Sponges from the 2010-2014, and 2017 *Paamiut,* and 2019 *Helga Maria* Multispecies Trawl Surveys, Eastern Arctic and Subarctic: Class Demospongiae, Subclass Heteroscleromorpha, Order Poecilosclerida, Family Iotrochotidae

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by

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ABSTRACT

Odenthal, B., Rios, P., Murillo, F. J., Walkusz, W., Cristobo, J., and Kenchington, E. 2023. Sponges from the 2010-2014, and 2017 *Paamiut,* and 2019 *Helga Maria* Multispecies Trawl Surveys, Eastern Arctic and Subarctic: Class Demospongiae, Subclass Heteroscleromorpha, Order Poecilosclerida, Family Iotrochotidae. Can. Tech. Rep. Fish. Aquat. Sci. 3559: v + 44 p.

Sponges (phylum Porifera) play an important role in habitat creation and nutrient cycling. However, despite these key functional roles, sponge communities in Arctic marine environments are still poorly known. Sponges were collected between 2010-2014, in 2017 and in 2019 during annual multispecies trawl surveys conducted by Fisheries and Oceans Canada in Baffin Bay, Davis Strait and portions of Hudson Strait. They were taxonomically examined under a microscope. Approximately 2800 sponge specimens were identified, comprising ~100 known sponge taxa. Here, results from the analysis of the family Iotrochotidae Dendy, 1922 are presented. This family currently has 6 genera and 35 valid species and is characterized by the possession of birotula microscleres in its skeleton. Thirty specimens collected from 442 to 1319 m depth were examined. Five taxa have been identified, all of them belonging to the Genus *Iotroata* (Laubenfels, 1936). Most of our specimens are *Iotroata affinis* (Lundbeck, 1905). The other described species include *Iotroata polydentata* (Lundbeck, 1905), as well as *Iotroata* sp.1, *Iotroata* sp.2, and *Iotroata* sp.3., which are likely new species. For each species a physical description, a discussion of their distinguishing characteristics, the dimensions and descriptions of their spicules, and a taxonomic discussion is included.

RÉSUMÉ

Odenthal, B., Rios, P., Murillo, F. J., Walkusz, W., Cristobo, J., and Kenchington, E. 2023. Sponges from the 2010-2014, and 2017 *Paamiut*, and 2019 *Helga Maria* Multispecies Trawl Surveys, Eastern Arctic and Subarctic: Class Demospongiae, Subclass Heteroscleromorpha, Order Poecilosclerida, Family Iotrochotidae. Can. Tech. Rep. Fish. Aquat. Sci. 3559: v + 44 p.

Les éponges (phylum Porifera) jouent un rôle important dans la création d'habitats benthiques et dans le cycle des éléments nutritifs. Néanmoins, malgré ces rôles fonctionnels clés, les communautés d'éponges marines dans l'Arctique sont encore très peu étudiées. Des éponges ont été collectées au cours des relevés plurispécifiques annuels au chalut effectués de 2010 à 2014, et également en 2017 et en 2019, par Pêches et Océans Canada dans la baie de Baffin, le détroit de Davis et certaines portions du détroit d'Hudson. Elles ont été examinées sous un microscope sur le plan taxonomique. Approximativement 2800 spécimens ont été identifiés, appartenant à ~100 taxons d'éponges connus. Presque la moitié des espèces recensées appartenaient à l'ordre Poecilosclerida. Les résultats de l'analyse de la famille Iotrochotidae Dendy, 1922 sont présentés dans le présent rapport. Cette famille a présentement 6 genres et 35 espèces valides et est caractérisée par la possession de microsclères appelées birotulas. Trente spécimens collectés entre 442 et 1319 m de profondeur ont été examinées. Cinq taxons ont été identifiés, tous appartenant au genre *Iotroata* Laubenfels, 1936, le plus commun étant l'espèce *Iotroata affinis* (Lundbeck, 1905). Les autres espèces décrites sont *Iotroata polydentata* (Lundbeck, 1905), ainsi que *Iotroata* sp.1, *Iotroata* sp.2, et *Iotroata* sp.3 qui sont probablement trois nouvelles espèces. Pour chacune d'entre elles, une description physique, une discussion des caractéristiques distinctives, une description complète des spicules incluant les dimensions de celles-ci, ainsi qu'une discussion taxonomique sont inclues dans ce rapport.

INTRODUCTION

Sponges are benthic sessile animals that mostly feed on plankton, particulate, and dissolved matter through filter feeding. They filter large amounts of water (Reiswig, 1971; Leys et al., 2011) and play an important role in nutrient cycling (reviewed in Maldonado et al. 2012, 2017). They also create complex structures which provide important habitats in deep-sea ecosystems, such as nursery and feeding grounds for demersal fish species (Kenchington et al., 2010; Miller et al., 2012; Kutti et al. 2015), and locally increase the diversity of epibenthic megafauna (Beazley et al., 2013, 2015). Due to their key functional roles in deep ocean ecosystems, sponge-dominated communities are recognized under the 2006 United Nations General Assembly Resolution (UNGA) 61/105 as vulnerable marine ecosystems (VMEs) in international waters. However, despite the important roles they play in ecosystems, information on sponge communities in Arctic marine environments is limited. Invertebrate species, including sponges, are collected regularly in the eastern Canadian Arctic during the Fisheries and Oceans Canada (DFO) shrimp and Greenland halibut multispecies trawl surveys. Samples were collected in western Baffin Bay, Davis Strait, portions of Hudson Strait and Ungava Bay. Approximately 2800 sponge specimens from 621 trawl sets (Figure 1) collected between 2010 and 2014 and in 2017 on the research vessel (RV) *Paamiut*, and collected in 2019 on the RV *Helga Maria* have been examined. Sponges from the order Poecilosclerida (class Demospongiae) comprised nearly half of the ~100 species identified. Five previous reports presented the morphological and spicule descriptions of poecilosclerid sponge species from the eastern Arctic, along with DNA barcodes for some species. Tompkins et al. (2017) documented sixteen species from genera *Forcepia* and *Lissodendoryx* (class Demospongiae, subclass Heteroscleromorpha, order Poecilosclerida, family Coelosphaeridae). Baker et al. (2018a) detailed six species from genus *Crella* (class Demospongiae, subclass Heteroscleromorpha, order Poecilosclerida, family Crellidae) and genera *Melonanchora* and *Myxilla* (class Demospongiae, subclass Heteroscleromorpha, order Poecilosclerida, family Myxillidae). Baker et al. (2018b) described six species from genera *Dendoricella* (class Demospongiae, subclass Heteroscleromorpha, order Poecilosclerida, family Dendoricellidae) and *Tedania* (class Demospongiae, subclass Heteroscleromorpha, order Poecilosclerida, family Tedaniidae). Bouchard Marmen et al. (2019) presented eight species from the families Microcionidae (genera *Artemisina* and *Clathria*), Acarnidae (genus *Iophon*), and Esperiopsidae (genera *Esperiopsis* and S*emisuberites*). Bouchard Marmen et al. (2021) documented four species from the family Mycalidae (subgenera *Mycale (Mycale*) and *Mycale (Rhaphidotheca*)) and one species from the family Isodictyidae (genus *Isodictya*). In keeping with the previous reports, our intent is to provide a resource to facilitate accurate, consistent and efficient identification of eastern Canadian Arctic sponges for the purpose of monitoring and mapping species distributions.

Taxonomic Background on Order Poecilosclerida

Sponges described in this report all belong to the class Demospongiae, subclass Heteroscleromorpha and order Poescilosclerida. The class Demospongiae includes sponges with a skeleton composed of siliceous spicules and/or spongin fibers (Hooper and Van Soest, 2002). Their spicules are monaxonic or tetraxonic (never triaxonic) (Hooper and Van Soest, 2002). The subclass Heteroscleromorpha is the most speciose group of demosponges and includes sponges with a large diversity of spicule types, from which it derives its name (Cárdenas et al., 2012). Of the 17 accepted orders under Heteroscleromorpha, Poecilosclerida is the largest order, including 2408 accepted species classified within 21 families: **Acarnidae***, Chondropsidae, **Cladorhizidae**, **Coelosphaeridae***, Crambeidae, **Crellidae***, **Dendoricellidae**, Desmacididae, Desmoxyidae, **Esperiopsidae**, Guitarridae, Hymedesmiidae*, **Iotrochotidae**, **Isodictyidae**, Latrunculiidae, **Microcionidae**, **Mycalidae***, **Myxillidae**, Phellodermidae, Podospongiidae, and **Tedaniidae** (de Voogd et al., World Porifera Database, Accessed February 1, 2023). Families represented within the 2010–2014, 2017 *Paamiut* and 2019 *Helga Maria* Arctic collections are in **bold**, and those marked by an asterisk (*) may not be monophyletic, according to recent molecular phylogenetic studies (Morrow and Cárdenas, 2015). Poecilosclerid sponges usually possess chelae, which are only found in this order. Other microsclere spicules found in these sponges are sigmas, sigmancistra-derivatives, raphides, forceps, toxas, onychaetes, microrhabds, spinorhabds, discorhabds, thraustoxeas, spirosigmata, thraustosigmata or microstyles (Hooper and Van Soest, 2002), (see definitions in Łukowiak et al., 2022). Skeletons of poecilosclerids are known to show megasclere differentiation between the outer ectosome and inner choanosome, forming at least two (but up to five) morphologically distinct regions. Sponges from this order are mostly viviparous. They are present worldwide, in habitats ranging from intertidal zones to abyssal depths (Hooper and Van Soest, 2002).

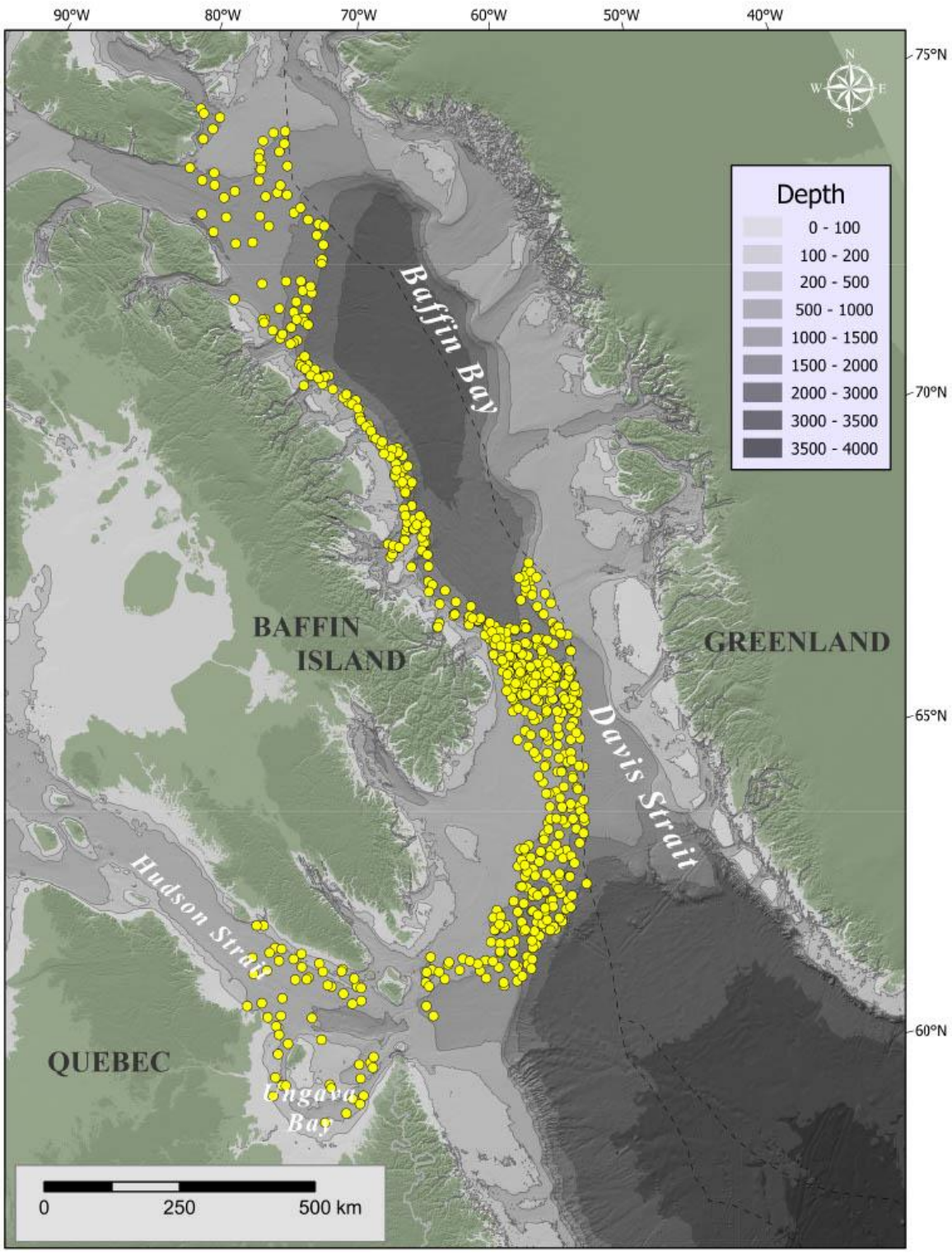

Figure 1. Locations of all *Paamiut* 2010-2014 and 2017 trawl sets and *Helga Maria* 2019 trawl sets with sponge catch (N=621). Trawls occurred within Baffin Bay, the Davis Strait, Ungava Bay and the Hudson Strait. Note that the species listed in this report were found in a subset of these locations.

