAE)
WITH REMARKS ON THE STRUCTURE
OF ITS UROGENITAL PAPILLA

BY

AD. S. JENSEN AND HELGE VOLSØE



KØBENHAVN
I KOMMISSION HOS EJNAR MUNKSGAARD
1949

DRY KGL. DANSKE VIDENSKABERNE SÆLSKAB
BIBLIOTEK NORDSTRØM GATE 121 KØB.

ARTIKEL I DE
VITENSKABERNE
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AD E. HANSEN & HANS FORLAG

1887



I.

A Revision of the Genus *Icelus*.

By AD. S. JENSEN.

In 1839 REINHARDT referred a new West Greenland fish, sent to him in 1838, to the genus *Cottus* and called it *bicornis*, because it had two cone-shaped, pointed, backward bent spines on the back of the neck. He further characterized it by the presence of four spines on the border of the preoperculum of which that in the uppermost corner is bifurcated. He adds that, like *Cottus uncinatus*, it has teeth both on the vomer and on the palatine bones¹.

In 1845 KRØYER gave a detailed description of two small cottid fishes (total length about 50 mm) which he had brought with him from Spitsbergen; he referred them to a new genus and a new species which he gave the name *Icelus hamatus*².

In his paper on Scandinavian *Cottoidei* LÜTKEN³ states that *Icelus hamatus* Krøyer is common in Greenland. He entertains no doubt that REINHARDT's *Cottus bicornis* is the same species; but as the original specimen could not possibly be found in this Museum, the name *bicornis*, although it is older, should not have priority. To this the present author⁴ has given the following remarks: "With regard to this LÜTKEN is right in so far as the

¹ Overs. Kongl. Danske Vidensk. Selsk. Forhandl. 1839, pp. 9—10.

² Naturhist. Tidsskr. II, 1, 1845, p. 253.—According to KRØYER *Icelus* is the son of *Hypnos*, the god of sleep, and KRØYER writes (l. c. p. 261), that he chose the name in view of the indolence of the species of *Cottus*, as well as with regard to the northern habitat assigned to the god of sleep by some of the ancient authors. The specific name *hamatus* refers, I presume, to the following paragraph in KRØYER's diagnosis (l. c. p. 263): "Aculei præoperculi quatuor, quorum tres superiores hamati, summus bifurcatus." The three uppermost spines on the preoperculum are just hook-shaped.

³ Vidensk. Medd. Naturhist. Foren. Kbhvn. 1876, p. 380.

⁴ AD. S. JENSEN: The fishes of East-Greenland. Meddel. om Grønland, XXIX, 1904, p. 245.

specimen from 1838 can no longer be pointed out. But in REINHARDT's notes from the year 1841, kept at the Museum, I find mentioned still 3 specimens of *Cottus bicornis* sent him from the missionary JØRGENSEN at Julianehaab; these specimens are still kept in the Museum, and have in the course of time been relabelled *Icelus hamatus* Kr. As there is now no more room for doubt, we ought to return to REINHARDT's specific name as being the older one."

In recent time two new and surprising papers have appeared in the discussion on *Icelus*, both published by Russian scientists. SCHMIDT¹ maintains that *Icelus bicornis*, besides the typical form of REINHARDT, embraces a subspecies *beringianus* occurring in the northern Bering Sea, and he characterizes the two forms as follows (l. c. p. 6—9):

Icelus bicornis Reinh.: The anal papilla of the male is not long; to the top it is conical and bears a long and acuminate appendage so long as or a little longer than the basal part of the papilla. The plates of the lateral line do not reach the base of the caudal fin, they disappear near the end of the second dorsal.

Icelus bicornis subsp. *beringianus* m.: The dorsal part of the anal papilla of the male is long with an incision on the top and bearing on the dorsal side a short, curved appendage. The plates of the lateral line reach the base of the caudal fin.

Ten years later ANDRIASHEV² maintains that SCHMIDT's *beringianus* is not a subspecies of *bicornis*, but is identic with *Icelus spatula* Gilbert and Burke and refers it to this species just on the basis of the characters pointed out by SCHMIDT for *beringianus*, so that according to ANDRIASHEV (l. c. p. 275—276) the case is as follows:

Für *Icelus bicornis* ist ein gertenförmiger Fortsatz der Analpapille und eine meist unvollständige Seitenlinie charakteristisch.

Für *Icelus spatula* ist ein krallenartiger Fortsatz an der Analpapille und eine vollständige Seitenlinie charakteristisch.

In one respect ANDRIASHEV's description differs, as will be

¹ P. SCHMIDT: A revision of the genus *Icelus* Krøyer (Pisces, *Cottidae*). Ann. Mus. Zool. de l'Acad. Sci. de l'URSS, T. XXVIII, 1, 1927. — SCHMIDT moreover regards *Cottus bicornis* Reinhardt and *Icelus hamatus* Krøyer as identic (l. c. p. 6).

² ANATOLY P. ANDRIASHEV (Ichthyol. Laboratorium der Staatsuniversität zu Leningrad): Neue Angaben über die Systematik und geographische Verbreitung der zweihörnigen pazifischen *Icelus*-Arten. Zool. Jahrb. Bd. 69, 4, 1937.

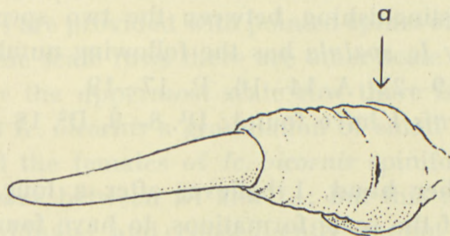
seen, from SCHMIDT's, since the lateral line in *Ic. bicornis* is said to be generally incomplete.

On the basis of these new views I have examined not only the previous East Greenland but also the West Greenland collections, to which have recently been added a great deal of new material.

A renewed revision of the East Greenland material shows that it contains only one species of males: all the males (20 specimens, of which the largest measures 65 mm) have a whip-like prolongation of the urogenital papilla¹. In the females (more than 100 specimens) the lateral line does not reach the basis of the caudal fin; in the largest female (90 mm) the lateral line stops 4 mm from the basis of the caudal fin, and in the smaller females the lateral line ends farther anteriorly on the tail. I conclude from the above that in East Greenland only *Icelus bicornis* (Reinh.) occurs.

In West Greenland, on the other hand, both *Ic. bicornis* and *Ic. spatula* occur, according to an examination of the males. But it appears at the same time that although the males can be distinguished from each other by the shape of the prolongation of the urogenital papilla, the females of the two species cannot always be distinguished from each other by the extension of the lateral line. In the females of *Ic. spatula* the lateral line extends to the base of the caudal fin, but this may sometimes also be the case in big specimens of *Ic. bicornis* (fig. 2) (cf. ANDRIASHEV: "eine meist unvollständige Seitenlinie"). That in certain

¹ Both SCHMIDT and ANDRIASHEV call the prolongation anal papilla; it is actually a urogenital prolongation, and the anus is situated at its base as a distinct aperture.



Urogenital papilla of *Icelus bicornis* ♂, seen ventrally and magnified 7 x. The aperture off *a* is the anus.

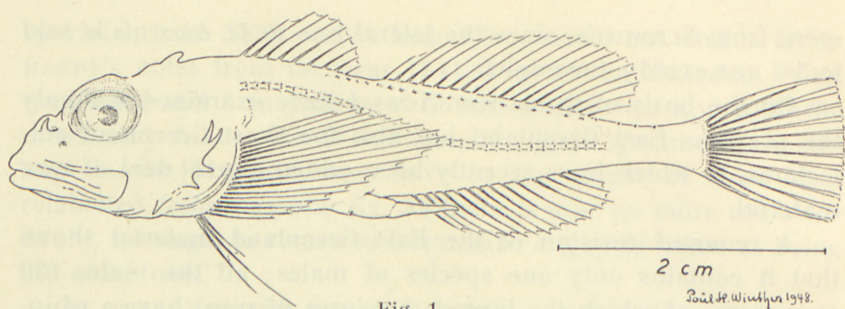


Fig. 1.

