

Approaching the Arctic: the occurrence of Parin's spinyfin *Diretmichthys parini* (Beryciformes: Diretmidae) in the Nordic Seas

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Two adult specimens of the tropical to subtropical fish species *Diretmichthys parini* are reported from the North Sea and the northern Norwegian Sea, respectively. Both were accidentally caught as bycatch by commercial trawlers. Although not uncommon in Icelandic waters, it has not been documented from the Nordic Seas previously. In light of the major currents and water temperatures in the area, this is puzzling. Whether this pattern reflects a true distributional change or increased awareness and reporting from fishermen is not known.

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INTRODUCTION

Parin's spinyfin *Diretmichthys parini* (Post & Quéro, 1981) is a deep water species mainly distributed in tropical and subtropical regions between 40° north and 40° south, in the meso- and bathypelagic zones (Post & Quéro 1981, Priede 2017). In these respects, all the four species of spinyfins (Diretmidae) are quite similar, and three of the species are known from the North Atlantic (Post 1986, Moore 2016). They overlap in their distribution, but so far only the present species is found in the Nordic Seas as defined by e.g. Blindheim (2004).

Little is known about the ecology of *D. parini*, but small teeth and filtering gill rakers seem to indicate a planktivorous diet (Moore 2016), and stable isotope ratios have recently confirmed this view (Cresson *et al.* 2017). Judged from the fact that a 33 cm TL Parin's spinyfin was estimated from otoliths to be 33 years, the life history might, according to Cresson *et al.* (2017), be similar to that of the slow growing and long-living orange roughy *Hoplostethus atlanticus* Collett, 1889 (see e.g. Minto & Nolan 2006). On the IUCN Red List of threatened species, it is currently listed as 'Least Concern' due to no commercial interest (Iwamoto 2015).

With the exception of 118 specimens caught during a single two hour trawl haul off Western Sahara in 1973 (Maurin & Quéro 1982), most records are single by-caught individuals such as one from Bay of Biscay (Arronte & Heredia 2006) and two specimens from Galicia Bank seamount between 1980–2011 (Bañon *et al.* 2016). Further north, two specimens have been recorded from Rockall Bank and the Faroe-Scotland Ridge at about 60°N (Quero *et al.* 1998). A specimen caught in the North Sea at 62°15'N, for which also biological

parameters were investigated (Cresson *et al.* 2017), was claimed to represent the northernmost record. However, Parin's spinyfin is caught almost annually off the eastern, southern and western coast of Iceland, close to 66°N (Jónsson & Pálsson 2013).

In the Northwest Atlantic, some specimens have been recorded from Georges Bank and Gulf of Maine (Moore *et al.* 2003) north to the Grand Banks (Kotlyar 1987). Although also found in the South Atlantic-, Pacific- and Indian oceans (Iwamoto 2015), the present paper will focus on the distribution in northern parts of the eastern Atlantic.

Here we report two new occurrences of *D. parini*, one of which is so far the northernmost record of the species in the world.

MATERIALS AND METHODS

Two specimens of *D. parini* were caught as bycatch from commercial trawlers and frozen for later identification. The trawler "Havbryn" has been part of the Norwegian Reference Fleet since 2015. The reference fleet is a comprehensive self-sampling scheme the Institute of Marine Research has with the commercial fishing fleet (IMR 2013). It provides not only data for improving the fish stock advice but is also an invaluable source for data on biodiversity. Compared to scientific surveys the trawl duration is usually much longer, which increases the chances for catching rare species. This is particularly so with a species as generally rare as *D. parini*. The close dialogue between scientists and fishermen secures also a verified species identification.

The trawler 'Tønsnes' is regularly operating in the Nordic Seas,

and similar to ‘Havbryn’, trawling duration and frequency is far higher than scientific surveys. There is no regular contact between the crew and scientists, but by coincidence one of the crew members noticed an unusual catch and kept it frozen for over two years.

