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# Range extension and first record of the deep-sea brittle star *Ophiactis abyssicola* (Echinodermata: Ophiuroidea) in Canadian waters

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## Abstract

This paper presents the first records of the brittle star *Ophiactis abyssicola* in Canadian waters and range extensions of up to 1900 km in the Northwest Atlantic from previously known locations. Samples were collected off northern Labrador and the northern portion of insular Newfoundland (eastern Canada) at 433 and 1097 m depths, respectively. This newly recorded species of brittle star from the bathyal zone off Newfoundland and Labrador adds to the marine biodiversity of Canada and to the general distribution knowledge of *O. abyssicola*.

## Introduction

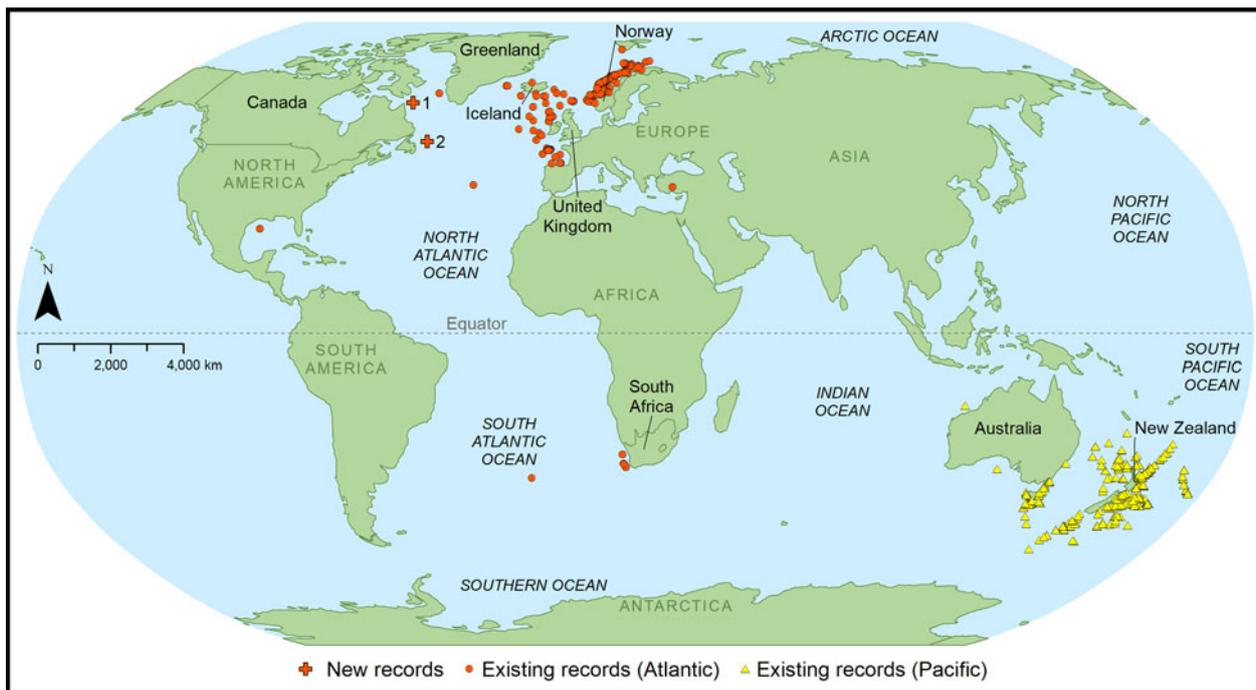
Brittle stars (Ophiuroidea) are among the most common echinoderms in oceans worldwide, including the deep waters of the North Atlantic and Arctic basins (e.g. Piepenburg & von Juterzenka, 1994; Mayer & Piepenburg, 1996; Piepenburg & Schmid, 1996; Piepenburg, 2000; Smirnov *et al.*, 2014). They are often described to dominate megafaunal assemblages (Cusson *et al.*, 2007; MacDonald *et al.*, 2010; Piepenburg *et al.*, 2011; Roy *et al.*, 2015; Lacharité & Metaxas, 2017) and they play important ecological roles in both inshore and offshore habitats (Gerald *et al.*, 2017; Volage *et al.*, 2021). Despite the growing number of exploratory surveys in northern Canada, brittle stars remain incompletely inventoried and poorly described.

The brittle star *Ophiactis abyssicola* (M. Sars, 1861) is a morphologically variable species that has been reported from both hemispheres in the Pacific and Atlantic Oceans (Figure 1). However, records from the South Pacific around New Zealand and Australia (Stöhr *et al.*, 2021) are most likely *Ophiactis cuspidata* Lyman, 1879, currently accepted as a subspecies of *O. abyssicola*, but representing a separate genetic clade (O'Hara *et al.*, 2014). In the Atlantic, *O. abyssicola* is reported from western Greenland (Smirnov *et al.*, 2014), Iceland and in other Scandinavian waters, around northern UK, western France, northern Spain, the Azores, Canaries, Cape Verde and the Gulf of Mexico (USA) (OBIS, 2021), as well as off South Africa (Mortensen, 1933; Olbers *et al.*, 2019) and Tristan da Cunha (Lyman, 1882). *Ophiactis abyssicola* is known to occur on fine sand, gravel, shells and rocks, and among sponges, corals and other sessile organisms (Farran, 1912; Stöhr & Segonzac, 2005). In the North Atlantic, it has been found at depths ranging between 118–2107 m (Koehler, 1909; Stöhr & Segonzac, 2005; Martynov & Litvinova, 2008).