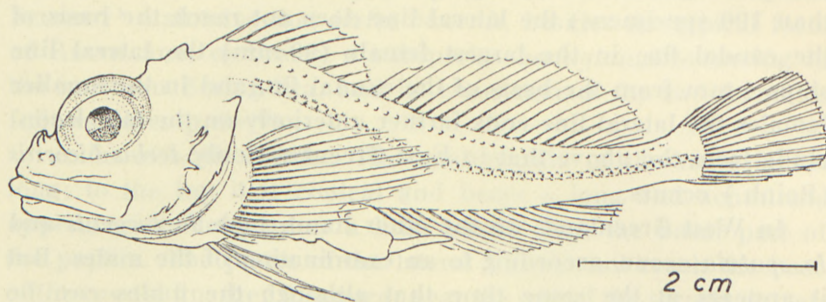


Fig. 2.

Fig. 1. *Icelus bicornis* (Reinhardt) ♂. Total length 62 mm. Southern West Greenland. The Rev. Jørgensen 1841. In this specimen the scales of the lateral line cease a good distance in front of the base of the caudal fin.

Fig. 2. *Icelus bicornis* (Reinhardt) ♂. Total length 70 mm. Baffin Bay, 50 fms. Th. Holm 1886. In this specimen the scales of the lateral line continue to the base of the caudal fin.

cases we have females of *Ic. bicornis* before us, although they have the lateral line complete, I conclude among other things from the fact that they were caught in the trawl together with males of *Ic. bicornis*.

Unfortunately, the number of fin rays does not provide any means for distinguishing between the two species. According to ANDRIASHEV *Ic. spatula* has the following number of fin rays: D¹. 8—9, D². 19—22, A. 14—16, P. 17—19.

In *Ic. bicornis* I have found: D¹. 8—9, D². 18—21, A. 14—16, P. 17—19.

On the other hand, I believe, after a long and thorough examination of the scale formations, to have found a character, by which it is possible to distinguish also between the females of the two species.

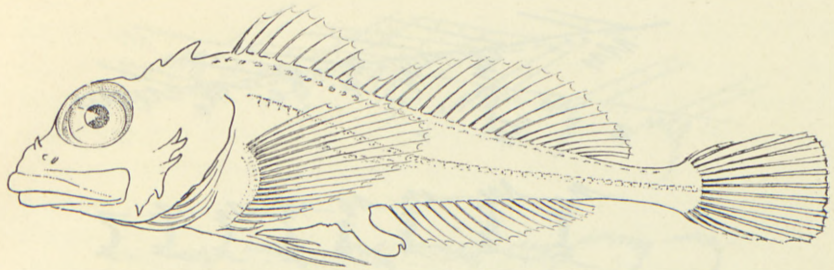


Fig. 3.

2 cm

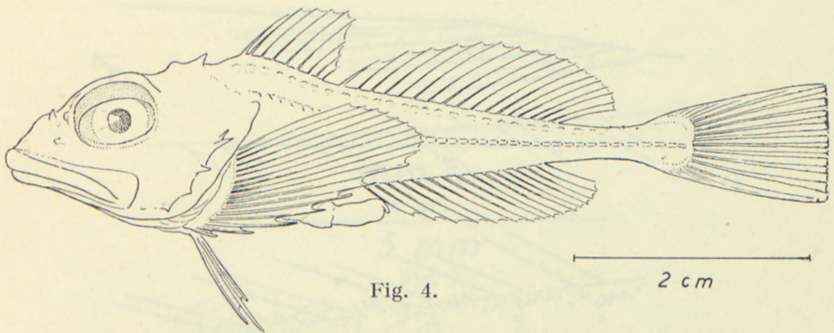


Fig. 4.

2 cm

Fig. 3. *Icelus spatula* Gilbert & Burke. ♂. Total length 93 mm. Nordre Strømfjord. V. Nordmann 1911.

Fig. 4. *Icelus spatula* Gilbert & Burke. ♂. Total length 70 mm. East coast of Canada, Exeter Sound, Cumberland Island, 207 m. "Godthaab" Expedition, St. 166, 1928.

Figs. 3 and 4 show the usual feature in *Ic. spatula*, viz. that the scales of the lateral line continue to the base of the caudal fin.

As will be known the genus *Icelus* is characterized, among other things, by two very conspicuous scale rows (figs. 1—4), viz. one along the back which I shall call Dl (the dorsal line) and another along the side, which I call Ll (the lateral line), which is furnished with pores for the lateral line canal. The scales in both these rows are provided with pointed spines along their edges.

Besides these scale rows there are other scale formations. On the skin above the uppermost scale row there is both in *Icelus spatula* and in *Ic. bicornis* a granulation of small grains. Both in the males and the females of *Ic. bicornis* spiniform scales may occur in the area between Dl and Ll; but this is only the case in some individuals, and consequently cannot be used as a systematic character. I have noted, however, that there is a slight difference as regards the scales of the lateral line (i. e. Ll) in

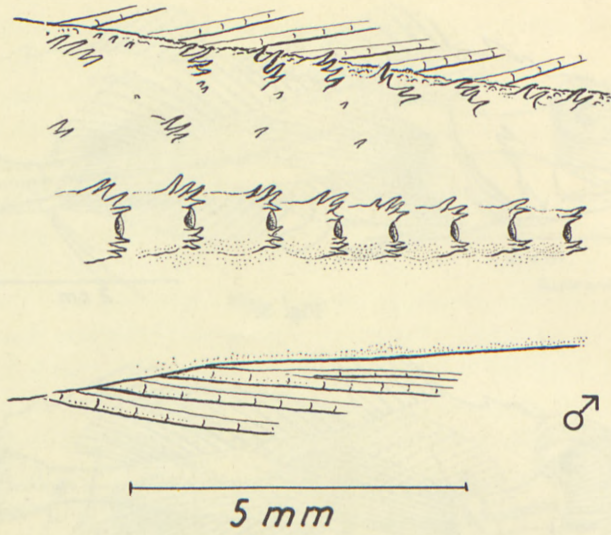


Fig. 5.

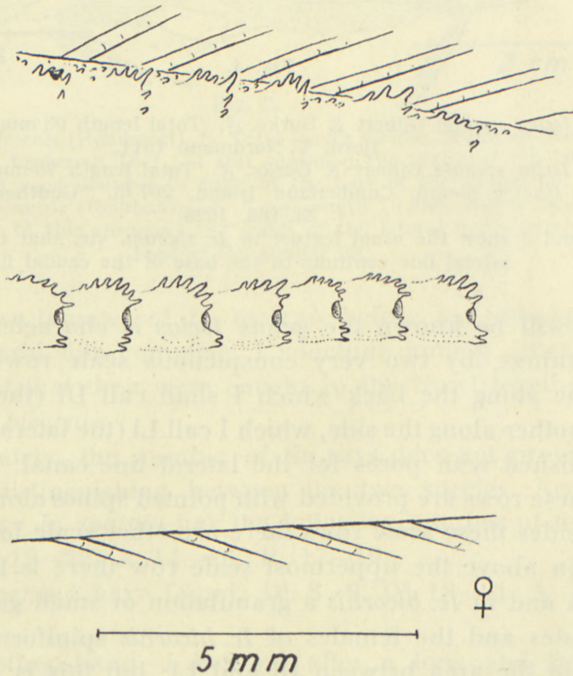


Fig. 6.

Fig. 5. *Icelus bicornis* (Reinhardt). A portion of the left side of the tail, between the dorsal and anal fins, of a male specimen. A number of lateral line scales is seen, each of these provided with spines on that part of the posterior edge which is below the pore for the lateral line. Baffin Bay, 50 fms. Th. Holm, 1886.

Fig. 6. *Icelus bicornis* (Reinhardt). In this specimen too, a female, there are spines in the corresponding place of the lateral line scales. Baffin Bay, 50 fms. Th. Holm, 1886.