Family Iotrochotidae Dendy, 1922

The family Iotrochotidae was originally described by Dendy (1922) as sponges usually possessing birotula and mostly symmetrically ended dermal megascleres. In this family, he grouped the genus *Iotrochota* with *Hymetrochota*, and *Microtylotella* (now named *Acarnus*), despite the later not having birotula. He did not include the birotula possessing genus *Amphiastrella*, since he said it seems more likely that birotula had "arisen independently in *Amphiastrella* than that this genus is very nearly related to *Iotrochota"*. It seems his definition of members of the family Iotrochotidae are sponges similar to *Iotrochota*, but he does not give further details.

The family Iotrochotidae was largely ignored until Hooper and Van Soest formally recognized it in 2002. They chose to define this family as sponges with the presence of birotula microscleres, rather than based on features of skeletal architecture. This is because, according to Hooper and Van Soest (2002), the presence of birotula is considered a stronger indicator of shared history than having similar skeletal features, which are likely more related to the size and shape of a sponge which is indirectly linked to habitat and ecology. Many sponge families have a large diversity of skeletal architecture within them, so the diversity found among Iotrochotidae species is not unusual. Hooper and Van Soest (2002) also describe members of the Iotrochotidae family as having both smooth and acanthoses styles, strongyles, and tylotes as their choanosomal megascleres, and occasionally isochelae and sigmas as their microscleres. They say Iotrochotidae members can be encrusting, massive, fistular, ramose, or flabellate. This is the most recent description of the family and the one this report will be referencing. There are currently 35 species in this family (de Voogd et al., World Porifera Database, Accessed January 25th, 2023).

The genera currently included in Iotrochotidae are *Amphiastrella, Hymetrochota, Iotroata, Iotrochopsama, Iotrochota,* and *Rotuloplocamia.* A list of defining characteristics of each genus, adapted from Hooper and Van Soest (2002) and its distribution (de Voogd et al., World Porifera Database, Accessed January 25th, 2023; Spalding et al., 2007), is given below:

Amphiastrella: Chonosomal skeleton vestigial. Growth form is massive, erect and fistular with a parchment like surface. The surface is made of intercrossing tylote and strongyle spicules. The choanosome also consists of tylotes and strongyles. Microscleres are birotula and sometimes sigmas. Species have been found in Temperate Australasia (Australia and New Zealand).

Hymetrochota: Skeleton is hymedesmioid. Growth form is encrusting and they have a hispid surface. The choanososmal skeleton and substrate contain acanthostyles. The ectosomal tornotes are smooth. Microscleres are birotula. Species have been found in the Temperate Northern Atlantic (Azores and Norway).

Iotroata: Skeleton is isotropic and reticulate. Growth form is encrusting, massive or flabellate. The ectosomal skeleton contains smooth tylotes with mucronate or spined ends in bundles on the surface. The choanosomal skeleton consists of smooth or slightly spined styles. Microscleres are birotula, sigmas, and anchorate isochelae. Species have been found in the Temperate Northern

Atlantic, Artic, Temperate Northern Pacific, Temperate Australasia and Southern Ocean (Shetland Islands, Iceland, Celtic Seas, Greenland, Aleutian Islands, Faroe Islands, Gulf of Cadiz, Josephine Bank, New Zealand and Antarctic).

Iotrochopsamma: Skeleton is reticulate. Growth form is ramose. No megascleres present. Microscleres are birotula. Species have been found in Temperate Australasia (Australia and New Zealand).

Iotrochota: Skeleton a regular reticulation of multispicular tracts. Growth form is encrusting, digitate, massive, or bushy. It often has a black colouration and purple stained mucus. Megascleres are smooth styles, oxea, or strongyles. They normally have two categories of megascleres, longer and thinner, and shorter and thicker. Microscleres are birotula. Species have been found in the Tropical Atlantic, Western Indo-Pacific, Central Indo-Pacific, Eastern Indo-Pacific and Temperate Australasia (Gulf of Mexico, Florida, Cuba, Jamaica, Dominican Republic, Puerto Rico, Virgin Islands, Belize, Colombia, Curaçao, Bonaire, Venezuela, Panamá, Bahamas, Guyana, Brazil, Red sea, Kenya, Mozambique, Madagascar, Seychelles, Banda Sea, China Sea, India, Thailand, Malacca Strait, Australia, New Caledonia, Borneo, Papua New Guinea, Caroline Islands, Hawaii, Sodwana Bay and Sodwana Bay).

Rotuloplocamia: Skeleton is plocamiid. Growth form is thin and encrusting. Has basal acanthostrongyles and echinating acanthostyles. Microscleres are birotula. Species have been found in the Temperate Northern Atlantic and Tropical Atlantic (Senegal, Ría Arousa, Angolan, Gulf of Guinea).

METHODOLOGY

Sponge Collection

Sponges described in this series of reports were collected during six annual multispecies trawl surveys (2010-2014, and 2017) with the Greenland Institute of Natural Resources (GINR) research vessel *Paamiut* and one survey in 2019 with the GINR research vessel *Helga Maria*. The surveys were coded as PAA2010-009, PAA2011-007, PAA2012-007, PAA2013-008, PAA2014-007, PAA2017-009, and HEL2019-005. These surveys were primarily conducted to provide fisheries-independent data on the status of Greenland Halibut for stock assessments in NAFO Subdivisions 0A and 0B (Baffin Bay/Davis Strait) and with depth coverage 200-1500 m. In addition to Greenland Halibut catches, bycatch was enumerated to provide data on diversity of benthic fauna. In 2010 and 2012, a small area of the NAFO 0A referred to as the Shrimp Fishing Area 1 (SFA1) was surveyed to assess the stock of northern shrimp. Also, in 2011 and 2013, samples were collected during the DFO Central and Arctic survey of northern and striped shrimp in the Shrimp Fishing Area 3 (SFA3) (Hudson Strait/Ungava Bay) with depth coverage of 100-1000 m. The Greenland Halibut survey was performed with an Alfredo trawl towed at 3 knots for 30 minutes at each location. The shrimp survey was performed with the Cosmos 2000 shrimp trawl towed at 2.6 knots for 15 minutes. A buffered random sampling approach designed by Kingsley et al. (2004) was employed and the areas were divided into the following depth strata: 100-200 m, 200-300 m, 300-400 m, 400-500 m, 500-750 m and > 750 m.

Documentation of Sponge Catches at Sea

For each trawl catch, sponges were separated from other invertebrates and then divided by morphology. Each sponge morphotype was photographed with a label identifying the survey and set number, along with a tentative sponge identification, then weighed and recorded in a database along with geospatial data. If sponge catches were very large, the weight of a subsample was extrapolated to the whole catch. A sample of each sponge was placed into a plastic bag with the original label. These samples were frozen (-20ºC) at sea and shipped to the Bedford Institute of Oceanography, Dartmouth, Nova Scotia, for further identification to species level.

Sponge Identification by Spicule Analysis

Each sponge that was examined at the Bedford Institute of Oceanography has been given a collection number (Col), which was a unique number within the same survey. Therefore, the combination of the survey details (vessel, year, survey type) and the collection number was a unique identification code for every sponge analyzed. Sponge species were mostly identified based on microscopic analysis of sponge spicules. However, some were identified by the arrangement of

their skeleton. Taxonomic resources frequently consulted for spicule comparison included Dinn and Leys (2018), Lundbeck (1905), Hooper and Van Soest (2002), and the World Porifera Database website (de Voogd et al., World Porifera Database, Accessed January 25th, 2023).

Permanent microscope slides with cleaned sponge spicules were prepared for each of the specimens used in this report. Several rice-sized pieces were taken from the exterior and interior regions of the sponge and digested in full strength bleach in microtubes. Since different spicule types are often present in different sections of a sponge, it is necessary to sample all of the regions of a specimen. Based on previous research on arctic sponges at our laboratory (discussed in Tompkins et al. (2017), Baker et al (2018a, 2018b), Bouchard Marmen et al. (2019, 2021)), taking 4-5 rice sized pieces from a specimen is enough tissue to sample all spicule types in a sponge.

After briefly spinning down spicules (~3000 rpm for 1 min) the supernatant was replaced with distilled water. This was repeated for a total of two water washes. In the final wash step the spicules were suspended in 95% ethanol. These cleaned spicules were pipetted on to glass slides, air dried and then mounted in Araldite resin as described in Tompkins et al. (2017). Slides were viewed on a Nikon E200 Microscope and photographed with a Nikon DS-Ri1 or DS-fi1 camera operated through a Digital Sight DS-U2 or DS-U3 camera control unit. Nikon NIS Elements Documentation software was used to capture and calibrate the microscope images and to collect measurements either on live or captured images as described in Tompkins et al. (2017). For each species, a single reference specimen and up to four supporting specimens were selected. Thirty length and width measurements were recorded for each spicule type from each reference specimen. Ten length and width measurements per spicule type were obtained from each of the supporting specimens. Reference specimens are the highest quality specimens, and were selected based on their size and how intact they are. Supporting specimens are the next highest quality specimens and were chosen in a similar manner to the reference specimens. Width measurements were taken at the thickest part of the spicule. Boury-Esnault and Rützler (1997) was frequently consulted for spicule type identification.

Sponge Skeleton Observation

Slices of tissue were cut out of sponge samples using a razor blade. The tissue slices were approximately 2 mm thick. The samples included tissue from both exterior and interior regions of the sponges. Tissue samples were placed on glass slides and viewed on a Nikon E200 Microscope. The skeleton type present in each tissue sample was identified and recorded. Hooper and Van Soest (2002) and Boury-Esnault and Rützler (1997) were frequently consulted for skeleton identification.

Descriptions

The remainder of this report is comprised of descriptions of five species collected in the multispecies trawl surveys which belong to the family Iotrochotidae. Each of the sponge descriptions includes the following:

- ITIS and WORMS reference numbers (when available)
- Physical description
- Specimen macrophotographs
- Habitat information including depth and geographic area (see Appendix 1 for exact location of each specimen)
- Map of *Paamiut* 2010-2014 and 2017, and *Helga Maria* 2019 collection locations
- Descriptions of spicule morphology
- Spicule figure with light microphotographs of each spicule type
- Table with spicule measurements
- Distinguishing characteristics
- Discussion of taxonomic literature

Once the new species are described, voucher specimens will be deposited at the Canadian Museum of Nature (Ottawa, Canada).

RESULTS

Five species from the family Iotrochotidae were collected, all belonging to the genus *Iotroata*. Specifically, *Iotroata affinis, Iotroata polydentata, Iotroata* sp.1, *Iotroata* sp.2, and *Iotroata* sp.3. were identified from our eastern Arctic collection. Our specimens all have birotula, which are only found in members of the family Iotrochotidae.

With the *Iotroata* sp.1, *Iotroata* sp.2, and *Iotroata* sp.3 specimens, we performed thick sections of sponge tissue to observe their skeletal organization. These samples all have an isotropic reticulate skeleton with paucispicular tracts, therefore they belong to the genus *Iotroata*. With all of our Iotrochotidae specimens the whole spicule complement was carefully examined and measured. These data were compared to the original species description and to other published descriptions (see the taxonomic remarks sections of this species' description) to confirm our taxonomic identification.

Spicule Key for Species Presented in this Report

A taxonomic key based on spicule characteristics is provided to allow end users of this report to efficiently key out sponges for identification. The key should be used with caution, as our spicule characteristics were chosen to distinguish amongst the species described in this report and therefore will probably not be applicable when considering broader groups of species or sponge species from different sampling areas. To obtain dimension ranges from previously published descriptions and to see how they compare to our measurements, please consult the "taxonomic remarks" within each species descriptions in the present report which will provide more information and references. The full descriptions should be consulted, and spicule measurements or morphological characteristics compared prior to confirming identification. We recommend consulting the World Porifera Database website at http://www.marinespecies.org/porifera/ at the time of identification to determine whether the taxa names included here are still accepted or have been replaced by alternate names.