Both specimens were donated to the University Museum of Bergen, Norway. Selected meristics and morphometrics were taken to nearest mm (with a ruler) or to nearest 0.1 mm (Vernier caliper) and are presented in Table 1. A tissue sample (muscle) was preserved in 96% ethanol. Finally, the specimens were fixed in formalin and stored in 75 % ethanol and were deposited in the fish collection of the Bergen University (ZMUB). Species identification was based on Post (1986) and Moore (2016).

RESULTS

Material examined:

ZMUB 23827 (DNA tissue sample VEV-4585), 311 mm SL, 1215 g, North Sea 62°17'N 1°10'E, 5 June 2015, bottom trawl (mesh size 130 mm), depth 495–585 m, commercial trawler ‘Havbryn’.

ZMUB 23826 (DNA tissue sample VEV-4574), 292 mm SL, 910 g, west off the bank Tromsøflaket 71°43'N 16°14'E, 10 April 2017, bottom trawl (mesh size 130 mm), depth 380–450 m, commercial trawler ‘Tønsnes’.

DISCUSSION

The Diretmidae family is characterized by their very large eyes, lack of lateral line and long-based dorsal and anal fins (Moore 2016). Within the family there are four species worldwide, and the combination of an anus located mid-way between pelvic and anal fins, a total number of 18 gill rakers and 28 dorsal fin rays (Table 1), leaves *Diretmichthys parini* as the only option (Post 1986, Kotlyar 1987, Moore 2016). The

two specimens reported here represent the second and third records of the Parin’s spinyfin off Norway (Figure 1), and the northernmost of these (ZMUB 23826, Figure 2) is close to Arctic waters as delimited by Mecklenburg *et al.* (2018). The first record was reported by Cresson *et al.* (2017) from 62°15'N, 1° 03'E, 277 mm SL, caught in June 2015, at the same time and not far from where the second specimen (ZMUB 23827) was caught. Although the species is undoubtedly rare in the North Atlantic, it has been found frequently in eastern, southern and western parts of Icelandic waters since 1992 (Jónsson & Pálsson 2013). This could indicate that it is more common than previously thought or, that a northeastward extension of its distribution is about to take place. A northward expansion in the northeastern Atlantic seems to be indicated by catches north to the British Isles in the last decades, as summed up by Cresson *et al.* (2017). The present climate change bringing warmer waters into the Northeast Atlantic (Perry *et al.* 2005,

Table 1. Morphometric and meristic data for the two North Atlantic specimens of *Diretmichthys parini*. All lengths are expressed in millimeters and weight in grams.

	ZMUB 23826	ZMUB 23827
Weight	910	1215
Standard length	292	311
Total length	350 (estimated from proportion on photo)	390
Body depth	131.3	138.2
Snout length	20.3	23.4
Eye diameter	42.3	46.1
Postorbital length	33.3	33.7
Length of caudal peduncle	34.0	36.8
Height of caudal peduncle	33.2	33.5
Length, dorsal fin base	131.8	145.8
Length, anal fin base	94.0	96.4
Length, pectoral fin (left/right)	damaged/70.3	69.2/72.1
Length, pelvic fin (left/right)	80.2/damaged	82.0/82.7
Length, caudal fin	64 (damaged, estimated from proportion on photo)	68 (damaged, estimated from proportion on photo)
Number of dorsal fin rays	28	28
Number of anal fin rays	21	21
Number of pectoral fin rays	17/17	17/17
Number of pelvic fin rays	7/7	7/7
Number of caudal fin rays	20	20
Number of procurrent caudal fin rays (dorsally/ventrally)	5/3	3/3
Number of pre-anal scutes	11	10
Number of post-anal scutes	14	15
Number of gill rakers	6 + 1 + 11	6 + 1 + 11
Tip of pelvic fin	at anal fin origin	4 mm anterior to anal fin origin