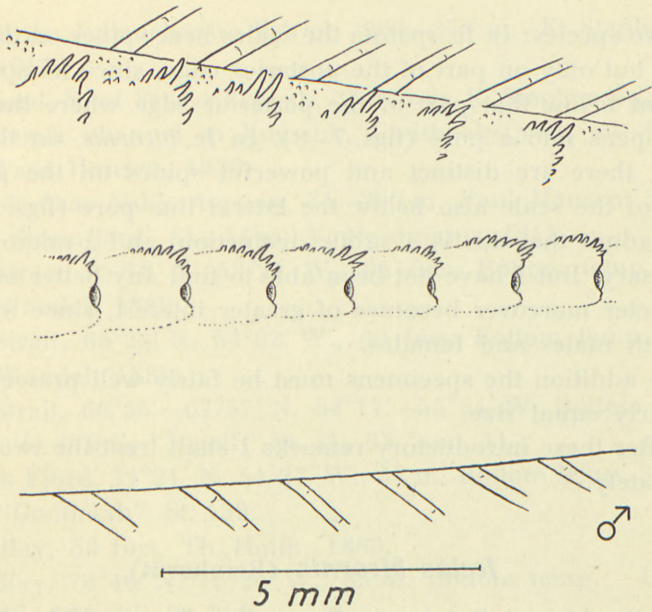


Fig. 7.

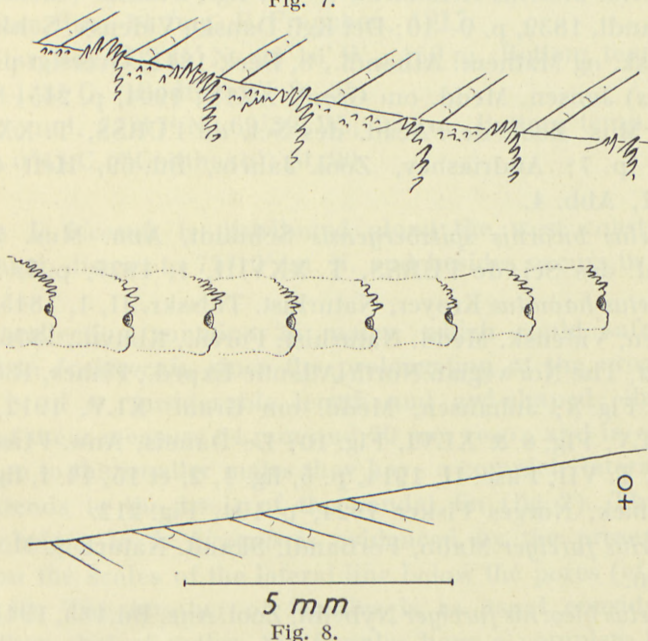


Fig. 8.

Fig. 7. *Icelus spatula* Gilbert and Burke. These lateral line scales lack spines on that part of the posterior edge of the scale which is below the pore for the lateral line. The specimen is a male. Nordre Ström fjord. V. Nordmann, 1911.
 Fig. 8. *Icelus spatula* Gilbert and Burke. These lateral line scales also lack spines on that part of the posterior edge of the scale which is below the pore for the lateral line. The specimen is a female. East coast of Canada, Exeter Sound, Cumberland Island. 207 m. "Godthaab" Expedition, 1928.

the two species: In *Ic. spatula* the scales bear spines on the upper edge, but only on part of the posterior edge, since no spines are present below that part of the posterior edge where the lateral line opens into a pore (figs. 7—8). In *Ic. bicornis*, on the other hand, there are distinct and powerful spines on the posterior edge of the scale also below the lateral line pore (figs. 5—6).

I admit that this is a subtle distinction, and a microscope is necessary. But I have not been able to find any better one. This character moreover becomes of greater interest, since it applies to both males and females.

In addition the specimens must be fairly well preserved and of fairly equal size.

After these introductory remarks I shall treat the two species separately.

Icelus bicornis (Reinhardt).

Cottus bicornis Reinhardt, Overs. Kgl. Danske Vidensk. Selsk. Forhandl. 1839, p. 9—10; Det Kgl. Danske Vidensk. Selsk. Naturvidensk. og Mathem. Afhandl., 8. Deel, 1841, Oversigt p. LXXV; (*Icelus*) Jensen, Medd. om Grønland. XXIX, 1904, p. 245; Schmidt, Ann. Mus. Zool. de l'Acad. des Sci. de l'URSS, T. XXVIII, 1, 1927, p. 7; Andriashev, Zool. Jahrb., Bd. 69, Heft 4, 1937, p. 261, Abb. 4.

Icelus bicornis spitzbergensis Schmidt, Ann. Mus. Zool. de l'Acad. des Sci. de l'URSS, T. XXVIII, 1, 1927, p. 7.

Icelus hamatus Krøyer, Naturhist. Tidsskr. II, 1, 1845, p. 253; Lütken, Vidensk. Medd. Naturhist. Foren., Kbhvn., 1876, p. 380; Collett, The Norwegian North-Atlantic Exped., Fishes, 1880, p. 34, Pl. I, Fig. 8; Johansen, Medd. om Grønland. XLV, 1912, p. 654, Pl. XLV, Fig. 8 & XLVI, Fig. 10; Le Danois, Ann. l'Inst. Océanogr., T. VII, Fasc. II, 1914, p. 5, fig. 1, 2, et 15, Pl. I, fig. 3 et 4; Wollebæk, Norges Fisker 1924, p. 194, Fig. 212.

Icelus furciger Malm, Forhandl. Skand. Naturf. 9. Möte 1863, p. 410.

Icelus bicornis furciger Nybelin, Zool. Anz. Bd. 133, 1941, p. 221.

West Greenland. *Icelus bicornis* has been taken at the following localities:

- Bredefjord, Julianehaab district, 200—270 m. K. Stephensen, 1912.
- Kvanefjord, S. of Frederikshaab, 37—45 m. K. Stephensen, 1912.
- Off Karusuk channel in Kugssuk, Godthaabsfjord, 50—100 m. Paul Hansen, 1936.
- Amarkok near Sukkertoppen, 75—200 m. Paul Hansen, 1935.
- Nordre Strømfjord, 51—54 m. V. Nordmann, 1911.
- Davis Strait, 65°18' N. 53°21' W., 65 fms. Bottom temp. 1° C. Wandel, 1889.
- Davis Strait, 65°22' N. 54°02' W., 60 fms. Bottom temp. 2° C. Wandel, 1889.
- Davis Strait, 66°35'—67°57' N. 54°17'—55°54' W. Bottom temp. 0°8—0°9 C. "Ingolf" St. 31, 33, and 34.
- Umanak Fjord, 71°21' N. 54°27' W., 47 m, Bottom temp. 3°96 C. "Godthaab" St. 139.
- Baffin Bay, 50 fms. Th. Holm, 1886.
- Baffin Bay, 76°40' N. 76°20' W., 85 m. Bottom temp. —1°12 C. "Godthaab" St. 114.
- North Star Bay, 14 fms. P. Freuchen, 1917.
- North Star Bay, 76°35' N. 68°16' W., 150 m. Bottom temp. —1°35 C. "Godthaab" St. 85.
- Whale Sound, 77°17' N. 69°59' W., 930 m. Bottom temp. —0°42 C. "Godthaab" St. 90.

Thus *Ic. bicornis* is distributed along the west coast from Julianehaab district to 77°17' lat. N. and besides occurs in Davis Strait.

The collection contains 25 males, which could safely be referred to *Ic. bicornis*, since the prolongation of the urogenital papilla is of a considerable length and awl-shaped; the two biggest of them measure 64 mm and 70 mm resp., and in contradistinction to the smaller males they have a complete lateral line, as it extends to the basis of the caudal fin (fig. 2). That the females belong to *Ic. bicornis* is evidenced by the presence of spines on the scales of the lateral line below the pores (cf. p. 10 and fig. 6). The number of females is as usual considerably greater than that of males. Six females have a complete lateral line and are larger than the other females; they are 80—130 mm long.