1. With acanthostyles 2
   Without acanthostyles 3
2. With isochelae ..... *Iotroata* sp.1
   Without isochelae ..... *Iotroata* sp.3
3. With sigmas ..... *Iotroata* sp.2
   Without sigmas 4
4. Birotula longer than 40 μm ..... *Iotroata affinis*
   Birotula not longer than 40 μm ..... *Iotroata polydentata*

Descriptions of Family Iotrochotidae

Iotroata

ITIS TSN 659422 (genus)

***Iotroata affinis* (Lundbeck, 1905)** WORMS AphiaID 133839 (species)

Physical description

Our reference specimen for *Iotroata affinis* (PAA2010-009 Set 60 Col 202) is approximately 5 cm long, 4 cm wide, and 1 cm thick (Figure 2). After being frozen, the specimen is mainly beige with some dark brown areas. The surface is mostly smooth with some bumpy areas. The sponge feels slightly rough to the touch and is easily compressed. A small soft coral belonging to the family Nephtheidae was found growing on this sponge. In total, 23 additional specimens were collected during the multispecies trawl surveys and identified as *Iotroata affinis* based on their spicule composition. Four of them were used as supporting specimens for this species description.

Habitat information

Specimens were found in Baffin Bay and the Davis Strait at 442–1319 m depth, extending from east of Qikiqtanga (Livingstone Island) to off Cape Dyer (Baffin Island, Nunavut) in the south (Figure 3, Appendix 1). *Iotroata affinis* has been found on the Western Greenland Shelf, in the Disco Fan conservation area, at a depth of 877 m, growing on a dead coral skeleton (Dinn and Leys, 2018). This species has also been found off the eastern coast of Greenland at a depth of 104 m (Lundbeck, 1905). With our specimens, the bathymetric range of the species is extended to 104–1319 m.

Spicules (Table 1, Figure 4)

Megascleres: Styles are 452–580 μm long and 13–21 μm wide (Table 1, Figure 4). Tylotes are 288–411 μm long and 8–13 μm wide (Table 1, Figure 4).

Microscleres: Birotula are distributed into two distinct size classes. Large birotula are 35–64 μm long and 7–14 μm wide (Table 1, Figure 4). Small birotula are 17–24 μm long and 5–7 μm wide (Table 1, Figure 4). The width measurements of the two size classes overlap when we compare the combined measurements of all 24 analyzed specimens. However, within each individual specimen, the dimension ranges for birotula do not overlap, and therefore the two size classes are easily differentiated on an individual basis.

Distinguishing characteristics

This species is best diagnosed by its spicule composition, as its external morphology is not particularly distinctive. It can be distinguished from the similar *Iotroata polydentata* by the length of its large birotula. Specifically, *Iotroata affinis* possess birotula longer then 40 μm, while *I. polydentata* do not.

Taxonomic remarks

Iotroata affinis was originally described by Lundbeck in 1905 as a greyish brown sponge with a thin membrane. The sample had styles (470–570 μm long and 11–15 μm wide), tylotes (350–440 μm long

and 3.5–5.7 μm wide), large birotula (37–51 μm long and 10–13 μm wide at the head), and small birotula (18–25 μm long and 5.7 μm wide at the head). Some of the styles are slightly curved.

In 2018, Dinn and Leys described one *I. affinis* specimen found in the Canadian Arctic near our collection sites. The sample was beige, and had a smooth surface with pores. The sample had styles (503–603 μm long and 13–20 μm wide), tylotes (325–441 μm long and 6–10 μm wide), large birotula (34–52 μm long) and small birotula (17–24 μm long). Three strongyles were also found in the sample; however, these are likely contamination.

Nearly all of the spicule measurements of our *I. affinis* specimens fall in the same range as the spicules described by Lundbeck (1905), and Dinn and Leys (2018). However, some specimens have a few spicules that are smaller or larger than expected. Specifically, some specimens have tylotes up to 37 μm shorter, and/or large birotula up to 12 μm larger than those described by Lundbeck (1905), and Dinn and Leys (2018). There appears to be variation in spicule sizes between *I. affinis* specimens. For example, the specimen described by Dinn and Lays (2018), had tylotes 25 μm shorter than those found in the specimen described by Lundbeck (1905). Since both Lundbeck (1905), and Dinn and Leys (2018), only looked at a single *I. affinis* specimen, it is likely that the spicule measurements they recorded are just a sample of the range of spicules occurring in *I. affinis*. Taking into consideration all of the information discussed above, we designated our samples as *I. affinis,* even when they had spicules slightly outside the expected size range.

Figure 2. *Iotroata affinis* specimen PAA2010-009 Set 60 Col 202 showing opposite surfaces.

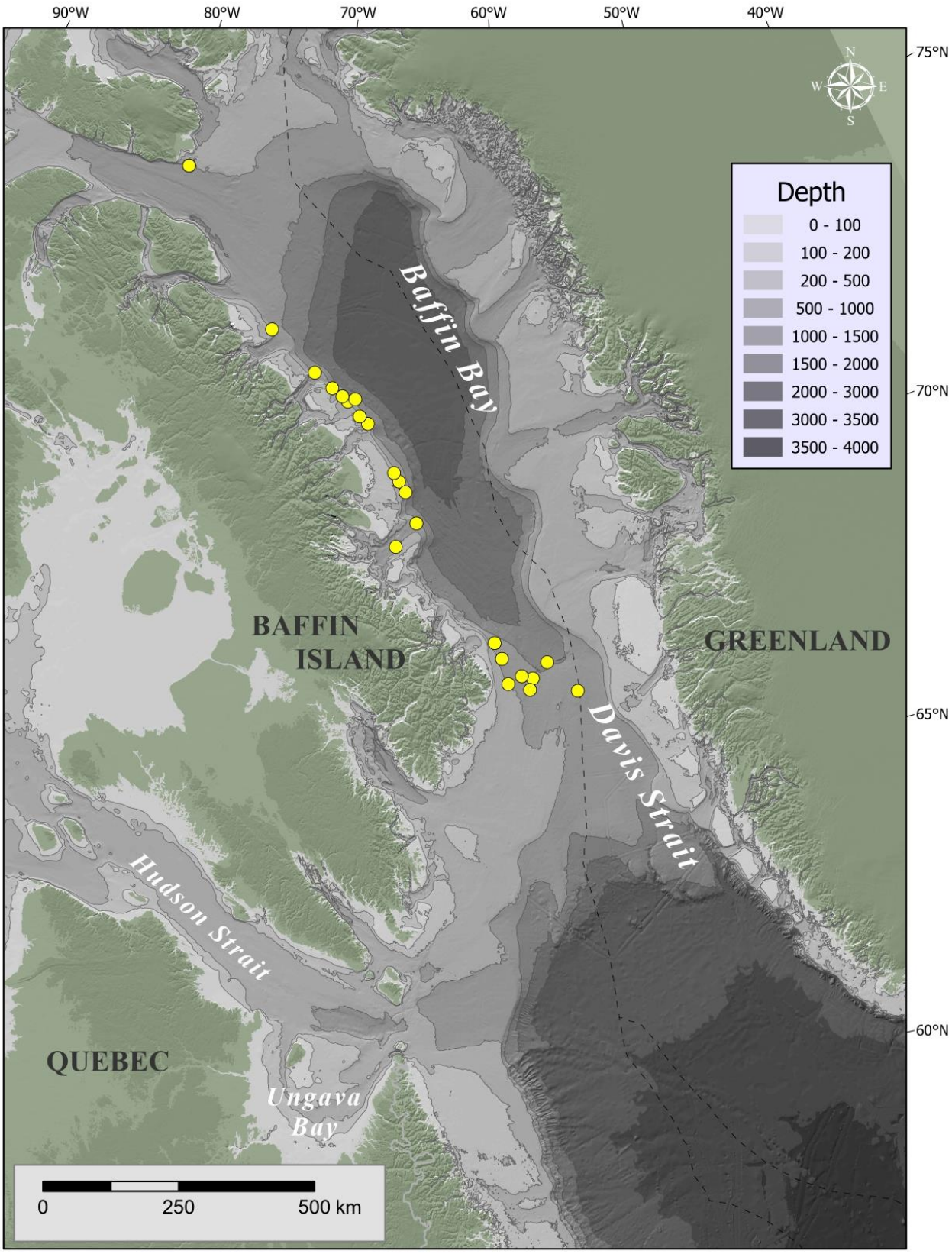

Figure 3. *Iotroata affinis* collection locations.

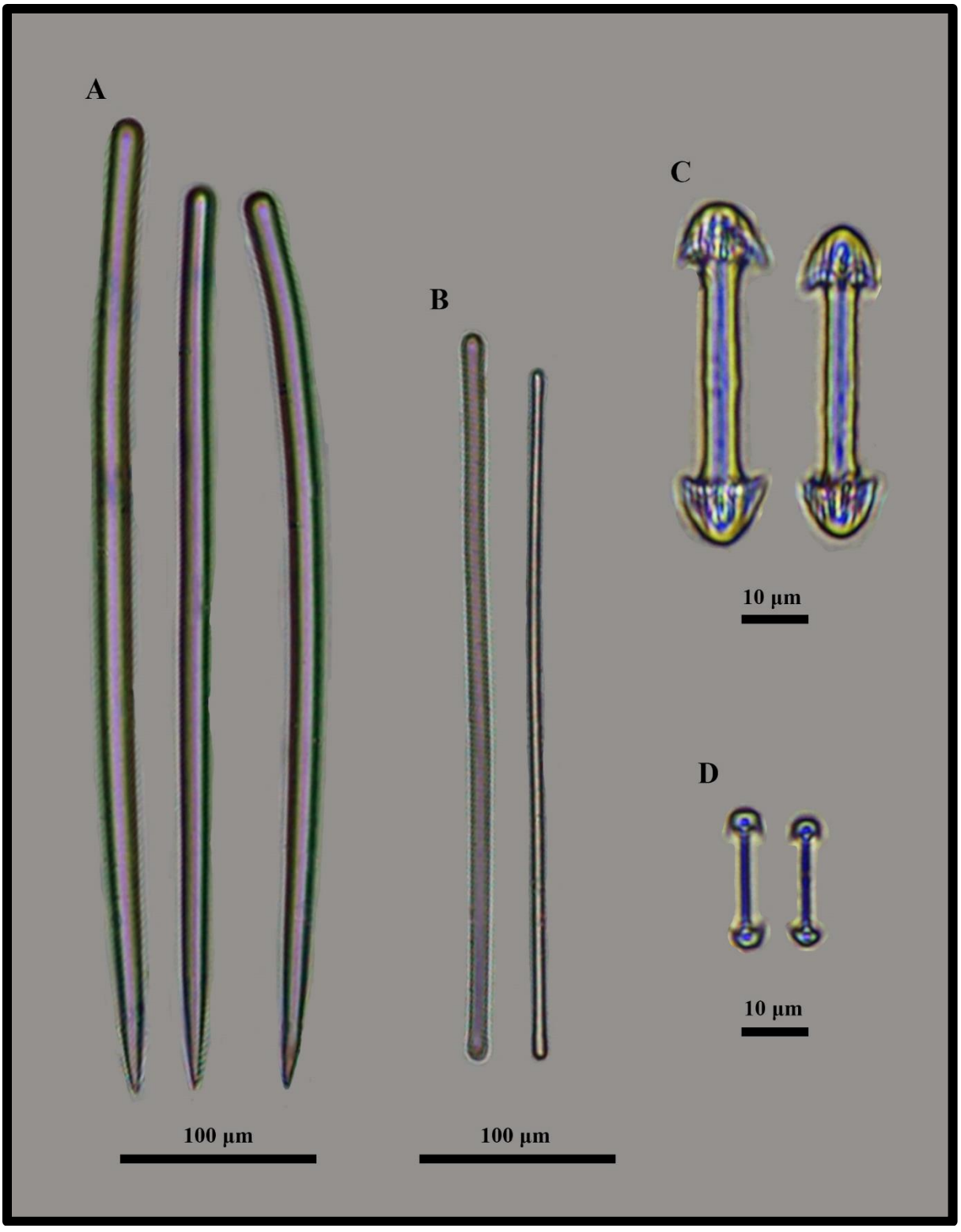

Figure 4. *Iotroata affinis* spicules from PAA2010-009 Set 60 Col 202. Styles (A), Tylotes (B), Large birotula (C), and Small birotula (D).

Table 1. Spicule measurements from specimens of *Iotroata affinis* all reported as minimum-(average)-maximum for length and width (μm). The number of spicule measurements (n) is specified for each spicule type. The specimen name is a unique ID (cruise, trawl set number, specimen collection number).