Despite this relatively broad distribution, *O. abyssicola* was conspicuously absent from records in Canadian waters (Figure 1). Two sampling campaigns conducted in deep waters off Newfoundland and Labrador confirmed its presence there, filling a major gap in the North Atlantic distribution of the species.

## Methods

Specimens were collected along the continental shelf of eastern Canada in two regions. In Newfoundland, sampling occurred opportunistically during the annual multispecies bottom-trawl surveys operated by the Department of Fisheries and Oceans Canada (DFO) with the vessel CCGS *Teleost* in November 2013 inside the North Atlantic Fisheries Organization (NAFO) subdivision 3K. A Campelen 1800 shrimp trawl was used following a stratified-random design towed for 15 min for ~1.4 km (gear opened and closed at depth). Details of the type of gear and net can be found in Walsh & McCallum (1997). In Labrador, eight samplings (across seven stations) were carried out with the vessel CCGS *Amundsen* in September 2020 inside the NAFO subdivisions 2G and 2H. A rock dredge (mesh size of 7 mm) was deployed between 123–804 m depths while the ship moved at a maximum speed of 2 knots for a duration ranging between 5 and 10 min of bottom time.



**Fig. 1.** World map showing existing and new records of *Ophiactis abyssicola* in the Atlantic and existing records attributed to *O. abyssicola* in the Pacific, which are likely *O. abyssicola cuspidata* (O'Hara *et al.*, 2014). Sites 1 and 2 from eastern Canada represent new records off northern Labrador and off insular Newfoundland, respectively.

Upon collection, brittle stars were sorted and preserved in 100% ethanol. The preserved specimens were examined under a dissecting microscope (M205A, Leica Microsystems, Singapore) and photographed (DFC7000T, Leica Microsystems, Wetzlar, Germany) with the software Leica Application Suite X, and identified morphologically using published keys and descriptions (Mortensen, 1927; Paterson, 1985). A voucher specimen was deposited at the Canadian Museum of Nature (Ottawa) under catalog number CMNI 2021-0509.

For molecular identification, the mitochondrial cytochrome c oxidase subunit I (COI) gene of one sample (September 2020) was sequenced using standard echinoderm primers (LCOech1aF1 TTTTCTACTAAACACAAGGATATTGG and HCO2198 TAA ACTTCAGGGTGACCAAAAATCA; Folmer *et al.*, 1994) and standard polymerase chain reaction (PCR) and DNA sequencing protocols (Ivanova *et al.*, 2006; DeWaard *et al.*, 2008). The sample was processed through the Canadian Centre for DNA Barcoding (University of Guelph) and compared with published sequences of specimens collected in the North Atlantic and around Norway on Barcode of Life Database (BOLD) and GenBank. We used BOLD ID engine, which assigns unknown sequences into BINS with other known sequences to obtain an identification (see Ratnasingham & Hebert, 2013 for details). The partial COI sequence with all meta-data were registered on BOLD, project AMLAB, and deposited in GenBank (accession number MZ364349).