East Greenland. *Icelus bicornis* has been taken at the following localities:

- Lindenowfjord, 40—50 m. Bertelsen, 1935.
 Sermilik off Ikagtek, 44 m. Bertelsen, 1933.
 Angmagssalik, 10—0 fms. Søren Jensen, 1900.
 Tasiusak, 30—50 fms. Kruuse, 1902.
 Uttental Sound, 9—11 m, 20—25 m, 30—90 m. Bertelsen, 1933.
 Kangerdlugssuak, 10 m and 11—15 m. Degerbøl, 1932.
 Cape Tobin, 57 fms. Søren Jensen, 1900.
 Hurry Inlet, 50 fms. Søren Jensen, 1900.
 Rosenvinge Bay, 0—20 m, 10—12 m. Alwin Pedersen, 1924—25.
 Hekla Harbour, 5—10 fms. Ryder, 1891—92.
 Forsblads Fjord, 90—50 fms. Søren Jensen, 1900.
 Dusénfjord, 240 m. "Godthaab" 1932.
 Isfjord, 55—59 m. "Godthaab" 1932.
 Danmarks Harbour, about 2—40 m. Young specimens, about 30—40 mm, in the littoral region, somewhat older specimens in the Laminaria region, the large specimens in the Delesseria region. According to Johansen, 1906—08.

The present collection contains 20 males which are all referable to *Ic. bicornis* on account of the long and awl-shaped prolongation of the urogenital papilla. About 100 specimens are females, which, like the males, have an incomplete lateral line, as it ends at a shorter or longer distance in front of the basis of the caudal fin.

Altogether it can be said that in East Greenland only one species of *Icelus* occurs, viz. *Ic. bicornis*. It has, however, as shown in the list, been demonstrated in many places from $60\frac{1}{2}^{\circ}$ to 77° lat. N. Still as far north as in the area near Danmarks Harbour it is one of the most common fishes, writes FRITS JOHANSEN, the zoologist. The largest male measures 65 mm, the largest female 90 mm. Large males and females may have spine-shaped scales between the dorsal and the median scale row.

Further distribution: The Zoological Museum of Copenhagen has *Ic. bicornis* also from the following localities: Iceland (N. of Iceland, 44 fms. 1 ♀, "Ingolf" St. 127, 1896; North Iceland, Skagestrand Bay, 114 fms. 1 ♀, Wandel 1890; East Ice-

land, Reyðarfjörður, 44 fms. 1 ♀, Hørring 1898). Jan Mayen, 55 fms., 4 ♂ 4 ♀, Søren Jensen 1900. Spitsbergen, about 10 fms. 2 ♀, Krøyer 1838—39 (s. n. *Icelus hamatus*). Norway, Bergen, 1 ♂, 1904. Kara Sea, 65—100 fms., 7 ♂ 11 ♀, "Dijmphna" 1882—83.

Besides, the following particulars are given of its distribution:

Regarding its occurrence in Norway WOLLEBÆK writes that it occurs along the entire coast. It also occurs in Bohuslän, whence MALM described it as a new species: *Ic. furciger*, in which is found a row of spines on either side of the base of the anal fin, while such spines are absent in arctic individuals; this view COLLETT could not adopt. Later on NYBELIN has compared 12 specimens from Bohuslän with 50 from Spitsbergen and he found a considerable difference between the arctic and the Swedish specimens of *Ic. bicornis*, viz.—besides that pointed out by MALM—fewer rays in D², A and P in the Bohuslän specimens than in the arctic individuals. NYBELIN, however, does not consider the difference sufficiently great to justify a segregation of species¹. On the other hand, NYBELIN finds it reasonable to regard the Swedish specimens as a geographical subspecies, which should bear the name *Icelus bicornis furciger* Malm. But where the limit is between the distribution of the arctic principal species and that of the boreal subspecies cannot be said at present. From northern Norway *Ic. bicornis*, according to ANDRIASHEV, continues into the Barents Sea and the Kara Sea, and according to P. SCHMIDT it is distributed near Spitsbergen Islands (s.n. subsp. *spitzbergensis*).

To the west *Ic. bicornis* extends from West Greenland to the east coast of Canada, where the "Godthaab" in 1928 took a male in Jones Sound on Ellesmere Island (76°08' N. 80°53' W.), depth 80 m, bottom temp. —1.05° C., St. 116.

¹ It is besides a matter of fact that the average number of fin rays (and vertebrae) within the same species may change according to whether it lives in boreal or arctic waters. I could give many examples of this, but shall here mention only one. The species *Triglops pingelli* occurs with 4 subspecies, whose average number of rays in D² and A increases gradually as we proceed from warmer to colder seas, from the Kattegat-Faroe area via Iceland to Greenland. (Cf. AD. S. JENSEN: Contributions to the Ichthyofauna of Greenland, 4, 1944, pp. 12—22 and pp. 29—30, charts 2 & 3).

On the naming of this species.

In his fundamental paper on *Icelus* ANDRIASHEV writes (pp. 275—276) on *Ic. spatula*: “Zu dieser Art könnte man die Exemplare von H. J. DRESEL aus der Davis Strait¹, von V. PIETSMANN von Westgrönland², von V. VLADYKOV aus der Hudsonbai³ und andere rechnen. Leider ist die Form des Fortsatzes der Analpapille bei keinem von diesen Exemplaren beschrieben. Im Zoologischen Institut befindet sich ein Weibchenexemplar aus Grönland (No. 4681), das eine vollständige Seitenlinie (42 Schilde) aufweist und allen anderen Merkmalen nach von der Form *Ic. spatula* aus dem Beringmeer nicht zu unterscheiden ist. Die Frage nach der systematischen Stellung dieses Exemplars (d. h. die Frage nach der Verbreitung von *Ic. spatula* bis Grönland) kann nur im Falle des Auffindens der Männchen in diesem Gebiet geklärt werden. Sehr möglich ist es, dass bei Westgrönland beide Arten, *Ic. spatula* und *Ic. bicornis*, vorkommen, ähnlich wie es im Karischen Meer der Fall ist. Falls es sich aber erweisen sollte, dass bei Grönland bloss solche Exemplare vorkommen, die einen krallenartigen Fortsatz der Analpapille aufweisen, so muss die Benennung der pazifischen Art *Ic. spatula* in *Ic. bicornis* (Reinh.) verändert werden. Für die nordatlantische Art mit einem langen gertenförmigen Fortsatz der Analpapille müsste dann die Benennung von KRØYER *Ic. hamatus* von neuem eingeführt werden.”

In view of the above I can give the following information: In the Zoological Museum of Copenhagen are kept, from the old times, eight specimens of *Cottus bicornis*, they were sent to REINHARDT from his correspondents in Greenland in the years 1840—42, at a time when he was engaged on the study of this species. Of the eight specimens only one is a male, its urogenital papilla is comparatively short, but provided with a considerable whip-formed prolongation. This male was sent to REINHARDT in 1841 by the Rev. JØRGENSEN, he has had it before him, and in his list of the Rev. JØRGENSEN's collection kept in this Museum, it is determined as *Cottus bicornis*. It must be justifiable therefore to regard this specimen, the urogenital papilla of which is figured in the present paper, note 1, p. 5 as the male type of *Icelus bicornis* (Reinhardt)⁴.

¹ Proc. U. S. Nat. Mus., vol. 7, 1885, p. 252; vgl. auch JORDAN u. EVERMANN, 1898, Pt. II, p. 1911.

² Medd. om Grønl., vol. 92, no. 3, 1932, p. 36, fig. 15.

³ Contrib. Canad. Biol. a. Fisheries, N. S., vol. 8, Toronto 1932, p. 14.

⁴ It might seem peculiar that REINHARDT did not mention the urogenital papilla conspicuous in his *Cottus bicornis*. But it should be borne in mind that his establishment of this species was published in 1839, while the male which he got from Rev. JØRGENSEN was not sent from Greenland until 1841. It is true

On the other hand, it appears that four of the females sent down at the same time, should be referred to *Ic. spatula*, as it is characterized in the present paper; a fifth female belongs to *Ic. bicornis*, and the two remaining females cannot be identified (one is poorly preserved, the other is too small).

