

The distribution of the fathead sculpin species *Cottunculus subspinosus* Jensen, 1902

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The range of the rarely caught fathead sculpin species *Cottunculus subspinosus* has been considered restricted to the waters off East Greenland and Northeast Iceland. For the first time the species is recorded from the east side of the Norwegian Sea, and also it is found further north in the Greenland Sea than previously known. Mapping all the corroborated specimens known indicates that the species seems confined to the continental slopes of the Nordic Seas, where it is found in waters with a temperature below zero and a depth of more than 900 m. Depth distribution shows almost no overlap with the closely related sympatric *Cottunculus microps*, perhaps as a result of competitive exclusion.

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INTRODUCTION

The family Psychrolutidae (Scorpaeniformes: Cottoidei) consists of 8 genera and about 38 species, which are more or less tadpole-shaped, limp, and scale-less (Nelson et al. 2016) and live in the benthic zone from shallow waters to 2800 m depth (Fedorov & Nelson 1986). In the North-eastern Atlantic two species occur in the arctic and subarctic part of the ocean, one of which, *Cottunculus microps* Collett, 1875, is common and widespread, while the other one, *Cottunculus subspinosus* Jensen, 1902, is known from only a few specimens (Fedorov & Nelson 1986, Mecklenburg et al. 2011, Byrkjedal et al. 2014). *C. subspinosus* has frequently been placed in the genus *Psychrolutes*, but its inclusion in *Cottunculus* is now strongly supported by DNA sequencing (Mecklenburg et al. 2018).

C. subspinosus was first described from four specimens caught off northeast Iceland by the Ingolf Expedition in 1895-

1896 (Lütken 1898; Jensen 1902) and these remained the only known specimens until 1989, when additional nine specimens were caught off eastern Greenland by the Shinkai Maru expedition (Møller et al. 2010). Subsequently, the species has been reported from Northeast Greenland, Iceland and near Jan Mayen Island (Christiansen 2003; Fossum et al. 2012; Jónsson & Pálsson 2013).

A few more specimens have been caught by recent research cruises, and especially one of them extends the known distribution of this species in the Nordic Seas considerably. The latest range map published for the species is that of Jónsson & Pálsson (2013). From the new records and a re-examination of the earlier published ones the present paper aims to draw a more complete and accurate picture of the geographic and spatial distribution of *C. subspinosus*. With possible interspecific competition in mind, a comparison of its depth distribution

is made with that of the morphologically similar sympatric psychrolutid species *C. microps*.

MATERIAL AND METHODS

The paper is based on unpublished material recently brought to the University Museum of Bergen, a re-examination of published records (Christiansen 2003; Møller et al. 2010; Fossum et al. 2012; Jónsson & Pálsson 2013), and an online search of records entered in Global Biodiversity Information Facility (GBIF; <http://www.gbif.org/>).

The unpublished material was obtained from the TUNU-IV Expedition (R/V ‘Helmer Hanssen’, August 2010) and the MAREANO project (R/V ‘G.O. Sars’, May 2012), the latter a project run by the Institute of Marine Research, Bergen, aiming to map benthic organisms off the Norwegian coast (www.mareano.no). The TUNU expedition used a Campelen 1800/96 NOFI bottom trawl with 49 m wing spread and a cod-end of 22 mm mesh size towed for 22 min at a speed of 2.4 knots, and the fish were frozen on board for final preservation and storage at the University Museum of Bergen. The MAREANO used a beam trawl with an opening of 2x2 m and a 4 mm mesh size, towed on the bottom for 5 min at a speed of 1 knot. The fish caught by this project (one specimen) was fixed in formalin on board, and final species identification was done at the museum as the material was transferred to 75% ethanol for permanent storage.