Specimens	Styles	Tylotes	Large Birotula	Small Birotula
PAA2010-009 Set 60 Col 202	452.0–(493.0)–525.6 x 12.7–(15.3)–17.3 n=30	313.7–(355.0)–410.7 x 7.5–(8.6)–10.1 n=30	42.0–(48.9)–56.4 x 7.7–(12.0)–14.4 n=30	16.6–(19.5)–24.2 x 4.7–(5.5)–6.8 n=30
PAA2010-009 Set 114 Col 198	476.8–(534.8)–579.5 x 13.7–(16.0)–18.5 n=10	312.7–(354.1)–390.8 x 9.8–(11.0)–13.4 n=10	40.7–(48.2)–54.8 x 10.9–(12.0)–13.2 n=10	16.8–(17.8)–18.9 x 4.7–(5.2)–5.9 n=10
HEL2019-005 Set 65 Col 125	454.7–(492.8)–520.3 x 13.9–(16.6)–20.1 n=10	287.8–(328.4)–355.5 x 8.7–(10.1)–12.4 n=10	40.8–(46.0)–53.0 x 10.2–(11.7)–13.3 n=10	17.6–(18.7)–21.3 x 4.5–(5.1)–6.2 n=10
PAA2010-009 Set 111 Col 204	483.3–(509.3)–579.8 x 15.3–(18.1)–21.4 n=10	360.8–(376.5)–397.4 x 9.3–(10.2)–11.2 n=10	35.3–(46.3)–54.2 x 10.8–(12.1)–13.9 n=10	18.0–(19.1)–20.7 x 4.7–(5.4)–6.8 n=10
PAA2012 Set 111 Col 100	500.5–(533.5)–574.5 x 14.5–(16)–17.9 n=10	332.2–(366.3)–410.2 x 7.3–(9.4)–10.7 n=10	44.9–(54.5)–64.2 x 11.1–(12.3)–13.8 n=10	17.0–(20.3)–22.9 x 5.6–(6.2)–7.1 n=10

ITIS TSN 659422 (genus)

***Iotroata polydentata* (Lundbeck, 1905)** WORMS AphiaID 133842 (species)

Physical description

Our reference specimen of *Iotroata polydentata* (PAA2013-008 Set 138 Col 285) is approximately 4.5 cm long, 4 cm wide and 1 cm thick (Figure 5). After being frozen, this specimen is dark brown. The surface has a rough texture, this may be due to this specimen being damaged from colliding with other objects when being trawled. The sponge is easily compressed. In total, 2 additional specimens were collected during the multispecies trawl surveys and they were used as supporting specimens for this species description.

Habitat information

Specimens were found in the Davis Strait, east of Resolution Island, at 503–1064 m depth (Figure 6, Appendix 1). *Iotroata polydentata* specimens have been found in the Faroe Islands and off northern Iceland at depths of 241 m and 293 m (Lundbeck, 1905). A specimen was also found in Josephine Bank at 208 m depth (Topsent, 1928) and in the Gulf of Cádiz by a mud volcano at 655 m depth (Sitjà et al, 2019). With our specimens, the bathymetric range of this species is extended to 208–1064 m.

Spicules (Table 2, Figure 7)

Megascleres: Styles are 423–547 μm long and 5–18 μm wide (Table 2, Figure 7). Tylotes are 267–375 μm long and 4–11 μm wide (Table 2, Figure 7).

Microscleres: Birotula are distributed into two distinct size classes. Large birotula are 20–37 μm long and 5–10 μm wide (Table 2, Figure 7). Small birotula are 14–18 μm long and 3–5 μm wide (Table 2, Figure 7).

Distinguishing characteristics

This species is best diagnosed by its spicule complement, as its external morphology is not particularly distinctive. It can be distinguished from the similar *I. affinis* by the length of its large birotula. Specifically, *I. polydentata* does not posses birotula larger then 40 μm, while *I. affinis* does.

Taxonomic remarks

Iotroata polydentata was originally described by Lundbeck in 1905 as a greyish brown sponge (after preservation in ethanol). The three specimens Lundbeck described are leaf shaped, or a mixture of the leaf shaped and massive forms. They had a somewhat grooved surface and a “not especially thin” dermal membrane. They had styles (420–570 μm long and 10–13 μm wide), tylotes (250–340 μm long and 3–5 μm wide), large birotula (20–28 μm long and 6–9 μm wide), and small birotula (13–18 μm long and 4 μm wide). Two small crusts were identified by Topsent (1928); they had styles (390–450 μm long and 11–12 μm wide), tylotes (250–340 μm long and 3–5 μm wide), large birotula (20–30 μm long), and small birotula (15–18 μm long). A specimen found in the Gulf of Cádiz was mentioned by Sitjà et al. (2019). However, the authors did not give a description of the specimen’s spicule composition or morphology.

Nearly all of the spicule measurements of our *I. polydentata* specimens fall in the same range as the spicules described by Lundbeck (1905). Specifically, all of the styles and small birotula that we measured fell into this range. However, some of our specimens have tylotes up to 35 μm longer, and/or large birotula up to 9 μm longer than those described by Lundbeck (1905). Lundbeck (1905) examined only three specimens. Therefore, it is likely the spicule measurements he recorded are just a sample of the range of spicules occurring in *I. polydentata*. Due to this, we have designated our samples as *I. polydentata*, even when they had some spicules slightly outside the expected size range.

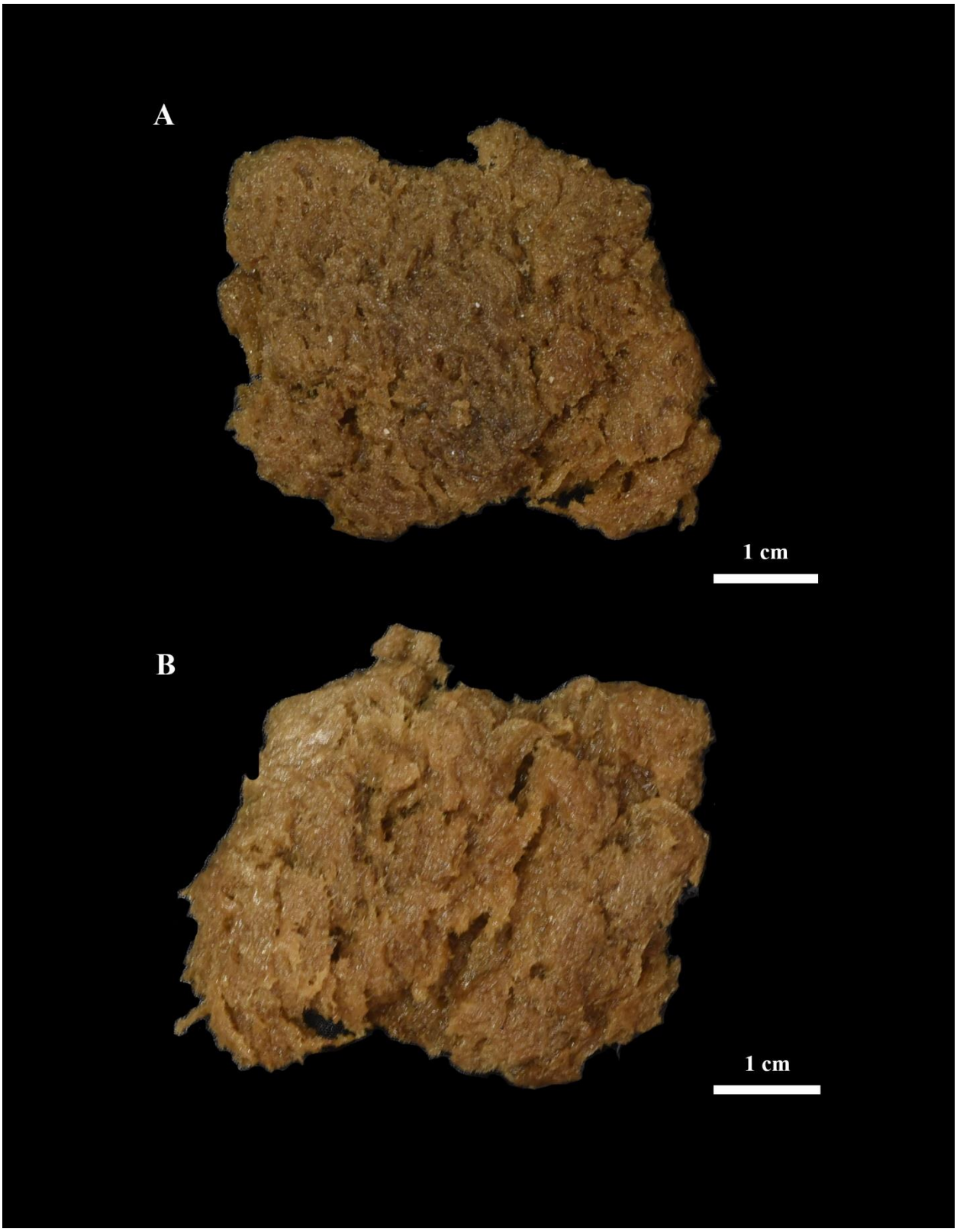

Figure 5. *Iotroata polydentata* specimen PAA2013-008 Set 138 Col 285 showing opposite surfaces.

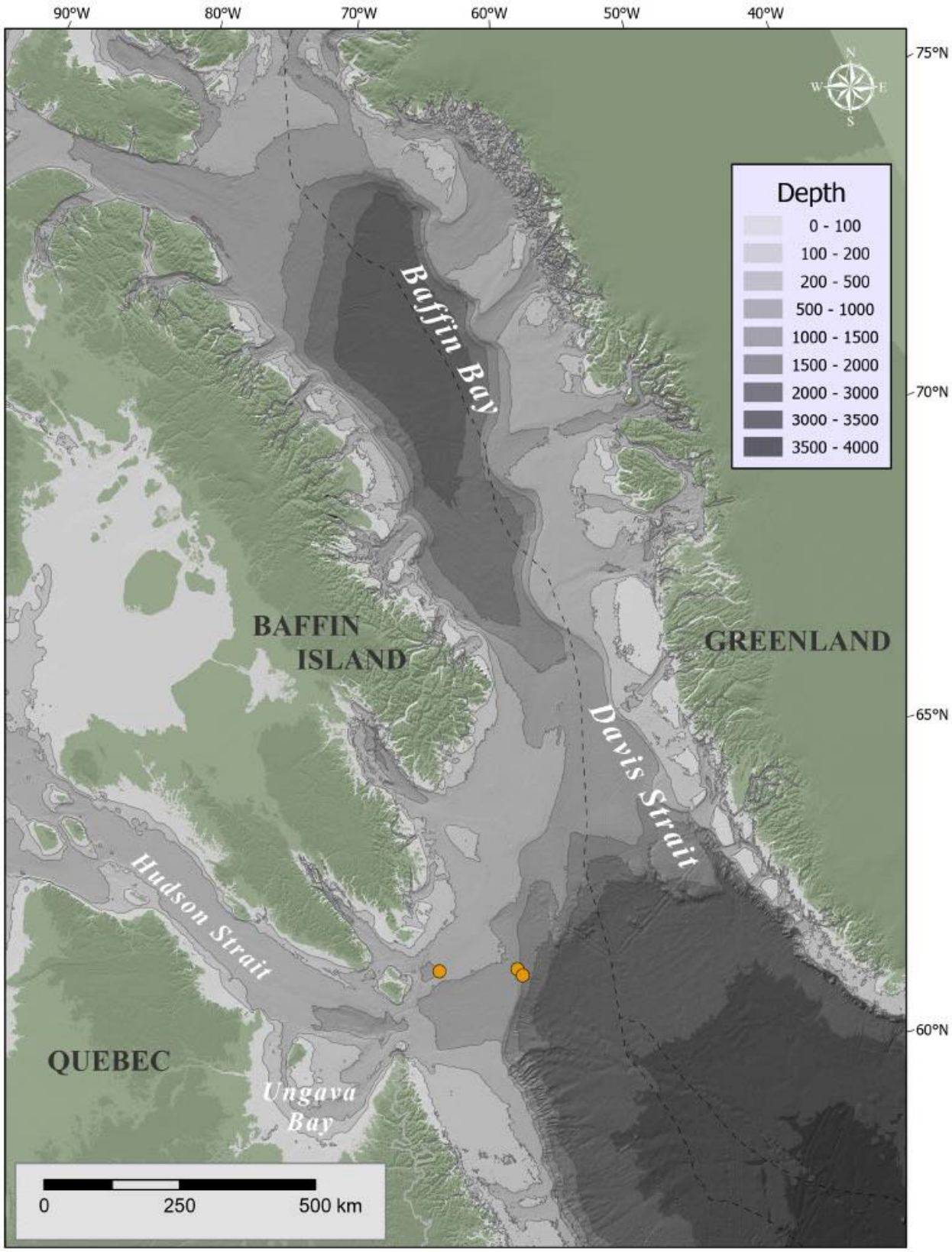

Figure 6. *Iotroata polydentata* collection locations.