Icelus spatula Gilbert and Burke.

Icelus spatula Gilbert and Burke, Fishes from Bering Sea and Kamchatka, Washington 1912, p. 41, fig. 3, 3a; Bulletin of the Bureau of Fisheries, Vol. XXX, 1910 (1912)¹.

Icelus spatula Andriashev, Zol. Jahrb. Bd. 69, Heft 4, 1937, p. 272, Abb. 3, Taf. 6, Fig. 6.

Icelus bicornis beringianus Schmidt, Ann. Mus. Zool. de l'Acad. des Sc. de l'URSS, T. XXVIII, 1, 1927, p. 7.

Icelus karaensis Soldatov, Ber. d. Wiss. Meeresinst. 1923, Lief. 3, Saratov, p. 31.

In the Zoological Museum of Copenhagen are kept specimens of *Ic. spatula* from the following localities in West Greenland:

Nordre Strømfjord, 33—95 m. 3 ♂, 2 ♀; V. Nordmann, 1911.

Disko Bay. 1 ♂; Traustedt, 1892.

Egedesminde. 1 ♂, 1 ♀; Traustedt, 1892.

Egedesminde and Jakobshavn. 2 ♂, 3 ♀; Traustedt, 1892.

Jakobshavn. 1 ♂; Traustedt, 1892.

Umanak, Spraglede Bay. 1 ♀; "Godthaab", 1928.

Besides, there are from the old times (1840—1842), 4 specimens, all females, which are labelled "Greenland" without further statement of locality.

The remarkable shape of the prolongation of the urogenital

that there is a note on *C. bicornis* in Vid. Selsk. Afhandl. from 1841, but it is nothing but a republication of REINHARDT's description from 1839.

¹ P. 42 GILBERT and BURKE characterize *Icelus spatula* in the following way: "The species is distinguished by the form of the anal papilla in the male. This is distinctly spatular in shape, widening from base to the end of the basal segment, which is broad, rounded at tip and emarginate on the middle line, the terminal segment being extremely short, curved like a claw, springing from the dorsal (posterior) side of the basal portion and not extending beyond it." In *Icelus bicornis* the anal papilla in the male is strikingly different in shape; the basal segment is comparatively short and terminates in a long, gently tapering process, about as long as the basal portion, from the summit of which it springs.

papilla (see figs. 3—4) makes the males easily distinguishable. The females were identified by the character pointed out on p. 10, i. e. no spines on the scales of the lateral line below that part where the pore of the lateral line opens (fig. 8).

At present the species is known to occur on the west coast of Greenland from about 66° to 71° lat. N. The specimens from Nordre Strømfjord are of a considerable size; the largest male measures 91 mm, the largest female 116 mm.

The Zoological Museum of Copenhagen moreover possesses *Ic. spatula* from the east coast of Canada, as the Godthaab Expedition in 1928 took one male (fig. 4) and two females in Exeter Sound, Cumberland in Baffin Land, St. 166b (66°19' N. 62°18' W.); the depth was 75—200 m, the bottom temperature -1.58° C.

Furthermore, the same Museum has the species from the Kara Sea, where the "Dijmphna" Expedition in 1882—83 took 5 ♂♂ and 4 ♀♀ at depths from 65—100 fms.

According to ANDRIASHEV Russian expeditions have taken the typical *Ic. spatula* in the northern Bering Sea, in Anadyr Gulf on Kamchatka and in the Tschukchee Sea; then it goes north round Asia and into the Kara Sea¹. According to the same author it is met with at depths from 20—130 m (generally 40—70 m) and mainly at temperatures from -0.8° C. to $+2.8^{\circ}$ C. The roe is light yellow, about 1.4 mm in diameter; a female measuring 93 mm had about 1100 ripe eggs in its ovaries.

In the Okhotsk Sea and in the northern part of the Sea of Japan three subspecies of the species occur.

Before I finish my part of the present paper I wish to extend my cordial thanks to Commander of the Royal Navy RIIS-CARSTENSEN, the leader of the Danish Research Vessel "Godthaab's" investigations in 1928 in Davis Strait, Baffin Bay and Smith Sound. His reports on the expedition² in many ways have added

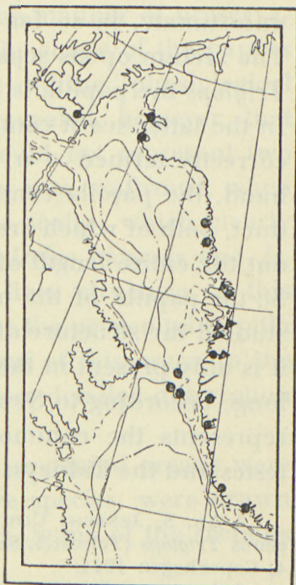
¹ Here *Ic. spatula* stops and does not occur again until off West Greenland and off north-eastern Canada. *Ic. bicornis* occurs in East Greenland and eastwards to Nowaja Zemlya, and throughout this area, which ANDRIASHEV (l. c. p. 261) calls "the North-Atlantic Ocean", it is the only species representing the *Icelus* genus. Besides, *Ic. bicornis* occurs in Kara Sea, and, as mentioned above, off West Greenland and north-eastern Canada.

² The Godthaab Expedition 1928. Report on the Expedition by EIGIL RIIS-CARSTENSEN. Medd. om Grøn. Vol. 78, Nr. 1, 1931. — The Hydrographic Work and Material by EIGIL RIIS-CARSTENSEN. Medd. om Grøn. Vol. 78, Nr. 3, 1936.

to our knowledge of the biologic and hydrographic conditions of these waters, from which zoologists have greatly benefited. In this place I furthermore wish to point out that RIIS-CARSTENSEN also undertook trawlings in the sounds in north-eastern Canada, and among the collections secured from these waters I found, as mentioned above, both *Icelus bicornis* and *Ic. spatula*, whereby it could be ascertained that both species of *Icelus* occur in America.



Map 1. The dotted parts show the distribution of *Icelus bicornis* in the area which stretches from East Greenland to the east right to Novaya Zemlya, and which ANDRIASHEV calls "The North Atlantic Ocean". Throughout this area this species is the only one representing the *Icelus* genus. The map is a copy of Abbildung 1 in ANDRIASHEV (l. c. p. 257), and its correctness—as mentioned in the above—has been verified in many ways by the present author.



Map 2. Distribution of *Icelus bicornis* (●) and *Icelus spatula* (▲) off western Greenland and north-eastern Canada.

II.

The Structure of the Urogenital Papilla in *Icelus*.

By HELGE VOISØE

The possession of an "anal" papilla is a common feature in Cottid fishes. It is of different length in the different species: in some genera and species it is completely absent, in others it is barely indicated, and in still others it is small, but distinct. In a few genera it forms a large and prominent organ. It is generally better developed in the male than in the female; in some species it is absent in the female, while large in the male. It probably often undergoes some seasonal variation in size and structure, being larger during the breeding season, but this seasonal variation has been examined in few species only.

The name of "anal" papilla, which is commonly used, is unfortunate, in so far as the papilla does not include the anus. The rectum opens separately in front of the papilla. In the genus *Triglops* the papilla is large in the male and small in the female¹. In the latter sex it contains only the urinary duct and is therefore correctly termed a urinary papilla. In the male, on the other hand, the papilla contains both the sperm duct and the urinary duct, both of which are unpaired and run independently throughout the entire length of the papilla, opening separately at its end. So the papilla of the male is a urogenital papilla.—SURBECK² studied the structure of the papilla in *Cottus gobio*. In this species it is only present in the male, and the entire papilla is only 3 mm long; according to SURBECK it contains only a single duct, which represents the common efferent canal for the products of the testes and the kidneys. The duct widens at the base of the papilla,

¹ AD. S. JENSEN: Contributions to the Ichthyofauna of Greenland. 4. The genus *Triglops* (Teleostei, Scleroparei — Cottidae). Spolia Zool. Mus. Hauniensis, 4, Copenhagen 1944.