Circumstances of previously published catches were described by Lütken (1898), Knudsen (1899) and Fossum et al. (2012), and the Shinkai Maru expeditions in Greenland waters by Okamura et al. (1995). The species was, however, not mentioned by Okamura et al. (1995), yet it did appear in the Shinkai Maru material brought to the Zoological Museum, University of Copenhagen (Møller et al. 2010 and pers. comm.). Judged from date and coordinates two specimens in the Zoological Museum, University of Alberta, almost certainly originated from one of the Shinkai Maru stations, but this has not been possible to confirm.

The depth distribution of *C. subspinosus* was based on data from specimen labels, and compared to that of *C. microps* from a material ranging from East Greenland to Svalbard and the Barents Sea, held in the collections of the University Museum of Bergen. In cases where depth at a trawl station was available as a maximum-minimum interval, the median value was used in calculations.

RESULTS

Cottunculus subspinosus is presently known to science from 14 geographic locations, comprising 48 specimens, of which 28 are permanently preserved and kept in scientific collections (Table 1, Figure 1). A majority of the locations (11) are on the

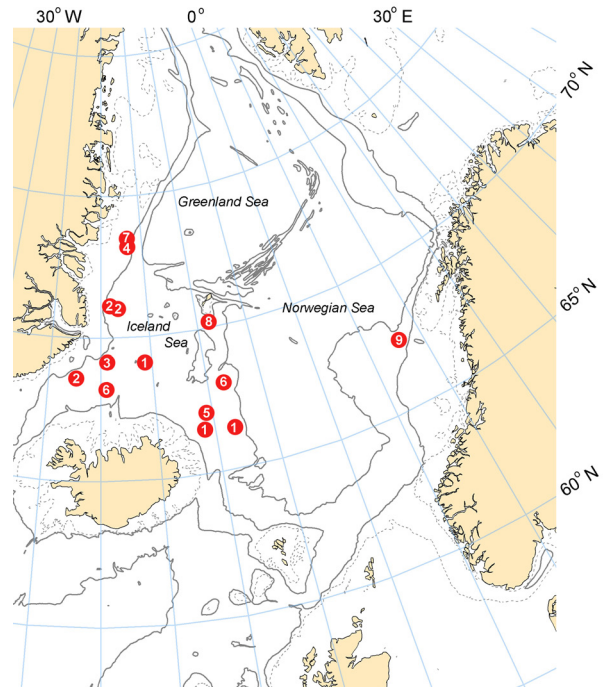


Figure 1. Known locations of *Cottunculus subspinosus*. Sources: 1 = Lütken (1898); Knudsen (1899); Jensen (1902). 2 = Zoological Museum, University of Copenhagen. 3 = Zoological Museum, University of Alberta. 4 = Christiansen (2003). 5 = Swedish Museum of Natural History, Stockholm. 6 = Jónsson & Pálsson (2013); Pálsson pers. comm. 7 = this study TUNU-IV Expedition. 8 = Fossum et al. (2012). 9 = this study MAREANO project. Further details in Table 1. The Greenland, Iceland and Norwegian Seas comprise the Nordic Seas.

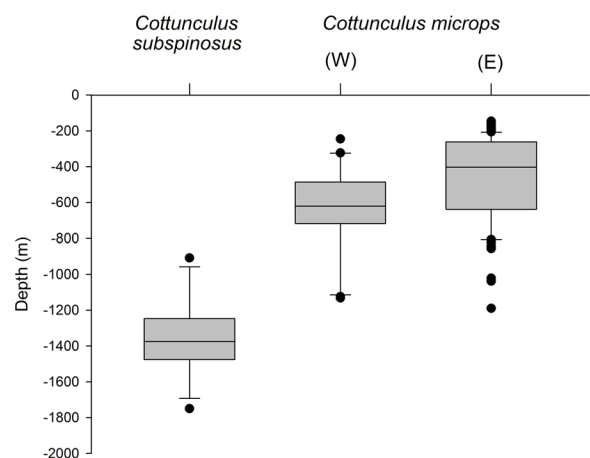


Figure 2. Depth distribution of *Cottunculus subspinosus* locations (n = 14 locations) compared to that of *C. microps* in northeastern Greenlandic waters (West, ‘W’; n = 23 locations) and in the Barents Sea – Svalbard region (East, ‘E’; n = 80 locations). Data for *C. microps* are from specimens held in the collections of the University Museum of Bergen. Median depths shown by horizontal bar, upper and lower quartiles by boxes, 95 percentiles by whiskers, and extremes by dots.