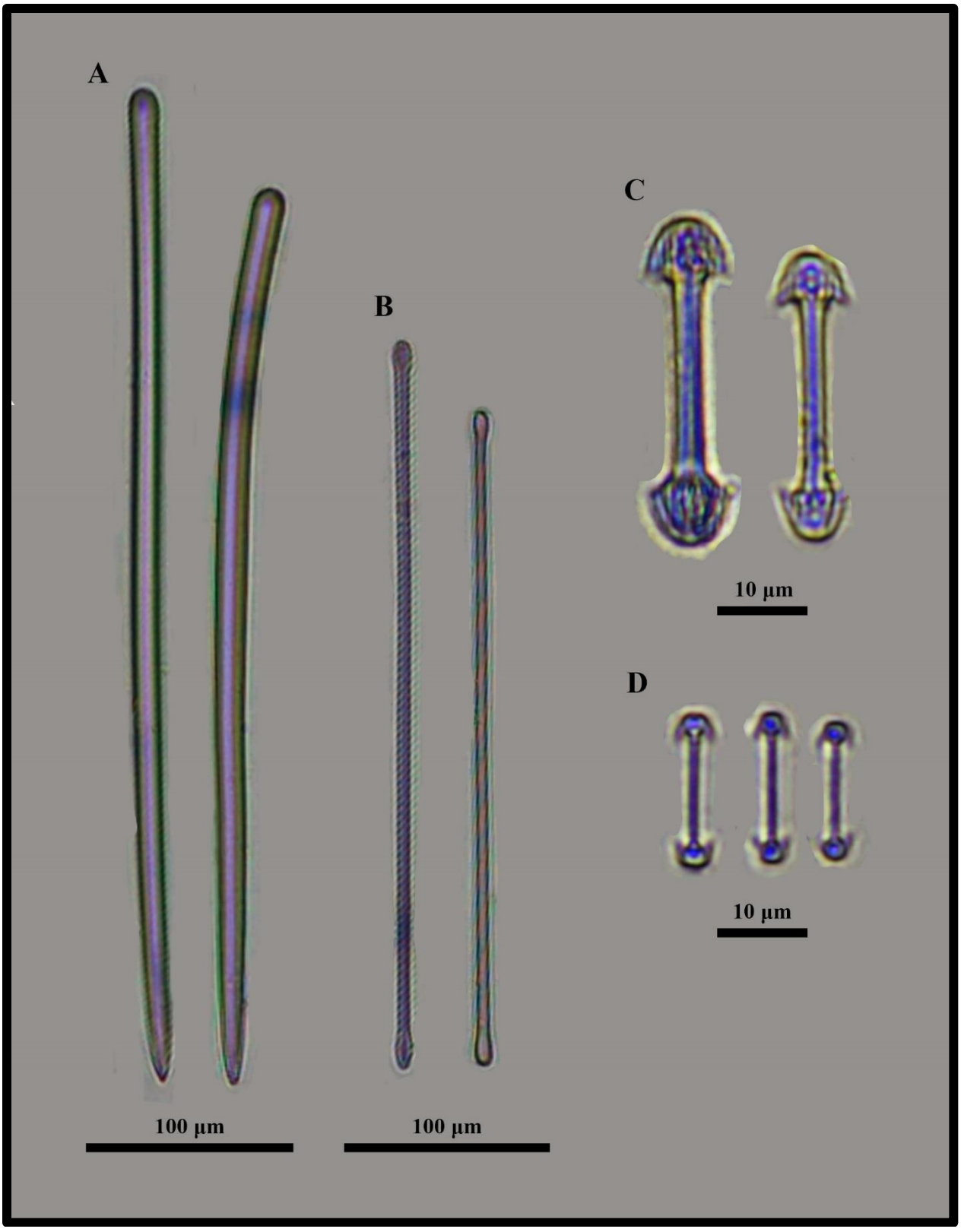

Figure 7. *Iotroata polydentata* spicules from PAA2013-008 Set 138 Col 285. Styles (A), Tylotes (B), Large birotula (C), and Small birotula (D).

Table 2. Spicule measurements from specimens of *Iotroata polydentata* all reported as minimum-(average)-maximum for length and width (μm). The number of spicule measurements (n) is specified for each spicule type. The specimen name is a unique ID (cruise, trawl set number, specimen collection number).

Specimens	Styles	Tylotes	Large Birotula	Small Birotula
PAA2013-008 Set 138 Col 285	423.2–(466.5)–547.0 x 5.0–(13.0)–16.9 n=30	266.8–(308.6)–338.4 x 4.1–(5.3)–7.9 n=30	26.0–(32.0)–37.1 x 4.8–(8.3)–10.2 n=30	14.8–(16.2)–18.2 x 2.6–(3.2)–3.9 n=30
PAA2013-008 Set 56 Col 197	448.0–(503.1)–539.0 x 12.5–(13.9)–15.0 n=10	309.1–(321.7)–334.5 x 6.1–(8.6)–10.8 n=10	26.2–(30.0)–33.2 x 7.9–(8.8)–9.8 n=10	14.1–(15.4)–16.9 x 3.5–(4.0)–4.5 n=10
PAA2014-007 Set 133 Col 299	466.8–(505.7)–539.8 x 13.3–(15.7)–17.6 n=10	313.8–(342.8)–375.2 x 8.1–(9.5)–10.8 n=10	20.1–(25.7)–30.6 x 4.8–(7.1)–8.5 n=10	13.8–(17.0)–18.4 x 3.9–(4.8)–5.3 n=10

ITIS TSN 659422 (genus)

***Iotroata* sp.1 (Laubenfels, 1936 – genus)** WORMS AphiaID 131964 (genus)

Physical description

Our reference specimen of *Iotroata* sp.1 (PAA2014-007 Set 74 Col 130) is approximately 5.5 cm long, 5 cm wide and 1 cm thick (Figure 8), and was the only specimen found. After being frozen, this specimen is mostly light brown with some darker brown areas. The surface has a rough texture, possibly due to the specimen being damaged from colliding with other objects while being trawled. The sponge is easily compressed.

Habitat information

The specimen was found in the Davis Strait, east of Cape Dyer, Nunavut, at 478 m depth (Figure 9, Appendix 1).

Spicules (Table 3, Figure 10)

Megascleres: Styles are 425–553 μm long and 9–19 μm wide (Table 3, Figure 10). Acanthostyles are 151–307 μm long and 11–17 μm wide (Table 3, Figure 10).

Microscleres: Birotula are distributed into two distinct size classes. Large birotula are 27–57 μm long and 9–14 μm wide (Table 3, Figure 10). Small birotula are 17–23 μm long and 5–7 μm wide (Table 3, Figure 10). Sigmas are 23–36 μm long (Table 3, Figure 10). Chelae are 27–41 μm long and 4–6 μm wide (Table 3, Figure 10).

Distinguishing characteristics

This specimen's external morphology is not particularly distinctive. It's spicule composition of styles, acanthostyles, large birotula, small birotula, sigmas, and chelae are unique to this specimen. Another member of the Iotrochotidae family, *Iotroata lamellata*, has sigmas (Hooper and Van Soest, 2002). However, it does not have acanthostyles and chelae. Therefore, this sponge is significantly different from other documented Iotrochotidae species.

Taxonomic remarks

This specimen has been placed in the family Iotrochotidae due to its possession of birotula. It has an isotropic reticulate skeleton with paucispicular tracts. Therefore, we have assigned it to the *Iotroata* genus (Hooper and Van Soest, 2002). This sponge also has other characteristics present in members of this genus. Specifically, it has a massive growth form, sigmas, smooth tylotes in bundles on its surface, and chelae. Our specimen has characteristics that are present in both members of the *Iotroata* and *Iotrochota* genera (smooth styles, a reticulate skeleton, etc.). However, it does not have the differentiation in shorter/fatter and longer/thinner spicules that is a characteristic of the *Iotrochota* species (Hooper and Van Soest, 2002). For these reasons we have assigned our specimen to the *Iotroata* genus.

Many *Iotroata* species have chelae. Specifically, *Iotroata abyssi, Iotroata acanthostylifera, Iotroata dubia, Iotroata intermedia, Iotroata oxeata, Iotroata rotulancora, Iotroata varidens,* and *Iotroata*

paravaridens all have unguiferous-anchorate isochelae. Our specimen is the only *Iotroata* sponge found with arcuate isochelae. For all the reasons discussed above we have designated this specimen *Iotroata* sp.1

Figure 8. *Iotroata* sp.1 specimen PAA2014-007 Set 74 Col 130 showing opposite surfaces.

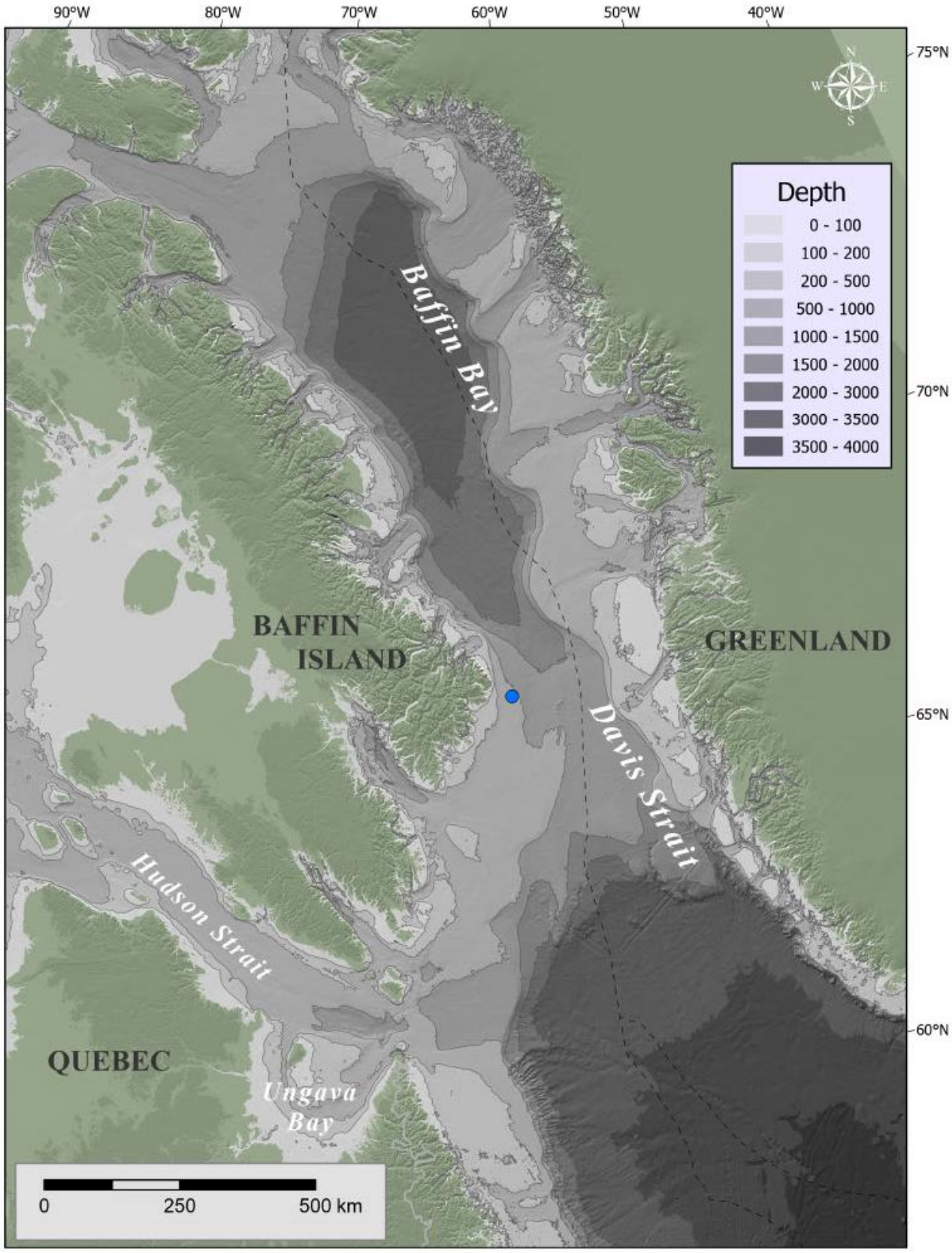

Figure 9. *Iotroata* sp.1 collection location.