² SURBECK, G.: Das "Copulationsorgan" von *Cottus gobio* L. Zool. Anz. 23. Jahrg., pp. 553—558, 1900.

and in this expansion are found the openings of the two vasa deferentia, of the two ureteres and of the urinary bladder. SURBECK (l. c.) called the papilla a penis, because he believed that it was used as an intromittent organ; since this function has never been proved (see below) it is better to use the neutral name: urogenital papilla.

In the arctic genera *Gymnocanthus*, *Cottunculus* and *Artediellus* (*Centridermichthys*) the males possess a large papilla, which is probably like that of *Triglops*, but the finer structure of the papilla has never been examined in these genera.

In the genus *Icelus*, finally, we find the largest and most complex papilla. The females in this genus have a small urinary papilla, much like that of the *Triglops* females (fig. 9). The males have a large urogenital papilla, which consists of two parts: a thick basal portion and a thin distal portion. ANDRIASHEV¹ used the length and shape of the papilla as an important specific and subspecific character in *Icelus*. As the senior author of the present paper found that other specific characters for separating the species were insufficient and that moreover the females could not be separated at all, he asked me to examine, whether the differences which notoriously are found in the shape of the papilla might be due to seasonal variation or to the manner of preservation. ANDRIASHEV himself remarked that the shape of the papilla is probably influenced by the preservation and the "physiological state". A histological examination soon revealed, however, that the two different shapes of the papilla could not represent two different seasonal stages. Later on this view was confirmed, when the senior author found characters in the scales, which clearly show that we have two "good" species, *Icelus bicornis* and *Ic. spatula* (see p. 6). Since, however, the finer structure of this papilla has never been described, and since the urogenital papilla of *Icelus* represents the highest development of this organ in the Cottidae we found it expedient to give a more detailed description of it here.

The papilla together with parts of the urogenital organs were excised from a male of each of the above species, were drawn (see fig. 10) and then cut in serial sections. Some of the sections

¹ ANDRIASHEV (l. c.), see p. 4.

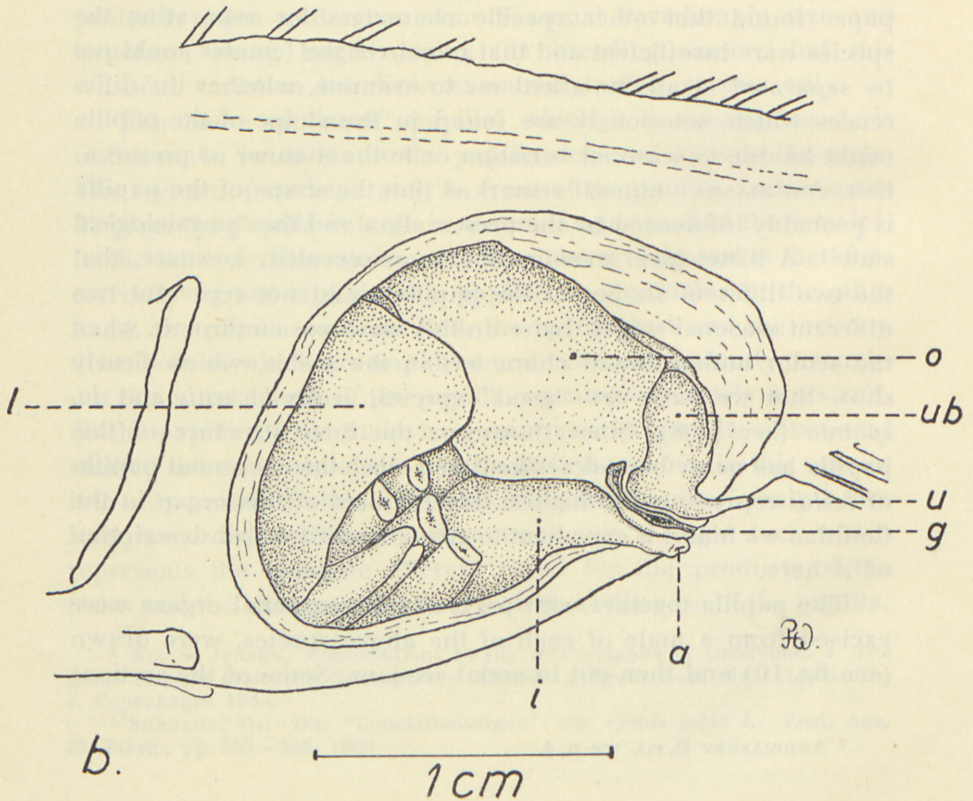
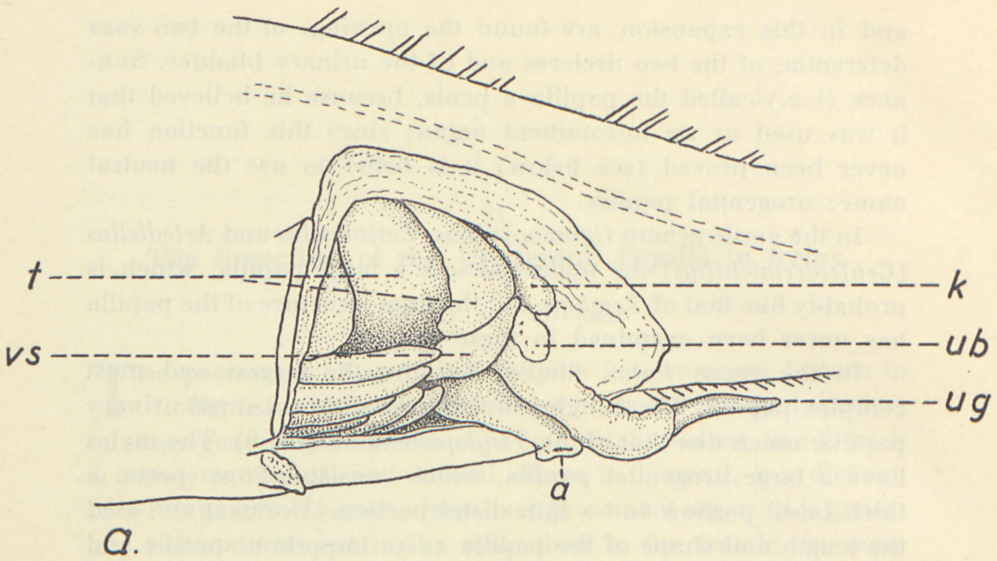


Fig. 9. Urogenital organs in situ of *Icelus bicornis*, ♂ above, ♀ below. *a*, anus; *g*, genital opening in female; *i*, intestine; *k*, kidney; *l*, liver; *o*, ovary; *t*, testis; *u*, urinary papilla in female; *ub*, urinary bladder; *ug*, urogenital papilla in male; *vs*, vesicula seminalis or ampulla.