Table 1. Known specimens of *Cottunculus subspinosus*. ZMUC = Zoological Museum, University of Copenhagen; Univ. Alberta = Museum of Zoology, University of Alberta; ZMUB = University Museum of Bergen; NRM = Swedish Museum of Natural History, Stockholm; HAF = Marine Research Institute, Reykjavik.

Coordinates	Date (dd.mm.yyyy)	Depth (m)	Bottom tem- perature (°C)	Bottom substrate	Number of preserved specimens	Collection catalogue no.	Project	Sources referred to under following numbers in Figure 1
N 68°08' – W 16°02'	29.07.1897	1333	-0.8	Brown mud ^a	2	ZMUC 1-2	Ingolf Expedition	1
N 66°23' – W 10°26'	10.07.1896	1372	-0.9	Brown mud ^a	1	ZMUC 3	Ingolf Expedition	1
N 66°23' – W 7°25'	10.07.1896	1750	-1.1	Light grey-brown mud ^a	1	ZMUC 4	Ingolf Expedition	1
N 68°19' – W 23°14'	22.09.1989	1476–1460			3	ZMUC 812646–48	Shinkai Maru 1989	2
N 68°49' – W 19°44'	25.09.1989	1380–1371			2	ZMUC 812649–50	Shinkai Maru 1989	3
N 71°06' – W 19°09'	28.09.1989	918–898			2	ZMUC 812644–45	Shinkai Maru 1989	2
N 71°04' – W 18°42'	28.09.1989	1488–1480			2	ZMUC 815651–52	Shinkai Maru 1989	2
N 68°49' – W 19°44'	25.09.1989				2	Univ. Alberta, F7337	Shinkai Maru 1989 (?)	3
N 73°05' – W 16°22'	13.10.2003	993–975	-0.6 – -0.4	Coral field with <i>Virgularia</i> sp. ^b	2*	ZMUB 16921	TUNU-I	4
N 66°57' – W 10°44'	19.07.2004	1487–1451	-0.77	Gravel and silt ^c	1**	NRM 60782	BIOICE	5
N 68°08' – W 19°04'	21.10.2004	1216–1107			1	HAF 2004-013		6
N 68°01' – W 8°34'	19.08.2008	1470–1449			2	HAF 2008-001		6
N 73°09' – W 16°22'	14.08.2010	1038–1024	-0.86 – -0.94		5***	ZMUB 20992	TUNU-IV	7
N 70°14' – W 8°50'	25.10.2010	1339			1	ZMUB 20932	JM OED environm. cruise	8
N 67°33' – E 8°34'	07.05.2012	1608	-0.81	Fine-grained compressed substrate ^d	1	ZMUB 23013	MAREANO	9

^a Lütken (1898); ^b Christiansen (2003); ^c Swedish Museum of Natural History, Stockholm; ^d Tandberg et al. (2012)

* 9 specimens recorded caught; ** 4 specimens reported caught; *** 15 specimens recorded caught

slopes surrounding the sea north of Iceland (Iceland Sea, *sensu* Blindheim 2004) while two are on the southwestern slope of the Greenland Sea and one on the eastern slope of the Norwegian Sea.