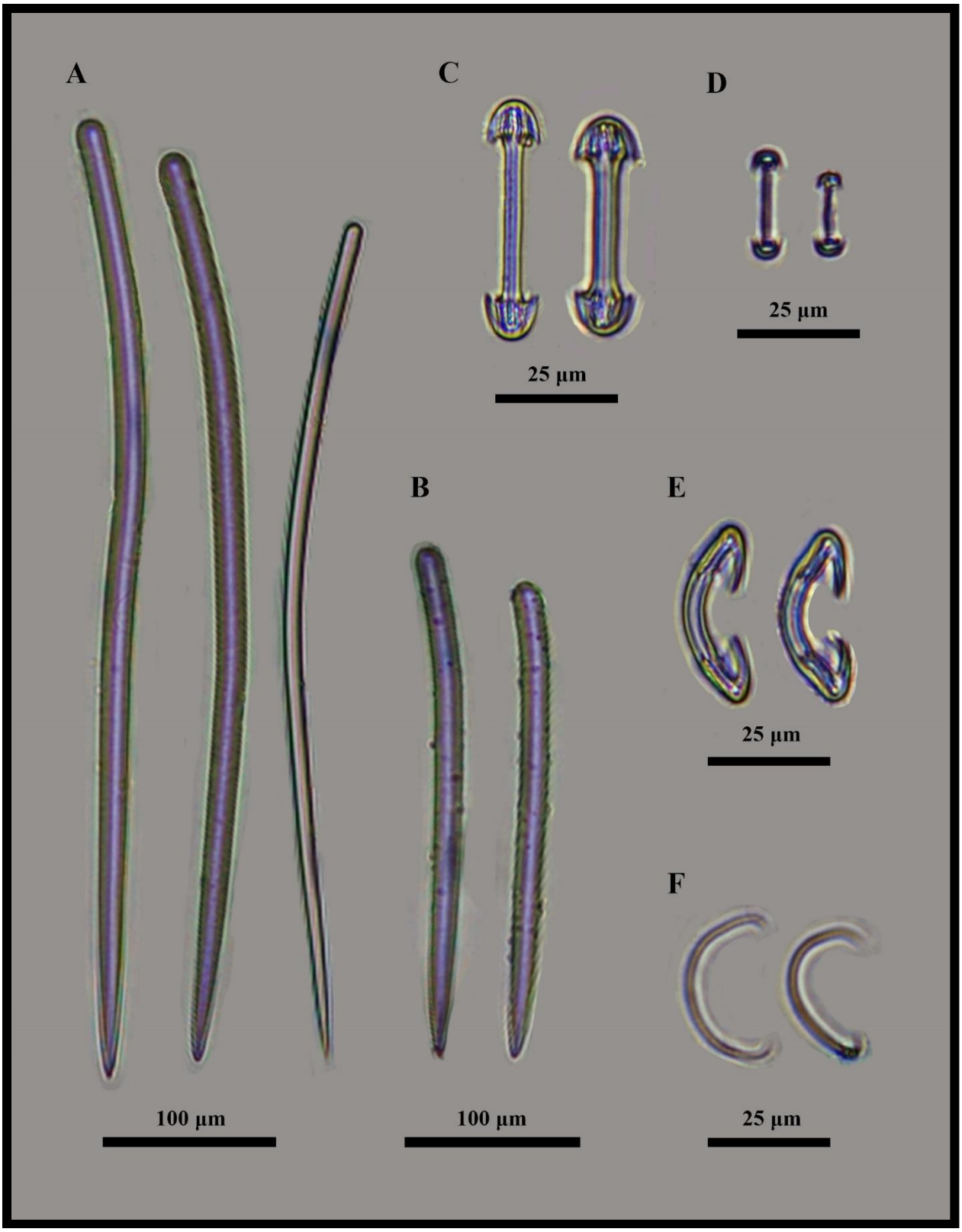

Figure 10. *Iotroata* sp.1 spicules from PAA2014-007 Set 74 Col 130. Styles (A), Acanthostyles (B), Large birotula (C), Small birotula (D), Chelae (E), and Sigmas (F)

Table 3. Spicule measurements from the *Iotroata* sp.1 specimen, all reported as minimum-(average)-maximum for length and width (μm). The number of spicule measurements (n) is specified for each spicule type. The specimen name is a unique ID (cruise, trawl set number, specimen collection number).

Specimen	Styles	Acanthostyles	Large Birotula	Small Birotula	Sigmas	Chelae
PAA2014-007 Set 74 Col 130	425.1–(497.3)–553.2 x 9.4–(15.2)–18.8 n=30	151.2–(275.6)–306.9 x 11–(15.2)–17.4 n=30	27.4–(47.2)–57.4 x 9–(11.7)–14 n=30	16.6–(19.1)–22.5 x 4.7–(5.7)–6.6 n=30	23–(27.9)–35.5 n=30	27.3–(34.1)–40.5 x 3.9–(4.9)–6.3 n=30

ITIS TSN 659422 (genus)

Iotroata sp.2 (Laubenfels, 1936 – genus)

WORMS AphiaID 131964 (genus)

Physical description

Our reference specimen of *Iotroata* sp.2 (PAA2014-007 Set 78 Col 548) is 3 cm long, 2.5 cm wide, and 0.5 cm thick (Figure 11). It was the only specimen collected. After being frozen, this specimen is mostly beige, with some darker brown spots. The surface is smooth with a slightly rough texture. The sponge is easily compressed.

Habitat information

The specimen was found in the Davis Strait, east of Cape Dyer, Nunavut, at 685 m depth (Figure 12, Appendix 1).

Spicules (Table 4, Figure 13)

Megascleres: Styles are 483–599 μm long and 10–19 μm wide (Table 4, Figure 13). Tylotes 327–426 μm long and 8–13 μm wide (Table 4, Figure 13). Tylostyles are 370–784 μm long and 9–22 μm wide (Table 4, Figure 13). Some tylostyles have a very pronounced knob on their end, while others have an only slightly swollen end, and could be mistaken for styles.

Microscleres: Birotula are distributed into two distinct size classes. Large birotula are 33–58 μm long and 9–15 μm wide (Table 4, Figure 13). Small birotula are 18–21 μm long and 4–6 μm wide (Table 4, Figure 13). Sigmas are 23–43 μm long (Table 4, Figure 13).

Distinguishing characteristics

This specimen is best diagnosed by its spicule complement, as its external morphology is not particularly distinctive. It's spicule composition of styles, tylotes, tylostyles, large birotula, small birotula, and sigmas is unique to this specimen. It is most similar to *Iotroata lamellata* (Hooper and Van Soest, 2002). However our sponge has tylostyles while *I. lamellata* does not. Our specimen's tylotes and large birotula are significantly longer than those found in *I. lamellata* (many twice as long). Therefore, we believe this sponge is a unique species.

Taxonomic remarks

This specimen is inferred to be in the family Iotrochotidae due to it's possession of birotula. It has an isotropic reticulate skeleton with paucispicular tracts, which is only found within this family in members of the *Iotroata* genus (Hooper and Van Soest, 2002). This specimen also has other characteristics present in members of this genus. Specifically, it has a massive growth form, smooth tylotes in bundles on the surface. It also has sigmas, which have only been found in members of the *Iotroata* genus. Our sponge has characteristics that are present in both members of the *Iotroata* and *Iotrochota* genera (smooth styles, a reticulate skeleton, etc.). However, unlike *Iotrochota* sponges, whose spicules are not functionally localized, our specimen has a ectosomal skeleton consisting of tylotes and a choanosomal skeleton consisting of styles. For the reasons discussed above we have designated this specimen *Iotroata* sp.2.

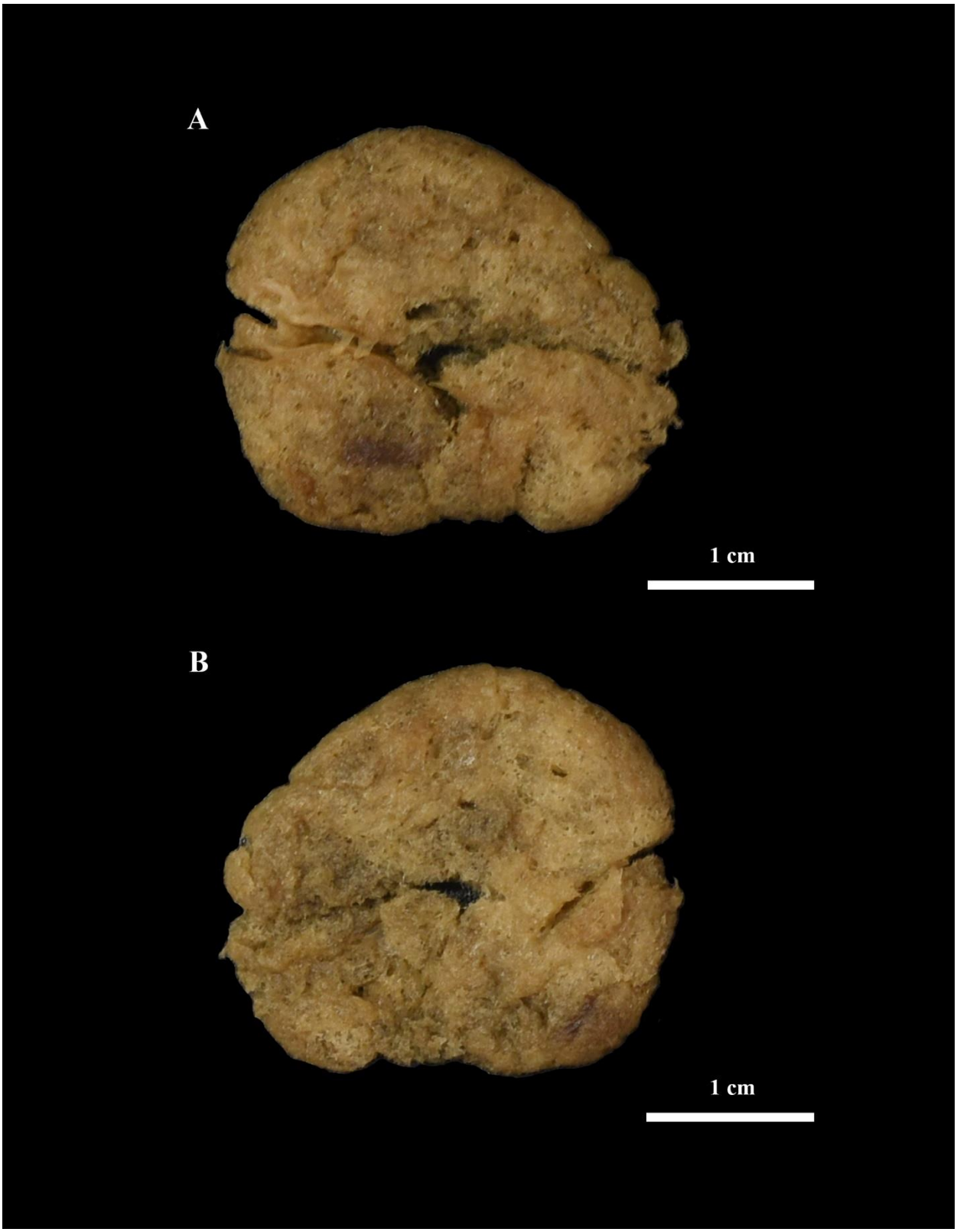

Figure 11. *Iotroata* sp.2 specimen PAA2014-007 Set 78 Col 548 showing opposite surfaces.

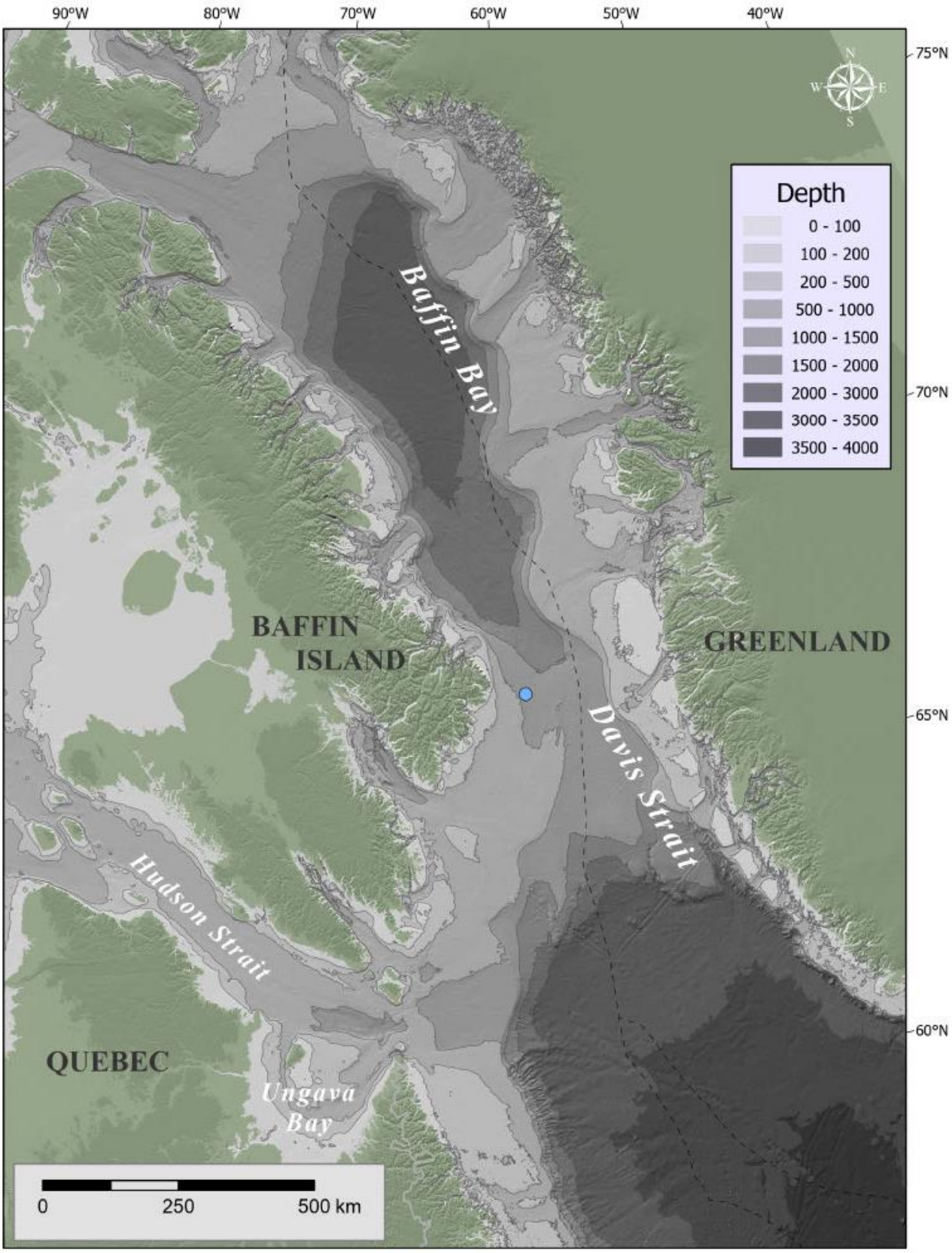

Figure 12. *Iotroata* sp.2 collection location.