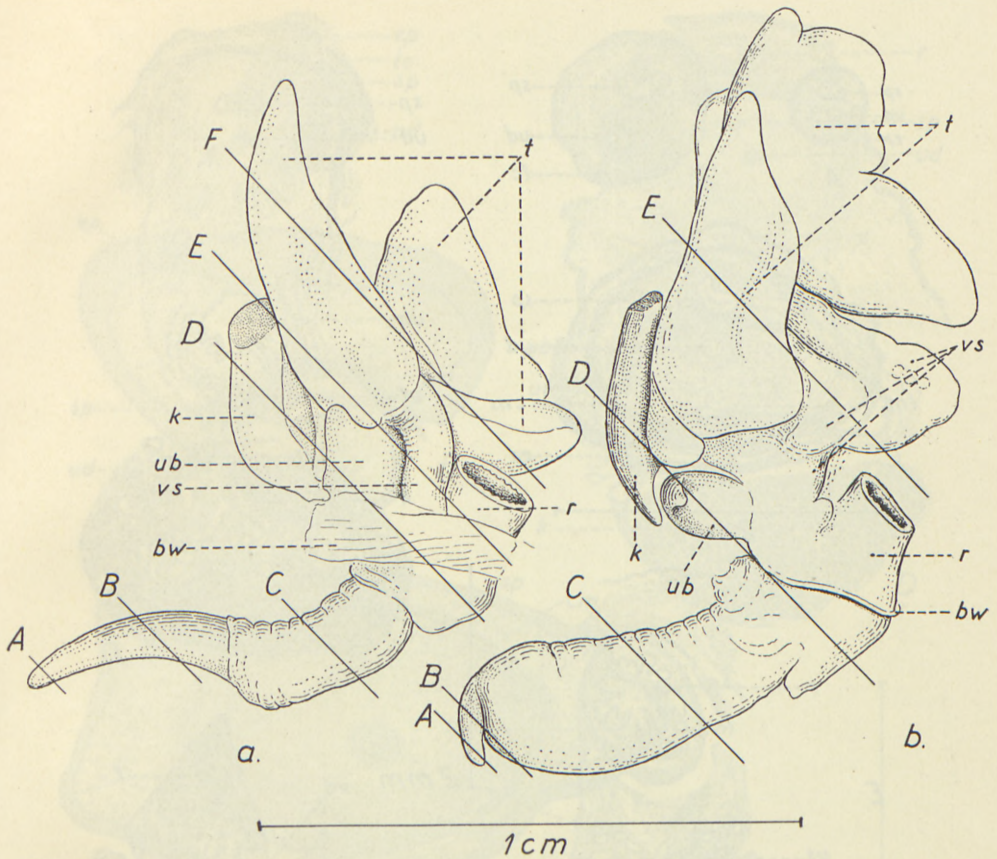


Fig. 10a & b. Isolated urogenital organs and urogenital papilla of *Icelus bicornis* (a) and *Icelus spatula* (b).—bw, body wall; k, caudal end of kidney; r, rectum; ub, urinary bladder; vs, vesicula seminalis or ampulla.—The thin lines marked A—F and A—E indicate the direction of the sections figured in figs. 11 and 12.

were drawn (figs. 11 and 12); the direction of these sections is indicated in fig. 10.

The urogenital papilla of *Ic. bicornis* consists of two parts: a basal, thicker part and a thinner, tapering distal part (figs. 9 and 10a). The two portions are of about equal length. The basal portion has a wrinkled surface and is apparently flexible. The distal portion is smooth and stiff. Throughout the papilla run two ducts (fig. 11A—C), a dorsal (or posterior) one, which is the urinary duct, and a ventral (or anterior) one, the sperm duct. The ducts open separately at the tip of the papilla. Both ducts have a single layer of columnar epithelial cells which are most

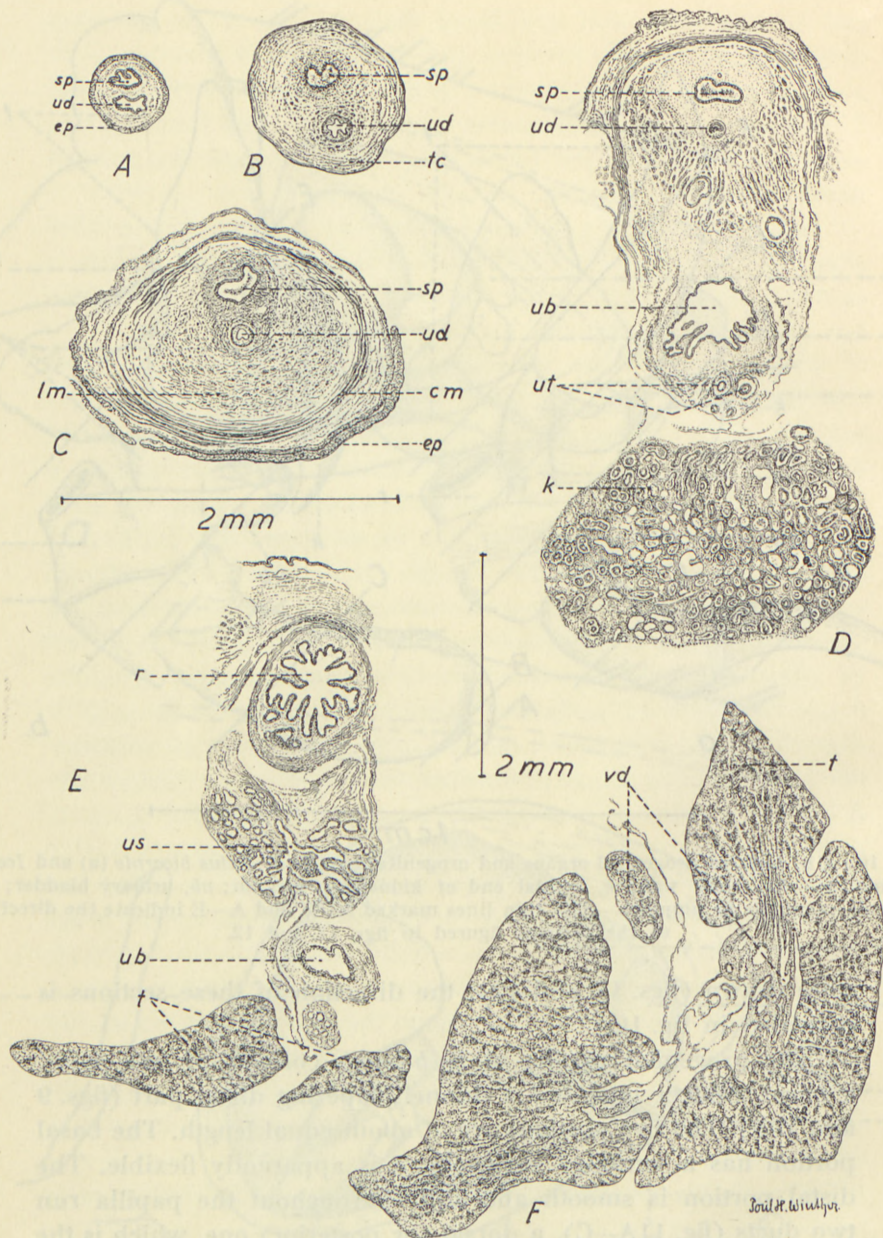


Fig. 11 A—F. Transverse sections through the urogenital papilla and the urogenital organs of *Icelus bicornis*. The organs were imbedded in paraffin and cut in serial sections of 10 μ . For explanation see fig. 12.

Fig. 12 A—E. Same of *Icelus spatula*.—The position and direction of the sections is given in fig. 10a and b. *at*, areolar tissue; *cm*, layer of circular striated muscle fibres; *ep*, epithelium; *k*, kidney; *lm*, longitudinal striated muscle fibres; *r*, rectum; *sp*, sperm duct; *t*, testis; *c*, tightwoven connective tissue; *ub*, urinary bladder; *ud*, urinary duct; *ut*, ureteres; *vs*, vesicula seminalis or ampulla.