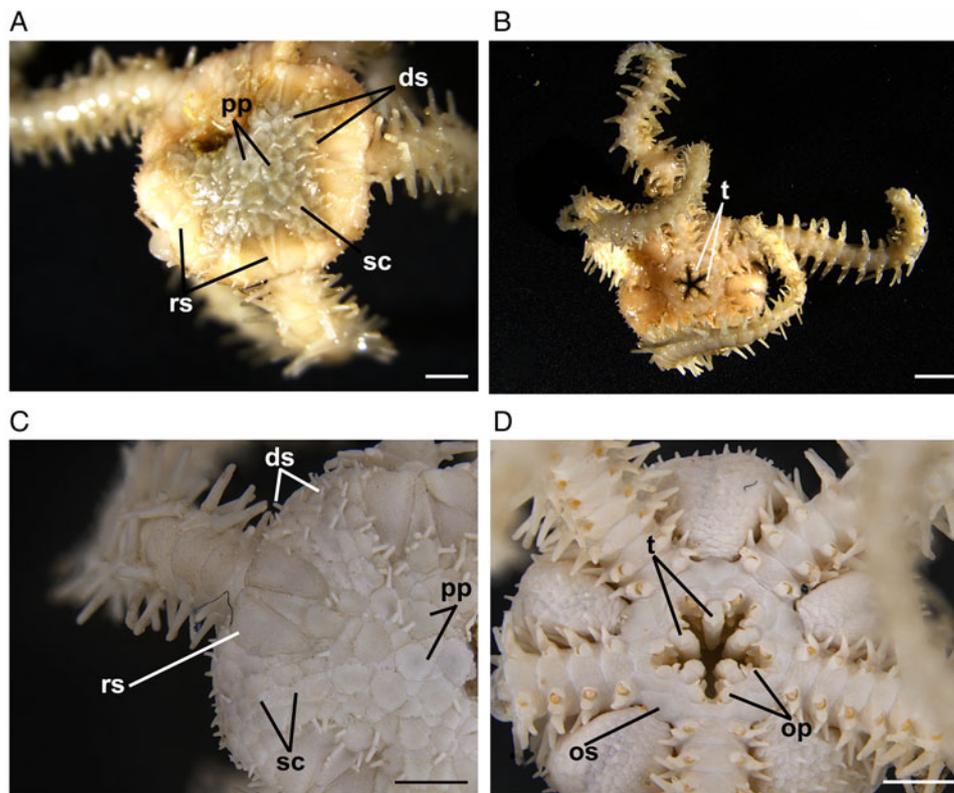
## Results

Two brittle star specimens were examined. The first was collected on 30 November 2013 along the northern coast of Newfoundland (49°58'00"N 49°45'24"W) at 1097 m depth and the other was collected on 2 September 2020 off northern Labrador (60°33'32"N 61°23'42"W) at 433 m depth (Figure 1). The specimens belong to the family Ophiactidae due to their tricuspid teeth (O'Hara *et al.*, 2018). They concur with the descriptions of *Ophiactis abyssicola* by Mortensen (1927) and Paterson (1985),

and the COI results showed 100% similarity with records of *O. abyssicola* available in GenBank and BOLD. Main diagnostic characters observed in these specimens (~5 mm in diameter) are pentaradial symmetry, coarse dorsal disc scales with obvious primary plates, smaller ventral disc scales, conical spines on the dorsal and ventral disc, large (longer than half the disc radius), broad and separated radial shields, fan-shaped contiguous dorsal arm plates, three to four arm spines, rhombic oral shields, tricuspid teeth, and two lateral oral papillae, distal one larger than proximal one (Figure 2). *Ophiactis abyssicola* is a variable species, which is evidenced by the fact that six nominal species have been synonymized with it (Stöhr *et al.*, 2021). Madeira *et al.* (2019) remarked that *Ophiactis canotia* (Lyman, 1879) from about 1830 m depth in the Azores is similar to *O. abyssicola* except for the outline of the dorsal arm plates. That species is only known from its two type specimens and has not been reassessed taxonomically, but it is highly likely that it is conspecific with *O. abyssicola*. The South Pacific subspecies *O. abyssicola cuspidata* that is currently unaccepted, cannot at present be separated morphologically from the Atlantic specimens, but molecular data have identified them as a distinct clade (O'Hara *et al.*, 2014). *Ophiactis balli* (Thompson, 1840) in the North Atlantic bears some resemblance to *O. abyssicola*, but its dorsal disc is covered by small scales and inconspicuous primary plates, it has a single lateral oral papilla, radial shields shorter than 1/4 disk radius, triangular oral shields and up to five arm spines (Paterson, 1985).

## Discussion

The morphological characters of the specimens under study were consistent with previous descriptions of *Ophiactis abyssicola*, and the results of the COI analysis reinforced the morphological identification. The bathymetric distribution of *O. abyssicola* has been characterized as upper bathyal (shallower than 1800 m) by O'Hara *et al.* (2014), which corresponds to the collection depth of our specimens. However, the present records establish *O. abyssicola* for the first time in Canadian waters (Figure 1). Based on the



**Fig. 2.** *Ophiactis abyssicola* (from Labrador). (A) Dorsal view showing the primary plates (pp), radial shields (rs), disc scales (sc) and disc spines (ds). (B) Ventral view showing the teeth (t). (C) Dorsal view showing the disc spines (ds), disc scales (sc), primary plates (pp) and radial shields (rs). (D) Ventral view showing the oral shields (os), teeth (t) and oral papillae (op). Scale bars: (A, B) 1.5 mm; (C, D) 1 mm.

closest site where the species was previously reported from (western Greenland; Figure 1), the present records extend its distribution range by about 500 km south-west in the Labrador Sea and about 1900 km south along the coast of northern Newfoundland (Figure 1). Due to sparse collecting effort on the continental slope in the study area (Coté *et al.*, 2019), it is impossible to determine how common *O. abyssicola* is along the eastern Canadian seaboard or whether these specimens reflect a long-established distribution or recent range extension.

This newly recorded species of brittle star from the bathyal zone off Newfoundland and Labrador coasts adds to the marine biodiversity of Canada and to the general distribution knowledge of *O. abyssicola*.

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