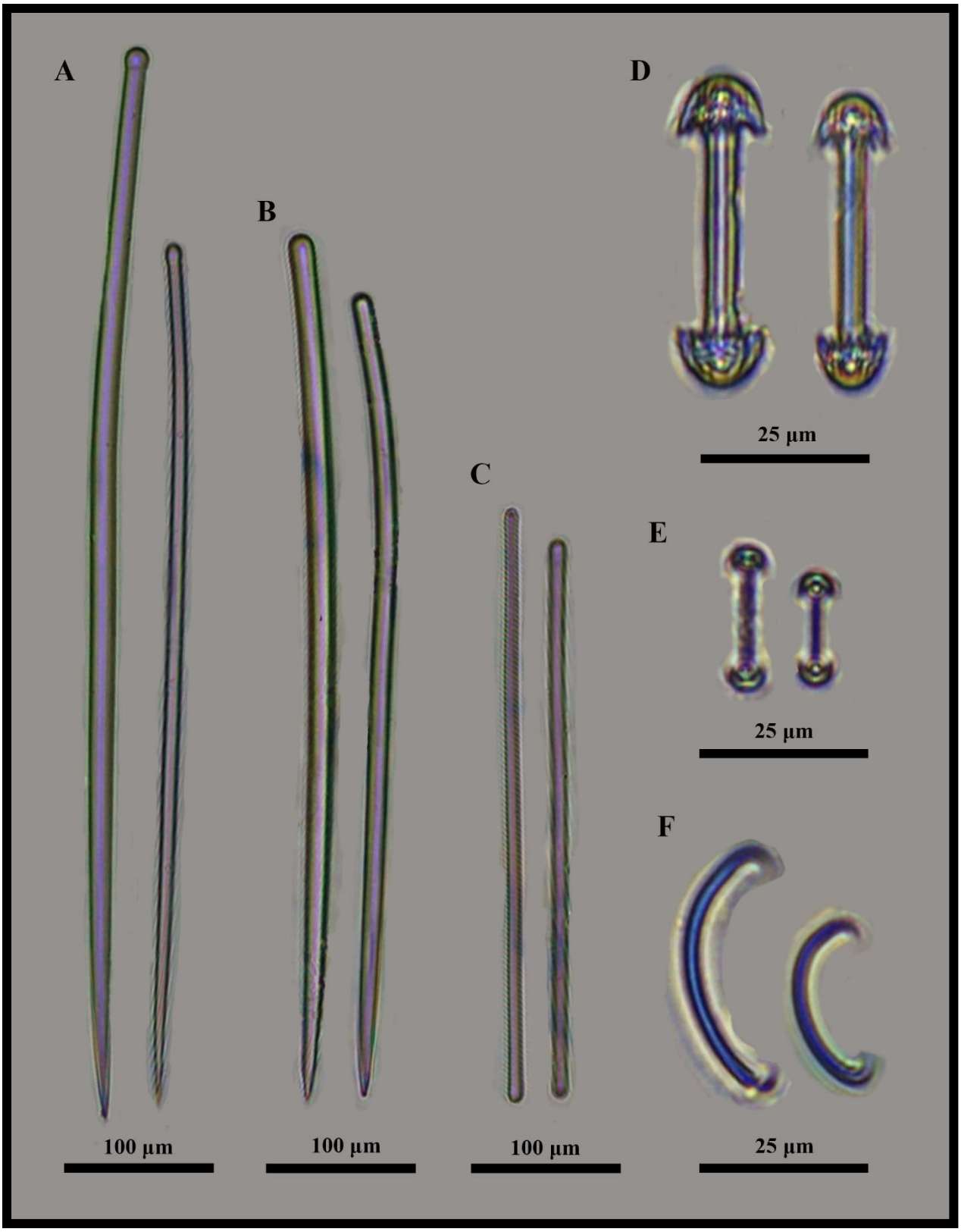

Figure 13. *Iotroata* sp.2 spicules from PAA2014-007 Set 78 Col 548. Tylostyles (A), Styles (B), Tylotes (C), Large birotula (D), Small birotula (E), and Sigmas (F).

Table 4. Spicule measurements from the *Iotroata* sp.2 specimen, all reported as minimum-(average)-maximum for length and width (μm). The number of spicule measurements (n) is specified for each spicule type. The specimen name is a unique ID (cruise, trawl set number, specimen collection number).

Specimen	Styles	Tylotes	Tylostyles	Large Birotula	Small Birotula	Sigmas
PAA2014-007 Set 78 Col 548	483.0–(550.5)–598.5 x 9.7–(15.1)–19.3 n=30	327.4–(373.8)–426.4 x 7.8–(9.7)–12.9 n=30	370.3–(629.6)–784.4 x 8.6–(13.8) –21.9 n=30	32.6–(45.2)–57.9 x 9.3–(11.3)–14.9 n=30	17.6–(19.1)–21.2 x 4.3–(5.0)–5.6 n=30	22.8–(31.4)–38.3 n=30

ITIS TSN 659422 (genus)

***Iotroata* sp.3 (Laubenfels, 1936 – genus)** WORMS AphiaID 131964 (genus)

Physical description

Our reference specimen of *Iotroata* sp.3 (PAA2014-007 Set 41 Col 73) is approximately 5 cm long, 2 cm wide, and 1 cm thick (Figure 14). After being frozen, this specimen is mostly beige with some darker brown areas. The sponge feels slightly rough to the touch and is easily compressed. The surface is mostly smooth with some bumpy areas.

Habitat information

The specimen was found in Baffin Bay, east of Clyde River, Nunavut, at 560 m depth (Figure 15, Appendix 1).

Spicules (Table 5, Figure 16)

Megascleres: Styles are 291–569 μm long and 11–17 μm wide (Table 5, Figure 16). Acanthostyles are 254–659 μm long and 14–23 μm wide (Table 5, Figure 16). Strongyles are 333–409 μm long and 6–12 μm wide (Table 5, Figure 16). Some strongyles are thinner at their middle and slightly thicker at their ends. However, their ends are not thick enough for them to be tylotes.

Microscleres: Birotula are distributed into two distinct size classes. Larger birotula are 44–62 μm long and 11–15 μm wide (Table 5, Figure 16). Smaller birotula are 16–25 μm long and 5–7 μm wide (Table 5, Figure 16).

Distinguishing characteristics

This specimen is best diagnosed by its spicule complement, as its external morphology is not particularly distinctive. It's spicule composition of styles, acanthostyles, strongyles, large birotula, and small birotula has not been found in any other sponge species. It is most similar to *Iotroata spinosa*. However, our sponge contains styles and strongyles, while *I. spinosa* does not (Lundbeck, 1905). Our specimen also has significantly longer large birotula then those found in *I. spinosa*. Therefore, we believe our specimen may represent a unique species.

Taxonomic remarks

This specimen is inferred to belong to the family Iotrochotidae due to it's possession of birotula. It has an isotropic reticulate skeleton with paucispicular tracts, which is only found within this family in members of the *Iotroata* genus (Hooper and Van Soest, 2002). This specimen also has other characteristics present in members of this genus. Specifically, it has a ecotosomal skeleton of smooth tylotes, massive growth form, and acanthostyles. Our sponge has characteristics that are present in both the *Hymetrochota* and *Iotroata* genera (presence of acanthostyles, only birotula as microscleres) However our specimen is not a member of the genus *Hymetrochota* since it does not have the encrusting growth form that is a characteristic of this genus. For this reason we have assigned our sponge to the genus *Iotroata.*

Other then this specimen, two other *Iotroata* species contain acanthostyles. One is *Iotroata acanthostylifera*, which has a spicule composition of acanthostyles, tylotes, birotula, and polydentate

chelae. The other is *Iotroata spinosa*, which has a spicule composition of acanthostyles, tylotes, and large and small birotula. No *Iotroata* sponge that has been documented in previous pieces of scientific literature contains both styles and acanthostyles. For the reasons discussed above, we have designated our specimen *Iotroata* sp.3.

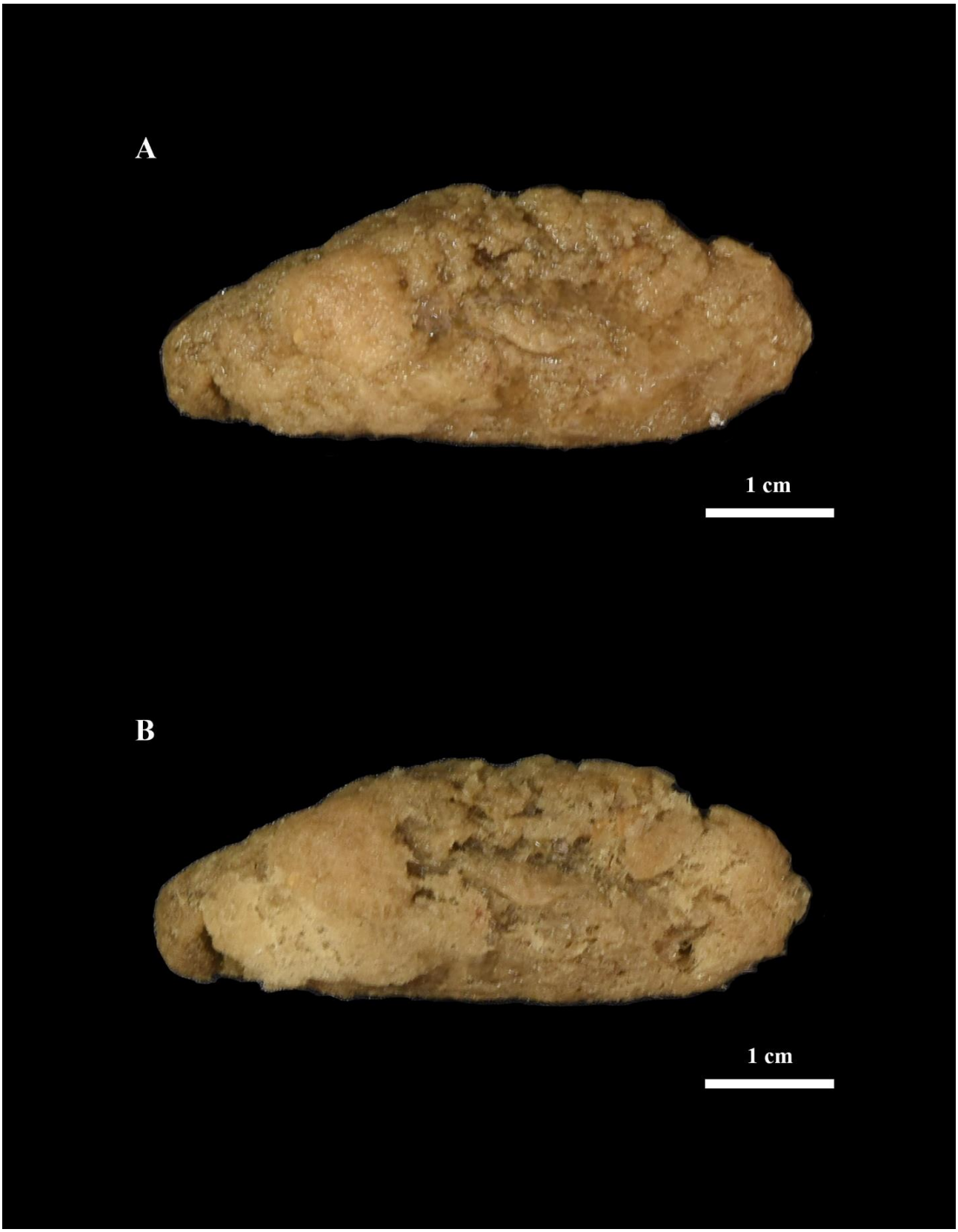

Figure 14. *Iotroata* sp.3 specimen PAA2014-007 Set 41 Col 73 showing opposite surfaces.