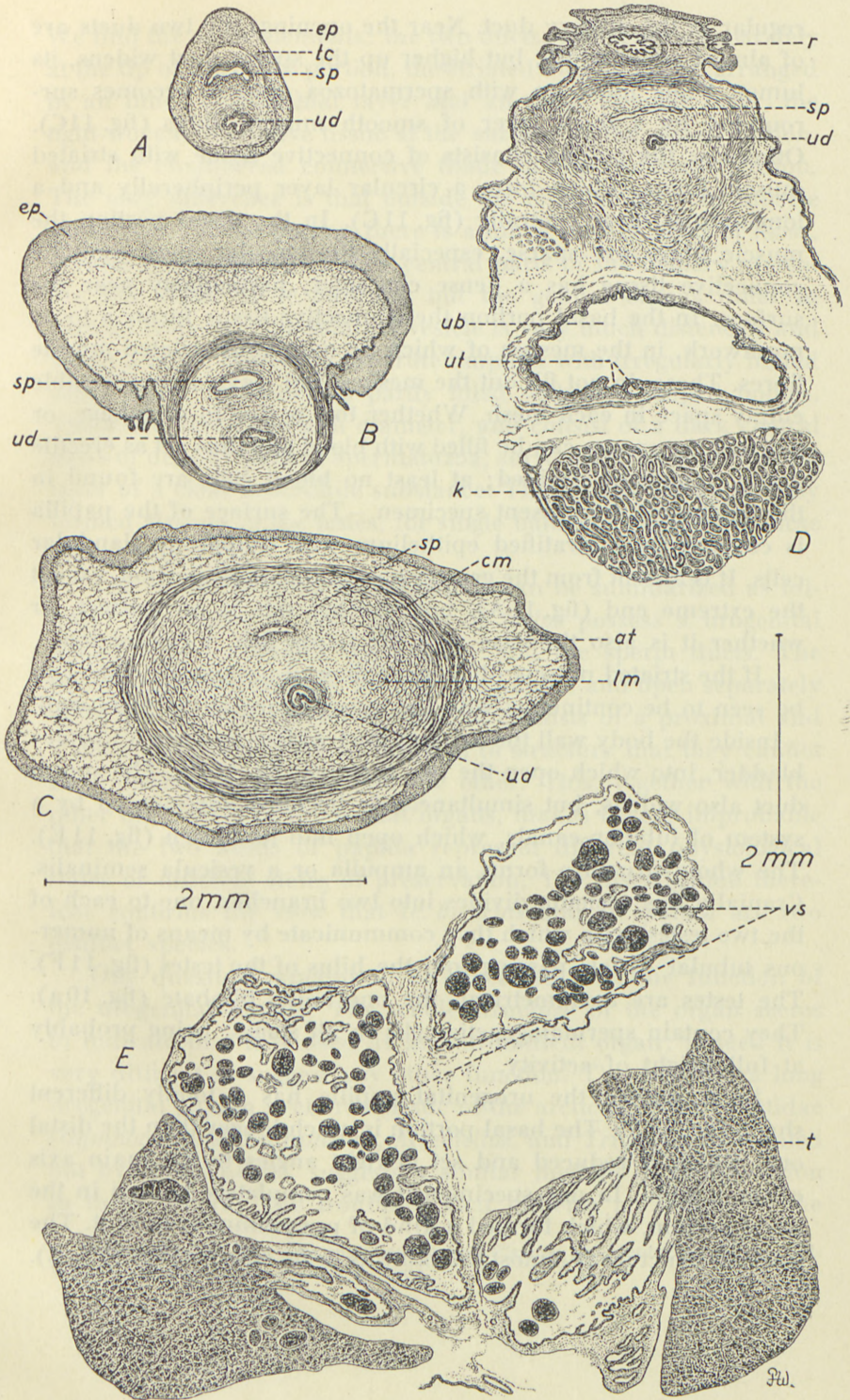


Fig. 12 A—E, see page 22.

regular in the urinary duct. Near the openings the two ducts are of almost equal width, but higher up the sperm duct widens, its lumen being filled up with spermatozoa, and it becomes surrounded by a thick layer of smooth muscle fibres (fig. 11C). Otherwise the papilla consists of connective tissue with striated muscle fibres, which form a circular layer peripherally and a longitudinal layer centrally (fig. 11C). In the distal portion the muscle fibres are sparse, especially the circular ones, and the connective tissue has a dense character, particularly near the surface. In the basal portion the connective tissue forms a loose meshwork, in the meshes of which lie numerous striated muscle fibres. These do not fill out the meshes, but leave a considerable empty space in each mesh. Whether this is due to shrinkage, or whether the spaces can be filled with blood and thus act as erectile tissue, cannot be decided; at least no blood cells are found in the meshes of the present specimen.—The surface of the papilla is covered by a stratified epithelium with numerous glandular cells. It is absent from the greater part of the distal portion, except the extreme end (fig. 11A), but whether this is an artifact, or whether it is also the case with the living fish, I cannot tell.

If the striated muscle fibres are followed proximally, they can be seen to be continuous with the musculature of the body wall.—Inside the body wall the urinary duct widens to form a urinary bladder, into which open the two ureteres (fig. 11D). The sperm duct also widens, but simultaneously becomes surrounded by a system of tubular canals, which open into its lumen (fig. 11E). The whole structure forms an ampulla or a vesicula seminalis. Cranially this vesicula divides into two branches, one to each of the two testes, with which they communicate by means of numerous tubular canals passing into the hilus of the testes (fig. 11F). The testes are asymmetrical, the one being bilobate (fig. 10a). They contain spermatogenetic cells in all stages, being probably at full height of activity.

In *Ic. spatula* the urogenital papilla has a totally different shape (fig. 10b). The basal portion is much longer than the distal one, which is reduced and set at right angles to the main axis of the papilla. In one specimen it was completely hidden in the basal portion, which formed a kind of præputium around it. The internal structure is almost the same as in *Ic. bicornis* (fig. 12A-E).

We find the same elements: the two ducts, which open separately at the tip of the distal portion, the striated muscle fibres, arranged in an inner longitudinal layer and an outer circular layer, the tight-woven connective tissue at the surface of the distal portion, and the chambered connective tissue of the proximal portion. The only difference is that outside the circular layer of muscle fibres in the basal portion there is a much thicker layer of loose, areolar tissue (fig. 12 C). The central parts of the urinary system are like those of *Ic. bicornis*; but the genital organs differ in various respects. The seminal vesicle is very much distended and forms a large, anteriorly bipartite ampulla with irregularly folded inner walls. Its lumen is partly filled with ball-shaped bodies. These are about 200 μ in diameter, and consist of a dark central mass of densely packed spermatozoa, surrounded by a peripheral layer of a clear acidophile substance. These balls are apparently formed already in the testes, for single balls are seen inside these organs (fig. 12 E).

The results of these investigations can be summarized as follows: The males of both species of *Icelus* possess a urogenital papilla which contains the urinary and the sperm ducts. The ducts pass independently through the papilla and open separately at its tip. In both species the papilla consists of a proximal and a distal part, which are so different in structure that they cannot be transformed the one into the other. This, together with the other differences in the sexual organs, makes it very improbable that the two kinds of papilla represent different physiological states or different states of preservation. The investigation therefore confirms the view that *Ic. bicornis* and *Ic. spatula* are two distinct species.

One question remains to be discussed, viz. the function of the urogenital papilla. The whole structure of the organ seems to indicate that it is used as an intromittent organ; indeed it is very difficult to suggest any other function. The fact that a long urogenital papilla is characteristic of the arctic genera of Cottidae (*Gymnocanthus*, *Cottunculus*, *Artediellus*, and *Triglops*), as pointed out by EHRENBAUM¹, suggests a similar method of reproduction in these genera. The trouble is that hitherto no female of the

¹ EHRENBAUM, E.: Eier und Larven von Fischen der Deutschen Bucht. III. Wiss. Meeresunters., N. F., Bd. 6, 1904.

above genera has been found to contain fecundated eggs or developing embryos. The only instance of viviparity in Cottids seems to be some old reports¹ from Finland, where female *Cottus scorpius* were found with far advanced embryos in the ovary. These observations have, however, not been confirmed by later investigators^{2,3}, on the contrary, it seems certain that viviparity cannot be the rule in this species. This fact does not exclude that copulation takes place and that the fecundated eggs are laid shortly after. It is, however, difficult to see how the advantage of this method of reproduction could be so great as to occasion the development of such a prominent and complex organ as the urogenital papilla in e. g. *Icelus*. For the present, however, the whole question must be left at this unsettled point, awaiting further investigations in the Arctic.

¹ NORDQVIST, O.: Rötsimpans eller "Ulkens" (*Cottus scorpius*) och hornsimpans (*C. quadricornis*) fortplantning. Svensk Fiskeri Tidskr., 6. Årg., 1899.

² EHRENBaum, E., l. c.

³ GILL, TH.: The sculpin and its habits. Smiths. Misc. Coll., vol. 47, no. 1552. 1905.