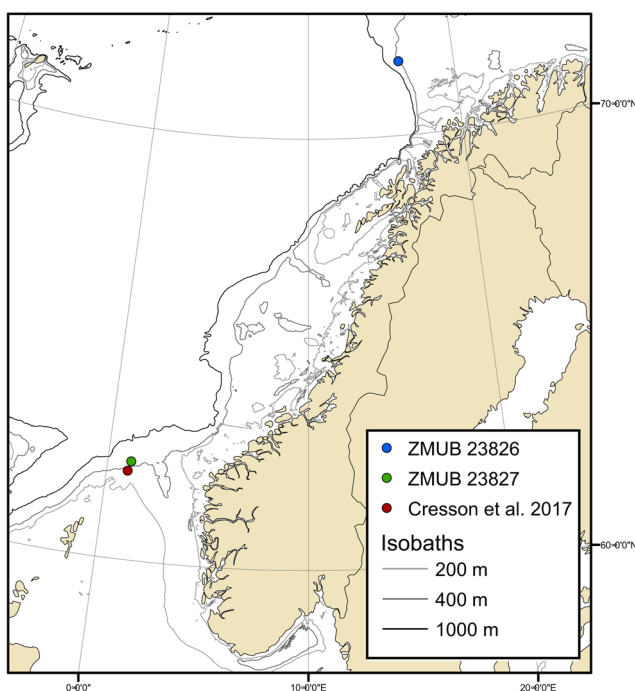


Figure 1. Map showing the two *Diretmichthys parini* specimens in the present study, as well as the specimen by Cresson *et al.* (2017).



Figure 2. *Diretmichthys parini* ZMUB 23826, Tromsøflaket 2017, 292 mm SL. By convention, fish should be photographed on their left side, but this was unknown to the photographer when the photo was taken at sea in 2017. Photo: Berit M. Bugjerde.

Ingvaldsen *et al.* 2006), may facilitate such an expansion, perhaps leading to the species' establishment in the Nordic Seas. In fact, a spawning specimen was caught south of Iceland in January 2004, in 6°C water (Jónsson & Pálsson 2013).

On the other hand, rare species may be caught by fishermen without being reported. The reason may be due to limited time available on board, or simply no tradition or opportunity for reporting extraordinary catches, as exemplified by the Indonesian coelacanth that turned out to be fairly well known among local fishermen (Erdmann *et al.* 1998). It is often difficult to judge whether a species actually changes its distribution or is more frequently reported due to an increased awareness by fishermen.

The Parin's spinyfin is usually found at depths from 250 to 2000 m (Moore *et al.* 2003, Cresson *et al.* 2017, OBIS database 2019). The western parts of the Nordic Seas are strongly influenced by the East Greenland Current which carries cold water from the Polar Basin and creates subzero water temperatures. This is in contrast to the warmer Atlantic water flowing northwards along the eastern part which contributes to keep the temperature above zero down to a depth of between 500 and 1000 m (Blindheim 2004). Pelagic species, such as the *D. parini*, are therefore more likely to reach high latitudes along the Norwegian coast and on the western edge of the Barents Sea than in waters north of Iceland and off northeast Greenland, as indicated by recent records of Atlantic species (Svendsen *et al.* 2011, Wienerroither & Bjelland 2013).

Despite being characterized as a "tropical to subtropical" species, the adults are found in the bathypelagic zone (Kotlyar 1987). Within the preferred latitudinal range (40°N–40°S), the annual average temperature at 1000 m depth is generally less than 4°C in the Pacific Ocean, and less than about 10°C in the Indian- and Atlantic Oceans (NOAA database 2019). Towards 2000 m depth, the corresponding temperatures are reduced to about 2 and 5°C, respectively. In the deep waters (>600 m) of the Nordic Seas, the temperature is considerably lower and typically below 0°C (Blindheim 2004). However, on the shelf at the northernmost record, near Tromsøflaket, bottom temperature was rarely above 5°C in recent years (Boitsov *et al.*

2012). In other words, the temperature at the bottom or deep water does not seem to represent a physical barrier to Parin's spinyfin latitudinal distribution. However, as filtering planktivore, it could potentially conduct vertical migrations. If so, the generally restricted distribution range in lower latitudes may be a compromise between bioenergetics and predation risk (Neilson & Perry 2001). According to the OBIS database (2019), most specimens are caught in stations where the surface temperature ranges from 15–30°C, and these high temperatures are on average maintained throughout the epipelagic zone (NOAA database 2019). Young specimens are found near the surface (Schneider 1990). The high temperatures here may explain the general distribution pattern to lower latitudes.

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