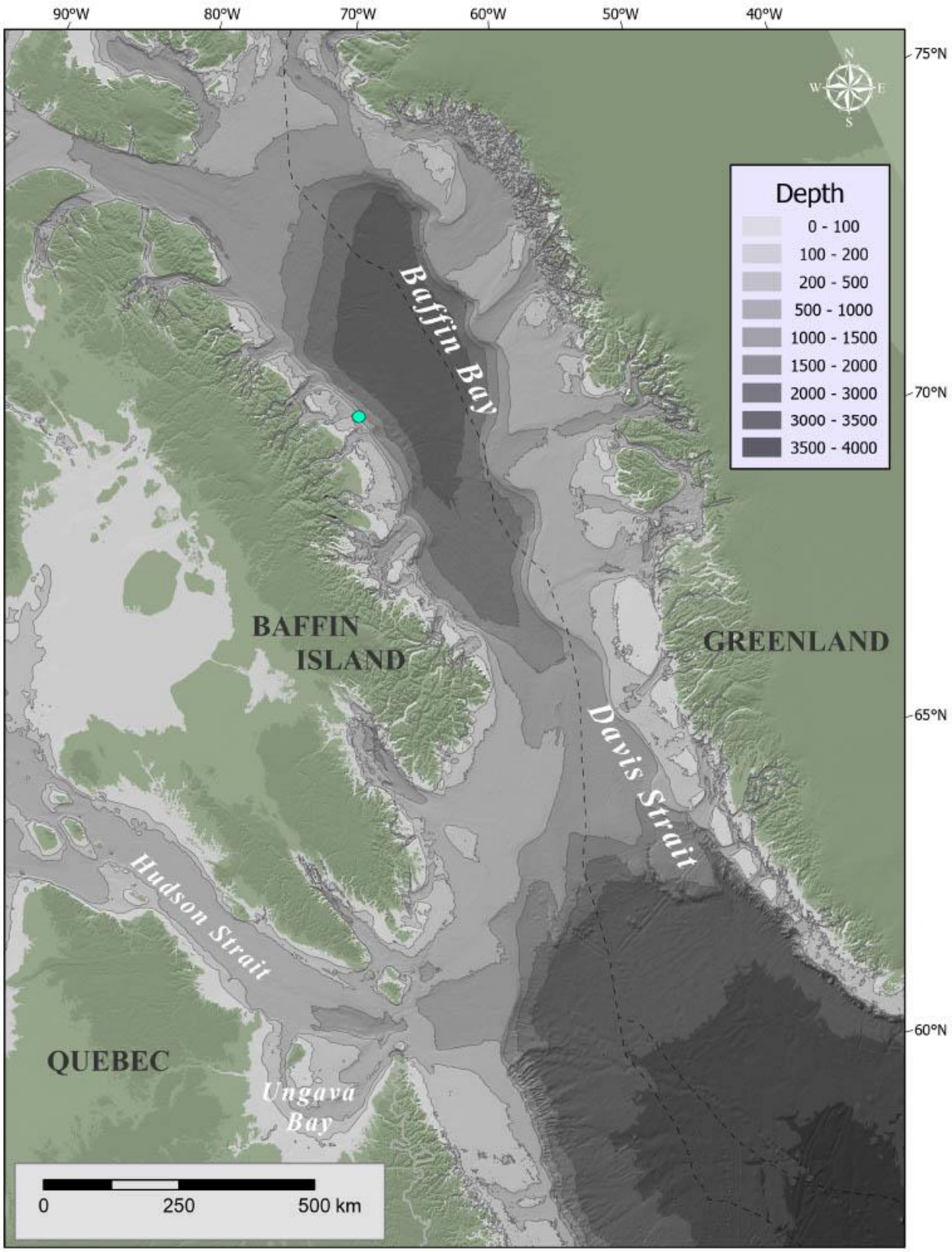

Figure 15. *Iotroata* sp.3 collection location.

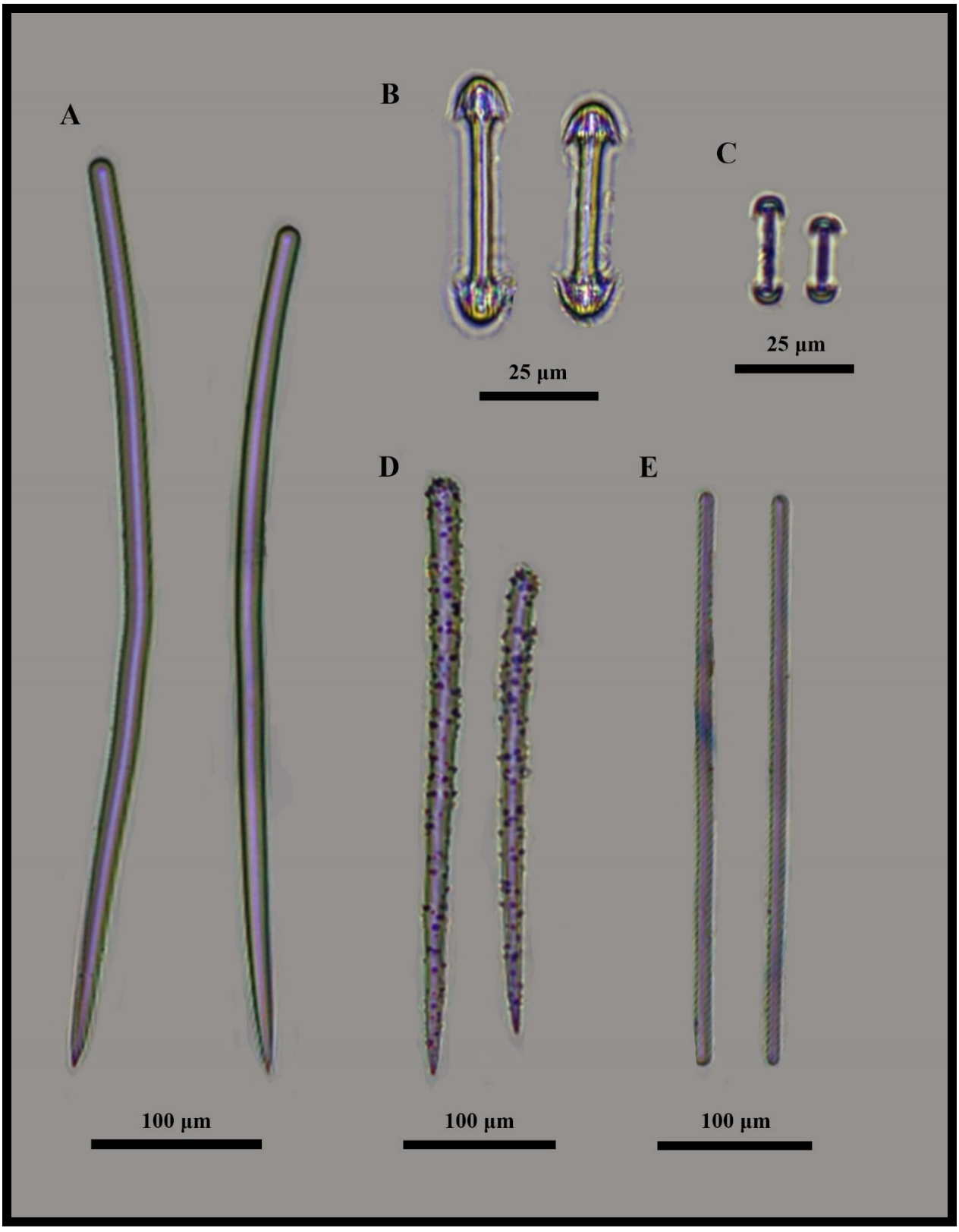

Figure 16. *Iotroata* sp.3 spicules from PAA2014-007 Set 41 Col 73. Styles (A), Large birotula (B), Small birotula (C), Acanthostyles (D), and Strongyles (E).

Table 5. Spicule measurements from the specimen of *Iotroata* sp.3, all reported as minimum-(average)-maximum for length and width (μm). The number of spicule measurements (n) is specified for each spicule type. The specimen name is a unique ID (cruise, trawl set number, specimen collection number).

Specimen	Styles	Acanthostyles	Strongyles	Large Birotula	Small Birotula
PAA2014-007 Set 41 Col 73	291.4–(502.5)–569.4 x 11.0–(14.8)–17.3 n=30	253.6–(355.29)–659.3 x 14.2–(17.8)–22.7 n=30	332.6–(372.8)–409 x 5.7–(8.5)–11.6 n=30	43.6–(51.1)–62.41 x 11.0–(12.7)–14.8 n=30	16.3–(19.6)–24.8 x 4.6–(5.5)–7.08 n=30

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APPENDIX 1

Lab_Mission_Set_ColNo	Lab_Final_ID	Trawl_Start_Date	Trawl_Start_Latitude	Trawl_Start_Longitude	Trawl_Depth_m
PAA2010009002200	*Iotroata affinis*	17-Oct-2010	71.221200	-68.211767	550
PAA2010009003238	*Iotroata affinis*	17-Oct-2010	71.269667	-67.850017	1319
PAA2010009060202	*Iotroata affinis*	25-Oct-2010	70.880133	-67.115483	749
PAA2010009068197	*Iotroata affinis*	26-Oct-2010	69.954033	-65.428217	552
PAA2010009071201	*Iotroata affinis*	26-Oct-2010	69.782400	-65.104983	688
PAA2010009076495	*Iotroata affinis*	27-Oct-2010	68.876867	-65.462767	540
PAA2010009111203	*Iotroata affinis*	1-Nov-2010	66.498700	-59.664217	781
PAA2010009111204	*Iotroata affinis*	1-Nov-2010	66.498700	-59.664217	781
PAA2010009112196	*Iotroata affinis*	1-Nov-2010	66.684333	-59.522483	899
PAA2010009114198	*Iotroata affinis*	1-Nov-2010	66.728633	-59.979233	712
PAA2010009168199	*Iotroata affinis*	8-Nov-2010	66.428067	-57.701400	561
PAA2012007003336	*Iotroata affinis*	29-Sep-2012	72.251183	-72.644683	540
PAA2012007030399	*Iotroata affinis*	4-Oct-2012	74.591283	-79.369633	530
PAA2012007096075	*Iotroata affinis*	13-Oct-2012	71.641267	-70.074050	689
PAA2012007098382	*Iotroata affinis*	13-Oct-2012	71.297517	-68.520317	527
PAA2012007101364	*Iotroata affinis*	13-Oct-2012	70.992417	-67.560517	575
PAA2012007101373	*Iotroata affinis*	13-Oct-2012	70.992417	-67.560517	575
PAA2012007111100	*Iotroata affinis*	15-Oct-2012	70.093567	-65.692900	474
PAA2012007157177	*Iotroata affinis*	21-Oct-2012	66.609983	-60.553850	511
PAA2017009041042	*Iotroata affinis*	3-Nov-2017	69.275317	-64.544450	675
PAA2017009068074	*Iotroata affinis*	7-Nov-2017	67.028833	-60.784033	587
HEL2019005006036	*Iotroata affinis*	16-Aug-2019	66.935900	-58.883333	1065
HEL2019005044083	*Iotroata affinis*	22-Aug-2019	71.417517	-69.080250	442
HEL2019005065125	*Iotroata affinis*	24-Aug-2019	67.294167	-61.069867	702
PAA2013008056197	*Iotroata polydentata*	29-Sep-2013	61.874383	-63.376950	503

Lab_Mission_Set_ColNo	Lab_ID	Trawl_Start_Date	Trawl_Start_Latitude	Trawl_Start_Longitude	Trawl_Depth_m
PAA2013008138285	*Iotroata polydentata*	11-Oct-2013	61.889083	-60.639367	885
PAA2014007133299	*Iotroata polydentata*	15-Oct-2014	61.783517	-60.461217	1064
PAA2014007074130	*Iotroata* sp.1	4-Oct-2014	66.408700	-60.450750	478
PAA2014007078548	*Iotroata* sp.2	4-Oct-2014	66.443700	-59.841033	685
PAA2014007041073	*Iotroata* sp.3	29-Sep-2014	71.002983	-67.593150	560