Depth distributions are known for all locations (Table 1), ranging from about 900 m to 1750 m, with most of the catches between 1300 and 1500 m (Figure 2). The depth distribution of *C. subspinosus* vs. *C. microps* shows a clear-cut segregation in the realised habitat for the two sympatric psychrolutids. *C. subspinosus* inhabits the deeper slopes, whereas *C. microps* is confined to waters of less depths (245 – 1090 m). The depth distribution of *C. microps* in the Greenland Sea region, where it could have gone far deeper, is the same as in the shallower Barents Sea (Figure 2). Bottom temperatures were available for seven of the *C. subspinosus* locations and all of them had sub-zero waters, ranging from -0.4 – -1.1 °C (Table 1).

Information on bottom substrate was available for six locations (Table 1). Fine-grained substrate was generally found, either as soft mud or as more firmly compressed substrate. Mud and gravel was recorded at one location and coral fields (with *Virgularia* sp.) at another. The easternmost location had a bottom fauna dominated by fanworms (Sabellidae) on the more compressed substrate found there.

DISCUSSION

The present study substantiates that *C. subspinosus* is distributed in the deep and cold waters along the continental slopes of the northeast Atlantic Ocean. The species has not been documented outside the Nordic Seas, *contra* map shown by Jónsson & Pálsson (2013) which extends the distribution along SE Greenland south of Denmark Strait.

The record on the eastern side of the Norwegian Sea extends the known range of *C. subspinosus* considerably, about 730 km eastward from the previously known locality nearest to it. The Psychrolutidae primarily comprises species with demersal eggs and a sedentary benthic life form (Fedorov & Nelson 1986), and it is unlikely that *C. subspinosus* undertakes long-distance migrations. The occurrence of the species on the Norwegian slopes is therefore probably not due to recent colonisation.

From the present records we would expect *C. subspinosus* to be continually distributed along the deeper slopes surrounding the Norwegian Sea, but to verify that, the species will have to be looked for on the northern slopes of the Iceland-Faroes-Norway Ridge, for which there presently is a hiatus in the documented range. Also, we do not know if the range extends to the deep plains of the Nordic Seas, which do have temperatures below zero (Blindheim 2004). Furthermore, the northern limit of the species' range has probably not yet been established in spite of many years of fisheries research carried out in the western part of the Barents Sea and around Svalbard (e.g., Wienerroither et al. 2011). Most of that sampling has probably not been deep enough for the species to be obtained. Future sampling deeper

than 1000 m in those waters would be needed. However, the species was not observed by Soltwedel et al. (2009) during samplings at the slope from Vestnesa Ridge (1650 m depth) to the Molloy Hole (5500 m depth) at about 79°N west of Spitsbergen.

With almost no overlap, the depth range of *C. subspinosus* succeeds that of the sympatric and common *C. microps*. The two species are morphologically very similar, and the distinct depth segregation could be a result of competitive exclusion. After all, the number of specimens caught on two of the trawl stations off NE Greenland (9 and 15 individuals, Table 1) indicates that *C. subspinosus* might be abundant in places. Usually, *C. microps* occurs in no higher numbers in bottom trawl hauls even in areas where it is considered common: 111 specimens of *C. microps* caught in 60 hauls (gear and towing time similar to the Greenland samplings) distributed over western Barents Sea (Byrkjedal & Høines 2007), gave median, as well as upper quartile numbers, of only 2 specimens per station, and a maximum of 6. However, because *C. subspinosus* is known from so few specimens, details about its feeding ecology and life history are virtually unknown (Fedorov & Nelson 1986). The two species are apparently also adapted to different temperatures, with *C. subspinosus* found solely in sub-zero waters and *C. microps* (Byrkjedal & Høines 2007) chiefly in temperatures above zero, and this could also explain their difference in depth distribution. In the North-western Atlantic *C. microps* overlaps in distribution with *Cottunculus thomsonii* (Günther, 1882) in Baffin Bay – Davis Strait. Here these two species seem not to be depth-segregated, but *C. thomsonii* is found in somewhat warmer water than *C. microps* (Coad & Reist 2018).

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